

Sector Guidance Note IPPC SG4

January 2006

# Integrated Pollution Prevention and Control (IPPC)

## Secretary of State's Guidance for A2 Activities in the Non-ferrous Metals Sector

Defra would like to acknowledge the work of the Environment Agency's Local Authority Unit in the drafting of this guidance note.



Environment  
Agency

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# 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 non-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](http://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 non-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 non-ferrous 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 Wales)<sup>1</sup>.

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<sup>1</sup> Further guidance on the Oil Storage Regulations, if needed, is available from [www.environment-agency.gov.uk/osr](http://www.environment-agency.gov.uk/osr)

## 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 issue 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 Section 2.2 Part A2 (in England and Wales) of Schedule 1 to the Pollution Prevention and Control Regulations 2000 ([Ref 1](#)) as follows:
- (a) Melting, including making alloys, of non-ferrous metals, including recovered products (refining, foundry casting, etc.) where -
- (i) the plant has a melting capacity of more than 4 tonnes per day for lead or cadmium or 20 tonnes per day for all other metals; and
  - (ii) no furnace (other than a vacuum furnace), bath or other holding vessel used in the plant for the melting has a design holding capacity of 5 tonnes or more; or
  - (iii) the plant uses a vacuum furnace of any design holding capacity.

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.

- 1.12 This guidance note addresses the following aspects of the prescribed installation:
- storage and handling of raw materials (those associated with the following foundry operations)
  - 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

- 1.13 Earlier guidance (PG 2/3(96), PG 2/4(96), PG 2/6(96), PG 2/7(96) and PG 2/8(96)), relating to emissions to air advised that upgrading to that standard should usually have been completed by 1st April 1997 or 1st April 2000, depending upon the history of the activity.
- 1.14 The previous version of this guidance, SG4 2003 contained improvements that were required to be completed up to 24 months after publication of the note. These include paragraph 3.41 - 3.44, BAT 19 and Table 3, Row 8, BAT 114, paragraph 3.164 & BAT 115, paragraph 3.140 & BAT 94 as presented in SG4 2003. Installations should be upgraded to these standards by the date of publication of this note.
- 1.15 The new provisions of this note 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(96), 2/4(96), 2/6(96), 2/7(96), 2/8(96), and SG4(03), 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(96), 2/4(96), 2/6(96), 2/7(96), 2/8(96) and SG4 2003 have been deleted in this guidance note or where this guidance note specifies less stringent provisions than those in PG notes 2/3(96), 2/4(96), 2/6(96), 2/7(96), 2/8(96) and SG4 2003, the new LAIPPC permit should reflect this straightaway.

**Table 1: Compliance requirements**

Guidance	Reference	Compliance Date
For stack emission points - a limit for particulate matter of 20 mg/m <sup>3</sup>	<b>Table 3</b> Rows 1 & 2	At the time of issue of permit if achievable otherwise by 1 Sept 2007
New limit for non-methane VOCs from thermal sand reclamation plant of 30 mg/m <sup>3</sup>	<b>Table 3</b> Row 3	1 Sept 2008
New limit of 200 mg/m <sup>3</sup> for SO <sub>2</sub> used in oxidation control of magnesium melting	<b>Table 3</b> Row 5	1 Sept 2008
Melting and charging practices	3.43 & BAT 8	1 April 2007
New and rebuilt furnaces should be fitted with sealed charging systems where secondary scrap or flux is being used	BAT 9	Immediately for furnaces fitted after the date of publication of the note
Action plan on improvements to minimise heat loss from open crucible furnaces, transfer ladles and holding furnaces	BAT 10	Within 24 months of publication of this note
Review of alternative melt oxidation controls for magnesium activities	BAT 17	1 January 2008
For existing evaporation systems or single pass cooling systems a closed circuit recycling system.	BAT 51	1 April 2015
Groundwater Contamination Audit	3.101 – 3.105 & BAT 60 - 61	31 October 2006
Groundwater Protection Systems	3.106 – 3.110 & BAT 62 - 67	1 April 2006

Solvent Storage Provisions	3.110 & BAT 68	31 October 2006
Odour Assessments	3.113 & BAT 69	1 April 2006
Odour Control	BAT 70 - 73	1 April 2007
Environmental Management Systems	3.132, 3.133 & BAT 74	1 April 2007
Competent Person for Regulator and Public Liaison	BAT 79	1 April 2006
Formal Structure for Environmental Control & Training	BAT 80 & BAT 81	31 October 2006
Raw Materials / Waste Minimisation Audit	BAT 85 & 86	Within 18 months of issue of this note
Options for foundry sand recovery	BAT 90	Within 18 months of issue of this note
Water Efficiency Audit	BAT 91	Within 18 months of issue of this note
Benchmarking and recording water usage	BAT 93 & BAT 95	31 October 2006
Waste Storage Provisions	BAT 96 to BAT 100	31 October 2006
Recycling Markets	3.165 & BAT 101	31 October 2006
Energy Audit	BAT 103	Within 12 months of issue of this note
New Additional Energy Efficiency Measures	BAT 108 & BAT 109	1 April 2007
Accident Prevention Measures	BAT 114 to BAT 119	1 April 2007
Noise Mitigation Measures	BAT 120	1 April 2007
QA/QC of Monitoring Systems	BAT 130	1 April 2007
Annual Waste Reporting	BAT 142	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

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

### **New installations or activities**

- 1.17 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**

- 1.18 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**

- 1.19 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

<b>Source</b>   <b>Releases</b> 									
	Material storage and handling	Melting of aluminium and its alloys	Melting of magnesium and its alloys	Melting of zinc and its alloys	Melting of copper and its alloys	Preparation of cores and moulds	Casting and cooling	Knocking out, reclamation	Fettling, dressing and finishing
Oxides of sulphur		A	A	A	A	A	A	A	
Oxides of nitrogen		A	A	A	A	A	A	A	
Carbon dioxide		A	A	A	A	A	A	A	
Carbon monoxide		A	A	A	A	A	A	A	
Hydrogen sulphide						A	A	A	
Ammonia		W				A	A	A	
Metal compounds				W					
SF <sub>6</sub>			A				A		
Metal oxide particulates	L	A	AW	A	AW		A	AL	AL
Non-metallic particulates	AW	A	A	A	A	A	A	AL	AL
PAH	A	A					A		AL
Chlorides / Fluorides	L								
Zinc, lead and their oxides	L				A				

Table 2: Summary of direct releases

<b>Source</b>   <b>Releases</b> 	Material storage and handling	Melting of aluminium and its alloys	Melting of magnesium and its alloys	Melting of zinc and its alloys	Melting of copper and its alloys	Preparation of cores and moulds	Casting and cooling	Knocking out, reclamation	Fettling, dressing and finishing
Amines/amides						A	A		
Dioxins		A		A	A				
Volatile organic compounds	A	A		A	A	A	A	A	
Oils and greases	WL	W				L			
Resins						WL		L	
Acid vapours		A		A		A	A		
Dross / slag waste		L	L	L	L				
Sludges			L	L	L				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 (<a href="#">Table 5</a> and <a href="#">Table 6</a>).</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 (subject to 3.189 - 3.193)
1	All furnace operations - charging, fluxing, melting, pouring	20 mg/m <sup>3</sup>	Indicative monitoring*, plus extractive monitoring BS EN 13284-1	Continuous plus once a Year extractive
2	Storage and transport of sand, including reclaimed sand, knock-out and sand recovery, shot blasting, fettling and other finishing operations	20 mg/m <sup>3</sup>	Indicative monitoring, plus extractive monitoring BS EN 13284-1	Continuous plus once a Year extractive

\* 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 138](#).

Row	Volatile organic compounds	Emission limit	Type of monitoring	Frequency of monitoring (subject to 3.189 - 3.193)
3	Thermal sand reclamation systems	non methane VOC – 30 mg/m <sup>3</sup>	Extractive sampling BS EN 12619: 1999 Extractive sampling BS EN 13649 (The term 'volatile organic compounds' includes all organic compounds released to air in the gas phase)	At least once a Year

Row	Amines*	Emission limit	Type of monitoring	Frequency of monitoring (subject to 3.189 - 3.193)
4	Processes likely to emit amines ( <a href="#">Table 5</a> )	5 ppm v/v	Extractive sampling BS EN 13649	Annually

\* 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	Sulphur Dioxide	Emission limit	Type of monitoring	Frequency of monitoring (subject to 3.189 - 3.193)
5	Oxidation control processes where sulphur containing products are used as a blanketing layer	200 mg/m <sup>3</sup>	Manual extractive testing	Annually

Row	Chloride / Fluoride (expressed as hydrogen chloride / fluoride)	Emission limit	Type of monitoring	Frequency of monitoring (subject to 3.189 - 3.193)
6	Fluxing	5 mg/m <sup>3</sup>	Manual extractive testing	Annually

Row	Metals and their salts	Substance	Emission limit (as the metal)	Type of monitoring	Frequency of monitoring (subject to 3.189 - 3.193)
7	Where appropriate in relation to the metal alloy being melted Certain alloys give rise to negligible particulate emissions as they do not contain zinc or lead, and extraction and monitoring is not applicable to processes melting these alloys. If other alloys make up more than 2% of the total melted in any twelve month period then the limits should apply	Lead	2 mg/m <sup>3</sup>	Manual extractive testing BS EN 13211	Annually
		Copper *	20 mg/m <sup>3</sup>		
		Nickel	5 mg/m <sup>3</sup>		
		Tin	5 mg/m <sup>3</sup>		
		Cobalt Chromium Cadmium	Total emission In combination = 1 mg/m <sup>3</sup>		

\* 20 mg/m<sup>3</sup> of copper compounds would only rarely be expected, when particulate matter comprises totally of copper compounds.

Row	Dioxins	Emission limit	Type of monitoring	Frequency of monitoring (subject to 3.189 - 3.193)
8	Processes likely to emit dioxins (i.e. using externally sourced scrap - see 3.45 - 3.47)	1 ng/m <sup>3</sup> (I-TEQ)	Manual extractive testing BS EN 1948:1997: Parts 1, 2 & 3	Annually

N.B. The dioxin limit will be reviewed once monitoring data has become available.

## 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
Zinc	0.75
Copper	0.75
Lead	0.3
Arsenic	0.15
Nickel	0.75
Cadmium	0.015

## 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.
- 3.5 This note relates to the melting of ingot metal and clean returned or scrap material and the concurrent refining operations carried out. During melting of ingot it is often necessary to carry out a limited form of refining operation sometimes described by operators as metal treatment operations.
- 3.6 This note only refers to activities where refining is carried out as a composite part of a melting and casting operation. Activities which are primarily refining operations, for example production of alloy ingots in any furnace with a designed holding capacity greater than 5 tonnes, are subject to national regulatory control and the subject of separate guidance.

### Summary of activities

- 3.7 For the purpose of this note, refining is defined as "to cleanse, reduce or remove deleterious elements, oxides or other gangue material, for example by means of the addition of salt flux or the injection of gases to the molten metal".

### Aluminium

- 3.8 Typical sources of aluminium raw materials are either process scrap (used beverage cans, foils, extrusions, commercial scraps, turnings, and old rolled or cast metal), aluminium ingots or a combination of the two. In addition to this, aluminium is also recovered from skimmings and salt slags. Various contaminants may be present. Scrap is sometimes pre-sorted into alloy types to produce the desired alloy with the minimum of reprocessing. Pre-sorting of scrap is important, especially, for example, segregation of scrap of a particular alloy specification for use in manufacture of products with the same alloy specification requirements. Operators that use ingots in the feedstock will generate less dross. Some contaminated feedstock may require to be de-coated or de-oiled prior to melting to improve melting rate and to reduce the potential for emissions.
- 3.9 A range of different fluxes is used to assist in the processing in a number of ways. Salt slags arise when mixtures of sodium and potassium chloride are used to cover the molten metal to prevent oxidation, increase yield and increase thermal efficiency. These slags are generally produced in rotary furnaces and can have an environmental impact if deposited on land. The melting of aluminium without a protective flux produces an oxide layer known as skimmings. This is skimmed from the metal surface before casting. Aluminium can be recovered from skimmings in a rotary furnace making use of a salt flux.

- 3.10 Depending on the feed materials the furnaces that are considered to be BAT are the reverberatory furnace, the tilting rotary furnace, the rotary furnace or a tower melting induction furnace. For other furnace types operators should demonstrate that BAT is being used on a case by case basis.
- 3.11 Aluminium may be tapped from the melting furnace where alloy additions are made either directly to a casting system or via a transfer system into a holding furnace. The metal is then refined to remove gases and other metals. Large ingots, billets and slabs are cast in vertical direct chill casting machines that use water-cooled metal moulds and a holding table that is lowered as the ingot is formed. A range of smaller castings may also be produced in a large variety of alloys.
- 3.12 There are three main metal treatment (or refining) operations that may be carried out in aluminium melting processes and these are as follows:
- grain modification - for aluminium alloys this usually involves the addition of small amounts of metal, for example sodium or strontium, to the melt to enhance casting characteristics.
  - fluxing - this usually involves the addition of solid fluoride based fluxes to the melt to remove solid contaminants.
  - degassing - this involves the removal of hydrogen gas from the melt, traditionally by the addition of solid degassing agents, for example hexachloroethane. A more recent variation involves flux injection where the solid degassing agent is carried into the furnace within a stream of either nitrogen or argon gas.
- The main control issues relating to a), b) and c) above are:
- containing the emissions
  - handling and disposal of slag or dross
- 3.13 **Appendix 3** contains process diagrams showing typical inputs and outputs from secondary aluminium processes.

## Magnesium

- 3.14 **Appendix 4** contains a flow diagram representing a typical secondary magnesium production process.
- 3.15 Scrap magnesium alloys may be directly recycled in-house or sent to an external recycling facility. Raw material is sorted and stored separately in order to define the most appropriate recycling route. Magnesium melting and alloying is carried out in indirect gas or electric furnaces. Fluxes or inert blanketing gas, sulphur hexafluoride (SF<sub>6</sub>) may be used. SF<sub>6</sub> is used to prevent the re-oxidation of magnesium metal. The melted metal is then cast into magnesium ingots or semi-finished products.
- 3.16 There are four main metal treatment (or refining) operations that may be carried out in magnesium melting processes and these are as follows:
- grain modification - grain modifiers for magnesium alloy processes are usually in the form of zirconium or hexachloroethane.
  - fluxing - this usually involves the addition of chloride or fluoride proprietary fluxes to the melt to remove solid contaminants.
  - degassing - for magnesium processes nitrogen or argon gas sparging may take place for degassing and oxide removal. Degassing of magnesium alloys may also be effected by a mixture of argon and chlorine gases, where argon is used as a carrier gas, (it is not considered to be best practice to use undiluted chlorine gas).
  - oxidation control - the presence of beryllium within the melt grain modifies and stops oxidation. Finished magnesium alloys may contain up to 15ppm beryllium by weight. A master alloy of aluminium/beryllium, containing up to nominally 5% beryllium, may be added to the molten magnesium alloy to give this beryllium loading. Oxidation control may also be achieved by blanketing the surface of the metal with a carrier gas, such as carbon dioxide or argon, containing up to 4% sulphur hexafluoride (SF<sub>6</sub>).

Some operators are experimenting with the use of sulphur dioxide instead of SF<sub>6</sub>. Although this is considered to be an emerging technology, operators should seek to minimise the use of SF<sub>6</sub>. Under certain circumstances, oxidation control may be achieved by sprinkling sulphur powder on the surface of the melt. At the time of drafting this guidance, a draft EU regulation on certain fluorinated greenhouse gases proposes to prohibit the use of SF<sub>6</sub> in magnesium die-casting above 850 kg/year from 1<sup>st</sup> January 2008. This is known as the f-gas Regulation.

## Zinc

- 3.17 Recycling of zinc and zinc containing products is a key issue for the industry. Residues and scrap which are significant to the secondary zinc industry include: dust from copper alloy making, residues from the diecasting industry, ashes, bottom and top drosses from the galvanizing industry, old roofing and other sheet materials, non-ferrous fraction from the shredding of old cars, dust from electric arc steel making, residues from chemical uses of zinc and burnt tyres.
- 3.18 Physical separation, melting and other high temperature techniques are used to recover zinc depending on the form and concentration of the zinc and the degree of contamination.
- 3.19 Melting and alloying are usually carried out in indirectly fired crucible furnaces or induction furnaces. Temperature control is critical as the temperature must not exceed 450 °C for most alloy compositions, to avoid metal loss by fuming. Standard flux contains zinc chloride, magnesium chloride and sodium silico-fluoride. Wet scrubbing is required to remove the emission of silicon tetrafluoride which decomposes to hydrogen fluoride and is absorbed by the scrubbing medium.
- 3.20 For zinc casting electric melters are usually used. Dross forms on the surface of the melt which is periodically removed. It consists mainly of zinc oxide, but may contain some zinc chloride, and can be recycled.
- 3.21 Metal is usually cast into permanent moulds that are commonly made of cast iron. Stationary or continuous conveyor casting machines are used. Static moulds and conveyor casting machines are used to produce blocks and ingots. Continuous casting machines are used to produce rod for reduction to wire.
- 3.22 Production of zinc dust - molten zinc is sprayed under pressure through an atomising nozzle and is then rapidly cooled in an inert atmosphere to produce dust. The dust is removed in a bag filter system and used on site or packaged.

## Copper

- 3.23 Copper and copper alloys are melted continuously in a shaft furnace or in batches in an electric, crucible, reverberatory or induction furnace, and cast. The cast products are precursors for a variety of materials such as sheets, strips, sections, bars, rods, wires and tubes.
- 3.24 To make tubes, sections or rods, billets of copper or copper alloy are preheated, extruded and drawn. A variety of oils and soaps are used as lubricant that contaminates the product and off cuts. Off cuts are de-oiled before returning to the furnace for melting.
- 3.25 For the fabrication of sheets and strips, the start material may be slabs, cakes or sections of copper or copper alloy. The material may be preheated in gas or oil fired furnaces, hot or cold rolled and then sent to the finishing operation which includes re-rolling, cutting to length and width. Surface milling, annealing, pickling, washing and drying may be required as intermediate steps to produce high quality strips and sheets.
- 3.26 Ingots of copper and copper alloys are produced for the foundry industry using a fixed mould casting process. A wide variety of alloys are produced with other metals such as nickel, tin, zinc, aluminium for example.
- 3.27 When scrap is used as a raw material, pre-blending is an important factor to reduce the time taken in preparing the melt, which minimises the energy used and reduces the reliance on expensive master alloys. Rotary furnaces are usually used for dirtier scrap. Oxy-fuel burners are frequently used. With induction furnaces scrap is cut into small sizes to improve melting efficiency and to allow easy deployment of extraction hoods. The fume collection and abatement systems are chosen according to the raw material and the degree of contamination present. When brasses are melted

good temperature control is required to reduce zinc oxide emissions. An afterburner followed by rapid cooling and a heat recovery system should be used where there is **organic contamination** (in particular oil or plastic in the raw feed), alternatively the furnace combustion control system should be able to accommodate the combustion of contaminants.

## Lead

- 3.28 Melting and alloying of lead is usually carried out in indirectly heated crucible furnaces or kettles using electricity, oil or gas. Alloying elements are added to the melt in the kettle. Lead and lead alloys are usually cast into permanent cast iron moulds. Static moulds and conveyor casting machines are used to produce blocks, slabs and ingots. Continuous casting machines are used to produce rod for reduction to wire. Fume extraction is used at the launders and tapping points.
- 3.29 Some processes use lead and tin alloys or other specialist alloys as castings that are used as cores for the manufacture of precision components. Many such processes remelt the alloy cores and by indirect contact methods for re-casting. The appropriateness of the ELVs in [Table 3](#) to such activities will be reviewed in the future in light of practical experience.

## Delivery, storage and handling of raw materials

### Summary of activities

- 3.30 Raw materials range from fine dusts to large single items. Materials are checked (by inspection and sorting). 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. Fuels and other oils should be stored in tanks or drums in bunded areas.
- 3.31 Sand is normally delivered in bags or bulk containers. For large sand users, sand may also be delivered in bulk and discharged directly to silo via pneumatic conveyor.
- 3.32 Scrap is usually stored in segregated piles (or areas) to keep different grades and alloy compositions separate.
- 3.33 Binders are usually premixed with the sand for small-scale core manufacture. Where binders are mixed with sand on site, liquid binders, resins and catalysts are delivered in drums, or by bulk container. The containers are connected by pipe directly to the sand/resin/catalyst mixing unit. Some catalysts and co-reactants are used in a gaseous form but these are also delivered as liquids and handled in a similar fashion before being vaporised and mixed with a carrier gas. Vaporisation is enclosed and may be effected by a variety of methods.
- 3.34 Refractories, release agents and other minor deliveries are stored indoors.
- 3.35 The main control issues relate to the potential for fugitive emissions.

### Environmental impact

<b>Water:</b>	Run off from contaminated or dirty scrap and external bulk stores. e.g. oils, suspended solids, metals.
<b>Land:</b>	Spillage, overfilling of silos and other containers.
<b>Air:</b>	Particulates, VOCs.
<b>Waste:</b>	Not significant.
<b>Energy:</b>	Not significant.
<b>Accidents:</b>	Delivery to silos - excessive transfer rates, failure of pipework or overfilling of silos and tanks. Drums containing liquids e.g. resins, need to be kept in good condition to avoid leakage.

**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.
- 5 Storage areas should be under cover and protected from the elements where appropriate to avoid or minimise environmental impact.
- 6 Material sampling and assay systems should be used to identify raw material quality.
- 7 Storage areas should be hard surfaced, unless damage to the surface is likely to occur during delivery. e.g. where heavy, bulky items are being delivered.

## Furnace operations

- 3.36 Process: the types of furnaces commonly used for the melting of non-ferrous metals are as follows:
- rotary furnace - aluminium, lead
  - reverberatory furnace - aluminium
  - electric arc furnace - aluminium
  - electric resistance furnace - aluminium, copper, lead, magnesium, nickel, zinc
  - induction furnace - aluminium, copper, lead, magnesium, nickel, zinc
  - small crucible furnaces – aluminium, copper, zinc
  - tower melt furnace – copper, aluminium

## Summary of activities

- 3.37 **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 end using oil as the fuel. The products of combustion 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. The furnace body is slowly rotated during melting thus bringing the underside of the metal bath into contact with the hot refractory lining. This action prevents the lining becoming overheated by the flame and reduces the melting time to about half that of the stationary furnace. The furnace is charged from one end the burner, the exhaust box being temporarily removed for the purpose. The plug is removed from the tapping hole when melting is complete and the furnace slowly rotated until the hole reaches the level of the bath, when the metal runs out into the waiting ladle. Melting takes place out of contact with the fuel in an atmosphere which may be controlled. The rotary furnace is a batch melter so metal compositions may be accurately controlled and the charge may be super heated to high temperatures. Rotary furnaces are used for melting a wide range of secondary raw materials. They can incorporate a tilting mechanism which can reduce the amount of flux required.

- 3.38 **Reverberatory Furnace** - This is a refractory lined, rectangular or circular bath furnace that is fired by wall or roof mounted burners. Varieties of fuels are used and oxy-fuel burners can be used to increase the melting rate. Extraction and treatment of the combustion gases is used and the furnaces are partially sealed. Hoods and covered launders provide extraction during tapping and charging. Slag or dross can be removed by raking or by tapping. Many designs have large access doors that allow large objects to be charged. This introduces the problem of sealing and extraction during charging. Water cooling of the doors can reduce this problem by reducing warping of doors. Sealed charging carriages can be used. Poor melting efficiency can be improved by the use of oxygen enrichment or by using combinations of fuel that extend the flame length. These furnaces are used for batch melting, refining and holding a variety of metals.
- 3.39 **Electric Arc Furnace** - Electric heating allows a closer control over metal temperature and composition, and 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 the 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 brickwork contained within a steel frame, circular in plan form.
- 3.40 **Electric (resistance) furnaces** operate in a similar arrangement to the electric arc furnace with 3 to 6 graphite electrodes but where melting temperature is maintained by means of electric resistance heating.
- 3.41 **The induction furnace** is a short circuited transformer with an iron core and a primary coil, and a secondary in the form of molten metal in a channel surrounding the coils. Melting power is induced into the secondary with high efficiency, normally about 95%. Secondary currents create electromagnetic pressure which cause the melt in the channels to be stirred. The stirring action takes place throughout the melt in the hearth distributing energy from the channel throughout the melt in the hearth. They can be completely enclosed for atmospheric control and temperature can be automatically controlled with immersion thermocouples and electric pyrometers.
- 3.42 **Crucible Melters** – either electric powered or gas fired, small crucible furnaces are used for melting specialist alloys or small volume melting. The temperature of the furnace can be automatically controlled to minimise the production of fume when melting. Crucible furnaces are often open melters but lids and covers can be fitted to minimise heat loss. Pouring is achieved using a tilt mechanism.
- 3.43 A variety of methods, which are dependent on the furnace type, are used to optimise energy efficiency while melting. Methods generally involve optimising melt temperature and combustion conditions, controlling melt composition, regular maintenance of burners and furnace linings and efficient dross removal. Optimal charging and melting 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.
- 3.44 Action Energy Guides ([Ref 8](#)) contain information on how furnace operations have been optimised for greater thermal efficiency and product yield.
- Operations melting externally sourced scrap**
- 3.45 Operators should be aware of the potential for the release of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans ("dioxins") from metals processes. For all furnace types the following is intended to ensure minimisation of dioxin emissions.
- If feedstock, fluxes or fuel contains chloride or fluoride (e.g. engine oil, plastic, grease, synthetic materials, potassium aluminium fluoride) and there is a source of organic carbon in the emissions (which may arise from contamination of raw materials or the fuel) then annual monitoring for dioxins should be carried out to demonstrate compliance with the limit of 1.0 ng/m<sup>3</sup> (I-TEQ).

Where there is no chloride or fluoride in the feedstock, or no source of organic carbon in the emissions, emissions of dioxins are not anticipated, and therefore the above measures do not apply.

- 3.46 Furthermore, where combustion gases are filtered or scrubbed prior to emission in order to achieve the emission limit for particulate matter of 20 mg/m<sup>3</sup>, then the gases should be cooled quickly (quick quench, within about two seconds) through the de-novo synthesis temperature zone of 250 - 650 °C.
- 3.47 If monitoring shows that the process complies with the dioxin emission limit, then further monitoring may not be necessary provided there is no change to the process operating conditions.

## Environmental impact

<b>Water:</b>	Used for cooling purposes and abatement.
<b>Land:</b>	The coarse dust from filtration plant is normally recycled. Localised deposition around filtration plant should be avoided.
<b>Air:</b>	Potential emissions include particulate matter, metal oxide fume, CO, CO <sub>2</sub> , NO <sub>2</sub> , SO <sub>2</sub> , H <sub>2</sub> S, VOCs, PAH, HCl, heavy metals, lead and dioxins.
<b>Waste:</b>	Sludge, dross / slag, spent refractory, filter plant waste.
<b>Energy:</b>	Furnace operations are critical to energy use.
<b>Accidents:</b>	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. Use of hydraulic oils creates a fire hazard. Release of hot metal can cause fire.
<b>Noise:</b>	May be significant, arising from charging operations, fan noise (abatement). Sound levels above 100 db(A) can arise.

## BAT

- 8 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.
- 9 New and rebuilt furnaces with charge doors should be fitted with sealed charging systems where secondary scrap or flux is being used, as they prevent fugitive emissions during charging.
- 10 Operators should investigate the potential for fitting lids or covers to open crucible furnaces, transfer ladles and holding furnaces in order to minimise heat loss. An action plan should be sent to the regulator identifying a programme of technically feasible improvements.
- 11 The following parameters should be measured to allow process control, and alarms should be provided for critical parameters:-
  - temperature of the melt
  - for combustion gases O<sub>2</sub> and CO should be monitored
- 12 Other control issues vary depending upon the type of furnace, as follows:
  - containing fugitive emissions, especially during charging of batch furnaces
  - control of flux additions
  - maintaining optimum combustion conditions
  - burner maintenance
  - maintenance of furnace linings

- 13 Feed should be weighed, metered and recorded.
- 14 Where raw materials involve externally sourced scrap, operators should carry out monitoring to demonstrate compliance with the emission limit for dioxins. If monitoring shows compliance with the emission limit to the satisfaction of the regulator, further monitoring may not be needed.
- 15 Operators should ensure that melt temperature is controlled for the desired casting temperature to avoid excessive heating.
- 16 Charge materials should be selected to minimise the environmental impact of the process having regard to product quality constraints.
- 17 Operators using SF<sub>6</sub> as a cover gas should identify and record the extent to which alternative oxidation control can be used in their process. Operators should regularly review alternatives to SF<sub>6</sub> having regard to the coming into force of the F-Gas Regulation<sup>2</sup> and its subsequent implementation.

## Manufacture of cores and moulds

- 3.48 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. Many different methods of mould manufacture have been developed. [Table 5](#) lists the various techniques together with potential emissions released during mould and core manufacture. Some of the most common are described below:-

### Summary of the activities

#### The shell sand method

- 3.49 This involves coating a hot metal pattern with sand pre-coated with a resin. The resin melts and binds the sand together. It forms a soft, fairly uniform "biscuit" about 0.5cm thick on the pattern surface. The longer the invest time the thicker the mould. The pattern with its adhering biscuit is passed into an oven when the resin component of the mixture "cures" and the biscuit becomes a rigid shell. 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.

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.

#### The greensand method

- 3.50 Greensand casting is less common in non-ferrous foundries. It uses a mixture of sand, an organic component such as dextrose, a clay binder and water, which is moulded around a pattern within an open box. It is then mechanically compacted. The mould is made in at least two parts which are separated for the removal of the pattern and joined again to receive the molten metal. Emissions include dust released during mixing.

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<sup>2</sup> On 11 August 2003, the Commission published a proposal for a Regulation to reduce emissions of certain fluorinated greenhouse gases [COM(2003) 492 final]

### Cold setting techniques

- 3.51 Cold-setting systems involve chemical reaction between a resin and a hardener, possibly in the presence of a catalyst. Processes may either be "cold set" in which sand, binder and curing agent are mixed together at the outset (so that curing commences immediately), or "cold box" where sand and binders are 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 (see [Table 5](#)):
- furan binders
  - alkaline phenolic binders
  - phenolic urethane system
  - resin dissolved in solvents
  - sodium silicate
- 3.52 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 can be necessary to collect and scrub the exhaust gases prior to discharge to minimise odour.

### Mould coating

- 3.53 Sand moulds are often coated with a refractory wash of fine particles in a suspension of either water or alcohol. Application may be by using sprays, flow coating, dipping, brushing or swabbing. 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.
- 3.54 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.

### Pattern release agents

- 3.55 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.

### Environmental impact

<b>Water:</b>	Not significant.
<b>Land:</b>	Not significant.
<b>Air:</b>	The most important issues from mould and core preparation and storage are as follows: <ul style="list-style-type: none"><li>▪ odour; the sources of which are the gases mentioned below</li><li>▪ dust from handling sand and other dusty materials</li><li>▪ solvent and VOC emissions from resin handling</li><li>▪ VOC emissions from organic chemical systems including amines, aldehydes and phenolics;</li><li>▪ combustion gases from heated systems</li><li>▪ leaks of gases being used as catalysts, such as dimethylethylamine (DMEA), which has an unpleasant odour. Gases also exude from the cores in storage</li><li>▪ emissions of ammonia arising from the thermal decomposition of hexamethylene tetramine which is a catalyst used in the shell process</li></ul>
<b>Waste:</b>	Choice of binder system determines potential for recycling and recovery. Management of sand system affects the reclaim rate.
<b>Energy:</b>	May be significant if a heated system is used.
<b>Accidents:</b>	Damage to resin containers or incorrect mixing of resins. Also leaks from pipelines.
<b>Noise:</b>	Not significant.

## BAT

- 18 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.
- 19 Consumption of binder chemicals should be minimised through good process control such as those techniques described in Envirowise Guidance Note GG104 ([Ref 4](#)).
- 20 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.
- 21 Solvent-based mould coatings should be torched off as soon as it is safe to do so after application.
- 22 In most cases waste moulds and cores should be segregated from other waste to facilitate reclamation.

**Table 5: 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
<b>GREENSAND</b> Clay Water	Pressure – low	Particulate matter	Fugitive emissions from conveyors. Process is usually Contained with internal venting.
<b>SHELL SAND</b> Phenol- formaldehyde (Novalak) Resin	Heat – high	Formaldehyde Ammonia* Phenol* Aromatics	Odour can be an issue as the shell machines are normally extracted to air
<b>ALKALI PHENOLIC</b> 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
<b>PHENOLIC URETHANE</b>  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 (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 persist.

**Table 5: Environmental impacts associated with the manufacture of moulds and cores**

<b>System name and Binder constituents</b>	<b>Setting method and relative energy required</b>	<b>Emissions to air during mixing and setting</b>	<b>Other environmental impacts</b>
<b>FURANE</b> 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 when in contact and may give rise to an uncontrolled emission.
<b>HOT BOX</b> 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.
<b>OIL SAND</b> Linseed oil and starch	Heat – high	Acrolein* Complex organics	Odour can be an issue as the core ovens are often extracted to air.
<b>CO<sub>2</sub> PROCESS</b> Sodium silicate	Gas hardened with CO <sub>2</sub> gas – low	None	Reclamation potential is more limited than with other binder systems.
<b>SILICATE ESTER</b> "Self set" Sodium silicate	Cold set with esters – Low	Esters	Reclamation potential is more limited than with other binder systems.
<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> <p>Note 5: Particular trade names have been listed for indicative purposes only. There are many other similar products used by the industry.</p>			

## **Casting and cooling**

- 3.56 Emissions generated during casting arise from two sources. Fine metal oxide may be 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 metal 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.
- 3.57 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.

- 3.58 **Table 6** identifies the type of emission that will be released into the atmosphere from casting depending on the mould and core type. 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. 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. Some of the most common casting practices are described below:

### Summary of the activities

#### Static Sand Casting

- 3.59 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.

#### Roll Casting

- 3.60 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.
- 3.61 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.

#### Diecasting

- 3.62 Diecastings are produced by pouring or injecting molten metal into metallic moulds (dies) which are not destroyed after the pouring of each casting. When the die closes the metal is pushed up through various points in the die and can either be under high or low pressure. The metal is cooled using a closed water system and aircooling. The parts may be ejected automatically onto a cooling conveyor. The necessity for subsequent machining is eliminated or minimised. Zinc, aluminium and magnesium based alloys have metallurgical characteristics, such as fluidity and low shrinkage, that makes them particularly suitable for this process. The die impression and runner and riser channels are given a thermally insulated coating to protect against the erosive action of the molten metal and to reduce the chilling effect of the metallic mould. The die coating may also contain inhibitors to prevent oxidation and burning within the mould.

#### Continuous and Semi-continuous Casting

- 3.63 Continuous and semi-continuous casting is used for specific products from copper, copper alloys but also from lead and zinc. Continuous casting uses either vertical or horizontal modes but discontinuous casting normally uses the vertical mode. Continuous surface cleaning and heat treatment can be associated with continuous casting activities.

### Environmental impact

<b>Water:</b>	Not significant.
<b>Land:</b>	Not significant.
<b>Air:</b>	Particulate matter during casting; VOCs, including odorous compounds, during cooling.
<b>Waste:</b>	Moulds and cores.
<b>Energy:</b>	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 6: Environmental impacts associated with casting and cooling**

System name and binder constituents	Emissions to air during casting and cooling	Comments
<b>GREENSAND</b> Clay, Water	Particulate matter Carbon monoxide and carbon dioxide Benzene, Toluene, Xylene	Potential odour
<b>SHELL SAND</b> Phenol Formaldehyde (Novalak) Resin	Carbon oxides Phenol*, cresols* and xylenols*  Ammonia Aldehydes, Benzene, PAH	Odour problems more prevalent - treatment may be necessary although dispersion may suffice
<b>ALKALI PHENOLIC</b> 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
<b>PHENOLIC URETHANE</b> 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, Phenol, cresols and xylenols Nitrogen oxides, Sulphur dioxide Monoisocyanates, Formaldehyde, Aromatics (incl polycyclics) Anilines, Naphthalenes Ammonia	Odour may be a problem
<b>FURANE</b> 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 (incl. polycyclics) Sulphur dioxide, Ammonia, Aniline	Odour occasionally a problem
<b>HOT BOX</b> 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 (including polycyclics) Anilines Ammonia	Odour occasionally a problem

**Table 6: Environmental impacts associated with casting and cooling**

<b>System name and binder constituents</b>	<b>Emissions to air during casting and cooling</b>	<b>Comments</b>
<b>OIL SAND</b> Linseed oil, starch	Particulate matter – soot from the incomplete combustion of the carbon based resins  Carbon oxides Butadiene Ketones Acrolein	Odour may be a problem.
<b>CO<sub>2</sub> PROCESS</b> Sodium silicate	Carbon oxides	
<b>SILICATE ESTER</b> "Self set"  Sodium silicate	Carbon oxides Alkanes Acetone Acetic acid Acrolein	
N.B. Particular trade names have been listed for indicative purposes only. There are many other similar products used by the industry.		

## BAT

- 23 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](#).
- 24 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.
- 25 The working area should be managed to control through draughts and the escape of fugitive emissions.
- 26 Mould cooling should not take place outside of buildings, except for moulds made only of metal.

## Knockout (also referred to as shakeout)

### Summary of activities

- 3.64 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 dislodges the casting from the box and allows any sand to fall through the open surface of the table. The knockout area may also be in a contained chamber. Dust from these operations is usually collected and cleaned by bag filters.
- 3.65 In repetition green sand 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 to hoppers for recycling and re-use. Recycling may take place off-site.

- 3.66 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. Large castings may be removed from their 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

<b>Water:</b>	Not significant.
<b>Land:</b>	Waste foundry sand (unless it is reclaimed).
<b>Air:</b>	During knockout the mould is broken open and 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. Dust is emitted upon which organic compounds may be adsorbed.
<b>Waste:</b>	Waste foundry sand (unless it is reclaimed).
<b>Energy:</b>	Not significant.
<b>Accidents:</b>	Not significant.
<b>Noise:</b>	Many parts of the machine are very noisy and require acoustic shelters for worker protection. Standard noise protection measures should be taken to minimise disturbance in the local neighbourhood. Vibration may arise at this knockout stage.

### BAT

- 27 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.
- 28 The knockout area should be normally contained and extracted, and should be exhausted to abatement plant where necessary to meet the emission limits.

### Sand reclamation

- 3.67 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

- 3.68 Primary reclamation, also known as attrition, involves breaking down the sand from moulds or cores to its original grain size. This includes breaking down used moulds in ball mills or vibrating crushers followed by screening the sand, removing tramp metal, and separating and removing fines and over sized agglomerates. In many cases chemically bonded sand moulds are put into shot blasts, 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.

- 3.69 Secondary reclamation involves further processing to remove residual binder. The main secondary reclamation techniques are high energy attrition, wet scrubbing and thermal treatment.
- 3.70 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. An after-burning zone ensures that combustible gases are completely oxidised. 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 needed to maintain the required quality. Generally, this will involve treatment of between 10 to 30 % of the mechanically reclaimed sand.
- 3.71 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.
- 3.72 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

<b>Water:</b>	Only significant where wet scrubbing technique used.
<b>Land:</b>	Not significant (but significant volumes of bag filter dust may be destined for landfill from abatement systems).
<b>Air:</b>	Particulate matter. Where thermal methods are used, VOCs and products of combustion.
<b>Waste:</b>	Particulate matter from abatement plant.
<b>Energy:</b>	Afterburners 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.
<b>Accidents:</b>	Not significant.
<b>Noise:</b>	Many parts of the machine are very noisy. Standard noise protection measures should be taken to minimise disturbance in the local neighbourhood.

### BAT

Where sand reclamation is carried out:

- 29 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.
- 30 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.
- 31 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

- 3.73 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:
- hot or cold rolling for metal strip
  - removal of excess metal such as feeder heads, runner or gating systems and any other superfluous metal
  - cutting, shearing, milling and grinding castings
  - cleaning by shotblasting or other means to remove core and mould materials and scale
  - 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
- 3.74 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

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

### BAT

- 32 Emissions from fettling, dressing and finishing activities should be contained and extracted and abated where necessary to meet the emission limits and other provisions.
- 33 Where continuous casting and rolling is carried out, machine lubricants from rolling operations should be recycled in a closed-loop system using filtration if required to maintain material specifications.

# Emissions control

## Point source emissions to air

- 3.75 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 operations, mould and core preparation and storage, casting, knockout and sand reclamation
  - combustion gases from heated processes

## Dispersion and dilution of stack emissions

- 3.76 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 impeding devices 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.

Revised stack height calculations should not be required unless it is considered necessary because of a breach, or serious risk of breach, of an EC Directive limit value and because it is clear from the detailed review and assessment work that the Part A2 activity itself is a significant contributor to the problem.

An operator may choose to meet a tighter emission limit in order to reduce the required stack height.

- 3.77 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 PM<sub>10</sub>, then this may have to be reviewed.
- 3.78 Dispersion models for vent and 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.
- 3.79 Vent and stack heights should be sufficient to ensure adequate dispersion under circumstances of foreseeable process upsets or equipment failure that may give rise to abnormally high emission levels over short periods.
- 3.80 Where offensive odour is likely outside the installation boundary, the assessment of stack or vent height should take into account the need to render harmless residual offensive odour.
- 3.81 Exhaust gases from a wet scrubber should be heated by the use of all available waste heat to raise the temperature of the exhaust gases and prevent immediate condensation on the exit from the vent. This procedure also aids the thermal buoyancy of the plume. Where there is no available waste heat and the vent contains no significant environmentally harmful substances, the operator may be able to demonstrate that the BAT criteria have nonetheless been met.

- 3.82 Arrestment plant should be used where practicable to ensure particulates are recovered and reused within the process.
- 3.83 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 dew-point
- 3.84 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
- 3.85 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:

- 34 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 limits.
- 35 The operator should ensure that an effective means of detection for abatement plant failure is in use.
- 36 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.
- 37 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.
- 38 Ensure that stack heights are sufficient to ensure adequate dispersion under normal conditions.
- 39 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.
- 40 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.
- 41 Investigate the cause and nature of any persistent visible emissions and provide a report to the regulator.
- 42 Ensure that emissions of water vapour are free from droplet fallout.
- 43 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.
- 44 Ensure that flues and ductwork are cleaned to prevent accumulation of materials, as part of the routine maintenance programme.

- 45 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.
- 46 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.

## Point source emissions to surface water and sewer

- 3.86 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.
- 3.87 The amounts of process water used is small and discharges comprise principally:
- discharge from wet scrubbers
  - cooling water, often containing biocides and anti-oxidants
  - site drainage and stormwater
- 3.88 The following general principles should be applied in sequence to control emissions to water:
- water use should be optimised and wastewater re-used or recycled
  - contamination risk of process or surface water should be minimised
  - wastewater treatment systems can maximise the removal of pollutants, for example metals, using precipitation, sedimentation and filtration. The mix of pollutants will define the methods and reagents used. Concentrated effluents should be pretreated as necessary before discharge into the final effluent treatment system
  - ultimately, surplus water is likely to need treatment to meet the requirements of BAT (and statutory and non-statutory objectives). Generally, effluent streams should be kept separate as treatment will be more efficient. However, the properties of dissimilar waste streams should be used where possible to avoid adding further chemicals, e.g. neutralising waste acid and alkaline streams. Also, biological treatment can occasionally be inhibited by concentrated streams, while dilution, by mixing streams, can assist treatment
  - systems should be engineered to avoid effluent by-passing the treatment plant
- 3.89 Minimising the use of water and minimising the level of pollutants in each water stream are the primary aims, followed by the recycling of wastewater 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 3.90 to 3.95 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.
- 3.90 For furnace gas cleaning, dry filtration systems eliminate potential wastewater 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.
- 3.91 The nature of the receiving water should be taken into account, with regard to any pollutant released to this media. However, irrespective of the receiving water, the adequacy of the plant to minimise emissions must be considered.
- 3.92 The removal of metals can be maximised 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.
- 3.93 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.

- 3.94 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.
- 3.95 Spent acidic water wash from acid surface cleaning is discharged to sewer. Effluent treatment should be by neutralisation and settlement.

#### **Local Authority Regulation**

- 3.96 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**

- 3.97 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 find 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.

- 3.98 For non-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:

- 47 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).
- 48 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.

- 49 All interceptors:
- are impermeable
  - are subject to at least weekly visual inspection (or other frequency to ensure the continuous function and contamination removed as agreed with the regulator)
  - have an annual maintenance inspection; prior to inspection all contents should be removed
- 50 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.
- 51 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](#).
- 52 Process effluent is kept separate from surface drainage unless agreed with the regulator.

### Point source emissions to groundwater

- 3.99 There should be no intentional point source emissions of List I and List II substances to groundwater from the non-ferrous foundries sector<sup>3</sup>.

#### BAT

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

### Fugitive emissions to air

- 3.100 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

Where there are opportunities for reductions in fugitive emissions, the permit may require an updated record of fugitive emissions to be submitted on a regular basis.

<sup>3</sup> 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.

## BAT

- 54 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.
- 55 Operations should be controlled to prevent visible emissions with the exception of one-off events during start-up and shutdown.
- 56 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.
- 57 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
- 58 When transferring volatile liquids into tanks, 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.
- 59 Vent systems should be chosen to minimise breathing emissions (e.g. pressure/vacuum valves) and, where relevant, be fitted with knockout pots and appropriate abatement equipment.

## Fugitive emissions to surface water, sewer and groundwater

- 3.101 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.
- 3.102 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 [3.104](#) 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.

- 3.103 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 [3.103](#).
- 3.104 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.

- 3.105 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 postcode of the installation <http://www.environment-agency.gov.uk/maps/info/groundwater/>

- 3.106 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.
- 3.107 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.
- 3.108 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.
- 3.109 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 of prevent overfilling (particularly where there is an auto-fill system). 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.
- 3.110 Operators should assess the pollution risks posed by the storage of solvents. In addition to the above preventative measures, solvent storage areas should be away from surface water sources, surface water drains, soakaways, drinking water boreholes or sumps and be fitted with impermeable flooring.

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/](http://www.defra.gov.uk/environment/water/ground/solvents/) (Ref 3)

## BAT

- 60 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.
- 61 The operator should identify the potential risk to the environment from drainage systems recorded by **BAT 60** 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.
- 62 The operator should ensure that all operational and storage 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.
- 63 Oil and solid interceptors should be used if necessary for the drainage of open storage areas.
- 64 All sumps should be impermeable and resistant to stored materials.

- 65 All liquid 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.
- 66 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 be located within a bunded area, fixed and locked when not in use.
- 67 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.
- 68 The operator should assess the pollution risks posed by the storage of solvents and devise control measures to minimise the pollution risk.

## Odour

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

### Assessment

- 3.113 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
- 3.114 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.
- 3.115 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

- 3.116 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.

- 3.117 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.
- 3.118 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**

- 3.119 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.
- 3.120 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.
- 3.121 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**

- 3.122 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.
- 3.123 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.
- 3.124 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.
- 3.125 Where odour problems persist, fume is extracted from shell sand core production areas. As a further control, extracted gases can be abated of phenols and ammonia 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.
- 3.126 Thermal oxidation is a possible alternative as it results in no aqueous waste streams although energy costs are high and CO<sub>2</sub> 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.
- 3.127 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.

- 3.128 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.
- 3.129 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 installation boundary, the equipment should be upgraded.
- 3.130 For complex installations, for example where there are a number of potential sources of odorous releases or where there is an extensive programme of improvements to bring odour under control, an odour response plan should be maintained. The regulator may incorporate the odour response plan in the permit.

## BAT

- 69 Operators should conduct odour assessments to determine whether emissions result in offensive odours at or beyond the installation boundary.
- 70 If operations are identified as resulting in offensive odour, operators should devise an odour control programme of improvements and maintain an odour management plan.
- 71 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.
- 72 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.
- 73 Following odour assessments, if it is found that there are offensive odours outside 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

- 3.131 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.
- 3.132 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.

- 3.133 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**

- 3.134 **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
- 3.135 **Training** – all relevant (including operational) staff should be trained 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.
- 3.136 **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.
- 3.137 **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**

- 74 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**

- 75 Effective operational and maintenance systems should be employed on all aspects of the installation whose failure could impact on the environment. For example 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.
- 76 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.

- 77 For equipment referred to in 76 (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.

78 Records of breakdowns should be kept and analysed by the operator in order to eliminate common failure modes.

### Competence and training

79 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).

80 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.

81 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.

82 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

83 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

3.138 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](#)).

- 3.139 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

- 3.140 Raw materials used in the non-ferrous metals sector may include:
- metal ingots
  - secondary raw materials
  - fuels (oils, gases and solid fuel)
  - flux materials
  - metal treatment materials, including process gases e.g. O<sub>2</sub>, Cl<sub>2</sub> and inert gases
  - additives e.g. for alloying
  - process chemicals e.g. for abatement systems
  - 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 ladle and furnace linings

- pattern release agents
  - lubricating oils, hydraulic oils, quench oils, transformer oils and fuel oils
  - water treatment materials (e.g. biocides, filter media, caustic solutions for neutralisation)
  - pickling acids, degreasants (for surface treatment)
  - gases for annealing (e.g. H<sub>2</sub>, N<sub>2</sub>)
- 3.141 Scrap metal, skimmings, flue or filter dusts and drosses are used as sources of non-ferrous metals, and these materials contain a number of metals or metal compounds. The source of the secondary raw material may give information of the potential emissions due to the presence of acids, oils, organic contaminants, anions and components such as ammonia from the reaction of skimmings with moisture. Materials are checked for unforeseen impurities and contamination, as this can be cost effective in maintaining a cleaner product and reducing emissions.
- 3.142 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.
- 3.143 The criteria in [Table 7](#) should be considered when selecting raw materials

**Table 7: Selection of raw materials**

Raw material	Selection criteria
Scrap	Impurities and contamination of scrap may affect emissions to all media
Water	Identify most sustainable source (consider recycled sources)
Coolants	Water-based coolants may cause less pollution
Water treatment chemicals	Select chemicals with a lower potential for causing odour problems
Fluxing Agents	Carbon fluxing agents minimise pollution
Cover gases	Global Warming Potential for SF6 (magnesium sector only)
Fuel oils	Sulphur content should be minimised. The maximum sulphur content of heavy fuel oil should be 1%*.
Machine oils/emulsions	Minimise organic content of emulsions Consider synthetic oils
Surface treatment materials	Limit acid strength Consider non-organic degreasants
Mould and core materials	Sand – well graded, to the desired angularity specification and free from excessive fines  Binder system – consider ease of reclamation, generation of odours etc.
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 <sup>3</sup> at 3% oxygen dry. Defra is the enforcing authority for these regulations.	

- 3.144 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.
- 3.145 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

- 84 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, fluxing agents 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)

- 3.146 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”*.
- 3.147 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.
- 3.148 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
- 3.149 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.
- 3.150 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.
- 3.151 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.
- 3.152 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
- 3.153 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.

3.154 The following techniques would be expected to minimise waste arising:

- selection of cleaner raw material
- pre-treatment of scrap
- optimising furnace operation
- reduction of melt agitation / oxidation
- careful construction of furnace lining
- avoidance of aggressive fluxing agents
- continuous use of the furnace
- careful cleaning of furnace and crucibles
- use of a totally sealed furnace reduces flue dust
- use of robust filter materials
- use of a closed cooling system
- recycling of scrubber liquor
- minimising the use of die lubricant ([Ref 7](#)) or using graphite dies
- regular maintenance of machinery e.g. can minimise oil loss

## BAT

- 85 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
- 86 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.
- 87 Specific improvements resulting from the recommendations of audits should be carried out within a timescale approved by the regulator.
- 88 For all furnace types minimisation of dross 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.
- 89 Operators should reclaim foundry sand having regard to the technical feasibility and record the optimal recovery rates achievable.
- 90 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

- 3.155 Most non-ferrous activities are low water users. Its main use is as a coolant. However, for significant users, 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.
- 3.156 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](#).

- 3.157 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
- 3.158 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.
- 3.159 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 95](#)).

## BAT

- 91 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.
- 92 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.
- 93 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.
- 94 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.
- 95 Cooling water top-up should be fitted with a water meter.

## Waste handling

- 3.160 Good segregation of materials is essential to facilitate opportunities for recovery, recycling and re-use and to maximise scope for good waste management.
- 3.161 The most important wastes are:
- foundry sand
  - particulate matter collected in bag or cartridge filters
  - slag from melting and metal treatment processes
  - dross and skimmings from smelting
  - scrubber liquors and sludges, and output from the effluent treatment plant

- waste hydraulic oils and brake and gearbox fluids
- tramp oil from any milling or rolling emulsions
- refractory waste from furnaces, launders and ladles
- chemical and oil containers
- absorbents, filter materials, wiping cloths etc.
- spent surface treatment acids
- packaging materials (e.g. card-board, steel bands)
- general inert industrial waste

3.162 As skimmings can react with moisture in the air to produce ammonia and other gases, storage, treatment and transport of skimmings requires careful consideration.

3.163 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.

### Environmental impact

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

### BAT

- 96 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.
- 97 Operators should segregate the main waste types described in paragraph 3.161. Some wastes, according to their type and analysis, may be recombined for treatment or disposal (e.g. slags, dross, and sludges).
- 98 Operators should ensure that waste stored in containers that are durable for the substances stored and that incompatible waste types are kept separate.
- 99 Operators should ensure that waste storage areas are clearly marked and signed, and that containers are clearly labelled.
- 100 All containers for dross, 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

- 3.164 Waste should be re-used, recovered or recycled unless the regulator has accepted a satisfactory BAT justification for landfill disposal.
- 3.165 **Table 8** 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.
- 3.166 In the context of this note, recycling means the residue is returned to the process from where it has been produced, re-use means that the residue is used for another purpose e.g. dross or slag may be re-used as a construction material.
- 3.167 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 8: Solid waste stream: routes currently taken**

Process waste stream	Fate
Raw material collected in abatement plant dust	Recovered where possible or landfilled. For induction furnaces, recycled to furnace if possible
Drosses, slag and skimmings	Recycled or used for metal recovery Aluminium dross dust used in the recovery of salt slag
Refractories and collected dusts	Metal recovery on or off-site where possible or landfilled.
Sand	Reclaimed for internal re-use to the extent possible, then beneficial re-use by third party wherever possible.
Dust from Greensand recovery plant abatement	Can be recycled. The potential for return to fines to the greensand plant is controlled by technical considerations of sand quality. Fines from chemically bonded sand should not be returned to the sand system
Particulate matter from knock-out or casting fume extraction abatement plant	Landfill
Fettling waste, swarf and metal turning disks	Recycled to furnace where practical or recycled off-site
Melting operations: refractory waste	Use as slagging agent or landfill
Steel bands from pallet packaging	Re-used or off-site recycling
Waste water treatment sludge	Re-use, off-site recovery/recycling or disposal
Scrubber liquors and sludges	Minimised, then to licensed waste disposal contractors
Graphite dies (semi-continuous casting)	Internal recovery for furnace oxidation prevention
Spent acids	Off site treatment
Wood, cardboard and paper	Segregated for off site re-use or recovery
Oil	Recovery off site

## BAT

- 101 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 8](#).
- 102 At a minimum of every two years, the operator should investigate potential markets for the recovery/re-use of wastes that are currently disposed of to landfill.

## Energy

3.168 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

3.169 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.

3.170 The following techniques result in improved energy efficiency:

- use of recuperative burners, heat exchangers and boilers to recover heat from process gases
- generation of steam or electricity for use on or off site
- pre-heating process or fuel gases; preheating of combustion air increases the flame temperature resulting in higher melting efficiency and a reduction in energy consumption.
- pre-heating charge material
- use of oxygen enriched air or oxygen in burners reduces energy consumption. Waste gas volumes are also significantly reduced allowing smaller fans, ducting and abatement plant to be used for example

## BAT

- 103 The operator should produce a report annually on the energy consumption of the installation.
- 104 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.)
- 105 In order to optimise combustion, the operator should, where practicable, monitor carbon monoxide and oxygen in waste gases.
- 106 The operator should ensure that all plant is operated and maintained to optimise the use and minimise the loss of energy.
- 107 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

- 3.171 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.

### BAT

#### Energy efficiency techniques

- 108 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
  - replacing oversized energy intensive equipment (e.g. air compressors)
  - using variable speed compressors
  - phase optimisation of electronic control motors and fans
  - optimised efficiency measures for melting plant
  - preventative maintenance programme targeting energy drops

#### Energy supply techniques

- 109 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
  - use of less polluting fuels

## Accidents

- 3.172 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
- 3.173 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**
- 3.174 In identifying the hazards particular areas to consider may include, but should not be limited to, the following:
- excessive transfer rates leading to over-pressure (e.g. loading or unloading from or to silos or storage tanks)
  - overfilling of silos or tanks causing spillage of liquids or powders
  - charging into the incorrect silo or storage tank
  - 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)
  - gaseous leakage from the furnace
  - unintentional release from bulk gas storage
  - spillage of hot metal (e.g. from the ladle during centrifugal casting)
  - fires and problems arising from fighting fires such as failure to contain firewaters

- inappropriately stored combustible materials
- 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**

- 3.175 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 is the overall risk (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)**

- 3.176 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

- 110 There should be written procedures for investigating incidents and near misses, including identifying suitable corrective action and following up.
- 111 The operator should maintain an accident management plan covering the matters listed in paragraphs 3.174 to 3.176 above and to the satisfaction of the regulator. The plan should be available for inspection by the regulator.
- 112 In the case of abnormal emissions arising from an accident, such as a spillage for example, the operator should:
- Investigate immediately undertake remedial action as soon as possible
  - promptly record the events and actions taken
  - ensure the regulator is made aware without delay

### Specific conditions

- 113 Specific conditions may need to be included within permits to prevent accidents. Examples of these are given in 114 – 119 below.
- 114 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.
- 115 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.
- 116 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.
- 117 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.
- 118 Operators should use safe systems of for the handling and storage of dust in order to minimise the risk of fire and explosion.
- 119 Operators should design delivery routes to minimise accidental damage by vehicles to any storage facilities for liquids or dusts. Where a risk of vehicular damage to such storage areas has been identified, crash barriers should be fitted.

## Noise and Vibration

- 3.177 Within this section, “noise” should be taken to refer to noise and/or vibration as appropriate, detectable beyond the site boundary.
- 3.178 The most significant source of noise arises as a result of the following activities:
- scrap handling (deliveries and charging)
  - other raw material handling
  - fans, motors and associated ductwork
  - vehicle movements
  - knock-out/ shake-out
  - shot blasting, grinding, milling, rolling, fettling and other engineering operations
  - activities using compressed air
  - general production plant
- 3.179 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.
- 3.180 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 sensitive receptors. [Table 9](#) identifies the noisiest operations and the control measures that have been employed to mitigate problems.
- 3.181 Further guidance can be found in chapter 16 of the General Guidance Manual.

**Table 9: Noise Mitigation Measures**

Operation	Control Measure
Scrap Deliveries	<ul style="list-style-type: none"> <li>▪ Scrap storage in enclosed area</li> <li>▪ Minimising deliveries at night*</li> <li>▪ Minimise the drop height for scrap deliveries</li> <li>▪ Deliveries using pallets or stillages</li> </ul>
Scrap Handling and charging	<ul style="list-style-type: none"> <li>▪ Develop storage systems to avoid double handling</li> <li>▪ Minimising charging height</li> <li>▪ Use screens and barriers to conceal noise sources</li> </ul>
Site Vehicle Movements	<ul style="list-style-type: none"> <li>▪ Using vehicles with “directional and localised sound” for reverse alarms to concentrate noise at the area of immediate danger</li> <li>▪ Replacing diesel powered forklift trucks with electric or LPG powered</li> <li>▪ Minimising vehicle movements at night</li> <li>▪ Using even roadways for vehicle movements</li> </ul>
Knock-out / shake-out	<ul style="list-style-type: none"> <li>▪ Acoustic screens and enclosures*</li> <li>▪ Cushion impacts using resilient linings</li> <li>▪ Make stillages, chutes and tables less effective noise radiators</li> </ul>
Fans, pumps and motors	<ul style="list-style-type: none"> <li>▪ Acoustic screens, enclosures and baffles</li> <li>▪ Fitting silencers to avoid noise travelling along ducting</li> <li>▪ Selection of less noisy engineering equipment</li> <li>▪ Fitting resilient hangers for wall-mounted equipment</li> </ul>
Grinding, fettling, shot blasting (finishing operations)	<ul style="list-style-type: none"> <li>▪ Acoustic screens and enclosures*</li> <li>▪ Selection of less noisy engineering equipment</li> <li>▪ Millings, fettling scrap and off-cuts transported in bags</li> </ul>
General	<ul style="list-style-type: none"> <li>▪ Fitting noise reducing flaps to outside doors</li> <li>▪ Maintaining a closed doors policy</li> <li>▪ Improving sound insulation of buildings</li> <li>▪ Holes and openings closed off (use mechanical where necessary)</li> </ul>

	<ul style="list-style-type: none"> <li>▪ Enclose foundry operations within buildings</li> <li>▪ Fitting anti-vibration mounts on plant</li> <li>▪ Using flexible connections between vibrating and fixed plant</li> <li>▪ Preventative maintenance programme e.g. equipment wear, bearings</li> </ul>
* Noise mitigation measures that are likely to be needed in most cases	

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120 The operator should identify key plant and equipment (or operations) 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 3.178 and Table 9 above.

121 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

3.182 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

3.183 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

3.184 The sampling analytical methods selected for compliance monitoring 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)

3.185 Guidance on standards for monitoring releases to air, water and land) relevant to IPPC can be found in Ref 8.

- 3.186 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.
- 3.187 If in doubt the operator should consult the regulator.

### **Monitoring and sampling protocols**

- 3.188 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**

- 3.189 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.
- 3.190 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/m<sup>3</sup>, against an emission limit of 50 mg/m<sup>3</sup> 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/m<sup>3</sup> when the limit is mg/m<sup>3</sup> might not qualify for a reduction in monitoring
- 3.191 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.
- 3.192 Where effective surrogates are available they may be used to minimise monitoring costs.
- 3.193 Where monitoring shows that substances are not emitted in significant quantities, consideration can be given to a reduced monitoring frequency.

### **Monitoring emissions to air**

- 3.194 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**

- 3.195 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)

- 3.196 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
- 3.197 Further guidance is given in chapter 15 of the General Guidance Manual.

## Monitoring of process variables

- 3.198 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

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### Monitoring and reporting

- 122 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
- 123 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
- 124 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.
- 125 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.
- 126 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.
- 127 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
- 128 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

129 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 operated to ensure less than 5% downtime over any 3-month period and all relevant maintenance and calibration (or referencing) should be recorded

130 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**

131 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.

132 The introduction of dilution air to achieve emission concentration limits should not be permitted.

133 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.

134 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.

135 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.

136 Frequency of monitoring for all pollutants (including particulate matter) where arrestment equipment is necessary to meet specified emission limits should be at least annually.

137 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 m<sup>3</sup> 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.

138 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**

139 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

140 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.

141 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

- 142 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

3.199 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

3.200 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 10a](#) below.

**Table 10a: Summary of Provisions for Reporting and Notification**

BAT Clause	Provision	Information Category	Frequency
<b>BAT 10</b>	Action plan on improvements to minimise heat loss from open crucibles, transfer ladles and holding furnaces	Report	Within 24 months of publication of this note
<b>BAT 36</b>	Investigation of the cause and nature of any persistent any visible emissions	Report	Reactive
<b>BAT 76</b>	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
<b>BAT 90</b>	Assessment of the extent to which further sand recovery is achievable	Report	Within 18 months of issue of the permit
<b>BAT 124 &amp; 125</b>	Report of results from non-continuous emission testing forwarded to the regulator.	Report	Within 8 weeks of completion of sampling – typically annual
<b>BAT 79</b>	Notification of appointed competent person to liaise with the regulator and the public with regard to complaints	Notification	Reactive
<b>BAT 112</b>	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
<b>BAT 123</b>	Notification at least 7 days before any periodic monitoring exercise to determine compliance with ELVs	Notification	Reactive
<b>BAT 126</b>	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

**\*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.

3.201 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.

3.202 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”

3.203 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

3.204 Additional information provisions are summarised in [Table 10b](#) below.

**Table 10b: Summary of Provisions for Additional Information**

BAT Clause	Category	Subject
<b>BAT 8</b>	Procedures	Optimal melting and charging practices
<b>BAT 40</b>	Procedures	Start-up and shut down, and changes of fuel or combustion load in order to minimise emissions
<b>BAT 61</b>	Procedures	Leak prevention from subsurface structures (control, maintenance and inspection).
<b>BAT 67</b>	Procedures	Preventative maintenance programme for tanks bunds and sumps
<b>BAT 68*</b>	Procedures	Control measures to minimise the pollution risk from solvent storage
<b>BAT 74</b>	Procedures	Environmental Management System. Records of EMS audits
<b>BAT 75*</b>	Procedures	Operational and maintenance systems for all aspects of the installation whose failure could impact on the environment – annual review
<b>BAT 80 &amp; 81</b>	Procedures	Formal structure of employee's responsibility for process control and environmental impacts and training provisions
<b>BAT 83</b>	Procedures	Investigating accidents, incidents and non-conformance

<b>BAT 84*</b>	Procedures	Control the specification of raw materials with respect to their environmental impact. Review of alternative raw materials
<b>BAT 100</b>	Procedures	Dealing with damaged or leaking containers
<b>BAT 110</b>	Procedures	Incidents and near misses investigation. Corrective action and following up
<b>BAT 115</b>	Procedures	Spills and firewater control to ensure containment and disposal of liquids
<b>BAT 116</b>	Procedures	Systems to avoid excessive transfer rates of solids
<b>BAT 118</b>	Procedures	Safe systems for the handling and storage of dust
<b>BAT 17</b>	Records	For magnesium processes, assess & review alternative melt oxidation controls
<b>BAT 49</b>	Records	Inspections and maintenance of interceptors
<b>BAT 57</b>	Records	Inspections of external surfaces of process buildings, roofs, guttering, ancillary plant, roadways and open yards and storage areas
<b>BAT 60 &amp; 61</b>	Records	Site drainage plans and inspection
<b>BAT 67</b>	Records	Visual inspection of tanks, bunds and sumps
<b>BAT 69</b>	Records	Odour assessments
<b>BAT 71*</b>	Records	Substitution plans for odorous production methods
<b>BAT 78</b>	Records	Analysis of breakdowns in order to eliminate common failure modes.
<b>BAT 85 &amp; 93</b>	Records	Raw material and water usage benchmarks
<b>BAT 86 &amp; 87*</b>	Records	Waste minimisation audits and improvement programme
<b>BAT 90</b>	Records	Assessment optimal primary reclamation of foundry sand
<b>BAT 91 &amp; 92*</b>	Records	Water efficiency audit and water efficiency improvement programme
<b>BAT 94</b>	Records	Water usage measurements
<b>BAT 96*</b>	Records	Waste inventory and treatment method
<b>BAT 101*</b>	Records	Annual review of waste disposal and recovery options
<b>BAT 103*</b>	Records	Annual energy audit
<b>BAT 111*</b>	Records	Accident management plan
<b>BAT 120</b>	Records	Identification of key plant and equipment with the potential to give rise to significant noise. Mitigation measures
<b>BAT 124</b>	Records	Results from continuous monitoring systems
<b>BAT 129</b>	Records	Maintenance and calibration of continuous monitoring systems
<b>BAT 141</b>	Records	Analysis for Schedule 5 substances (where needed)
<b>BAT 142</b>	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		

3.205 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 10a 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](http://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](http://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](http://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](http://www.defra.gov.uk)
  - Groundwater Protection Code – Solvent Use and Storage, Defra 2004
- Ref 4 'Envirowise (formerly the Environmental Technology Best Practice Programme, ETBPP), Harwell International Business Centre, Didcot, Oxfordshire OX11 0QJ. Helpline 0800 585794. Good Practice Guides:
- GG104 Cost effective management of chemical binders in foundries.
  - GG711 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/](http://www.nisp.org.uk/)
  - Envirowise, GG043, Environmental Management Systems in Foundries
  - Envirowise, GG025, Saving money through waste minimisation: Raw Material Use
  - Envirowise, GC161 Minimising the use of die lubricant in casting operations
- 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, GPG253, A Managers Guide to optimising furnace performance
  - Action Energy, GPCS036, Computer simulation of solidification in non-ferrous sand foundries
  - Action Energy, GPCS344, Energy Savings From Small; Efficient Melting and Holding Furnaces
- Ref 9 Waste & Resources Action Programme (WRAP), The Old Academy, 21 Horse Fair, Banbury, Oxon OX16 0AH. [Helpline@wrap.org.uk](mailto: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/business>" How and why we regulate your business/Principles and approaches"*
  - *Direct Toxicity Assessment for Effluent Control: Technical Guidance (2000)*, UKWIR 00/TX/02/07

## Abbreviations

<b>BAT</b>	Best Available Techniques
<b>BOD</b>	Biochemical Oxygen Demand
<b>BREF</b>	BAT Reference Document
<b>CCA</b>	Climate Change Agreement
<b>CEM</b>	Continuous Emissions Monitoring
<b>CHP</b>	Combined Heat and Power plant
<b>CO<sub>2</sub></b>	Carbon Dioxide
<b>CO</b>	Carbon Monoxide
<b>COD</b>	Chemical Oxygen Demand
<b>COSHH</b>	Control of Substances Hazardous to Health
<b>DMEA</b>	Dimethylethylamine
<b>DPA</b>	Direct Participation Agreement
<b>EA</b>	Environment Agency
<b>EAL</b>	Environment Assessment Level
<b>ELV</b>	Emission Limit Value
<b>EMS</b>	Environmental Management System
<b>ETP</b>	Effluent Treatment Plant
<b>EU</b>	European Union
<b>EUETS</b>	European Union Emissions Trading Scheme
<b>EQS</b>	Environmental Quality Standard
<b>HCl</b>	Hydrogen Chloride
<b>H<sub>2</sub>S</b>	Hydrogen Sulphide
<b>ITEQ</b>	International Toxicity Equivalents
<b>MCERTS</b>	Monitoring Certification Scheme
<b>MDI</b>	Methyl Di-isocyanate
<b>NIEHS</b>	Northern Ireland Environment and Heritage Service
<b>NO<sub>2</sub></b>	Nitrogen Dioxide
<b>PAH</b>	Polyaromatic Hydrocarbon
<b>SAC</b>	Special Areas of Conservation
<b>SECp</b>	Specific Energy Consumption
<b>SEPA</b>	Scottish Environment Protection Agency
<b>SO<sub>2</sub></b>	Sulphur Dioxide
<b>SPA</b>	Special Protection Area
<b>TEA</b>	Triethylamine
<b>TSS</b>	Total Suspended Solids
<b>TOC</b>	Total Organic Carbon
<b>VOC</b>	Volatile Organic Compound
<b>WAG</b>	Welsh Assembly Government

# Appendix 1: Summary of Changes

Reasons for the main changes are summarised below.

Table 11: Summary of changes

Section/ Paragraph/ Heading	Change	Reason	Comment
<b>1. Introduction</b>			
Table 1	compliance timetable amended	New provisions of note	
<b>2. Emission limits and other provisions</b>			
Table 4	New suspended solids limit 50 mg/l limit	BAT	Previously the ELV was 20 mg/l. Amended following BAT assessment
Table 4	New ELVs for metals	BAT	Previously lower ELVs based on monthly averages (BREF) amended to reflect spot samples and BAT
<b>3. Techniques for pollution control</b>			
<b>Installation description and in-process controls</b>			
BAT 1 to BAT 7 Deliveries	BAT provisions consolidated	BAT/industry good practice	Seven BAT clauses reduced to 4 in light of review information
BAT 8 and BAT 10 Melting operations	Documenting optimal melting and procedures and minimising heat loss	BAT/industry good practice	Open crucible furnaces, transfer ladles and holding furnaces
BAT 17	Alternative oxidation controls for magnesium activities	BAT/industry good practice	BAT clause
BAT 18	Selection criteria for core and mould manufacturing techniques	BAT/industry good practice	Odour control
<b>Emissions Control</b>			
BAT 50 - 51 Point source emissions to surface water and sewer	Inclusion of BAT clauses for recycling water cooling and wet-abatement	Revised guidance  BAT	Separate provisions for new and existing plant
3.97 - 3.98 Point source emissions to surface water and sewer	Amended text relating to off-site effluent treatment	Consolidation of AQ11(05)	
3.99 & BAT 53 Point source emissions to groundwater	Amended text and BAT clause	Groundwater Regulations - extra guidance to regulators and operators	
BAT 54 – 59 Fugitive emissions to air	BAT provisions amended	BAT/industry good practice	
3.101 – 3.105 & BAT 60 – 68 Fugitive emissions to surface water, sewer and groundwater	Additional text for groundwater and surface water protection	Industry good practice, further guidance to industry and regulators	
3.111 to 3.130 and BAT 69 – 73 Odour	Inclusion of paragraphs and BAT provisions on assessment, prevention, minimising and abatement	Restructuring Sector Guidance – revised guidance BAT/industry good practice	Principle of assessment and specific
<b>Management</b>			
3.132 and BAT 74	Additional BAT – using EMS	Industry good practice	

BAT 80 - 81	A formal organisational structure for environmental control	BAT/industry good practice	
<b>Raw Materials</b>			
3.140 and Table 7	Amended text and table for selection criteria for raw materials	Extra guidance to regulators and operators	
3.153	Guidance on sustainable consumption and production	Extra guidance to regulators and operators	Government Policy
BAT 85	BAT provision – benchmarks for raw materials usage	BAT/industry good practice	
BAT 88	BAT provisions – dross minimisation	BAT	
BAT 89 to 90	BAT provisions – optimising recovery/recycling of foundry sand	BAT/industry good practice	Envirowise Guides given as reference
BAT 93	BAT provision – benchmarks for water use	BAT/industry good practice	
<b>Waste Handling</b>			
BAT 96 - 100	BAT provisions consolidated	BAT/industry good practice	Seven BAT clauses reduced to 4 in light of review information
<b>Waste re-use, recovery, recycling or disposal</b>			
BAT 102	Annual review of disposal options and new recycling markets	BAT	Envirowise and WRAP guides given as reference
<b>Energy</b>			
BAT 108 and 109	Additional provisions for energy efficiency and supply techniques	BAT	
<b>Accidents</b>			
3.175	Inclusion of text for identification of the risks	Extra guidance to regulators and operators	
BAT 113 to 119	Additional provisions – specific measures for accident prevention	Industry good practice	
<b>Noise and Vibration</b>			
3.180 and Table 9	Additional text and new table identifying noise mitigation measures	BAT/industry good practice	
BAT 120 and 121	Identification of significant noise sources and implementing mitigation measures in Table 10.	BAT/industry good practice	
<b>Monitoring</b>			
3.186	Considering appropriateness when selecting test methods	Extra guidance to regulators and operators	
BAT 125	Reporting monitoring uncertainty	BAT	
BAT 142	Waste reporting	BAT/industry good practice	To assist in waste auditing to minimise the impact of waste to land
<b>Information Provisions</b>			
3.199 to 3.205 Tables 10a and 10b	Additional text and new tables identifying information and reporting provisions	Extra guidance to regulators and operators	
References	Amended reference list	New guidance available	
Appendix 1 and Table 12	New Appendix 1 included as a summary of changes		
Appendix 2	List of water test methods	Replacing Appendix 1	New Appendix 2
Appendix 2	Original Appendix 2 deleted	Furnaces for Aluminium melting was incomplete	
Appendices 3 & 4	Replaced by new appendix 4	Secondary aluminium inputs and outputs	
Appendices 6 & 7	Original Appendices 6 & 7 deleted	Contained incomplete data	

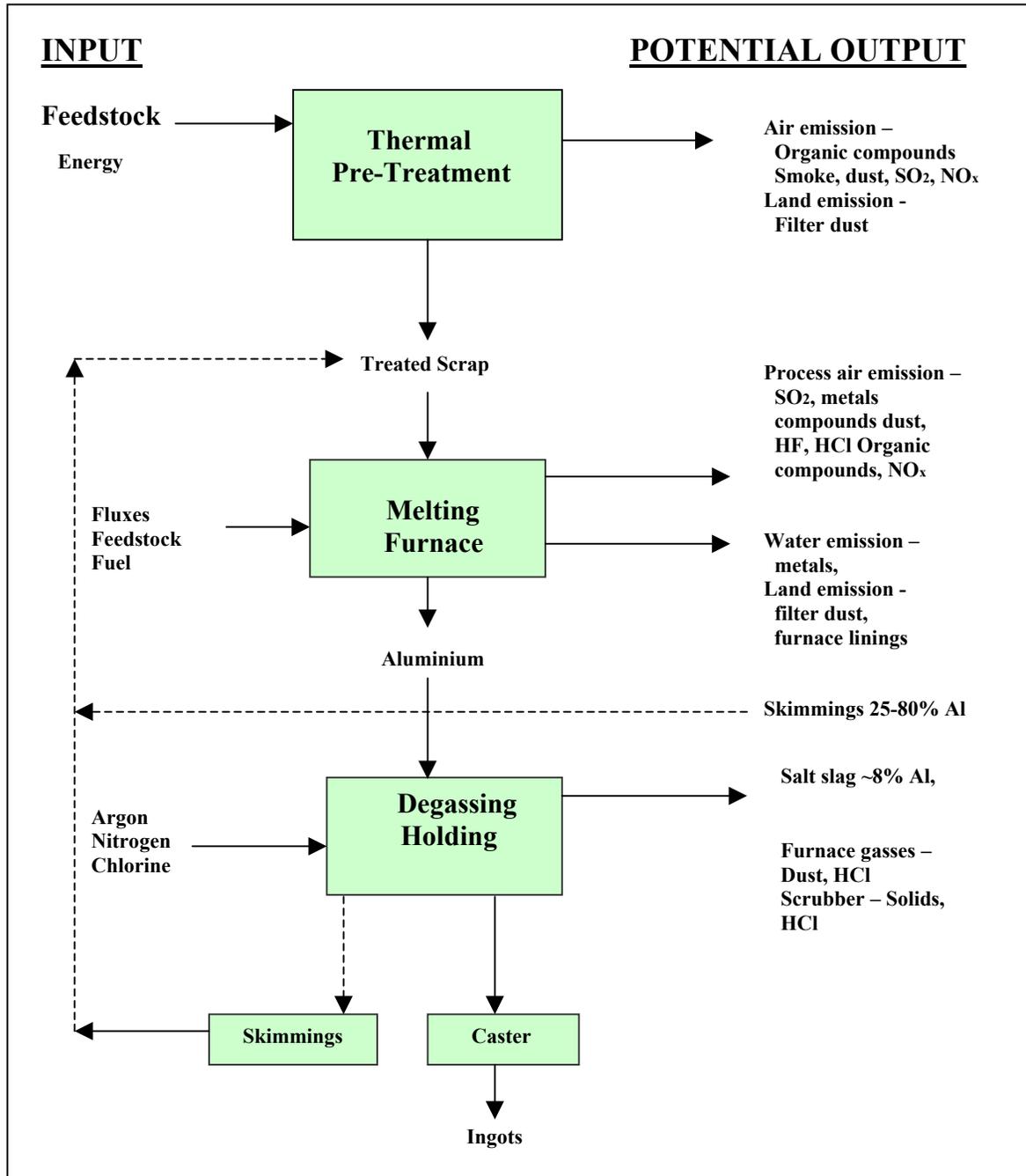
# Appendix 2: Some Common Monitoring Methods for Releases to Water

Table 12: Measurement methods for common substances to water

Determinand	Method	Detection limit	Valid for range mg/l	Standard
<b>Suspended solids</b>	Filtration through glass fibre filters	2 mg/l	20% 10-40	ISO 11929:1997, EN872 - Determination of suspended solids
<b>COD</b>	Oxidation with di-chromate	12 mg/l	20% 50-400	ISO 6060: 1989, Water Quality - Determination of chemical oxygen demand
<b>BOD</b>	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
<b>Total hydrocarbon oil</b>	Infra Red Absorption and Gravimetry 1983		0.2mg/l	SCA blue book 77 ISBN 0117517283
<b>AOX</b>	Adsorption on activated carbon and combustion		20% 0.4 - 1.0	ISO 9562: 1998, EN1485 - Determination of adsorbable organically bound halogens
<b>Total N</b>	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.
<b>pH</b>				BS 6068-2.50:1995, ISO 10523:1994
<b>Turbidity</b>				BS EN ISO 7027:2000 BS 6068-2.13:2000
<b>Temperature</b>				SCA temperature measurement for Natural, Waste and Potable Waters and other items of interest in the Water and Sewage Disposal Industry ISBN 0117520179
<b>Metals</b>	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
<b>Phenol index</b>	By flow analysis (FIA and CFA)		0.01 – 1 mg/l	BS EN ISO 14402:1999 BS 6068-2.68:1999
<b>Formaldehyde</b>				SCA The determination of formaldehyde, other volatile aldehydes, ketones and alcohols in water
<b>Ammonia</b>		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

# Appendix 3: Inputs and output from secondary aluminium production

Figure 3.1: Input and output from secondary aluminium production



# Appendix 4: Typical production process for secondary magnesium

Figure 3.2: Typical production process for secondary magnesium

