

Sector Guidance Note IPPC SG3

January 2006

Integrated Pollution Prevention and Control (IPPC)

Secretary of State's Guidance for the A2 Ferrous Foundries Sector

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Contents

Introduction	1
Background	1
Best Available Techniques (BAT)	1
Installations covered	2
Review and Upgrading Periods	3
Existing installations or activities	3
New installations or activities	4
Substantially changed installations or activities	5
Permit Reviews	5
Summary of Releases	5
Emission limits and other provisions	7
Emissions to air associated with the use of BAT	7
Benchmark emissions to water associated with the use of BAT	9
Techniques for pollution control	10
Installation description and in-process controls	10
Delivery, storage and handling of raw materials	10
Melting operations	11
Desulphurisation of molten iron in ladles	14
Nodularisation in ladles	15
Manufacture of cores and moulds	15
Casting and cooling	19
Sand reclamation	23
Fettling, dressing and finishing of castings	25
Emissions control	26
Point source emissions to air	26
Point source emissions to surface water and sewer	28
Point source emissions to groundwater	30
Fugitive emissions to air	30
Fugitive emissions to surface water, sewer and groundwater	31
Odour	33
Management	35
Raw Materials	37
Raw materials selection	37
Waste minimisation (optimising the use of raw materials)	38
Water use	39
Waste handling	41
Waste re-use, recovery, recycling or disposal	42
Energy	43
Basic energy efficiency requirements	43
Additional energy efficiency requirements	43
Accidents	44
Noise and Vibration	46
Monitoring	47
Monitoring emissions to air	49
Monitoring emissions to water	49
Environmental monitoring (beyond installation)	49
Monitoring of process variables	49
Information Provisions	52
References	55
Abbreviations	56
Appendix 1: Summary of changes.....	57
Appendix 2: Some common monitoring methods for releases to water	59

List of Tables

Table 1	Compliance requirements	4
Table 2	Summary of direct releases	5
Table 3	Contained emissions to air associated with the use of BAT	7
Table 4	Emissions to water associated with the use of BAT	9
Table 5	Environmental impacts from melting	13
Table 6	Environmental impacts from current foundry processes	18
Table 7	Environmental impacts from casting and cooling	21
Table 8	Selection of raw materials	37
Table 9	Solid waste stream: routes currently taken	42
Table 10	Noise Mitigation Measures.....	47
Table 11a	Summary of Provisions for Reporting and Notification	52
Table 11b	Summary of Provisions for Additional Information.....	53
Table 12	Summary of Changes.....	57
Table 13	Measurement methods for common substances to water.....	59

1 Introduction

Background

- 1.1 This sector guidance note is issued by the Secretary of State and the Welsh Assembly Government (WAG), following consultation with relevant trade bodies, representatives of regulators including members of the Industrial Pollution Liaison Committee, and other interested organisations.
- 1.2 The note constitutes statutory guidance under regulation 37 of the Pollution Prevention and Control (England and Wales) Regulations 2000, SI 1973 (Ref 1) on the integrated pollution control standards appropriate for the generality of new and existing A2 installations in the ferrous foundries sector.
- These installations require a permit to operate in accordance with the 2000 Regulations under what is known as the Local Authority-Integrated Pollution Prevention and Control (LA-IPPC) regime. Local authority regulators are required by regulation 37 to have regard to this guidance. The Secretary of State / WAG will also treat this guidance as one of the material considerations when determining any appeals made under the Regulations against a local enforcing authority decision.
- 1.3 The guidance also (where appropriate) gives details of any mandatory requirements affecting emissions and impacts from these installations, which are in force at the time of publication. These include requirements contained in directions from the Secretary of State / WAG.
- 1.4 This is one of a series of such guidance notes aimed at providing a strong framework for consistent and transparent regulation of LA-IPPC installations.
- 1.5 General guidance explaining LA-IPPC and setting out the policy and procedures, is contained in the "General Guidance Manual on Policy and Procedures for A2 and B Installations" (Ref 2) available from www.defra.gov.uk/environment/ppc/index.htm, to be referred to in this document as the "General Guidance Manual." This is designed for operators and members of the public, as well as for local authority regulators.

Best Available Techniques (BAT)

- 1.6 BAT is the main basis for determining standards in LA-IPPC. This sector guidance note addresses what is considered by the Secretary of State/WAG to constitute BAT for ferrous foundries.

As made clear in chapter 12 of the General Guidance Manual, BAT for each installation should be assessed by reference to the appropriate sector guidance note, and these notes should be regarded by local authorities as their primary reference document for determining BAT in drawing up permits. In general terms what is BAT for one installation is likely to be BAT for a comparable installation. However, determination of what is BAT is ultimately a matter for case-by-case decision taking into account that individual circumstances may affect BAT judgements and what are the appropriate permit conditions.

Thus, for each ferrous foundry installation, local authorities (subject to appeal to the Secretary of State / WAG) should regard this guidance note as a baseline, but ensure they take into account any relevant case-specific factors such as the individual process configuration and other characteristics, its size, location, and any other relevant features of the particular installation. Further guidance on this, including the issue of taking account of operators' individual financial position, is contained in chapter 12 of the General Guidance Manual.

- 1.7 If there are any applicable mandatory EU emission limits, these must be met, although BAT may go further. The same applies to UK regulations, except that, in reconciling BAT with the Control of Pollution (Oil Storage) (England) Regulations 2001, SI 2954, it may be acceptable to achieve an equivalent level of control to that specified in the 2001 regulations (although the oil storage regulations do not apply in Wales, they should be regarded as an indication of BAT in Wales¹).

Who is this guidance for?

- 1.8 This guidance is for:
- local authority regulators: who must have regard to the guidance when determining applications and when regulating installations which have a permit
 - operators: who are best advised also to have regard to it when making applications and in the subsequent operation of their activities
 - members of the public: who may be interested to know what standards are envisaged for the generality of installations in this sector.
- 1.9 The guidance is based on the state of knowledge and understanding of installations in this sector, their potential impact on the environment, and the available control techniques at the time of writing. The guidance may be amended from time to time in order to keep abreast with developments, including improvements or changes in techniques and new understanding of environmental impacts and risks. Any such amendments may be issued in a complete revision of this note, or in separate additional guidance notes which address specific issues. (N.B. It may not always be possible to issue amending guidance quickly enough to keep in absolute step with rapid changes, which might be another justification in particular cases for diverging from this note.) Steps will be taken to ensure that those who need to know about changes are informed of any amendments. Operators (and their advisers) are, however, strongly advised to check with the relevant local authority whether there have been any amendments before relying on this note for the purposes of applying for a permit or making any other decisions where BAT and related matters may be a consideration.

Terminology

- 1.10 In addition to the General Guidance Manual referred to above, explanation or clarification of certain terms used in this sector guidance note may be found in a general guidance note issued under Part I of the Environmental Protection Act 1991: 'Interpretation of terms used in process guidance notes', known as General Guidance Note 4 - GG4 - published by HMSO in 1991. Where there is any conflict between GG4 and the guidance issued in this note or in the General Guidance Manual, the latter two documents should prevail, as should any subsequent guidance issued in relation to LA-IPPC.

Installations covered

- 1.11 This note covers installations, described in paragraphs (a) and (d) of Section 2.1 Part A(2) (in England and Wales) of Schedule 1 to the PPC Regulations ([Ref 1](#)) as follows:
- producing pig iron or steel, including continuous casting, in a plant with a production capacity of more than 2.5 tonnes per hour unless falling within paragraph (b) of Part A(1) of this Section²
 - casting ferrous metal at a foundry with a production capacity of more than 20 tonnes per day
- 1.12 In this Section, "ferrous alloy" means an alloy of which iron is the largest constituent, or equal to the largest constituent, by weight, whether or not that alloy also has a non-ferrous metal content greater than any percentage specified in Section 2.2.
- 1.13 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.

¹ Further guidance on the Oil Storage Regulations, if needed, is available from www.environment-agency.gov.uk/osr

² Paragraph (b) of Section 2.1 Part A(1) covers 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, vacuum, electro-slag or resistance furnaces

- 1.14 This guidance note does not address A(1) activities that are covered by the IPPC Guidance note S2.01; Guidance for the Coke, Iron and Steel Sector.
- 1.15 This guidance note addresses use of cupola, crucible, reverberatory, rotary, induction or resistance furnaces, and the use of electric arc furnaces with a designed holding capacity of less than 7 tonnes, for production of pig iron or steel, including continuous casting, where the production capacity of the plant exceeds 2.5 tonnes per hour. The note also addresses the casting of ferrous metal at a foundry with a production capacity of more than 20 tonnes per day.
- 1.16 Handling of raw materials (including iron ore, coke, steel scrap, fluxing agents and other additives), melting processes, hot metal transfers, waste heat recovery and slag handling are covered.
- 1.17 This guidance note also addresses the following aspects of the prescribed installation, which are considered to be "foundry" operations.
- storage and handling of raw materials (those associated with the following foundry operations)
 - desulphurisation of molten iron in ladles
 - nodularisation of SG iron in ladles
 - preparation of moulds and cores
 - casting
 - knocking out
 - heat treatment
 - fettling, dressing and finishing of castings
 - sand reclamation
 - waste handling and recycling facilities

Review and Upgrading Periods

Existing installations or activities

- 1.18 The previous guidance PG 2/3, 2/4 and 2/5 (95) Secretary of State's Guidance Notes, relating to emissions to air, advised that upgrading should usually have been completed by 1st April 2000, and for cupola operations, a range of dates up to 2010 depending on the history of the activity. Requirements still outstanding from any existing upgrading programme should be completed.
- 1.19 The previous version of this guidance, SG3 2003 contained improvements that were required to be completed up to 24 months after publication of the note. These include Table 3 Rows 2, 3, 4, 6, 7 and 12, BAT 83, BAT 84, BAT 97, BAT 99, 3.106, 3.107, BAT 117 and BAT 118 as presented in SG3 2003. Installations should be upgraded to these standards by the date of publication of this note.
- 1.20 The new provisions of this note and outstanding provisions of previous relevant notes and the dates by which compliance with these provisions is expected, are listed in [Table 1](#) below, together with the paragraph number where the relevant guidance is to be found. Compliance with the new provisions should normally be achieved by the dates shown. Permits should be drafted having regard to this compliance timetable.
- (1) Where this guidance note specifies provisions which are additional to, higher than or different to those in PG notes 2/3, 2/4, 2/5(95) and SG3 2003 only in exceptional circumstances should upgrading of existing installations and activities having regard to these additional/higher/different provisions be completed later than the compliance date specified in [Table 1](#) below.
 - (2) Where standards or provisions in PG notes 2/3, 2/4, 2/5(95) and SG3 2003 have been deleted in this guidance note or where this guidance note specifies less stringent provisions than those in PG notes 2/3, 2/4, 2/5(95) and SG3 2003, the new LA-IPPC permit should reflect this straightaway.

Table 1: Compliance requirements

Guidance	Reference	Compliance Date
For cupolas and rotary furnaces with existing wet abatement plant a limit of 20 mg/m ³	Table 3 Row 5	1 April 2010
Melting and charging practices	3.13 & BAT 5	1 April 2007
Selection of Core and Mould Production Techniques	BAT 10	1 April 2006
Water Recycling	BAT 46	From the date of publication of this note
For existing evaporation systems or single pass cooling systems a closed circuit recycling system.	BAT 47	1 April 2015
Groundwater Contamination Audit	BAT 57 & BAT 58	31 October 2006
Groundwater Protection Systems	BAT 59 - 63	1 April 2006
Solvent Storage Provisions	BAT 64	31 October 2006
Odour Assessments	3.84 & BAT 65	1 April 2006
Odour Control	BAT 66 - BAT 69	1 April 2007
Environmental Management Systems	3.102 & BAT 70	1 April 2007
Competent Person for Regulator and Public Liaison	BAT 75	1 April 2006
Formal Structure for Environmental Control & Training	BAT 76 & BAT 77	31 October 2006
Raw Materials / Waste Minimisation Audit	BAT 81 & 82	Within 18 months of issue of the permit
Options for foundry sand recovery	BAT 87	Within 18 months of issue of the permit
Water Efficiency Audit	BAT 88	Within 18 months of issue of the permit
Benchmarking and Recording Water Usage	BAT 90 & BAT 92	31 October 2006
Waste Storage Provisions	BAT 94 - BAT 97	31 October 2006
Recycling Markets	3.134 & BAT 99	31 October 2006
Energy Audit	BAT 100	Within 12 months of issue of the permit
New Additional Energy Efficiency Measures	BAT 105 & BAT 106	1 April 2007
Accident Prevention Measures	BAT 107 - BAT 116	1 April 2007
Noise Mitigation Measures	BAT 117 & BAT 118	1 April 2007
QA/QC of Monitoring Systems	BAT 127	1 April 2007
Annual Waste Recording	BAT 138	1 April 2007
All Other Requirements		To be complied with as soon as practicable, which in most cases should be within 12 months of the publication of this note

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

New installations or activities

- 1.23 For new installations or activities - from the first day of operation the permit should have regard to the full standards of this guidance.

Substantially changed installations or activities

- 1.24 For substantially changed installations or activities - as from the first day of operation, the permit should normally have regard to the full standards of this guidance with respect to the parts of the installation that have been substantially changed and any part of the installation affected by the change.

Permit Reviews

- 1.25 Permits should be reviewed in accordance with the guidance in chapter 26 of the General Guidance Manual. The review frequencies given in that chapter are considered appropriate for activities and installations covered by this sector guidance note.

Summary of Releases

Table 2: Summary of direct releases

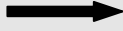

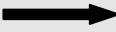
Source  Releases 								
	Material storage and handling	Furnace operations	Desulphurisation of molten iron	Nodularisation of SG iron	Preparation of cores and moulds	Casting and cooling	Knocking out, reclamation	Fettling, dressing and finishing of castings
Oxides of sulphur		A	A		A	A	A	
Oxides of nitrogen		A			A	A	A	
Carbon dioxide		A	A	A	A	A	A	
Carbon monoxide		A	A	A	A	A	A	
Hydrogen sulphide					A	A	A	
Ammonia					A	A	A	
Oxides of iron	L	A	A	A		A	AL	AL
Alkali metal compounds		A	AL					
Alkaline-earth metal compounds		A	AL	A		A		
Metal oxide particulates	L	A	A	A		A	AL	AL
Non-metallic particulates	AW	A	A		A	A	AL	AL

Table 2: Summary of direct releases

Source  Releases 	Material storage and handling	Furnace operations	Desulphurisation of molten iron	Nodularisation of SG iron	Preparation of cores and moulds	Casting and cooling	Knocking out, reclamation	Fettling, dressing and finishing of castings
Metallic iron particulates		A						AL
Cadmium and cadmium oxide		A						
Zinc, lead and their oxides	L	A						
Sulphur			A					
Amines/amides					A	A		
Dioxins		A						
Volatile organic compounds	A	A			A	A	A	
Oils and greases	WL				L			
Resins					WL		L	
Acid vapours		A			A	A		
Slag waste		L	L	L				
Sludges								LW
Refractory waste		L	L	L	L			
KEY	A – Release to Air, W – Release to Water, L – Release to Land							
<p>Substances include their compounds, except where separate reference to the compound is made.</p> <p>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.</p> <p>Some releases are specific to a particular binder system (Table 6 and Table 7).</p> <p>N.B. It should be noted that this is not necessarily an exhaustive list. Equally not all installations will necessarily have all these releases.</p>								

2 Emission limits and other provisions

2.1 This section contains emission limits, mass release rates and other requirements that are judged for the generality of the activities within the sector to represent BAT.

Emissions to air associated with the use of BAT

2.2 Concentration limits are only applicable to contained emissions exhausted to external atmosphere.

Table 3: Contained emissions to air associated with the use of BAT

Row	Total particulate matter	Emission limit	Type of monitoring	Frequency of monitoring
1	Electric arc furnaces with existing abatement equipment	50 mg/m ³	Continuously recorded indicative monitoring (BS ISO 10155) Annual extractive monitoring (BS EN 13284-1:2002)	Continuous plus annual
2	New electric arc furnaces	20 mg/m ³	Continuously recorded indicative monitoring (BS ISO 10155) Annual extractive monitoring (BS EN 13284-1:2002)	Continuous plus annual
3	Crucible, electric induction and reverberatory furnaces	20 mg/m ³	Continuously recorded indicative monitoring (BS ISO 10155) Annual extractive monitoring (BS EN 13284-1:2002)	Continuous plus annual
4	Cupola and rotary furnaces with dry abatement plant	20 mg/m ³	Continuously recorded indicative monitoring (BS ISO 10155) Annual extractive monitoring (BS EN 13284-1:2002)	Continuous plus annual
5	Cupola and rotary furnaces with existing wet abatement plant	100 / 115 mg/m ³ until upgraded 20 mg/m ³ by 2010	Scrubber and scrubber liquor flow monitored as described in BAT 134 . Continuously recorded indicative monitoring* Plus annual extractive monitoring (BS EN 13284-1:2002)	Continuous plus annual
6	Casting, cooling and knockout.	20 mg/m ³	Continuously recorded, quantitative or indicative monitoring * Plus annual extractive monitoring (BS EN 13284-1:2002)	Continuous plus annual
7	Knock-out and all sand recovery systems, shot blasting, fettling and other finishing operations	20 mg/m ³	Continuously recorded indicative monitoring* Plus annual extractive monitoring (BS EN 13284-1:2002)	Continuous plus annual
* For wet plant where not technically feasible having regard to the moisture content of the emission, indicative monitoring may be replaced by process controls, for example, as described in BAT 134				

Row	Volatile organic compounds	Emission limit	Type of monitoring	Frequency of monitoring
8	Thermal sand reclamation systems, investment foundry coating, shelling and setting operations	Total non methane VOC – 30 mg/m ³	Manual extractive test (BS EN 13526: 2001)	At least once a year.

Row	Amines	Emission limit	Type of monitoring	Frequency of monitoring
9	Processes likely to emit amines Table 6	5 ppm v/v*	Manual extractive test (BS EN 13649, or USEPA Method 18 or Method 320)	Annual

* This limit should be disapplied where it is considered that there is no potential for offensive odour beyond the site boundary. The only likely case is where triethylamine is the only amine used in the activity

Row	Hydrogen sulphide	Emission limit	Type of monitoring	Frequency of monitoring
10	Processes likely to emit hydrogen sulphide Table 6	5 ppm v/v *	Manual extractive test	Annual

Row	Metals and their salts	Emission limit (as the metal)	Type of monitoring	Frequency of monitoring
11	Processes likely to emit copper or its compounds	5 mg/m ³	Manual extractive test (BS EN 14385)	Annual
12	Processes likely to emit lead or its compounds	1 mg/m ³	Manual extractive test (BS EN 14385)	Annual

Row	Metals and their salts	Substance	Emission limit (as the metal)	Type of monitoring	Frequency of monitoring
13	Where Appropriate In relation to the metal alloy being melted.	Nickel, cobalt, chromium, cadmium, arsenic and their compounds	Total emission For any individual metal or any combination of Listed metals 2mg/m ³	Manual extractive test (BS EN 14385)	Annual

Benchmark emissions to water associated with the use of BAT

2.3 Limit values for water discharges will be specified in individual cases taking account of the receiving environment. 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. [Table 4](#) provides information regarding achievable levels associated with the use of wastewater treatment systems for discharge to surface water.

Table 4: Emissions to water associated with the use of BAT

Determinand	Benchmark release concentration, mg/litre
BOD	100
Total hydrocarbon oil	5
Total suspended solids	50
Ammoniacal nitrogen expressed as N	15
Dissolved iron	10
Total chromium	0.2 (0.5 where stainless steel is processed)
Dissolved nickel	0.2 (0.5 where stainless steel is processed)
Zinc	2

3 Techniques for pollution control

- 3.1 This section summarises, in the outlined BAT boxes, what BAT should be in most circumstances. The boxes should not be taken as the only source of permit conditions; compliance with emission limits and other provisions contained in this guidance note together with any relevant case-specific considerations will also need to be taken into account.
- 3.2 The standards cover the techniques and measures which, in combination with those in the relevant previous (LAPC/IPC/Waste) guidance, have been identified as representing BAT in a general sense. They also cover the other requirements of the Pollution Prevention and Control (England and Wales) Regulations 2000 and requirements of other regulations, such as the Waste Management Licensing Regulations and the Groundwater Regulations insofar as they are relevant to an IPPC Permit. For the sake of brevity these boxes simply use the term "BAT".
- 3.3 Where techniques or operating conditions are referred to in the BAT boxes below, provided that it is demonstrated to the satisfaction of the regulator that an equivalent or better level of control of environmental impacts will be achieved, then other techniques or operating conditions may be used.

Installation description and in-process controls

- 3.4 The meaning of "installation" and "directly associated activity" is addressed in chapter 2 of the General Guidance Manual.

Delivery, storage and handling of raw materials

Summary of activities

- 3.5 Raw materials including coke, limestone, deoxidants, refractories and fluxes in lump and powder form may be stored under cover. Following delivery, handling is kept to a minimum. Powdered materials can be stored in sealed silos and conveyed pneumatically or kept and handled in sealed bags.
- 3.6 Sand is normally delivered in bulk and discharged directly to silo via pneumatic conveyor. Specialist sands may arrive in bags.
- 3.7 Scrap is stored in specially designated and carefully marked areas.
- 3.8 Liquid binders, resins, catalysts, oils and liquid fuels are delivered in drums, or by bulk container or road or rail tanker. They are stored in their delivery containers or, in the case of road and rail tankers, discharged direct into dedicated storage.
- 3.9 Refractories, release agents and other minor deliveries are stored indoors.
- 3.10 The main control issues relate to the potential for fugitive emissions.

Environmental impact

Water:	Run off from contaminated or dirty scrap and external bulk stores.
Land:	Spillage, overfilling of silos and other containers.
Air:	Dust.
Waste:	Refer to accidents.
Energy:	Not significant.

- Accidents:** Potentially from delivery and transfer of solids and powders. Raw materials such as coal dust and calcium carbide have specific handling requirements to avoid accidents.
- Noise:** Vehicles and delivery operations may cause noise disturbance, especially if close to the site boundary. Blowing into hoppers from road tankers can create noise disturbance.

BAT

- 1 Stocks of dusty, or potentially dusty, materials (including waste sand and sand awaiting reclamation) should be stored in such a manner as to minimise wind whipping and loading to and from stockpiles should be carried out so as to minimise emissions to the air.
- 2 All new or reclaimed dry sand or dusty materials should be stored in covered containers, purpose-built silos, sealed bags or undercover whenever practicable. Any sand stored outside should be stored in purpose-built silos, sealed bags, or closed containers.
- 3 Transport of dusty materials should be carried out so as to prevent or minimise airborne particulate matter emissions for example, covering vehicles and adjusting vehicle speeds. Double handling of dusty materials should be avoided.
- 4 A high standard of housekeeping should be maintained. All spillages should be cleared as soon as possible; solids by vacuum cleaning, wet methods, or other appropriate techniques. Dry sweeping of dusty spillages should not be permitted in circumstances where it may result in the generation of airborne dust outside any building.

Melting operations

Summary of the Activities

- 3.11 The types of furnaces used for the melting of ferrous metals are as follows:
- (a) cupola (iron only).
 - (b) reverberatory furnace.
 - (c) rotary furnace.
 - (d) electric arc furnace.
 - (e) induction furnace.

- 3.12 The choice of furnace depends upon the type and quantity of cast iron required.

Cupola - The cupola consists of a vertical cylindrical steel shell lined internally with refractory material enclosed at the base (well). Pig iron (and/or scrap), coke and limestone are charged from the charging door at the top of the cupola. The rate of coke combustion and therefore the melting rate is by a blast of air blown in through tuyeres near the base of the cupola. Molten iron collects in the well, and is tapped off at intervals whilst fresh charges of pig iron, coke, and limestone charged for continuity of operation. The limestone act as a flux, reacting with the ash, sand, etc to form a slag which, floats on molten cast iron and is run off through the slag hole situated below the tuyere level. The cupola shell is continued above the charging floor level thus constituting a chimney to facilitate the removal of the products of combustion.

Good combustion control involves minimising the incomplete combustion of coke and the consequent formation of carbon monoxide (CO). CO may be observed burning with a bluish flame on top of the charge air. It is possible to balance the air supply between the main and the auxiliary tuyeres to give almost complete coke combustion. For cold blast cupolas thermal efficiency can be optimised by oxygen enrichment of the air resulting in higher combustion temperature of the coke. Hot blast cupolas have an increased melting rate and are therefore more energy efficient. Oxygen enrichment takes place here via tuyere lancing which can result in reduced coke consumption, enhanced thermal efficiency, better process control as well as consequential reduced emissions.

Reverberatory Furnace - the important feature of this type of furnace is that the metal is melted out of contact with the fuel and is therefore not so liable to the changes in composition, which may occur in the cupola. The reverberatory furnace is a batch furnace.

Rotary Furnace - this type of furnace consists of a horizontal cylindrical steel shell mounted on rollers and lined with refractory material. The furnace is fired from one side using oil as the fuel. The furnace body is slowly rotated during melting thus bringing the underside of the metal bath into contact with the hot refractory lining thus minimising overheating of the lining and reducing the melting time to about half that of the stationary furnace. Melt conditions can also be accurately controlled by the air to fuel ratio. In addition melting takes place out of contact with the fuel so there is no carbon or sulphur pick up in contrast with the cupola melting. Greater energy efficient and reduced emissions of NOx can be achieved by using pure oxygen gas instead of air in the burners. The efficient melting conditions allow the use of light scrap, which is unsuitable for melting in a cupola. The furnace is a batch furnace charged from one end and the burner or the exhaust box being temporarily removed for the purpose. The combustion gases leave the opposite end passing to a recuperator or pre-heater where some of the heat is transferred to the air supply necessary for the fuel burner. When melting is complete a plug is removed from the tapping hole and the furnace rotated to enable the metal to run out into the waiting ladle.

Electric Arc Furnace - Electric heating can allow a closer control over metal temperature and composition and a furnace atmosphere than can be attained in any other type of melting unit. In a direct arc furnace the metal charge is contained within a bowl shaped hearth over which are suspended three graphite electrodes. From the electrodes electric arcs strike downwards onto the metal charge which is thus melted by direct heat from the arcs. The furnace is stationary during melting but may be tilted for pouring. It is built of refractory brick work contained within a steel frame circular in plan form. For the melting of cast iron the hearth is lined with an acid refractory material. Scrap is principally worked to which pig iron is added according to requirements. Enhanced efficiency reduced fuel use and emissions have been claimed where oxygen-fuel has been applied to Electric Arc Furnaces and Cupola Furnaces although these should be seen as emerging technologies.

Induction Furnace - is used for melting metallic scrap and additives to give the required metal It consists of a crucible melting vessel into which the charged is placed. The vessel is surrounded by a water-cooled copper coil through which a current passes. A secondary current is induced in the charge and the heat generated promotes the melting of charged material. Furnaces vary in capacity and are emptied over the spout by tilting. They are used for ferrous alloys and also special steels, to which additions are made of nickel, cobalt, chromium, tungsten, molybdenum and vanadium etc.

- 3.13 A variety of methods are used to optimise energy efficiency while melting which are dependent on the furnace type. Methods generally involve optimising melt temperature and combustion conditions, controlling melt composition, regular maintenance of burners and furnace linings and efficient slag removal (see 3.12 above).

Optimal charging practices can result in enhanced furnace efficiency and therefore lower emissions as well as minimising maintenance downtime for replacing refractory linings etc. It would aid transparency for regulators to set down which practices are being used for each individual furnace.

Action Energy Guides ([Ref 8](#)) contain information on how furnace operations have been optimised for greater thermal efficiency and product yield.

Environmental impact

Water:	used for cooling purposes and abatement – where used for abatement, sludge separation is required.
Land:	the coarse dust from abatement plant is normally recycled. Localised deposition around abatement plant should be avoided.
Air:	potential emissions include particulate matter, CO, CO ₂ , NO ₂ , SO ₂ , H ₂ S, HC, PAH, heavy metals, lead and dioxins.
Waste:	sludge disposal, slag (re-use options), spent refractory, filter plant waste.

Energy: furnace operations are critical to energy use; use heat exchange from waste furnace gas for hot blast cupolas.

Accidents: Leakage from the furnace system may release gases and particulate matter to the environment. Pressure relief systems are usually installed and when in use emissions are unabated. Releases of furnace gas can expose people on or off site to elevated levels of carbon monoxide and particulate matter.

Noise: May be significant, arising from charging operations, fan noise (blast air and abatement). Sound levels above 100 db(A) can arise.

Table 5: Environmental impacts from melting

	Cupola	Rotary	Electric arc	Induction
Water	May be used for cooling and abatement		Same as cupola	May be used for cooling
Land	Localised deposition around abatement plants if collected dusts and sludges are not properly managed. The potential is greater around wet plant			
Air:				
Particulates	Significant emission - abatement always necessary			Low if charge material is clean
Metals	From coke and scrap	Scrap dependent		
Combustion Gases	Significant	Trivial where clean charge material is used; may be significant if scrap is oily, painted or contains plastics		
VOCs	Trivial where clean charge material is used; may be significant if scrap is oily, painted or contains plastics			
Acid gases	SO ₂ and small amounts of HCl and NO _x may be formed from coke. Emissions are reduced significantly by wet abatement	Possible sulphur dioxide if high sulphur fuel is used. Small amount NO _x	HF where fluoride fluxes are used. Small amount NO _x	Small amount NO _x
PAH	Some from coke; Remaining potential is scrap dependent	May be emitted if charge material contains combustible organics		
Dioxins		May be emitted if material contains plastics or chlorinated cutting fluids		
Odour	Sulphur compounds Where abatement is dry	Possible if charge is contaminated with oil, plastics etc.		
Waste	Ash from coke bed; other wastes as other furnaces	Slag, refractory, abatement plant dusts and sludges		
Energy	All melting processes are energy intensive			
	Coke fuel	Oil, gas or electric	High electricity use	
Accidents	CO explosions possible; unabated emission where pressure relief system used		Explosion in furnace resulting in high fugitive emission	Metal eruption through bridging Possible fire / explosion risk if furnace lining fails and metal contacts water
	Uncontrolled release of hot metal can cause fire			
Noise	May be significant from charging operations or fan noise			

BAT

- 5 All melting operations are energy intensive. Operators should identify, document and maintain procedures for optimal melting and charging practices to ensure that metal is produced in the most energy efficient manner and whilst maintaining the required product quality.
- 6 Operators should ensure that melt temperature is controlled for the desired casting temperature to avoid excessive heating.
- 7 Containment, abatement and dispersion of emissions should be employed as appropriate to ensure that emission limits / Environmental Quality Standards (EQS) are met and impacts are minimised. The use of more contaminated charge materials is likely to result in the need for abatement and / or more complex abatement arrangements to ensure adequate control.

Desulphurisation of molten iron in ladles

- 3.14 Molten iron can be desulphurised using calcium carbide, calcium oxide or a calcium oxide / calcium fluoride mixture which reacts with the sulphur to produce a slag which can be separated from the metal.

Summary of the activities

- 3.15 A number of different methods can be used. In the “shaking” process a barrel shaped ladle containing iron and de-sulphurising agent is shaken to swirl the contents around the inner lining of the ladle and thereby promote mixing.
- 3.16 In the continuous divided ladle process, the iron is tapped continuously from the cupola through a slag of lime and calcium carbide into the first compartment of the divided ladle. The compartment is stirred by injecting nitrogen into the base of the ladle through a porous plug. Iron which reaches the bottom of the compartment will be de-sulphurised and passes under the dividing wall into the second compartment, from where it flows into a transfer ladle, driven continuously by the head of the hot metal pouring from the furnace. Because of its continuous nature the divided ladle process produces a steadier emission of fume.

The main control issues are:

- containing the emissions
- handling and disposal of slag

Environmental impact

Water:	Not significant.
Land:	Not significant.
Air:	Dust and local odour.
Waste:	High pH slag which may still contain unreacted materials e.g. carbide, lime. (carbide releases acetylene (ethyne) if it gets wet – this is a flammable gas.)
Energy:	Not significant.
Accidents:	Carbide raw materials – may give rise to flammable gases if they get wet.
Noise:	Not significant.

BAT

- 8 Desulphuration slag should be handled to ensure that it does not get wet and is not released to the environment.

Nodularisation in ladles

- 3.17 Conversion of flake grey iron into ductile iron (nodular or spheroidal graphite iron) is accompanied by an improvement in mechanical properties. Such conversion is referred to as nodularisation and involves the treatment of the liquid metal with magnesium and rare earth elements.
- 3.18 The aim should be that emissions of magnesium oxide fume from nodularisation processes do not cross the installation site boundary.

Summary of the activities

- 3.19 There are a number of methods of introducing the nodularising agent into the metal which reduce fume emissions and these include pour over, plunging, pressure vessel, tundish cover ladle, in-stream and in-mould techniques. If magnesium is used, white magnesium oxide fume is created.
- 3.20 The main control issue is containing the emissions of fume.

Environmental impact

Water:	Not significant.
Land:	Not significant.
Air:	Magnesium oxide fume.
Waste:	Slag, magnesium oxide dust if collected.
Energy:	Not significant.
Accidents:	Not significant.
Noise:	Not significant.

BAT

- 9 Emissions from nodularisation should be captured and abated where necessary to prevent visible emission beyond the site boundary.

Manufacture of cores and moulds

- 3.21 The mould contains a cavity which represents the shape of the component or casting to be produced. The cavity in the mould is produced by a pattern which is an oversize replica of the component required. Any hole required in the component is made using a core. (Cores may also be used as moulds). Many different methods of mould manufacture have been developed. [Table 6](#) lists the various techniques together with potential emissions released during production and casting.

Good process control of binder chemicals can be achieved by using the techniques for the system as described in Guidance Note GG104 (Ref 4) Cost Effective Management of Chemical Binders in Foundries. Some of the most common mould manufacturing techniques are described below: -

Summary of the activities

The greensand method

- 3.22 This uses a mixture of sand, an organic component such as dextrose or coal dust (optional), a clay binder (bentonite) and water, which is compacted around a pattern within an open box.

The shell sand method

- 3.23 This involves coating a hot metal pattern with sand pre-coated with a novolak resin. The resin melts and binds the sand together. It forms a soft, fairly uniform “biscuit” about 5 mm thick on the pattern surface. The longer the invest time the thicker the mould. Shell cores are made in a similar way to shell moulds. The method is mainly used for mass production of cores, and in some foundries for moulds for relatively small castings.
- 3.24 Fumes are emitted during production and during cooling. The fumes are normally extracted and discharged to atmosphere uncleaned and emissions may therefore be odorous. The emissions are primarily VOCs and ammonia.

Cold setting techniques

- 3.25 These systems rely on the chemical reaction between a resin and a hardener, possibly in the presence of a catalyst. The term “cold set” describes processes in which sand, binder and curing agent are mixed together at the outset so that curing commences immediately, with the cure time depending upon the type and amount of curing agent. The term “cold box” is used to describe processes in which sand and binder are mixed together and shaped into a mould or core before the curing agent is introduced in the form of a gas or a vapour. There are several basic systems although minor variations may be applied:
- furan binders - a series of binders based on furfuryl alcohol, often in combination with urea or phenol formaldehyde hardened by mixing with catalysts such as phosphoric acid for binders containing urea and benzene-sulphonic, or toluene-sulphonic acids for low-nitrogen binders. Sulphuric acid can be used to improve the reactivity of catalysts, but its presence generates sulphurous fumes on casting and there is a danger of pick up by SG irons
 - alkaline phenolic binders - a water soluble alkaline phenolic resin which is hardened by mixing with a liquid ester. It is also possible to set with methyl formate vapour or carbon dioxide
 - phenolic urethane system – there are three components of this binder system: a phenol formaldehyde resin dissolved in solvents, a polymeric isocyanate in solvents and a liquid or gaseous amine catalyst
 - sodium silicate - sodium silicate is hardened by mixing with an ester or curing with carbon dioxide gas
- 3.26 Fans are sometimes used to disperse fumes which are evolved during mixing and curing, collection and extraction being rarely employed. However, when using amine gas catalysts it may be necessary to collect and scrub the exhaust gases prior to discharge, to eliminate odour complaint (see Row 9, Table 3”).

Mould coating

- 3.27 Sand moulds are often coated with a refractory wash containing fine particles. This improves the refractoriness of the mould surface and reduces penetration of the metal between the sand grains, which improves the surface finish of the casting. The coating may be based on either water or alcohol and may be applied using spray, flow coating, dipping, brushing or swabbing.
- 3.28 Iron moulds may be coated with a powdered refractory material to protect the mould surface and to reduce the chilling effect of the iron. The coating is water based and is usually applied by spray under local fume extraction hoods leading to bag filters.

- 3.29 Some steel moulds or dies are not coated but are externally water-cooled. They are used for pipe casting where the limited thickness of the pipe wall does not have a significant impact on the steel mould temperature and the pipe quickly contracts away from the mould to be ready for withdrawal. Details of components such as the socket ends of pipes or the spigot ends of rolls are formed by sand sub-moulds within the main mould.

Oil sand process

- 3.30 This technique makes use of an oil which is polymerised by heating in an oven. Larger installations may require hoods and abatement plant to collect and destroy associated VOC emissions.

Pattern release agents

- 3.31 Pattern release agents are applied to the pattern to facilitate removal and are most commonly used in core production. They are usually alcohol based. Some foundries may use small quantities of chlorinated solvent products (usually in aerosol cans) to remove the build up of sand from patterns after several uses.

Lost foam process

- 3.32 This involves the 3D design and production of a precision moulded foam pattern, made from expanded polystyrene (EPS) or PMMA, produced by automated injection moulding machines. These patterns can be made from one piece or by assembling a number of parts by adhesives.

Environmental impact

- Water:** Not significant.
- Land:** Not significant.
- Air:** The most important issues from mould and core preparation and storage are as follows:
- dust from handling sand and other dusty materials
 - solvent and VOC emissions from resin handling
 - VOC emissions from organic chemical systems including amines, aldehydes and phenolics
 - combustion gases from heated systems
 - odour; the sources of which are the gases mentioned below
 - leaks of gases being used as catalysts, such as dimethylethylamine (DMEA), which has an unpleasant odour. Gases also exude from the cores in storage
 - emissions of ammonia arising from the thermal decomposition of hexamethylene tetramine which is a catalyst used in the shell process
- Waste:** Choice of binder system determines potential for recycling and recovery. Management of sand system affects the reclaim rate.
- Energy:** May be significant if a heated system is used.
- Accidents:** Damage to resin containers or incorrect mixing of resins. Leaks from pipelines.
- Noise:** Not significant.

BAT

- 10 Selection of techniques for manufacture of cores and moulds should be determined by the environmental impact of the process having regard to product quality constraints.
- 11 The operator should seek to substitute organic based mould and core coatings with water-based coatings and inorganic solvents to minimise VOC emissions.

- 12 Consumption of binder chemicals should be minimised through good process control such as those techniques described in Envirowise Guidance Note GG104 ([Ref 4](#)).
- 13 Where gas-fired heating systems are used (resin shell or oil sand), particular attention should be paid to good cleaning and maintenance of burner systems.
- 14 Solvent-based mould coatings should be torched off as soon as it is safe to do so after application.
- 15 In most cases waste moulds and cores should be segregated from other waste to facilitate reclamation.

Table 6: Environmental impacts associated with the manufacture of moulds and cores

System name and Binder constituents	Setting method and relative energy required	Emissions to air during mixing and setting	Other environmental impacts
GREENSAND Clay Coal dust or substitute Water	Pressure – low	Particulate matter – no significant emission to the environment	Fugitive emissions from conveyors. Abatement from mixing process not essential. (Process is usually contained with displaced air vented to the foundry.)
SHELL SAND Phenol- formaldehyde (Novalak) Resin	Heat – high	Formaldehyde Ammonia* Phenol* Aromatics	Odour can be an issue as the shell machines are normally extracted to air.
ALKALI PHENOLIC Alkaline phenol Formaldehyde resin 1. Self-setting, e.g. "Alphaset", "Novaset" 2. Gas hardened, e.g. "Betaset"	Cold set with esters - Low Gas hardened with methyl formate vapour – low	Formaldehyde Phenol* Esters Formaldehyde Phenol* Methyl formate	Minimal odour
PHENOLIC URETHANE 1. Gas hardened, e.g. "Coldbox", "Isocure" 2. Self setting, e.g. "Novathane", "Pepset"	Amine vapour – low Self set with substituted pyridine – low	Solvents* Isocyanate (MDI) Amine* Solvents* Isocyanates (MDI)	Odour is frequently a problem – where DMEA is used abatement is essential for odour control. This may be incineration or gas scrubbing (using sulphuric or phosphoric acids) – the latter gives rise to liquors, which are a hazardous waste. Where TEA is used scrubbing only required if odour problems arise.
FURANE Combination resins of: Phenol Urea Furfuryl alcohol Formaldehyde	Cold set with acids – Low	Formaldehyde Phenol* Furfuryl alcohol* Hydrogen sulphide Acid mists	Resins and acids must be kept apart (unless sand is present) as they are vigorously exothermic and may give rise to an uncontrolled emission.

Table 6: Environmental impacts associated with the manufacture of moulds and cores

System name and Binder constituents	Setting method and relative energy required	Emissions to air during mixing and setting	Other environmental impacts
HOT BOX Combination resins of: Phenol Urea Furfuryl alcohol Formaldehyde	Heat – high	Formaldehyde* Acids Furfuryl alcohol* Phenol*	Odour can be an issue as the core machines are normally extracted to air.
OIL SAND Linseed oil and starch	Heat – high	Acrolein* Complex organics	Odour can be an issue as the core ovens are often extracted to air.
CO₂ PROCESS Sodium silicate	Gas hardened with CO ₂ gas – low	None	Reclamation potential is more limited than with other binder systems.
SILICATE ESTER "Self set" Sodium silicate	Cold set with esters – Low	Esters	Reclamation potential is more limited than with other binder systems.
EXPENDABLE PATTERN CASTING Lost foam process	Expanded polystyrene – high	None	Water usage for process cooling
<p>Note 1: All the above processes give rise to spent sand (including broken cores, spillage and mixer Residues) that may go to landfill.</p> <p>Note 2: Substances marked with * are those most likely to give rise to odour from the process Referred to.</p> <p>Note 3: Any resin binder component would be regarded as hazardous waste for disposal purposes and if spilled could give rise to a risk to contamination of water systems.</p> <p>Note 4: Amines and methyl formates used for gas hardening are highly flammable and odorous. Avoidance of leaks in storage is essential.</p>			

Casting and cooling

- 3.33 Emissions generated during casting arise from two sources. Fine iron oxide is generated at the surface of the molten metal as it is poured, and the organic products are expelled from the mould as the binders and organic constituents oxidise and decompose. Fine iron oxide only occurs as the metal is being poured, whilst smoke and fumes caused by oxidation and decomposition of organics will continue to be evolved as the mould cools.
- 3.34 Whilst COSHH assessments can be of value in assessing the environmental impact of fugitive releases, they should be interpreted with care. The high temperatures involved make the emitted fume very buoyant, and significant environmental releases can occur even though the work areas remain clear of fume.
- 3.35 Where moulds are water-cooled or no sand/binder systems are used, casting fume production is small and extraction and abatement may not be needed.
- 3.36 **Table 7** identifies the type of emission that will be released into the atmosphere from curing and casting. Breakdown products from phenol, in particular cresols and xylenols, have very low odour thresholds and can be the source of odour from any of the organic chemical binder systems.

Casting Practices

Summary of the activities

Static Sand Casting

- 3.37 This is the simplest technique whereby the sand moulds are arranged on the shop floor, on roller tracks, on conveyor belts, in pits etc. and filled from a ladle. The castings are then left to solidify. It is generally impracticable to have fixed extraction hoods and ductwork in the casting area. Provision of good general ventilation and a reasonable rate of air change (10 per hour) can assist in clearing the building and dispersing casting emissions. In more automated foundries the moulds may be moved by conveyor into the pouring position where local extraction can be employed.

Repetition Greensand Casting

- 3.38 Semi-automated plants move greensand moulds past fixed pouring stations, where the metal is dispensed either automatically from holding furnaces or from ladles handled on a monorail system. The casting fumes are extracted from vents behind the line. The moulds are moved into cooling tunnels where further extraction of fume and water vapour is undertaken.

Spun Pipe Casting

- 3.39 Spun pipe casting is carried out by pouring hot metal from a ladle, via a tundish and runner into the rapidly rotating horizontal mould. The metal is forced out on to the inner cooling surface where it solidifies.

Roll Casting

- 3.40 This can be carried out centrifugally or statically. In the centrifugal system the vertical mould is placed in a machine and spun at high speed while the hot metal is bottom poured into it. Some time after filling, the mould is lifted from the machine, and is left for several days before stripping. Fume extraction is normal on the machine although not in the cooling pit.
- 3.41 In the static system the mould is mounted vertically and bottom poured from the ladle. It remains stationary while it cools and solidifies. Typically no fume extraction is required.

Environmental impact

Water:	Not significant.
Land:	Not significant.
Air:	Particulate matter during casting; VOCs, including odorous compounds, during cooling.
Waste:	Moulds and cores.
Energy:	Not significant.
Accidents:	Uncontrolled release of metal from a ladle or from an accident during centrifugal casting can result in fire if combustibles are present.
Noise:	Not significant.

Table 7: Environmental impacts from casting and cooling

System name and binder constituents	Emissions to air during casting and cooling	Comments
GREENSAND Clay Coal dust or substitute Water	Particulate matter Carbon monoxide and carbon dioxide Benzene, Toluene, Xylene	Potential odour (may be associated with sulphur content of the coal.)
SHELL SAND Phenol Formaldehyde (Novalak) Resin	Particulate matter – soot from the incomplete combustion of the carbon based resins Carbon oxides Phenol*, cresols* and xylenols* Ammonia Aldehydes Benzene PAH	Where the binder system is used for moulds odour problems more prevalent – treatment may be necessary although dispersion may suffice. Where the binder systems are used for cores only, the emissions from the cores will largely condense onto the mould material and is unlikely to cause an odour problem.
ALKALI PHENOLIC Alkaline phenol Formaldehyde resin 1. Self-setting, e.g. "Alphaset", "Novaset" 2. Gas hardened, e.g. "Betaset"	Particulate matter – soot from the incomplete combustion of the carbon based resins Carbon oxides Formaldehyde Phenol*, cresols* and xylenols* Aromatics	Odour may be a problem
PHENOLIC URETHANE 1. Gas hardened, e.g. "Coldbox", "Isocure" 2. Self setting, e.g. "Novathane", "Pepset"	Particulate matter – soot from the incomplete combustion of the carbon based resins Carbon oxides Nitrogen oxides Monoisocyanates Formaldehyde Phenol, cresols and xylenols Aromatics (inc polycyclics) Anilines Naphthalenes Ammonia	Where the binder system is used for moulds odour may be a problem – treatment may be necessary although dispersion may suffice. Where the binder systems are used for cores only, the emissions from the cores will largely condense onto the mould material and is unlikely to cause an odour problem
FURANE Combination resins of: Phenol Urea Furfuryl alcohol Formaldehyde	Particulate matter – soot from the incomplete combustion of the carbon based resins Carbon oxides Phenol, cresols and xylenols Formaldehyde Aromatics (inc. polycyclics) Sulphur dioxide Ammonia Aniline	Odour occasionally a problem

Table 7: Environmental impacts from casting and cooling

System name and binder constituents	Emissions to air during casting and cooling	Comments
HOT BOX Combination resins of: Phenol Urea Furfuryl alcohol Formaldehyde	Particulate matter – soot from the incomplete combustion of the carbon based resins Carbon oxides Nitrogen oxides Formaldehyde Phenol, cresols and xylenols Aromatics (inc. polycyclics) Aniline Ammonia	Odour may be a problem.
OIL SAND Linseed oil, starch or core grease	Particulate matter – soot from the incomplete combustion of the carbon based resins Carbon oxides Butadiene Ketones Acrolein	Odour may be a problem.
CO₂ PROCESS Sodium silicate	Carbon oxides	
SILICATE ESTER "Self set" Sodium silicate	Carbon oxides Alkanes Acetone Acetic acid Acrolein	
EXPENDABLE PATTERN CASTING Lost foam process	Benzene Toluene Xylene	Potential odour

BAT

- 16 For production line foundries, emissions from casting and cooling should be contained (to minimise fugitive emissions) and abated where necessary to meet the emission limits in [Table 3](#).
- 17 For floor moulding foundries, emissions from casting and cooling should be contained where necessary (to minimise fugitive emissions). Otherwise they should be dispersed and diluted using ventilation.
- 18 The working area should be managed to control through draughts and the escape of fugitive emissions.
- 19 Mould cooling should not take place outside of buildings.

Knockout (also referred to as shakeout)

- 3.42 Knocking out or stripping is the practice of removing the casting from the mould. Cooling of the mould before knockout reduces the mass of organics released. Smaller castings may be removed from the casting box manually or by use of a vibrating table, which allows any sand to fall through the open surface of the table. Dust from these operations is usually collected and cleaned by bag filters.

- 3.43 In repetition greensand moulding systems, knockout is frequently carried out using large rotating drums. The castings and sand are separated on a grid at the discharge from the drum. Sand is returned for recycling and re-use.
- 3.44 Large moulds will be broken up and castings removed in-situ, using an overhead crane or bucket excavator. Although large quantities of dust may be generated, local extraction and filtration is impractical. Pipes are removed from their rotary moulds by mechanical means. The sand from the knocking-out area is excavated, normally by mechanical digger and is either recycled or disposed of to landfill.

Environmental impact

Water:	Not significant.
Land:	Waste foundry sand (unless it is reclaimed).
Air:	As the mould is broken open, the surface area from which organic compounds may be liberated is significantly increased. Pyrolysis products adsorbed onto the resin coated sand, such as phenolic breakdown products for example, volatilise and are emitted to the foundry atmosphere. Formaldehyde will be present in the knockout section as it exists in the resin binder. Particulate matter is emitted upon which organic compounds may be adsorbed.
Waste:	Waste foundry sand (unless it is reclaimed).
Energy:	Not significant.
Accidents:	Not significant.
Noise:	The operation can be very noisy. Standard noise protection measures should be taken to minimise disturbance in the local neighbourhood. Vibration may arise at this knockout stage.

BAT

- 20 Sand intended for mechanical reclamation should be allowed to cool as long as possible prior to knockout, to maximise burn out of organics and improve the reclamation rate. This also reduces the emission of organics to air.
- 21 The knockout area should normally be contained and extracted, and should be exhausted to abatement plant where necessary to meet the emission limits.

Sand reclamation

- 3.45 Reclaimed sand is not generally of sufficient quality to be used for core making without further processing to remove residual binding materials and is therefore used principally for moulds. Internal reclamation however, significantly reduces the environmental impact of using sand mould and coremaking systems, as it greatly reduces both the consumption of virgin materials as well as the need for waste disposal.

Summary of the activities

- 3.46 Primary reclamation, also known as attrition, involves breaking down the sand from moulds or cores to its original grain size. This includes screening the sand, removing tramp metal, and separating and removing fines and over sized agglomerates. Used moulds can be broken down in

ball mills or vibrating crushers. In many cases chemically bonded sand moulds are put into rotary drums or on to vibratory screens where the castings are separated from the sand. The sand can then be sent for storage, returned to the sand system or blended with new sand. Primary reclaimed sand is not generally of sufficient quality to be used for core making without further processing to remove residual binding materials and is therefore used principally for moulds.

- 3.47 Secondary reclamation involves further processing to remove residual binder. The main secondary reclamation techniques are high energy attrition, wet scrubbing and thermal treatment.
- 3.48 Thermal reclamation is used primarily for organic binder systems. It is used as a second stage, after mechanical reclamation, and achieves a high reclamation rate. The waste gases are burnt at 750 °C to 800 °C. Units of up to 5 tonnes/hr are in use, usually employing a fluidised bed. After cooling, the gases should be cleaned by bag filtration before release to atmosphere. Where thermal reclamation is used, it should only be employed on the proportion of sand (10 to 30%) needed to maintain the required quality.
- 3.49 Secondary reclamation of greensand to increase the total amount recovered has recently been implemented in a few UK foundries and involves the use of high intensity mechanical scrubbing systems.
- 3.50 Guidance on optimisation of sand use in foundries and the most appropriate reclamation techniques for greensand and the different types of chemically bonded sand can be found in Envirowise Guides ([Ref 4](#)) (GG119 etc.). For example, chemically bonded sand should be cooled and classified to achieve the optimum grading for return to the sand system. Fines should be removed to below 0.4%. Reclaimed chemically bonded sand should be tested regularly for critical parameters, depending on the system in use. Loss on ignition should normally be controlled to less than 2%.

Environmental impact

- Water:** Only significant where wet scrubbing technique used.
- Land:** Not significant (but significant volumes of bag filter dust may be destined for landfill from abatement systems).
- Air:** Particulate matter. Where thermal methods are used, VOCs and products of combustion.
- Waste:** Particulate matter from abatement plant.
- Energy:** Thermal reclaimers are significant energy users, and temperature settings should be the minimum compatible with acceptable emission control; the amount of sand processed through secondary systems should be minimised to a level consistent with maintenance of the necessary sand quality.
- Accidents:** Not significant.
- Noise:** Many parts of the machine are very noisy. Noise protection measures should be taken to minimise disturbance in the local neighbourhood.

BAT

- 22 Sand should normally be handled in a fully enclosed system following knockout, or stored under cover prior to reclamation. Storage of sand in open piles that require manual transfer should be avoided to minimise fugitive dust emissions.
- 23 Dust emissions from reclamation should be abated to achieve the emission limits. On dry abatement plants, this may require the use of trace heating to prevent condensation problems in filtration plant.
- 24 There should be an afterburner when thermal reclamation is used; effective and reliable temperature control systems are required on the afterburner to ensure efficient oxidation of VOCs.

Fettling, dressing and finishing of castings

Summary of the activities

- 3.51 After the castings have cooled they are subjected to a number of finishing processes in order to obtain the final finish required for the product. These operations, some of which are referred to as fettling or dressing include:
- cleaning by shotblasting or other means to remove core and mould materials and scale.
 - removal of excess metal such as feeder heads, runner or gating systems and any other superfluous metal.
 - removal of blemishes and defects.
 - smoothing over of weldments, areas from which metal has been cut, and any other rough areas on the surface of the casting, generally by grinding.
 - general machining
 - fettling is generally achieved by general machining, flame cutting, grinding or chiselling, and usually results in the generation of dust and fume. In the case of pipes the internal surface is dressed by extending a rotating grinding wheel or burr the full length of the pipe. Another method uses an electric arc to selectively remelt unwanted small areas of the casting.

Environmental impact

Water:	Sludge where wet techniques are used.
Land:	Not significant.
Air:	Particulate matter and fume, combustion gases from heated processes.
Waste:	Particulate matter collected by abatement plant, grinding wheel stubs.
Energy:	Not significant
Accidents:	Particulate matter from shot blasting or grinding operations is highly aggressive and damaging to paintwork. Fire risk from hot processes.
Noise:	Many of these processes are very noisy. Standard noise protection measures should be taken to minimise disturbance in the local neighbourhood.

BAT

- 25 Emissions from fettling, dressing and finishing activities should be contained and extracted and abated where necessary to meet the emission limits and other provisions.
- 26 The operator should ensure that an effective means of detection for abatement plant failure is in use.

Emissions control

Point source emissions to air

Sources

- 3.52 The nature and source of the emissions to air expected from each activity are given in previous sections. In general they comprise:
- particulate matter from most foundry operations
 - particulate matter and fume from melting and refining operations
 - inorganic and organic chemical emissions from mixing and curing of chemical binders, at casting, knock out and sand reclamation
 - odorous compounds from furnace and desulphurisation operations, from mould and core preparation and storage, from casting, from knock out and from sand reclamation
 - combustion gases from heated processes
- 3.53 There should not normally be persistent visible emission from foundry contained sources which are complying with the 20 mg/m³ particulate limit, although it will not necessarily be essential to take action to prevent such emissions if the particulate limit is being respected on a continuous basis. Continuous indicative monitoring and recording in accordance with [Table 3](#) would be expected to demonstrate that this is the case.

Dispersion and dilution of stack emissions

- 3.54 The basis upon which stack heights are calculated using HMIP Technical Guidance Note D1 (D1) ([Ref 5](#)) is that pollutants are dispersed and diluted in the atmosphere to ensure that they ground at concentrations that are harmless under the theoretical conditions of the D1 model. The emission limits in this sector note should be used as the basis for stack height calculation. The stack height so obtained is adjusted to take into account local meteorological data, local topography, nearby emissions and the influence of plant structure. It is necessary that the assessment also takes into account the relevant air quality standards that apply for the emitted pollutants.

The calculation procedure of D1 is usually used to calculate the required stack height but alternative dispersion models may be used in agreement with the regulator. D1 relies upon the unimpeded vertical emission of the pollutant. A cap or other restriction over the stack impedes the vertical emission and hinders dispersion. For this reason where dispersion is required such flow impeder should not be used. A cone may sometimes be useful to increase the efflux velocity and achieve greater dispersion. An operator may choose to meet a tighter emission limit in order to reduce the required stack height.

- 3.55 Where an emission consists purely of air and particulate matter, the above provisions relating to stack height calculation for the purpose of dispersion and dilution should not normally be applied. However, if the emission point is within a designated air quality management area with respect to PM₁₀, then this may have to be reviewed.
- 3.56 Liquid condensation on internal surfaces of flues and exhaust ducts might lead to corrosion and ductwork failure or to droplet emission.
- adequate insulation should be provided to minimise the cooling of waste gases and prevent liquid condensation by keeping the temperature of the exhaust gases above the dewpoint
- 3.57 Unacceptable emissions of droplets could possibly occur as a result of entrainment from wet abatement plant where the linear velocity within the associated ductwork exceeds 9 m/s. The use of mist eliminators reduces the potential for droplet emissions.
- where a linear velocity of 9 m/s is exceeded in the ductwork of existing wet abatement plant, the linear velocity should be reduced, subject to health and safety considerations, to ensure that droplet fallout does not occur

- 3.58 The dispersion from all emission points to air can be impaired by low exit velocity at the point of discharge, or deflection of the discharge.
- flues and ductwork should be cleaned to prevent accumulation of materials, as part of the routine maintenance programme
 - a minimum discharge velocity should be required in order to prevent the discharged plume being affected by aerodynamic down wash

BAT

All releases to air

The operator should:

- 27 Ensure that all operations which generate emissions to air are contained and adequately extracted to suitable abatement plant, where this is necessary to meet specified emission limit values.
- 28 Ensure that emissions from combustion processes in normal operation are free from visible smoke and in any case do not exceed the equivalent of Ringelmann Shade 1 as described in British Standard BS 2742:1969.
- 29 Ensure that hot emissions take place from the minimum practicable number of stacks, in order to obtain maximum advantage from thermal buoyancy. This is particularly important when new plants are being designed or when changes are being made to existing processes. If practicable a multi-flue stack should be used.
- 30 Ensure that stack heights are sufficient to ensure adequate dispersion under normal conditions.
- 31 Ensure that the minimum stack height is 3 metres above roof ridge height of any building within a distance of 5 times the uncorrected stack height and in no circumstances should it be less than 8 metres above ground level.
- 32 Be able to demonstrate to the regulator that all reasonably practicable steps are taken during start-up and shut down, and changes of fuel or combustion load in order to minimise emissions.
- 33 Investigate the cause and nature of any persistent visible emissions and provide a report to the regulator.
- 34 Ensure that emissions of water vapour are free from droplet fallout.
- 35 Ensure that liquid entrainment in the duct of wet abatement, leading to droplet fallout, does not occur as a result of the linear flow rate within the duct exceeding 9 m/s.
- 36 Ensure that flues and ductwork are cleaned to prevent accumulation of materials, as part of the routine maintenance programme.
- 37 Ensure that exhaust gases discharged through a stack achieve an exit velocity greater than 15 m / sec during normal operating conditions to achieve adequate dispersion.
- 38 Ensure that stacks are not fitted with any restriction at the final opening such as a plate, cap or cowl, with the exception of a cone which may be necessary to increase the exit velocity of the emissions.

Dispersion modelling

- 39 Dispersion models for stack height calculations should take into account any emissions of the same pollutants from any other permitted activity on the installation, in order to avoid exceeding local ground-level pollution thresholds and limit national and transboundary pollution impacts. Such models should be based on the most sensitive receptor, be it human health, soil or terrestrial ecosystems.
- 40 The requirement to use D1 or another dispersion model for calculation of stack height should not normally be applied where an emission consists purely of air and particulate matter.

- 41 An operator may choose to meet tighter emission limits in order to reduce the required stack height. For existing stacks, the heights do not need to be recalculated, except where EU air quality standards are breached.
- 42 Where offensive odour is likely outside the installation boundary, the assessment of stack height should take into account the need to render harmless residual offensive odour.

Point source emissions to surface water and sewer

- 3.59 The nature and source of the emissions expected from each activity is given in previous sections. In general, wastewater can arise from storm water, from cooling water, from accidental emissions of raw materials, products or waste materials and from fire fighting.
- 3.60 The amounts of process water used in foundries is small and discharges comprise principally:
- discharge from wet scrubbers
 - cooling water, often containing biocides and anti-oxidants
 - discharge from wet sand reclamation plant; (not used in the UK)
 - site drainage and stormwater
- 3.61 The following general principles should be applied in sequence to control emissions to water:
- water use should be minimised and wastewater reused or recycled
 - contamination risk of process or surface water should be minimised
 - ultimately, surplus water is likely to need treatment to meet the statutory and non-statutory objectives. Generally, effluent streams should be kept separate as treatment will be more efficient. However, the properties of dissimilar waste streams should be used where possible to avoid adding further chemicals, e.g. neutralising waste acid and alkaline streams. Also, biological treatment can occasionally be inhibited by concentrated streams, while dilution, by mixing streams, can assist treatment
 - systems should be engineered to avoid effluent by-passing the treatment plant
- 3.62 Minimising the use of water and minimising the level of pollutants in each water stream are the primary aims, followed by the recycling of waste water streams wherever possible. In this industry cleaning the water to 50 mg/l of suspended solids is likely to ensure that most of the insoluble pollutants will be within their normal limits. If not, further abatement may be necessary (see paragraphs 3.63 to 3.67 below). Such cleaned water would generally be of good quality and should be considered for recycling - however it is also important to consider the levels of dissolved chemicals before concluding that recycling of the water is viable.
- 3.63 For furnace gas cleaning, dry filtration systems eliminate potential waste water streams, however with a wet cleaning system there is no need for an aqueous discharge if appropriate measures are taken to clean the water and recycle it. As long as solids are removed to a level acceptable to the scrubbing device solubles can normally be allowed to reach saturation without any adverse effects. There are a variety of techniques, or combination thereof, which would adequately separate the solids - e.g. multistage separation, flocculation, chemical precipitation, hydrocyclones, sand filtration, filter pressing and flotation.
- 3.64 Abatement for the removal of suspended solids are normally appropriate for achieving ELVs for metals given in Table 4. However if additional abatement is required, either chemical coagulation or ion exchange can be used.
- 3.65 Oils and grease may be present in drainage from scrap storage areas. Scrap storage should be designed to minimise contamination of drainage in order to meet the 5 mg/l ELV in Table 4. Should water treatment be needed separators can be used. It is not likely that chemical treatment would be needed but can be used as an additional measure.
- 3.66 Additional abatement is unlikely to be needed in achieving the ELV for BOD given in Table 4. However, in IPPC the prevention or reduction of BOD is also subject to BAT and further reductions which can be made at reasonable cost should be carried out. Furthermore, irrespective of the receiving water, the adequacy of the plant to minimise the emission of specific persistent harmful substances must also be considered.

- 3.67 The nature of the receiving water should be taken into account, with regard to any pollutant released to this media. Irrespective of the receiving water, the adequacy of the plant to minimise emissions must be considered.

Local Authority Regulation

- 3.68 Regulation 13 of The Pollution Prevention and Control (England and Wales) Regulations 2000 states that:
- "(1) In the case of a Part A installation or Part A mobile plant in relation to which a local authority regulator exercises functions under these Regulations, the Environment Agency may, at any time, give notice to the local authority regulator specifying the emission limit values or conditions which it considers are appropriate in relation to preventing or reducing emissions into water."
 - "(3) Where a notice under paragraph (1) specifies conditions in relation to emissions into water from an installation or mobile plant, the permit authorising the operation of that installation or mobile plant, shall include those conditions or more onerous conditions dealing with the same matters as the local authority regulator considers to be appropriate."

Off site effluent treatment

- 3.69 Where an operator discharges to a Sewage Treatment Works via sewer, the sewerage undertaker is a statutory consultee and must be sent a copy of the application. The STW operator is likely to confirm to the Environment Agency and the local authority the levels of pollutants (considering levels specified in the trade effluent consent) that the sewer is able to take.

In all cases the effluent discharged from the installation must not give rise to a potential breach of an EQS or EAL for the final receiving water, when taken with compliance with any water company permit. In a significant number of cases the Environment Agency finds that the STW operator's discharge consent and the Environment Agency's concerns to protect watercourses are closely aligned. Where they are aligned and there is a simple discharge, it is common Agency practice just to rely on the consent and not to replicate limits in permit conditions.

- 3.70 For ferrous activities, although certain effluents can be defined as complex, it is unlikely that BAT equates with tighter limits than those specified by the Environment Agency. Therefore, the consent can be relied upon (as for simple discharges above) without replicating limits in permit conditions.

Further guidance on regulating water discharges from A2 Installations can be found in AQ11(05) ([Ref 3](#)).

BAT

The operator should ensure that:

- 43 All emissions are controlled, as a minimum, to avoid a breach of water quality standards. (Calculations and/or modelling to demonstrate this may be required to be submitted to the regulator).
- 44 Run-off from the installation is controlled and managed and where necessary (given the nature of the run-off) treated before discharge in a suitable effluent treatment plant.
- 45 All interceptors:
 - are impermeable
 - are subject to at least weekly visual inspection and, where necessary to ensure the continuous function, contamination removed
 - have an annual maintenance inspection; prior to inspection all contents should be removed
- 46 For new plant, cooling water and water used for wet abatement is recycled in a closed circuit in order to minimise or avoid effluent discharge.
- 47 Where existing evaporation systems or single pass cooling systems are used, a closed circuit recycling system is installed when the plant is renewed or at least by the date specified in [Table 1](#).

- 48 Where necessary to protect the environment, process effluent is channelled / transported to suitable effluent treatment plant.
- 49 Process effluent is kept separate from surface drainage unless agreed with the regulator.

Point source emissions to groundwater

- 3.71 There should be no intentional point source emissions of List I and List II substances to groundwater from the ferrous foundries sector⁴.

BAT

- 50 There should be no intentional point source emissions of List I and List II substances to groundwater.

Fugitive emissions to air

- 3.72 Common sources of fugitive emissions are:
- inorganic and organic chemical emissions from mixing and curing of chemical binders in mould and core preparation; at casting, knock out and sand reclamation
 - solvents e.g. from mould coatings
 - storage areas (e.g. bays, stockpiles etc.)
 - the loading and unloading of transport containers
 - 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.)
 - casting
 - poor building containment and extraction
 - potential for bypass of abatement equipment (to air or water)
 - accidental loss of containment from failed plant and equipment including leakage e.g. from sand reclamation plant

BAT

- 51 Operations such as handling and transfer of molten metal or dusty materials, metal treatment, casting, finishing and handling of odorous raw materials should be controlled to minimise fugitive emissions.
- 52 Operations should also be controlled with the aim of preventing visible emissions, although this does not include occasional, one-off events of short duration or emissions from nodularisation.
- 53 Where dusty materials are handled, dust should normally be controlled by covering of skips and vessels, using enclosed conveyors, spraying water on sand conveyors, minimising drops and by avoiding outdoor or uncovered stockpiles.

⁴ The Groundwater Regulations 1998 require that List I substances are prevented from entering groundwater, and that List II substances are controlled so that pollution of groundwater does not occur. Any discharge of listed substances onto or into land must be subject to a prior investigation under the terms of the Groundwater Regulations, and this investigation should be carried out by the applicant and submitted in support of the permit application.

- 54 External surfaces of the process buildings, roofs, guttering, ancillary plant, roadways and open yards and storage areas should be inspected at least annually. Cleaning operations should be carried out if necessary to prevent the accumulation of dusty material using methods which minimise emissions of particulate matter to air.
- 55 When transferring volatile liquids, the following techniques should be employed; subsurface filling via filling pipes extended to the bottom of the container; the use of vapour balance lines that transfer the vapour from the container being filled to the one being emptied; or an enclosed system with extraction and abatement where necessary to minimise offensive odour at the site boundary.
- 56 Vent systems should be chosen to minimise breathing emissions (e.g. pressure / vacuum valves) and, where relevant, be fitted with knock-out pots and appropriate abatement equipment.

Fugitive emissions to surface water, sewer and groundwater

3.73 The operator should have a clear diagrammatic record of the routing of all installation drainage for surface water and process effluent, to include subsurface pipework, the position of any sumps and storage vessels including the type and broad location of the receiving environment.

3.74 An inspection and maintenance programme should be established for all subsurface structures. Inspection frequencies and test methods should be chosen to prevent pollution by minimising leaks from subsurface pipework, sumps and storage vessels, having regard to the risk factors in paragraph 3.76 below.

The minimum inspection frequency should normally be no less than once every five years for yard drainage (i.e. rainwater from roofs, hardstanding etc) and no less than once every three years for process effluent. The precise choice of inspection frequency and the sophistication of the method should be guided by the level of risk presented but a likely maximum frequency may be once per annum.

3.75 Examples of inspection and test methods are pressure tests, leak tests, material thickness checks, and CCTV survey. Using secondary containment and/or leakage detection can serve to reduce the inspection frequency to the minimum quoted in paragraph 3.74.

3.76 The likely risk to the environment from drainage systems is dependant on the following factors:

- nature and concentration of contaminants in the water transferred in the drainage systems
- volume of water transferred
- vulnerability of the groundwater in the locality
- proximity to surface waters.

For yard drainage, it is likely that the minimum inspection frequency and least complex inspection methods will suffice irrespective of volume of water, vulnerability of local groundwater and proximity to surface waters.

3.77 The vulnerability is defined by the nature of the subsurface, and is mapped for England and Wales in a series of Groundwater Vulnerability maps. An additional measure of risk is whether the installation sits within a Groundwater Source Protection Zone (GPZs) as defined by the Environment Agency's Groundwater Protection Policy. GPZs help to identify areas, which are particularly sensitive to groundwater pollution because of their proximity to an important water supply.

The location of GPZs can be searched on the Environment Agency website by inserting the post code of the installation <http://www.environment-agency.gov.uk/maps/info/groundwater/>

3.78 Operational areas should be equipped with an impervious surface, spill containment kerbs, sealed construction joints, and connection to a sealed drainage system unless the operator fully justifies that this is not necessary. Management controls such as recording the design and condition of the

surfacing (capacities, thickness, falls, material, permeability, strength/reinforcement, and resistance to chemical attack), and regular inspections and maintenance should be used.

- 3.79 The operator should ensure that all tanks containing liquids whose spillage could be harmful to the environment are contained. Bunds should be impermeable and resistant to the stored materials, have no outlet (drains, soakaways etc) and drain to a blind collection point. Pipework should be routed within bunded areas with no penetration of contained surfaces. Bunds should be designed to have a holding capacity of at least 110% of the largest tank and be located more than 10m from watercourses and 50m from drinking water boreholes.

It is good practice for bunds to be fitted with a high-level probe and an alarm as appropriate and are inspected regularly by the operator. Rainwater should be prevented from entering bunds, but any spills and rainwater accumulations should be removed as soon as possible.

- 3.80 All storage tanks should be fitted with high-level alarms or volume indicators to warn of overfilling. Where practicable the filling system should be interlocked to the alarm system to prevent overfilling. Tanks should have delivery connections located within a bunded area, fixed and locked when not in use and have their integrity inspected, recorded and documented, particularly where corrosive substances are involved. These inspections should be included in the maintenance schedule.
- 3.81 Operators should assess the pollution risks posed by the storage of solvents and in addition to the above controls, have impermeable flooring away from surface water sources, surface water drains, soakaways, drinking water boreholes or sumps.

For further information, a Code of Practice on the use and storage of solvents is available on the Defra website. www.defra.gov.uk/environment/water/ground/solvents/ (Ref 3)

BAT

- 57 The operator should have a clear diagrammatic record of the routing of all installation drains, subsurface pipework, sumps and storage vessels including the type and broad location of the receiving environment.
- 58 The operator should identify the potential risk to the environment from drainage systems recorded by **BAT 57** and should devise an inspection and maintenance programme having regard to the nature and volume of waste waters, groundwater vulnerability and proximity of drainage systems to surface waters.
- 59 The operator should ensure that all operational areas are equipped with an impervious surface, spill containment kerbs, sealed construction joints, and connected to a sealed drainage system or such alternative requirements as approved by the regulator.
- 60 All sumps should be impermeable and resistant to stored materials.
- 61 All storage tanks should be located within bunds that are designed, constructed and located to appropriate standards and ensuring that the volume is more than 110% of the largest tank.
- 62 Storage tanks should be fitted with high-level alarms or volume indicators to warn of overfilling and where practicable the filling system should be interlocked to the alarm system to prevent overfilling. delivery connections should located within a bunded area, fixed and locked when not in use.
- 63 All tanks bunds and sumps should be subject to regular visual inspection as agreed with the regulator, placed on a preventative maintenance programme. The contents of bunds and sumps should be pumped out or otherwise removed as soon as is practicable after checking for contamination.
- 64 The operator should assess the pollution risks posed by the storage of solvents and devise control measures to minimise the pollution risk.

Odour

- 3.82 Typically the most odorous processes involve the manufacture of cores and moulds. Other potentially odorous processes include:
- melting operations and furnace extraction/abatement
 - manufacture of moulds and cores
 - desulphurisation
 - casting operations
 - knock-out/shake-out
 - paint spraying and other coating activities
- 3.83 Chapter 17 of the General Guidance Manual provides guidance on controlling odour from installations and the information required in an application.

Assessment

- 3.84 Operators should assess the likely sources of odour and carry out olfactory assessments at the site boundary. Odour control should be carried out in the following order of priority:
- prevention - substitution
 - minimisation of use of binder materials
 - containment and extraction
 - abatement
- 3.85 Implementation of the best available techniques and the emission limit values and provisions of this note should ensure that offensive odours are not perceived beyond the site boundary, other than where unavoidable plume grounding occurs due to extreme weather conditions. It may be necessary to include additional controls to avoid offensive odours, for example where local meteorological conditions frequently lead to poor dispersion conditions.
- 3.86 The overall aim should be that all emissions are free from offensive odour outside the site boundary, as perceived by the regulator. The locality will influence the assessment of the potential for odour impact for example local meteorological conditions (all predicted wind directions and weather conditions) which may lead to poor dispersion conditions. Where the site has a low odour impact due to its remoteness from sensitive receptors, the escape of offensive odour beyond the installation would be unlikely to cause harm. In these circumstances, operations should still be optimised as described above.

Prevention

- 3.87 Operators should seek to prevent and minimise odours from the installation by prevention i.e. by reducing the production of odorous chemicals, for example substitution with less odorous binders.
- 3.88 In general, operators should determine which binders can be substituted with less odorous processes. For example, non-aromatic solvents for cold-box core production can minimise VOC and odour problems during casting and knock-out/shake-out. The low volatility of the vegetable-oil methyl esters also enhances the storage capabilities in humid atmospheres and their persistence when applying water-based coatings. Vegetable based solvents can however give rise to greater fume production during pouring. The use of inorganic binders such as sodium silicate will substantially reduce emissions, but benefit in odour reduction may be offset by less effective sand reclamation.
- 3.89 Substitution of shell sand production with its use of phenolic resin binders can reduce odours. Odorous emissions vary according to the type of system used, but the phenolic breakdown products, cresols and xylenols, are the most common source of odour complaint due to their very low odour detection thresholds.

Minimisation

- 3.90 Where odour generation is not preventable, odours should be minimised at source and/or contained with effective treatment prior to discharge. The use of odorous binder systems may be required to ensure product quality, or used prior to substitution. In which case binder material consumption should be minimised.

- 3.91 Keeping binder additions as low as possible can minimise raw material costs, reduce hardener consumption, facilitate sand reclamation by increased burn-out from the casting, reduce the risk of hot tearing and blowhole defects as well as reduce emissions of VOCs and odours.
- 3.92 The development of “low-odour” variety phenolic resin sands has resulted in reduction of odour and particulate emissions at many foundries. Movement towards using low-odour sands should be considered an important odour management strategy.

Containment, Extraction and Abatement

- 3.93 The odour impact should be assessed to determine whether additional controls are required such as extraction and abatement are needed in order to minimise the odour impact. Mould or core production using phenolic urethane binders with DMEA should be fitted with fume extraction systems with abatement for destroying odours. Where TEA is used abatement should be fitted where odour problems persist.
- 3.94 Gas scrubbing to remove amine odours can be achieved using aqueous solutions of sulphuric or phosphoric acid can abate to levels well below the ELVs in [Table 3](#) and are widely used at non-ferrous foundries. Removal efficiencies of 90% can be achieved using this method.
- 3.95 For other binder types, odorous emissions should be contained if required to ensure that offensive odours are not perceived beyond the site boundary. The emission limit values and provisions of this note should fulfil this objective.
- 3.96 Where odour problems persist, fume extracted from shell sand core production areas, abatement of phenols and ammonia can be achieved using wet scrubbing with either alkaline (NaOH) or acidic (acidified hydrogen peroxide using ferrous sulphate as a catalyst) aqueous solutions. Scrubbing using aqueous acidic solutions is the most common method. Removal efficiencies of greater than 95% phenolics are achievable using this method. Hypochlorite scrubbing has also shown to be successful although chlorine odours can be problematic. Wet scrubbing in general leads to an aqueous waste stream that should be treated in either on-site or off-site effluent treatment plant.
- 3.97 Thermal oxidation is a possible alternative as it results in no aqueous waste streams although energy costs are high and CO₂ is released. Other alternatives for VOC and odour abatement include bio-filtration and bio-scrubbing techniques. However neither of these techniques are currently used in the foundry UK industry.
- 3.98 Casting fume can also be contained and abated if required to reduce odour at the site boundary. The relatively low VOC concentrations in the fume however necessitates combustion using almost entirely support fuel and adds greatly to energy usage. Thermal oxidation of casting fume would therefore not normally be expected if VOC prevention measures described in this note were used.
- 3.99 The dispersal of odours during casting, cooling and knocking-out is associated with large volumes of air, which makes collection and treatment difficult and often impracticable. In many cases, appropriate dilution is sufficient to minimise odours. However, where odour problems persist, in addition to preventative measures described above, operators should investigate more localised containment and fume extraction to avoid contaminating less odorous air by dilution.
- 3.100 In the case of existing processes where odour abatement equipment has been installed, the regulator should consider permitting the use of the existing equipment provided that emissions from the equipment do not result in offensive odours beyond the installation boundary. The regulator should still require that the available equipment is optimised for odour removal and should establish the odour abatement efficiency based upon operating data. Where emissions from the odour abatement equipment are still leading to persistent offensive odours beyond the process boundary, the equipment should be upgraded.

BAT

- 65 Operators should conduct odour assessments to determine whether emissions result in offensive odours at or beyond the installation boundary.

- 66 If operations are identified as resulting in offensive odour, operators should devise an odour control programme of improvements and maintain an odour management plan.
- 67 The operator should seek to substitute the most odorous activities such as mould and core production using phenolic resin binders with less odorous production methods having regard to product quality specification.
- 68 Operational areas where mould or core production uses phenolic urethane binders with DMEA should be fitted with appropriate fume extraction systems with abatement for destroying odours. Where TEA is used abatement should be fitted where odour problems persist.
- 69 Following odour assessments, if required to ensure that offensive odours are not caused at the site boundary, core and mould production using binders such as alkali phenolic, hot box, shell sand and oil sand processes should be contained, treated and extracted.

Management

- 3.101 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.
- 3.102 An effective Environmental Management System (EMS) will help the operator to maintain compliance with regulatory requirements and to manage other significant environmental impacts. An EMS includes 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.
- 3.103 The operator should have demonstrable procedures (e.g. written instructions) which incorporate environmental considerations into process control, design, construction and review of new facilities and other capital projects (including provision for their decommissioning), capital approval and purchasing policy.

Audits should be carried out, at least annually, to check that all activities are being carried out in conformity with the above requirements. Reporting should be carried out annually on environmental performance, objectives and targets, and future planned improvements. Ideally, these should be published environmental statements.

Guidance on how to develop Environmental Management Systems in the foundry sector can be found in by Envirowise publications GG043 ([Ref 7](#))

Operations and maintenance

- 3.104 **Maintenance** - It is good practice to ensure:
- effective preventative maintenance on all aspects of the process the failure of which could impact on the environment
 - clear written maintenance instructions for all relevant items are developed and maintained
 - a method of reviewing maintenance needs, with demonstrable evidence that this process takes place
- 3.105 **Training** – it is good practice to train all relevant (including operational) staff in the regulatory implications of the permit, all potential environmental impacts (under normal and abnormal circumstances). Training should also include the procedures for dealing with a breach of the permit conditions, prevention of accidental emissions and action to be taken when accidental emissions occur and also in all operating procedures.

- 3.106 **Responding to problems** - The regulator needs to be notified about certain events and expects the operator to respond to problems, which may have an effect on emissions to the environment. Such problems may arise within the process itself or, for example, with the abatement plant.
- 3.107 **Contractors on site** - It is important to be aware that in complying with their permit, operators will be responsible for work undertaken by contractors. Operators are advised to provide instructions to contractors regarding protecting the environment whilst working on site.

BAT

Environmental Management System

- 70 Operators should use an effective Environmental Management System with policies and procedures for environmental compliance and improvements. Audits should be carried out against those procedures at regular intervals.

Operations and maintenance

- 71 Effective operational and maintenance systems should be employed on all aspects of the installation whose failure could impact on the environment. As a minimum this should include refractory linings, sand reclamation equipment, abatement plant, extraction fans and also major 'non productive' items such as tanks, pipework, retaining walls, bunds, ducts and filters. Such systems should be reviewed and updated annually.
- 72 Environmentally critical process and abatement equipment (whose failure could impact on the environment) should be identified and listed. The regulator should be provided with a list of such equipment.
- 73 For equipment referred to in 72 (above):
- alarms or other warning systems should be provided, which indicate equipment malfunction or breakdown.
 - such warning systems should be maintained and checked to ensure continued correct operation, in accordance with the manufacturer's recommendations
 - essential spares and consumables for such equipment should be held on site or be available at short notice from suppliers, so that plant breakdown can be rectified rapidly.
- 74 Records of breakdowns should be kept and analysed by the operator in order to eliminate common failure modes.

Competence and training

- 75 A competent person should be appointed to liaise with the regulator and the public with regard to complaints. The regulator should be informed of the designated individual(s).
- 76 A formal structure shall be provided to clarify the extent of each level of employee's responsibility with regard to the control of the process and its environmental impacts. This structure shall be prominently displayed on the company within the process building at all times. Alternatively, there must be a prominent notice referring all relevant employees to where the information can be found.
- 77 Personnel at all levels shall be given training and instruction sufficient to fulfil their designated duties under the above structure. Details of such training and instruction shall be entered into the employees record and be made available for inspection by the regulator.
- 78 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.

Accidents/incidents/non conformance

- 79 There should be written procedures for investigating incidents, (and near misses) which may affect the environment, including identifying suitable corrective action and following up.

Raw Materials

- 3.108 This section covers the use of raw materials and water and the techniques for optimising their use and minimising their impact by selection (Energy and fuels are covered under [Energy](#)).
- 3.109 As a general principal, the operator will need to demonstrate the measures taken to:
- **reduce** the use of chemicals and other materials ([Waste minimisation \(optimising the use of raw materials\)](#))
 - **substitute** with materials presenting lower risks to the environment
 - **understand** the fate of by-products and contaminants and their environmental impact

Raw materials selection

- 3.110 Raw materials used in foundry processes consist of:
- ferrous scrap
 - iron ore, pig iron and ferro-alloys
 - limestones and dolomites
 - coal and coke
 - desulphurisation materials
 - nodularisation materials
 - mould and core materials; principally sand, binder chemicals, and mould and core coatings; (Note: “binder chemicals” is taken to include resins, hardeners and catalysts.)
 - refractories for launder, ladle and furnace linings
 - pattern release agents
 - lubricating oils, hydraulic oils, quench oils, transformer oils and fuel oils
 - water treatment chemicals
 - grinding wheels and steel shot
- 3.111 The primary consideration for operators when selecting core and mould making techniques is the ability of the foundry to produce castings of the required quality at a competitive price. Quality requirements feed forward to mould and core manufacture, and ultimately to the raw materials to be used. This in turn may place restrictions on the proportion of sand that can be recycled. However when selecting a new binder system or reviewing an existing one, the environmental impact should be considered and where practicable, a binder system selected with a reduced impact.
- 3.112 Similarly, the nature of the binders used will affect the fume released during casting, and also the ease with which sand can be removed and recycled.
- 3.113 The criteria in [Table 8](#) should be considered when selecting raw materials.

Table 8: Selection of raw materials

Raw material	Selection criteria
Scrap	For electric furnaces clean scrap should be used to minimise furnace emissions For cupolas there should be careful examination and control of scrap quality to minimise pollution. Scrap should be free from contaminants (paint, oil, grease or rubber and plastic) unless full and effective abatement is being used.
Water	Identify most sustainable source (consider recycled sources)
Coke	The lowest sulphur cokes should be used Coke with low calorific values result in lower melting efficiency and higher emissions of particulates and other pollutants.
Fuel oils	Sulphur content should be minimised. The maximum sulphur content of heavy fuel oil should be 1%*.

Mould materials	Sand – well graded, to the desired angularity specification and free from excessive fines binder system – consider ease of reclamation, generation of odours etc. coal dust with low sulphur content
Mould coatings: use of solvent vs water-based systems	Take into account technical feasibility, air emissions and energy efficiency
Solvent usage	Where solvent based de-greasing is necessary, then non-chlorinated solvents should be used.
*Sulphur in liquid fuels regulations, Regulation 3 (3) states that combustion plant (other than new large combustion plant covered by the LCPD for which there is a separate provision) can burn heavy fuel oil with a sulphur content greater than 1% so long as the sulphur dioxide emissions from the plant is less than or equal to 1700mg/m ³ at 3% oxygen dry. Defra is the enforcing authority for these regulations.	

- 3.114 When selecting alternative raw materials, operators should ensure that decisions are taken on the basis of their environmental impact, whilst not compromising casting quality and product integrity.
- 3.115 Operators should maximise the amount of sand reclaimed and reused in the installation whilst maintaining mould quality specifications. Unburned sand cores can be recovered and reused as greensand moulds. Envirowise publications GG119 etc. (Ref 4) identify how greensand usage can be optimised and recovery maximised.

BAT

- 80 The operator should adopt procedures to control the specification of those types of raw materials with the main potential for environmental impact, such as scrap quality, calorific value of fuels, and binder materials in order to minimise any potential environmental impact. An annual review of alternative raw materials should be carried out with regard to environmental impact.

Waste minimisation (optimising the use of raw materials)

- 3.116 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”.
- 3.117 A variety of techniques can be classified under the term waste minimisation and they range from basic housekeeping techniques through statistical measurement techniques, to the application of clean technologies.
- 3.118 Key operational features of waste minimisation should be:
- the ongoing identification and implementation of waste prevention opportunities
 - the active participation and commitment of staff at all levels including, for example, staff suggestion schemes
 - monitoring of materials’ usage and reporting against key performance measures or benchmarks
- 3.119 Using this information, opportunities for waste reduction, changes in process and improved efficiency should be generated and assessed, and an action plan prepared for the implementation of improvements.
- 3.120 The use and fate of all materials should be mapped onto a process flow diagram 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. The mass balance can then be used to identify opportunities for improvements.

- 3.121 Monitoring and mapping material usage in this way can be carried out to determine benchmarks in terms of the amount of any given raw material used per tonne of product manufactured. Assessment against benchmarks can reveal whether the process is being maintained “in control” or to trigger investigations in to why raw material usage is increasing.
- 3.122 The following benchmarks are typically used in the non-ferrous sector for process control and waste minimisation:
- sand to good castings ratio
 - mould or core sand to binder ratio
 - binder to catalyst ratio
 - waste generation to tonne good product ratio
 - returned castings to tonne good product ratio
- 3.123 There should be continuous movement towards more Sustainable Consumption and Production (i.e. doing more for less) as laid out in Government Guidance “ Changing Patterns - UK Government Framework for Sustainable Consumption and Production” (Ref 7). Section 3.3 of the guidance identifies advice and funding programmes available to achieve more sustainable production practices. The National Industrial Symbiosis Programme shares information across all industrial sectors to produce guidance and case studies for resource efficiency (Ref 7). See also Envirowise Guides (Ref 7) for information.

BAT

- 81 The operator should record materials usage and waste generation in order to establish internal benchmarks. Assessments should be made against internal benchmarks to maintain and improve resource efficiency.
- 82 The operator should carry out a waste minimisation audit at least as frequently as the permit review period. If an audit has not been carried out in the 2 years prior to submission of the application it should be completed within 18 months of the issue of the first PPC permit. The methodology used and an action plan for optimising the use of raw materials should be submitted to the regulator within 2 months of completion of the audit.
- 83 Specific improvements resulting from the recommendations of audits should be carried out within a timescale approved by the regulator.
- 84 For cupola furnaces, slag production should be minimised by optimising the charge ratio of scrap to coke and limestone.
- 85 For all furnace types minimisation of slag production should be achieved by a range of good practice measures such as computer controlled charging operations, simulation models, management and operational procedures to improve metal yield and to optimise material flows.
- 86 Operators should optimise the primary reclamation of foundry sand having regard to the technical feasibility and record the optimal recovery rates achievable.
- 87 Operators should evaluate the options for the beneficial re-use of waste sand. A written report should be submitted to the regulator detailing the extent to which further sand recovery is achievable.

Water use

- 3.124 Water use should be minimised within the BAT criteria for the prevention or reduction of emissions and be commensurate with the prudent use of water as a natural resource.
- 3.125 Reducing water use may be a valid environmental and/or economic aim in itself, perhaps because of local supply constraints. Also, from the point of view of reducing polluting emissions, any water passing through an industrial process is degraded by the addition of pollutants, and there are distinct benefits to be gained from reducing the water used. These include:

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

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

Advice on cost-effective measures for minimising water use can be found in [Ref 6](#).

- 3.126 The amount of water used in foundries is small. Its main uses are as a coolant, as an addition to greensand and as a scrubber medium in abatement plant.
- 3.127 The following general principals should be applied in sequence to reduce emissions to water:
- water-efficient techniques should be used where possible
 - water should be recycled within the process from which it issues, treating it first if necessary. Where this is not practicable, it should be recycled to another part of the process which has a lower water quality requirement
- 3.128 Furnace cooling water (and wet abatement systems) can be maintained within a closed circuit recycling system. Operators should monitor the quality of the return water to ensure that levels of contamination are kept to a minimum. Treatment may be required. The quality specification may be constrained by the need to discharge a recycle purge. The need to purge may be removed by dilution from make-up water required to compensate for evaporative losses.
- 3.129 The volumes of water used by an installation should normally be metered so that water efficiency audits can be carried out and benchmarks can be set for optimal efficiency. In addition, sub-processes that are principal water users should be metered to optimise water usage at individual process plant (see [BAT 92](#)).

BAT

- 88 The operator should carry out a regular review of water use (water efficiency audit) at least as frequently as the permit review period. If an audit has not been carried out in the 2 years prior to submission of the application it should be completed within 18 months of the issue of the first PPC permit.
- 89 Using information from the water efficiency audit, opportunities for reduction in water use should be assessed and, where appropriate, should be carried out in accordance with a timescale approved by the regulator.
- 90 Information from audits should be used to establish benchmarks. Operators should keep records of such benchmarks and make measurement against them to reveal whether the process is being maintained “in control” or to track improvements.
- 91 The volume of mains and abstracted water used in the activities should be directly measured when the installation is operating once a day for at least a fortnight and there after, once a week with an annual exercise taking daily measurements for at least a fortnight. All measurements should be recorded and the records held on site.
- 92 Cooling water top-up should be fitted with a water meter.

Waste handling

- 3.130 Good segregation of materials is essential to facilitate opportunities for recovery, recycling and re-use and to maximise scope for good waste management.
- 3.131 Other than sand, the most important wastes are:
- particulate matter collected in bag or cartridge filters from abatement and sand reclamation plant
 - slag from melting and metal treatment processes
 - scrubber liquors and sludges, and output from the effluent treatment plant
 - refractory waste from furnaces, launders and ladles
 - chemical and oil containers
 - general inert industrial waste
 - packaging waste including wood and paper

Environmental impact

Water:	Not significant
Land:	Fugitive releases, particularly leaks from liquid wastes or “empty” containers.
Air:	Fugitive dust from handling and transfer.
Waste:	Most foundry wastes are disposed of to landfill.
Energy:	Not significant
Accidents:	Not significant
Noise:	Not significant

BAT

- 93 The operator should produce an inventory of the quantity, nature, origin and where relevant, the destination, frequency of collection, mode of transport and treatment method of any waste which is disposed of or recovered.
- 94 Operators should segregate the main waste types described in [3.131](#).
- 95 Operators should ensure that waste stored in containers that are durable for the substances stored and that incompatible waste types are kept separate.
- 96 Operators should ensure that waste storage areas are clearly marked and signed, and that containers are clearly labelled.
- 97 All containers for slag, swarf and packaging materials should be stored under cover or in sealed containers with lids secured and in place (this also applies to emptied containers). Liquid wastes should be stored in sealed containers in bunded areas. Operators should ensure that procedures are in place to deal with damaged or leaking containers.

Waste re-use, recovery, recycling or disposal

- 3.132 Waste should be re-used, recovered or recycled unless the regulator has accepted a satisfactory BAT justification for landfill disposal.
- 3.133 **Table 9** summarises the routes currently taken by the various waste streams from a typical foundry site. Whether re-use, recovery or recycling is possible at a particular site will depend on the particular fuels and raw materials being used, the products being made and the methods of operation employed. The table reflects where recycling can be achieved when the appropriate combination of these factors is in place.
- foundry sand recycling should be optimised. Recovery of core sand with mould sand recovery systems can minimise the need for top-up of mould sand.
 - where recycling cannot be achieved most foundry sands can be beneficially re-used by third parties provided that they are kept dry, separate from other materials, and in many cases, reduced to grain size. In many cases, the technical feasibility of re-use has yet to be matched by economic viability.
- 3.134 Operators should seek to establish markets for the recovery or recycling of wastes generated within the installation. Envirowise guides provide information on the recycling of foundry wastes (**Ref 4** and **Ref 7**) such as foundry sand and slag. In addition, the Waste & Resources Action Programme (WRAP) researches and can provide guidance into recycling of other wastes such as wood, paper, cardboard and plastics (**Ref 9**).

Table 9: Solid waste stream: routes currently taken

Process waste stream	Fate
Particulate matter collected in abatement plant	Recycled where possible, or landfilled
Dust from Greensand recovery plant	Can be recycled
Greensand	Reclaimed for internal re-use to the extent possible, then beneficial re-use by third party wherever possible.
Core sand	Can be recycled within Greensand recovery plant Burnt cores often landfilled
Particulate matter from knock-out or casting fume extraction abatement plant	Landfill
Desulphurisation: slag	Landfill - not suitable for recycling
Melting operations: slag	Can be recycled to furnace depending on melt quality constraints
Melting operations: refractory waste	Landfill
Nodularisation dust - primarily magnesium oxide	Recycling to be investigated - otherwise to landfill
Fettling scrap, swarf and metal turning disks	Recycled to furnace, where practical
Ceramic filters from fettling extraction	Can be recycled to furnace
Scrubber liquors and sludges	Minimised, then to licensed waste disposal contractors
Wood, cardboard and paper	Segregated for off site re-use or recovery
Oil	Recovery off site

BAT

- 98 The operator should carry out an annual review to demonstrate that the best environmental options are being used for dealing with the waste streams listed on [Table 9](#).
- 99 The operator should regularly investigate potential markets for the recovery/re-use of wastes that are currently disposed of to landfill.

Energy

3.135 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 efficiency requirements below and is a participant to a Climate Change Agreement (CCA), a Direct Participation Agreement (DPA) with the Government or European Union Emission Trading Scheme (EUETS) commitments

or

- the operator meets the basic energy efficiency requirements below and the additional energy efficiency requirements

Basic energy efficiency requirements

3.136 The requirements of this section are basic, low cost, energy standards that apply whether or not a CCA or DPA is in force or the operator has EUETS commitments for the installation.

BAT

- 100 The operator should produce a report annually on the energy consumption of the installation.
- 101 The operator should monitor energy flows and target areas for reduction which should be updated annually. ("Sankey" diagrams and energy balances would be useful as aids.)
- 102 In order to optimise combustion, the operator should, where practicable, monitor carbon monoxide and oxygen in waste gases.
- 103 The operator should ensure that all plant is operated and maintained to optimise the use and minimise the loss of energy.
- 104 The operator should ensure that all appropriate containment methods, (e.g. seals and self-closing doors) are employed and maintained to minimise energy loss.

Additional energy efficiency requirements

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

Energy efficiency techniques

105 The following techniques should be considered:

- heat recovery from different parts of the processes
- minimisation of water use and closed circulating water systems
- good insulation
- plant layout to reduce pumping distances
- using dedicated air compressors for finishing when mould preparation not operating
- phase optimisation of electronic control motors
- optimised efficiency measures for combustion plant e.g. air/feedwater preheating, excess air etc.

Energy supply techniques

106 The following techniques should be considered:

- use of Combined Heat and Power (CHP)
- utilising waste heat from cooling operations to provide space heating
- generation of energy from waste
- optimising calorific value of fuels (e.g. coke)
- use of less polluting fuels

Accidents

3.138 For accident management, there are three particular components:

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

3.139 Further guidance can be found in chapter 20 of the General Guidance Manual and provide guidance that may be relevant in the event of fire. See also [Ref 10](#) and [Ref 11](#).

Identification of the hazards

3.140 In identifying the hazards particular areas to consider may include, but should not be limited to, the following:

- transfer of substances (e.g. loading or unloading from or to silos or storage tanks)
- overfilling of silos or tanks
- failure of plant and/or equipment (e.g. extraction fans or pumps, over-pressure of storage silos and pipework, blocked drains)
- failure of containment (e.g. bund and/or overfilling of drainage sumps)
- fires and problems arising from fighting fires such as failure to contain firewaters
- making the wrong connections in drains or other systems
- preventing incompatible substances coming into contact
- unwanted reactions and/or runaway reactions
- emission of an effluent before adequate checking of its composition has taken place
- steam main issues
- vandalism
- vehicle movements

Identification of the risks

3.141 The hazards having been identified, the process of assessing the risks should address the following:

- 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)?

Measures to reduce the risks (identified by risk assessment)

3.142 Risk reduction can be achieved by process management controls and preventative measures. The following techniques will be relevant to most installations, although this is not an exhaustive list.

Process management controls

- process design, alarms, trips and other failsafe control techniques to ensure the safe operation of the plant
- security systems to prevent unauthorised access
- records of all incidents, near-misses, changes to procedures, abnormal events and findings of maintenance inspections and procedures to learn from such incidents
- personnel suitably trained in accident management
- guidance for specific accident scenarios
- procedures to ensure good communication among operations staff during shift changes and maintenance or other engineering work
- safe shutdown procedures
- established communication routes with relevant authorities and emergency services

Preventative measures

- procedures to ensure that the composition of the contents of a bund /sump is checked before treatment or disposal
- drainage sumps equipped with a high-level alarm with automatic pump to storage (not to discharge)
- high-level alarms etc. (which should not be routinely used as the primary method of level control)
- adequate standby plant or equipment maintained and tested to operational standards sufficient storage to contain process waters, site drainage waters, emergency firewater, chemically contaminated waters and spillages of chemicals, which should be routed where necessary, having regard to a site-specific assessment of risks, to the effluent system
- provision to contain surges and storm-water flows, which should be treated where necessary, having regard to a site-specific assessment of risks, before emission to controlled waters or sewer
- spill contingency procedures to minimise the risk of accidental emission of raw materials, products and waste materials and to prevent their entry into water
- 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.
- suitable barriers to prevent damage to equipment from the movement of vehicles, as appropriate, having regard to a site-specific assessment of risks
- 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.
- where indicated by the site-specific assessment of risks, containment or abatement for accidental emissions from vents and safety relief valves/bursting discs should be provided. Where this may be inadvisable on safety grounds, attention should be focused on reducing the probability of the emission

BAT

Accidents/incidents/non conformance

107 There should be written procedures for investigating incidents and near misses, including identifying suitable corrective action and following up.

108 The operator should maintain an accident management plan covering the matters listed in paragraphs 3.140 to 3.142 above and to the satisfaction of the regulator. The plan should be available for inspection by the regulator.

109 In the case of abnormal emissions arising from an accident, such as a spillage for example, the operator should:

- investigate undertake remedial action immediately
- promptly record the events and actions taken
- ensure the regulator is made aware without delay

Specific conditions

110 Specific conditions may need to be included within permits to prevent accidents. Examples of these are given in 111 – 116 below.

111 Operators should provide for safe storage and conveying systems for both liquid raw materials and wastes in order to minimise the potential for vandalism or accidental damage. Regular inspection should be carried out on pipelines, valves and pumps to inspect for damage and wear.

112 The operator should maintain procedures for the control of spills and of firewater to ensure containment and disposal of liquids in order to prevent or minimise pollution.

113 Systems should be used to avoid excessive transfer rates of solids by pneumatic conveyors that might lead to over pressurisation and filter failure or tank / silo overfilling leading to spillage of liquids or powders.

114 Operators should ensure that materials are charged into the correct silo or tank to minimise the potential for causing waste, spillage or uncontrolled chemical reaction.

115 Operators should use safe systems for the handling and storage of coal dust used for mould manufacture in order to minimise the risk of fire and explosion which would cause an emission of smoke, particulate matter and other combustion products to air and deposition of coal dust to land.

116 Calcium carbide used for desulphurisation must be kept dry to avoid the risk of acetylene gas emission.

Noise and Vibration

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

3.144 The most significant source of noise arises as a result of the following activities:

- scrap handling (deliveries and charging)
- other raw material handling
- fans and motors
- vehicle movements
- knock-out/ shake-out
- shot blasting, grinding, fettling and other engineering operations
- activities using compressed air

3.145 Noise surveys, measurement, investigation (which can involve detailed assessment of sound power levels for individual items of plant) or modelling may be necessary for either new or existing installations depending upon the potential for generating significant noise. Operators may have a noise management plan as part of their management system. Where an installation poses no risk of noise related environmental impact because the activities undertaken are inherently quiet or remote from receptors; these measures would not normally be required.

3.146 Following investigation of the impact of the installation, systems to minimise the environmental impact of the noisiest operations should be employed. The level of noise control required depends on the scale of operations and the proximity of operations to the public. **Table 10** identifies the noisiest operations and the control measures that have been employed to mitigate problems.

3.147 Further guidance can be found in chapter 16 of the General Guidance Manual.

Table 10: Noise Mitigation Measures

Operation	Control Measure
Scrap Deliveries	<ul style="list-style-type: none"> ▪ scrap storage in enclosed area ▪ minimising deliveries at night* ▪ minimise the drop height for scrap deliveries
Scrap Handling and charging	<ul style="list-style-type: none"> ▪ develop storage systems to avoid double handling ▪ minimising charging height ▪ use screens and barriers to conceal noise sources
Site Vehicle Movements	<ul style="list-style-type: none"> ▪ using vehicles with “directional and localised sound” for reverse alarms to concentrate noise at the area of immediate danger ▪ replacing diesel powered forklift trucks with electric powered ▪ minimising vehicle movements at night
Knock-out / shake-out	<ul style="list-style-type: none"> ▪ acoustic screens and enclosures* ▪ cushion impacts using resilient linings ▪ make stillages, chutes and tables less effective noise radiators
Fans, pumps and motors	<ul style="list-style-type: none"> ▪ acoustic screens, enclosures and baffles ▪ fitting silencers to avoid noise travelling along ducting ▪ selection of less noisy engineering equipment
Grinding, fettling and shot blasting	<ul style="list-style-type: none"> ▪ acoustic screens and enclosures* ▪ selection of less noisy engineering equipment
General	<ul style="list-style-type: none"> ▪ fitting noise reducing flaps to outside doors ▪ maintaining a closed doors policy ▪ improving sound insulation of buildings ▪ holes and openings closed off (use mechanical where necessary) ▪ enclose foundry operations within buildings
* Noise mitigation measures that are likely to be needed in most cases	

BAT

117 The operator should identify key plant and equipment with the potential to give rise to significant noise and take such measures as are necessary by way of mitigation and maintenance of existing plant and equipment in order to minimise noise having regard to paragraph 3.146 and **Table 10** above.

118 Scrap handling systems should be so designed, where practicable (having regard to legitimate space constraints) to avoid double handling and to minimise the drop height for deliveries and charging operations.

Monitoring

3.148 This section describes general monitoring and reporting requirements for emissions to all environmental media. Guidance is provided for the selection of the appropriate monitoring methodologies, frequency of monitoring, compliance assessment criteria and environmental monitoring. The specific monitoring requirements with respect to emissions to air are described in **Table 3**.

Standards for monitoring equipment and procedures

- 3.149 The Environment Agency has introduced its Monitoring Certification Scheme (MCERTS) to improve the quality of monitoring data and to ensure that the instrumentation and methodologies employed for monitoring are fit for purpose.
- operators should ensure their monitoring arrangements comply with the requirements of MCERTS where available, e.g. using certified instruments and equipment, and using a registered stack testing organisation etc.

See <http://www.environment-agency.gov.uk> for listing of MCERTS equipment.

Sampling and analysis standards

- 3.150 The sampling analytical methods selected for compliance monitoring given in Table 3 should normally be used in the following order of priority:
- Comité Européen de Normalisation (CEN)
 - International Standardisation Organisation (ISO)
 - British Standards Institution (BSI)
 - United States Environmental Protection Agency (US EPA)
 - American Society for Testing and Materials (ASTM)
 - Deutsches Institut für Normung (DIN)
 - Verein Deutscher Ingenieure (VDI)
 - Association Française de Normalisation (AFNOR)
- 3.151 Guidance on standards for monitoring releases (to air, water and land) relevant to IPPC can be found in [Ref 8](#).
- 3.152 When selecting monitoring test methods, it is important to note that test methods are normally applicable to specific matrices (in relation to water) and concentrations of various pollutants (in relation to air). It is necessary to identify the most appropriate method in consideration of the hierarchy of methods. For example, if two methods are appropriate, the hierarchy is used to determine priority.
- 3.153 If in doubt the operator should consult the regulator.

Monitoring and sampling protocols

- 3.154 Where monitoring is needed the operator should devise a monitoring strategy to address the following:
- determinands to be monitored
 - selection of monitoring points
 - monitoring methods and procedures (selection of appropriate Standard Reference Methods)
 - reference conditions and averaging periods
 - measurement uncertainty of the proposed methods and the resultant overall uncertainty
 - drift correction for continuous analysers
 - quality assurance (QA) and quality control (QC) protocols, including accreditation and certification
 - 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 to the regulator

Monitoring frequency

- 3.155 The frequency of testing should be increased, for example, as part of the commissioning of new or substantially changed activities, or where the emission levels are near to or approach the emission limit.
- 3.156 Where non-continuous quantitative monitoring is required, the frequency may be varied. Where there is consistent compliance with emission limits, regulators may consider reducing the frequency. When determining 'consistent compliance' factors to consider include:
- the variability of monitoring results, for example, results which range from 15 - 45 mg/m³, against an emission limit of 50 mg/m³ might not qualify for a reduction in monitoring

- the margin between the results and the emission limit, for example, results which range from 45 - 50 mg/m³ when the limit is 50 mg/m³ might not qualify for a reduction in monitoring.
- 3.157 Consistent compliance should be demonstrated using sequential results for example at least three or more monitoring exercises within two years, or two or more monitoring exercises in one year supported by continuous monitoring. Any significant process changes which might have affected the results should be taken into account.
- 3.158 Where effective surrogates are available they may be used to minimise monitoring costs.
- 3.159 Where monitoring shows that substances are not emitted in significant quantities, consideration can be given to a reduced monitoring frequency.

Monitoring emissions to air

- 3.160 The reference conditions of substances in releases to air from point sources are: temperature 273.15 K (0°C), pressure 101.3 kPa (1 atmosphere) and measured wet, no correction for water vapour. To convert measured values to reference conditions, see Technical Guidance Note M2 ([Ref 12](#)) for more information.

Monitoring emissions to water

- 3.161 The appropriateness of the monitoring requirements in Section 2 will vary depending upon the sensitivity of the receiving water and should be proportionate to the scale of the operations, nature of the discharge and receiving water. For each release point the following information is required:
- the specific volume flow from the process to sewer/controlled water
 - the quality of the receiving water
 - the volume of discharge compared to the percentage dry river flow of the receiving water

Environmental monitoring (beyond installation)

- 3.162 Environmental monitoring may be required, for example, when:
- there are vulnerable receptors
 - the emissions are a significant contributor to an Environmental Quality Standard (EQS) which may be at risk
 - the operator is looking for departures from standards based on lack of effect on the environment
 - the operator is required to validate modelling work
- 3.163 Further guidance is given in chapter 15 of the General Guidance Manual.

Monitoring of process variables

- 3.164 Some process variables will have potential environmental impact and these should be identified and monitored where they have an environmental relevance. For foundry activities, examples of monitoring these variables include:
- keeping inventories of materials used and disposed of
 - monitoring for contaminants in raw materials where scrap is used or where there is inadequate supplier information
 - monitoring temperature or pressure where relevant, for example molten metal temperature, pressure drop across bag filters
 - plant efficiency monitoring, for example sand reclamation plant efficiency

Monitoring and reporting

- 119 The operator should monitor emissions, make tests and inspections of the process and keep records; in particular the operator should keep records of audits, inspections, tests and monitoring, including all non-continuous monitoring, inspections and visual assessments. Monitoring may include process variables and operating conditions where relevant to emissions. In such cases:
- current records should be kept on site and be made available for the regulator to examine
 - records should be kept by the operator for at least two years
- 120 The operator should notify the regulator at least 7 days before any periodic monitoring exercise to determine compliance with emission limit values. The operator should state the provisional time and date of monitoring, pollutants to be tested and the methods to be used.
- 121 The results of non-continuous emission testing should be forwarded to the regulator within 8 weeks of the completion of the sampling. Results from continuous monitoring systems should be recorded and be made available for inspection by the regulator.
- 122 All results submitted to the regulator should include details of process conditions at the time of monitoring, monitoring uncertainty as well as any deviations from the procedural requirements of standard reference methods and the error invoked from such deviations.
- 123 Results exceeding the emission limit value from **any** monitoring activity (both continuous and non-continuous) and malfunction or breakdown leading to abnormal emissions should be investigated and corrective action taken immediately. The operator should ensure that the regulator is notified without delay identifying the cause and corrective action taken. Where there is immediate danger to human health, operation of the activity should be suspended.
- 124 Sampling points on new plant should be designed to comply with CEN or Other Standards. e.g. BS EN 13284-1 or BS ISO 9096: 2003 for sampling particulate matter in stacks.
- 125 Continuous monitoring is normally expected for the main abated releases in [Table 3](#). Where continuous monitoring is required by the permit instruments should be fitted with audible and visual alarms, situated appropriately to warn the operator of arrestment plant failure or malfunction, the activation of alarms should be automatically recorded and readings should be on display to appropriately trained operating staff.
- 126 All continuous monitors should be operated, maintained and calibrated (or referenced) in accordance with the appropriate standards and manufacturers' instructions, which should be made available for inspection by the regulator. Instruments should be designed for less than 5% downtime over any 3-month period and all relevant maintenance and calibration (or referencing) should be recorded.
- 127 Where available, operators should use monitoring equipment and instruments certified to MCERTS and use a stack-testing organisation accredited to MCERTS standards or such alternative requirements as approved by the regulator.

Monitoring and reporting of emissions to air

- 128 Exhaust flow rates of waste gases should be consistent with the efficient capture of emissions, good operating practice and meeting the requirements of the legislation relating to the workplace environment.
- 129 The introduction of dilution air to achieve emission concentration limits should not be permitted.
- 130 Dilution air may be added where justified for waste gas cooling or improved dispersion. In such cases, monitoring should be carried out upstream of the dilution air input or procedures designed to correct for the ratio of input air to the satisfaction of the regulator.

131 Monitoring to determine compliance with emission limit values should be corrected to the following standard reference conditions: temperature, 273.15 K (0°C), pressures 101.3 kPa (1 atmosphere) and measured wet, no correction for water vapour.

132 Periodic visual assessment of releases should be undertaken as required by the regulator to ensure that all final releases are colourless, free from persistent visible emissions and free from droplets.

133 Where abatement equipment is required to comply with the particulate matter provisions of this note then the particulate matter emissions should be continuously monitored to indicate the performance of the abatement plant. Where airflow is less than 150 m³ per minute, surrogate parameters as an alternative to continuous monitoring may be considered where the operator can demonstrate equivalent control to the satisfaction of the regulator.

134 Where wet scrubbers are being used, monitoring surrogate parameters may be acceptable as an alternative to continuous monitoring where the operator can demonstrate equivalent control. Scrubber liquor flow should be continuously monitored, triggering an alarm and stand-by pump in the event of pump failure.

Monitoring and reporting emissions to water and sewer

135 The appropriateness of the monitoring requirements will vary depending upon the sensitivity of the receiving water and should be proportionate to the scale of the operations, nature of the discharge and receiving water. For each release point the following information is required:

- the specific volume flow from the process to sewer/controlled water
- the sensitivity of the receiving water
- the volume of discharge compared to the percentage dry river flow of the receiving water

136 Increased monitoring should be carried out where substances to which the local environment may be susceptible could be released from the installation, e.g. where releases of common pesticides or heavy metals may occur.

137 A full analysis, to include the substances listed in Schedule 5 of the Regulations, should be carried out annually on a representative sample from each release point, unless it is agreed with the regulator that this is inappropriate.

Monitoring and reporting of waste

138 The following should be monitored and recorded:

- quantity nature and origin of the waste
- the physical description of the waste
- a description of the composition of the waste
- any relevant hazardous properties (hazard and risk phrases)
- European Waste Catalogue code
- handling precautions and substances with which it cannot be mixed
- disposal routes for each waste category

Information Provisions

- 3.165 This guidance note contains many provisions relating to information. There are two general categories of information identified in this note:
- reports or notifications
 - additional information
- 3.166 Reports are required and notifications are information that should be sent to the regulator at a frequency that is specified in this guidance. Such information provisions are summarised in [Table 11a](#) below.

Table 11a: Summary of Provisions for Reporting and Notification

BAT Clause	Provision	Information Category	Frequency
BAT 33	Investigation of the cause and nature of any persistent visible emissions	Report	Reactive
BAT 72	List of key process equipment and process and abatement equipment whose failure could impact on the environment	Report	Within 12 months of publication of this note
BAT 87	Assessment of the extent to which further sand recovery is achievable	Report	Within 18 months of issue of the permit
BAT 121 & 122	Report of results from non-continuous emission testing forwarded to the regulator.	Report	Within 8 weeks of the completion of the sampling – typically annual
BAT 75	Notification of appointed competent person to liaise with the regulator and the public with regard to complaints	Notification	Reactive
BAT 109	Investigation of abnormal emissions arising from an accident. Remedial action taken immediately. Prompt recording of the events and actions taken. Notification of the regulator without delay*	Notification	Reactive
BAT 120	Notification at least 7 days before any periodic monitoring exercise to determine compliance with ELVs	Notification	Reactive
BAT 123	Investigation of results exceeding an ELV from any monitoring activity and malfunction or breakdown leading to abnormal emissions. Corrective action taken immediately. Notification without delay* identifying the cause and corrective action taken.	Notification	Reactive
<p>*Without delay In most cases it should be enough to notify the local authority (by telephone or facsimile) within an hour of the start or detection of the emission. Local authorities will wish to consider what notification arrangements to require outside working hours.</p>			

- 3.167 Additional information relates to procedures or records (including details of assessments, investigations and audits). Such information should be held by the operator and be accessible so that the regulator may view the information. For much of the information, on-site inspection may be sufficient for the regulator, subject to the particular circumstances. Regulators may be more likely to ask operators to send them copies of those items marked with an asterisk. The majority of this information is likely to be the same as would be required in any event when using an effective EMS, so documents can be produced which serve both purposes.
- 3.168 Annex 4 of ISO 14001 gives some detailed examples of information and document control but by way of generality A.4.4 states that “The extent of the environmental management system documentation may differ from one organization to another depending on
- (a) the size and type of organization and its activities, products of services,
 - (b) the complexity of processes and their interactions, and
 - (c) the competence of personnel

Examples of documents include

- statements of policy, objectives and targets,
- information on significant environmental impacts,
- procedures,
- process information,
- organisational charts,
- internal and external standards,
- site emergency plans, and
- records”

3.169 Relating to documentation, Annex I of the EC Regulation No 761/2001 on the eco-management and audit scheme (EMAS) states that “the organisation shall establish and maintain procedures for controlling all documents required by this International Standard...”. The Annex goes on to provide details on what is required and includes the following headings:

- Structure and responsibility
- Training, awareness and competence
- Management review
- Communication
- Environmental management system documentation
- Document control
- Operational control
- Emergency preparedness and response
- Monitoring and measurement
- Non-conformance and corrective and preventive action
- Records
- Environmental management system audit

3.170 Additional information provisions are summarised in [Table 11b](#) below.

Table 11b: Summary of Provisions for Additional Information

BAT Clause	Category	Subject
BAT 5	Procedures	Optimal melting and charging practices
BAT 32	Procedures	Start-up and shut down, and changes of fuel or combustion load in order to minimise emissions
BAT 58	Procedures	Preventative maintenance programme for subsurface structures (control, maintenance and inspection).
BAT 63	Procedures	Preventative maintenance programme for tanks bunds and sumps
BAT 64*	Procedures	Control measures to minimise the pollution risk from solvent storage
BAT 66	Procedures	Odour management plan
BAT 70	Procedures	Environmental Management System. Records of EMS audits
BAT 71*	Procedures	Operational and maintenance systems for all aspects of the installation whose failure could impact on the environment – annual review
BAT 76 & 77	Procedures	Formal structure of employee’s responsibility for process control and environmental impacts and training provisions
BAT 79	Procedures	Investigating accidents, incidents and non-conformance
BAT 80*	Procedures	Control the specification of raw materials with respect to their environmental impact. Review of alternative raw materials
BAT 97	Procedures	Dealing with damaged or leaking containers
BAT 107	Procedures	Incidents and near misses investigation. Corrective action and following up
BAT 112	Procedures	Spills and firewater control to ensure containment and disposal of liquids
BAT 113	Procedures	Systems to avoid excessive transfer rates of solids
BAT 115	Procedures	Safe systems for the handling and storage of coal dust
BAT 45	Records	Inspections and maintenance of interceptors
BAT 54	Records	Inspections of external surfaces of process buildings, roofs, guttering, ancillary plant, roadways and open yards and storage areas

BAT 57	Records	Drainage plans
BAT 63	Records	Visual inspection of tanks, bunds and sumps
BAT 65	Records	Odour assessments
BAT 67*	Records	Substitution plans for odorous production methods
BAT 74	Records	Analysis of breakdowns in order to eliminate common failure modes.
BAT 81 to 83*	Records	Waste minimisation audits and improvement programme
BAT 88 & 89*	Records	Water efficiency audit and water efficiency improvement programme
BAT 91	Records	Water usage measurements
BAT 93*	Records	Waste inventory and treatment method
BAT 98*	Records	Annual review of waste disposal and recovery options
BAT 100*	Records	Annual energy audit
BAT 108*	Records	Accident management plan
BAT 117	Records	Identification of key plant and equipment with the potential to give rise to significant noise. Mitigation measures
BAT 121	Records	Results from continuous monitoring systems
BAT 126	Records	Maintenance and calibration of continuous monitoring systems
BAT 137	Records	Analysis for Schedule 5 substances (where needed)
BAT 138	Records	Records of waste monitoring and recording
* Information that Regulators may be more likely to ask operators to send them copies of rather than relying only on inspection		

3.171 The amount of information and size of reports or documents required under the information provisions should be decided on a 'fit for purpose' basis. The label 'report' or 'record' should not be taken to imply that a sizeable document must be submitted if the required information can be provided in much shorter form. A report could comprise a paragraph or two if that was agreed to be sufficient for the purpose. Alternatively, lengthy documents may be necessary in particular circumstances.

All the information listed in tables 11a and b is considered necessary either

- a) for regulators to keep a watch on the performance of an installation (e.g. monitoring data and who is the competent person to liaise with over complaints) or on the operator's efforts to improve performance (e.g. waste minimisation and energy audits), and/or
- b) for operators to maintain an appropriate level of control over the installation, and which regulators should have access to should they wish to check that the information is being properly kept or to examine the information for regulatory purposes.

References

Environment Agency documents referred to below are available from the Environment Agency website <http://www.environment-agency.gov.uk>. Many of the references below are being made available free of charge for viewing or download on the website. The same information can also be accessed via the SEPA website <http://www.sepa.org.uk>, or the NIEHS website www.ehsni.gov.uk

- Ref 1 *The Pollution Prevention and Control (England and Wales) Regulations (SI 1973 2000) as amended* (www.legislation.hmso.gov.uk) or the Scottish equivalent SSI 323 2000
- Ref 2 *Secretary of State's Guidance (England and Wales): General Guidance Manual on Policy and Procedures for A2 and B Installations*, March 2003 - available from the Defra website and, in hard copy, from the Defra Publications line 08459 556000 www.defra.gov.uk/environment/ppc/index.htm
- Ref 3 Surface water & Groundwater Protection Guidance
- AQ11 (05) - Regulating water discharges from A2 Installations. Available via the Defra website www.defra.gov.uk
 - Groundwater Protection Code – Solvent Use and Storage, Defra 2004
- Ref 4 'Envirowise (formerly the Environmental Technology Best Practice Programme, ETBPP) www.envirowise.gov.uk, Harwell International Business Centre, Didcot, Oxfordshire OX11 0QJ. Helpline 0800 585794. Good Practice Guides:
- GG104 Cost effective management of chemical binders in foundries.
 - GG71 Cost-effective reduction of fugitive solvent emissions.
 - GG119 Optimising sand use in foundries.
 - EG172 Trends in Chemically Bonded Sand Use and Reclamation
 - EG173 Trends in Greensand Use and Reclamation.
 - CH171 Savings from Re-Use of a Foundry By-Product
- Ref 5 *HMIP Technical Guidance Note (Dispersion) D1*, 1993 The Stationery Office ISBN 0 11 752794 7
- Ref 6 Water efficiency references available from Envirowise:
- GC22, Simple measures restrict water costs,
 - GG26, Saving money through waste minimisation: Reducing water use, GG26
- Ref 7 Management, Resource Efficiency and Waste Minimisation References
- Defra/DTI - Changing Patterns - UK Government Framework for Sustainable Consumption and Production Sept 2003
 - National Industrial Symbiosis Programme www.nisp.org.uk/
 - Envirowise,GG043, Environmental Management Systems in Foundries
 - Envirowise, GG025, Saving money through waste minimisation: Raw Material Use
- Ref 8 Process Optimisation References
- Envirowise, GG470, Improving yield and reducing costs in foundry operations
 - Action Energy, FL98014, The Essentials: Foundries
 - Action Energy, GPG166, Energy Savings in Foundry Services
 - Action Energy, GPCS344, Energy Savings From Small; Efficient Melting and Holding Furnaces
 - Action Energy, GPG017, Achieving High Yields in Iron Foundries
- Ref 9 Waste & Resources Action Programme (WRAP), The Old Academy, 21 Horse Fair, Banbury, Oxon OX16 0AH. helpline@wrap.org.uk
- Ref 10 *BS 5908: Code of Practice for Fire Precautions in the Chemical and Allied Industries*
- Ref 11 *Environment Agency, Pollution Prevention Guidance Note - Pollution prevention measures for the control of spillages and fire-fighting run-off*, PPG 18, gives information on sizing firewater containment systems ([Environment Agency website](http://www.environment-agency.gov.uk))
- Ref 12 Monitoring Guidance ([Environment Agency website](http://www.environment-agency.gov.uk))
- *M1 Sampling requirements for monitoring stack emissions to air from industrial installations*, Environment Agency July 2002
 - *M2 Monitoring of stack emissions to air*. Environment Agency October 2004
 - *Guidance on sampling and testing of wastes to meet landfill waste acceptance procedures*. Environment Agency Version 4.3a December 2003
 - *MCERTS approved equipment link via <http://www.environment-agency.gov.uk/> "Guidance for Business and industry"*

Abbreviations

BAT	Best Available Techniques
BOD	Biochemical Oxygen Demand
BREF	BAT Reference Document
CCA	Climate Change Agreement
CEM	Continuous Emissions Monitoring
CHP	Combined Heat and Power plant
CO₂	Carbon Dioxide
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
COSHH	Control of Substances Hazardous to Health
DMEA	Dimethylethylamine
DPA	Direct Participation Agreement
EA	Environment Agency
EAL	Environment Assessment Level
ELV	Emission Limit Value
EMS	Environmental Management System
ETP	Effluent Treatment Plant
EU	European Union
EUETS	European Union Emissions Trading Scheme
EQS	Environmental Quality Standard
HCl	Hydrogen Chloride
H₂S	Hydrogen Sulphide
ITEQ	International Toxicity Equivalents
MCERTS	Monitoring Certification Scheme
MDI	Methyl Di-isocyanate
NIEHS	Northern Ireland Environment and Heritage Service
NO₂	Nitrogen Dioxide
PAH	Polyaromatic Hydrocarbon
SAC	Special Areas of Conservation
SEC_p	Specific Energy Consumption
SEPA	Scottish Environment Protection Agency
SG Iron	Spheroidal Graphite Iron
SG Iron	Spheroidal Graphite Iron
SO₂	Sulphur Dioxide
SPA	Special Protection Area
TEA	Triethylamine
TSS	Total Suspended Solids
TOC	Total Organic Carbon
VOC	Volatile Organic Compound
WAG	Welsh Assembly Government

Appendix 1: Summary of Changes

Reasons for the main changes are summarised below.

Table 12: Summary of changes

Section/ Paragraph/ Heading	Change	Reason	Comment
1. Introduction			
Table 1	compliance timetable amended	New provisions of note	
2. Emission limits and other provisions			
Table 3, Row 9	Note included relating to ELV for amines	Consolidated AQ16(04)	ELV applied where offensive odour occurs.
Table 4	New suspended solids limit 50 mg/l limit	BAT	Previously the ELV was 20 mg/l. Amended following BAT assessment
3. Techniques for pollution control			
Installation description and in-process controls			
BAT 1 – BAT 4 Deliveries	BAT provisions consolidated	BAT/industry good practice	Seven BAT clauses reduced to 4 in light of review information
3.12 Melting operations	Reduced text on melting activity descriptions	BREF descriptions	
BAT 5 Melting operations	Documenting optimal melting and charging procedures	BAT/industry good practice	BAT clause
BAT 10 Manufacture of Cores and Moulds	Selection criteria for core and mould manufacturing techniques	BAT/industry good practice	Odour control
Tables 6 & 7 Manufacture of Cores and Moulds	Inclusion of information on expandable pattern casting	Extra guidance to regulators	
BAT 22 – BAT 24 Sand reclamation/ product engineering	The provisions of 2 BAT clauses moved to other Sections	Restructuring Sector Guidance	The 2-year review resulted in sector specific clauses added or moved to other sections
Emissions Control			
BAT 46 and 47 Point source emissions to surface water and sewer	Inclusion of BAT clauses for recycling water cooling and wet-abatement	BAT	Separate provisions for new and existing plant
3.69 to 3.70 Point source emissions to surface water and sewer	Amended text relating to off-site effluent treatment	Consolidation of AQ11(05)	
3.71 and BAT 50 Point source emissions to groundwater	Replacement paragraph and BAT clause	Groundwater Regulations - extra guidance to regulators and operators	
BAT 51 – BAT 56 Fugitive emissions to air,	BAT provisions consolidated	BAT/industry good practice	Seven BAT clauses reduced to 4 in light of review information
3.73 to 3.81 & BAT 57 - 58 Fugitive emissions to surface water, sewer and groundwater	New paragraphs and BAT clauses on groundwater and surface water protection	Industry good practice, further guidance to industry and regulators	
3.82 to 3.100 and BAT 65 to 69 Odour	Inclusion of provisions on assessment, prevention, minimising and abatement	BAT/industry good practice	Restructuring Sector Guidance - extra guidance to regulators and operators

Management			
BAT 70	Additional BAT provision for using effective EMS	BAT/industry good practice	
BAT 75 to 77	A formal organisational structure for environmental control	BAT/industry good practice	
Raw Materials			
3.113 and Table 8	Amended text and table for raw materials selection criteria	Extra guidance to regulators and operators	
3.123	Guidance on sustainable consumption and production	Extra guidance to regulators and operators	Government Policy
3.122 & BAT 81	BAT provision – Benchmarks for raw materials usage	BAT/industry good practice	
BAT 84 to 87	BAT provisions – slag minimisation and sand reclamation	BAT/industry good practice	Envirowise Guides given as reference
BAT 90	BAT provision – establishing benchmarks for water use	BAT/industry good practice	
Waste Handling			
BAT 93 to 97	BAT provisions consolidated	BAT/industry good practice	Seven BAT clauses reduced to 4 in light of review information
Waste re-use, recovery, recycling or disposal			
BAT 98	Annual review disposal options and to investigate new markets for waste recovery	BAT	Envirowise and WRAP guides given as reference
Energy			
BAT 105 and 106	Additional provisions for energy efficiency and supply techniques	BAT	
Accidents			
3.141	Inclusion of text for identification of the risks	Extra guidance to regulators and operators	
BAT 111 to 116	Additional provisions - specific measures for accident prevention	BAT/industry good practice	
Noise and Vibration			
3.146 and Table 10	Additional text and new table identifying specific noise mitigation measures	BAT/industry good practice	
BAT 117 and 118	Additional provisions – identification of significant noise sources and implementing mitigation measures in Table 10.	BAT/industry good practice	
Monitoring			
3.152	Considering appropriateness when selecting test methods	Extra guidance to regulators and operators	
BAT 122 & BAT 123	Provisions for reporting monitoring uncertainty and abnormal emissions	BAT/industry good practice	Previous text referred to reporting continuous monitoring if double the ELV
BAT 138	Waste reporting	BAT/industry good practice	To assist in waste auditing to minimise the impact of waste to land
Information Provisions			
3.165 to 3.171, Tables 11a and 11b	Additional text and new tables identifying information and reporting provisions	Extra guidance to regulators and operators	
References	Amended reference list	New guidance and information available	
Appendix 1 and Table 12	New Appendix 1 included as a summary of changes		Appendix 1 on test methods now Appendix 2

Appendix 2: Some Common Monitoring Methods for Releases to Water

Table 13: Measurement methods for common substances to water

Determinand	Method	Detection limit	Valid for range mg/l	Standard
Suspended solids	Filtration through glass fibre filters	2 mg/l	20% 10-40	ISO 11929:1997, EN872 - Determination of suspended solids
COD	Oxidation with di-chromate	12 mg/l	20% 50-400	ISO 6060: 1989, Water Quality - Determination of chemical oxygen demand
BOD	Seeding with micro-organisms and measurement of oxygen content	3 mg/l O 0.5 mg/l O	0 – 6000 mg/l O 0.5 – 6 mg/l O 0-6 mg/l O extended by dilution	BS EN 1899-1:1998 BS EN 1899-2:1998 SCA blue book 130 ISBN 0117522120
Total hydrocarbon oil	Infra Red Absorption and Gravimetry 1983		0.2mg/l	SCA blue book 77 ISBN 0117517283
AOX	Adsorption on activated carbon and combustion		20% 0.4 - 1.0	ISO 9562: 1998, EN1485 - Determination of adsorbable organically bound halogens
Total N	Method using oxidative digestion with peroxodisulfate	0.02 mg/l.	0 – 5 ml/l, extended by dilution	BS EN ISO 11905-1:1998, BS 6068-2.62:1998 Water quality. Determination of nitrogen.
pH				BS 6068-2.50:1995, ISO 10523:1994
Turbidity				BS EN ISO 7027:2000 BS 6068-2.13:2000
Temperature				SCA temperature measurement for Natural, Waste and Potable Waters and other items of interest in the Water and Sewage Disposal Industry ISBN 0117520179
Metals	Inductively coupled plasma atomic emission spectroscopy			BS EN ISO 11885:1998, BS 6068-2.60:1998 Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy
Phenol index	By flow analysis (FIA and CFA)		0.01 – 1 mg/l	BS EN ISO 14402:1999 BS 6068-2.68:1999
Formaldehyde				SCA The determination of formaldehyde, other volatile aldehydes, ketones and alcohols in water
Ammonia		0.1 – 1 mg/l	0.1 – 10 mg/l	BS 6068: Section 2.11 1987, Method for the determination of ammonium: automated spectrometric detection