



**BAT Guidance Note on
Best Available Techniques for
Non-Ferrous Metals and Galvanising
(1st Edition)**

ENVIRONMENTAL PROTECTION AGENCY
An Ghníomhaireacht um Chaomhnú Comhshaoil
PO Box 3000, Johnstown Castle Estate, Co. Wexford, Ireland

Telephone: +353 53 916 0600; Fax: +353 53 916 0699
E-Mail: info@epa.ie Website: www.epa.ie

Lo Call: 1890 33 55 99

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1. INTRODUCTION

1.1 GENERAL

This Guidance Note is one of a series issued by the Environmental Protection Agency (EPA), which provides guidance on the determination of Best Available Techniques (BAT) in relation to:

- applicants seeking Integrated Pollution Prevention and Control (IPPC) licenses under Part IV of the Environmental Protection Agency Acts 1992 to 2007,
- existing Integrated Pollution Prevention and Control (IPPC) Licensees, whose licence is to be reviewed under the Environmental Protection Agency Acts 1992 to 2007,
- applicants seeking Waste Licenses under Part V of the Waste Management Acts 1996 to 2008,
- existing Waste Licensees, whose licence is to be reviewed under Waste Management Acts 1996 to 2008.

This Guidance Note shall not be construed as negating the installation/facility statutory obligations or requirements under any other enactments or regulations.

1.2 BAT GUIDANCE NOTE STRUCTURE

This Guidance Note has been structured as follows:

| Section | Details |
|---------|---|
| 1 | Introduction |
| 2 | Interpretation of BAT |
| 3 | Sector(s) Covered by this Guidance Note |
| 4 | Process Description, Risk to the Environment and Control Techniques |
| 5 | Best Available Techniques |
| 6 | BAT Associated Emission Levels |
| 7 | Compliance Monitoring |

Where relevant, references are made to other detailed guidance; such as the reference documents (BREF) published by the European Commission, Agency Guidance Notes for *Noise in Relation to Scheduled Activities*, and the determination of BAT should be made giving regard to these.

The information contained in this Guidance Note is intended for use as a tool to assist in determining BAT for the specified activities.

2. INTERPRETATION OF BAT

2.1 STATUS OF THIS GUIDANCE NOTE

This Guidance Note will be periodically reviewed and updated as required to reflect any changes in legislation and in order to incorporate advances as they arise.

Techniques identified in these Guidance Notes are considered to be current best practice at the time of writing. The EPA encourages the development and introduction of new and innovative technologies and techniques, which meet BAT criteria and look for continuous improvement in the overall environmental performance of the sectors activities as part of sustainable development. Operators should therefore continue to keep up to date with the best available techniques relevant to the activity and discuss appropriate innovations with the EPA.

2.2 INTERPRETATION OF BAT

BAT was introduced as a key principle in the IPPC Directive, 96/61/EC. This Directive has been incorporated into Irish law by the Protection of the Environment Act 2003. To meet the requirements of this Directive, relevant Sections of the Environmental Protection Agency Act 1992 and the Waste Management Act 1996 have been amended to replace BATNEEC (Best Available Technology Not Entailing Excessive Costs) with BAT.

Best available techniques (BAT) is defined in Section 5 of the Environmental Protection Agency Acts 1992 to 2007 and Section 5(2) of the Waste Management Acts 1996 to 2008 as the “most effective and advanced stage in the development of an activity and its methods of operation, which indicate the practical suitability of particular techniques for providing, in principle, the basis for emission values designed to prevent or eliminate or where that is not practicable, generally to reduce an emission and its impacts on the environment as a whole” where:

- B** **‘best’** in relation to techniques means the most effective in achieving a high general level of protection of the environment as a whole.
- A** **‘available techniques’** means those techniques developed on a scale which allows implementation in the relevant class of activity under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced within the State, as long as they are reasonably accessible to the person carrying on the activity.
- T** **‘techniques’** includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

The range of BAT associated emission level values specified in Section 6 indicate those that are achievable through the use of a combination of the process techniques and abatement technologies specified as BAT in Section 5. The licensee must demonstrate to the satisfaction of the Agency, during the licensing process, that the installation/facility will be operated in such a way that all the appropriate preventative measures are taken against pollution through the application of BAT and justify the application of other than the most stringent ELV in the range.

At the installation/facility level the most appropriate techniques will depend on local factors. A local assessment of the costs and benefits of available options may be needed to establish the best option. The choice may be justified on:

- technical characteristics of the installation/facility;

- its geographical location;
- local environmental considerations;
- the economic and technical viability of upgrading existing installation/facility;

The overall objective of ensuring a high level of protection for the environment as a whole will often involve making a judgment between different types of environmental impact, and these judgements will often be influenced by local considerations. On the other hand, the obligation to ensure a high level of environmental protection including the minimisation of long-distance or transboundary pollution implies that the most appropriate techniques cannot be set on the basis of purely local considerations.

The guidance issued in this Note in respect of the use of any technology, technique or standard does not preclude the use of any other similar technology, technique or standard that may achieve the required emission standards and is demonstrated to the Agency to satisfy the requirement of BAT.

2.3 BAT HIERARCHY

In the identification of BAT, emphasis is placed on pollution prevention techniques rather than end-of-pipe treatment.

The IPPC Directive 96/61/EC and the Environmental Protection Agency Acts 1992 to 2007 (section 5(3)), require the determination of BAT to consider in particular the following, giving regard to the likely costs and advantages of measures and to the principles of precaution and prevention:

- (i) the use of low-waste technology,
- (ii) the use of less hazardous substances,
- (iii) the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate,
- (iv) comparable processes, facilities or methods of operation, which have been tried with success on an industrial scale,
- (v) technological advances and changes in scientific knowledge and understanding,
- (vi) the nature, effects and volume of the emissions concerned,
- (vii) the commissioning dates for new or existing activities,
- (viii) the length of time needed to introduce the best available techniques,
- (ix) the consumption and nature of raw materials (including water) used in the process and their energy efficiency,
- (x) the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it,
- (xi) the need to prevent accidents and to minimise the consequences for the environment, and
- (xii) the information published by the Commission of the European Communities pursuant to any exchange of information between Member States and the industries concerned on best available techniques, associated monitoring, and developments in them, or by international organisations, and such other matters as may be prescribed.

3. SECTOR COVERED BY THIS GUIDANCE NOTE

This Guidance Note covers the following activities under the First Schedule to the Environmental Protection Agency Acts 1992 to 2007:

- 3.4.1 The-
 - (a) production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes,
 - (b) smelting, including the alloyage, of non-ferrous metals, including recovered products, (refining, foundry casting, etc.) with a melting capacity exceeding 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals.
- 3.4.2 The production, recovery or processing of non-ferrous metals, their compounds or other alloys including antimony, arsenic, beryllium, chromium, lead, magnesium, manganese, phosphorus, selenium, cadmium or mercury, by thermal, chemical or electrolytic means in installations with a batch capacity exceeding 0.5 tonnes, not included in paragraph 3.4.1.
- 3.2.1 The processing of ferrous metals:
 - (c) application of protective fused metal coats with an input exceeding 2 tonnes of crude steel per hour.
- 3.9 Boilermaking and the manufacture of reservoirs, tanks and other sheet metal containers where the production area exceeds 500 square metres.

4. PROCESS DESCRIPTION, RISK TO THE ENVIRONMENT AND CONTROL TECHNIQUES

(Note: any reference to BREF in this document means the reference document on *Best Available Techniques for the Non Ferrous Metal Industries*, published by the European Commission, December 2001).

The general production sequences involved in the Irish Non-Ferrous Metals Industry Classes 3.4.1 and 3.4.2 are described herein, the emission sources are presented outlined in section 4.2.

4.1 DESCRIPTION OF PROCESSES

4.1.1 General Production Processes

The production of non-ferrous metals in the aforementioned classes 3.4.1 and 3.4.1 in Ireland typically involves the following primary metals groups, which will be the central focus of this particular BAT document:

- Copper and its alloys;
- Aluminium and its alloys;
- Zinc and lead;
- Precious metals;
- Refractory metals;
- Ferro-alloys.

Several different production processes are carried out but despite this diversity, individual stages of production processes are common to most of the non-ferrous metals processed. These include receipt, storage and handling of raw materials, pre-processing and pre-treatment of raw materials (and transfer to production processes), pyrometallurgical extraction/production (smelting and melting, refining, and alloying), and finishing. Central to the processes of smelting, refining and alloying is the *type of furnace* employed while other matters of importance are the nature of *drosses, skimmings and slags* produced, and *moulding and casting* methods. *Electrochemical processes* and *hydrometallurgical extraction* techniques are also used to manufacture non-ferrous metal products.

4.1.1.1 Receipt, storage and handling of raw materials

The principal raw materials used by Irish industry are ores and concentrates, secondary raw materials, fuels (oils, gases and solid fuel), process chemicals and gases. Other materials employed include fluxes and additives. Such a variety of substances require particular handling and storage solution, which depends on the exact physical and chemical properties of the material concerned (see BREF Section 2.4).

Ores and concentrates: Unloading, storage and distribution of solid material is done using similar methods to those used for solid fuels. Ores, concentrates and other dusty materials are normally stored in enclosed buildings. Open stockpiles are usually made on hard, impervious surfaces such as concrete to prevent loss of

material, land contamination, ore contamination and leaching to ground or surface waters. Closed, covered stockpiles and silos are also employed. Water sprays or sealing agents including molasses or lime may be used to suppress dust, while sealing can also prevent oxidation of surface layers and subsequent leaching. Unloading of minerals can also be a significant source of dust emissions. Material can be reclaimed by underfeed conveyor, grab crane or front-end loader with totally enclosed conveyors used to transport dust-forming material. Transfer by pneumatic, dense phase systems may also be used (see BREF Section 2.4.1.1).

Secondary raw materials: There is a wide range of secondary raw materials including scrap metal, skimmings, flue or filter dusts, drosses and engineering wastes (e.g. swarf, grindings and turnings). The nature of the raw material gives information about the potential emissions which will arise due to contaminating substances such as acids, oils, organic contaminants (can produce dioxins during melting processes), plastics, etc. (see BREF Section 2.4.1.2).

A material's physical state affects the storage and handling methods (e.g. dusty, oily, solid, etc.) as does the form of delivery (loose material, tote bags, drums, etc.). Quality control and analysis of feed material is normally practiced. Large components and potentially contaminated materials such as swarf or grindings are stored on concrete areas, which may be in the open, covered or inside buildings. Different materials are normally segregated into separate piles to keep different grades and types of material apart. Dusty materials and skimmings are also stored in separate piles in the open, covered over or indoors.

Storage methods determine whether handling is by grab, conveyor, shovel, etc. Where secondary materials require blending prior to processing or pre-treatment intermediate storage is used.

Fuels: Fuels are generally used as heating sources, delivery and storage of fuels is controlled to prevent leaks and spills. Distribution of fuels from site storage tanks to the process is by pipeline or service trench. Pipes are generally aboveground to facilitate leak identification of leaks and protected by barriers (see BREF Section 2.4.1.3).

Gaseous fuels are most commonly delivered via pipelines and using pressure reduction equipment or occasionally compression equipment. Pressure and volume monitoring is frequently carried out to identify leaks. Gas monitors may also be used to monitor the workplace and the areas adjacent to storage tanks. Again, site distribution is by overhead pipeline using suitable damage protection techniques.

Solid fuels are stored in silos, enclosed or open stockpiles and buildings depending on the type of fuel and its dust-forming tendencies. Moisture content can be used to control dust release and the possibility of dust explosions. As for ores and concentrates, molasses or another suitable material may be used to control dust formation or oxidation. On-site movement may be by underfed conveyor, grab crane, front-end loader or truck.

Process chemicals and gases: Acids, alkalis and other chemical reagents are typically used in the main processes (e.g. cleaning, leaching) and in abatement equipment (off-gas or effluent treatment) and are produced during processes. Liquids are usually stored in suitably coated drums or tanks in open or closed bunded areas. Solids are normally stored in drums or bags with isolated drainage systems while

silos are used for materials such as lime. Pneumatic transport systems are used (see BREF Section 2.4.1.4).

Residues: The various processes in this sector produce different types of residues and these may form the basis of raw materials for other sectors of the industry. The same handling and storage processes apply as for secondary raw materials (see BREF Section 2.4.1.5).

Table 1 below summarises the different types of raw materials and the most suitable methods for handling and storage of each of these.

Table 1: Summary of raw material storage and handling techniques

| Raw material | Metal group | Method for handling | Method for storage | Comments |
|---|-------------------------------|---|--|---|
| Concentrates | All – if dust forming | Enclosed conveyors or pneumatic | Enclosed building | Prevention of water contamination |
| | All – if non dust forming | Covered conveyors | Covered store | |
| Fine grained material (e.g. metal powder) | Refractory materials | Enclosed conveyors or pneumatic Covered conveyors | Closed bins, bins and hoppers | Prevention of water contamination and fugitive air emissions |
| Secondary raw materials | All – Large items | Mechanical loader | Open | Prevention of water contamination or reactions with water. Oily drainage from water |
| | All – Small items | Charge skips | Covered bays | |
| | All – Fine material | Enclosed or agglomerated | Enclosed if dusty | |
| Fluxes | All – if dust forming | Enclosed conveyors or pneumatic | Enclosed building | Prevention of water contamination |
| | All – if non dust forming | Covered conveyors | Covered store | |
| Liquid fuels and LPG | All | Overhead pipeline | Certified storage Bunded areas | Back venting of delivery lines |
| Process gases | All | Overhead pipeline Reduced pressure pipeline (Chlorine, CO) | Certified storage | Pressure loss monitoring. Alarms for toxic gases |
| Solvents | Cu, Zn group, Precious Metals | Overhead pipeline | Drums, tanks | Back venting of delivery lines |
| Products – Ingots, cakes, etc. | All | Depends on conditions | Open concrete area or covered storage | Appropriate drainage system |
| Process residues for recovery | All | Depends on conditions | Open, covered or enclosed depending on | Appropriate drainage system |

| | | | | |
|---------------------|-----|-----------------------|---|-----------------------------|
| | | | dust formation and reaction with water | |
| Wastes for disposal | All | Depends on conditions | Open covered or enclosed bays or sealed (drums) depending on the material | Appropriate drainage system |

4.1.1.2 Pre-processing and pre-treatment processes

Ores, concentrates and secondary raw materials are not always in a form conducive to direct use in the main process so a certain amount of pre-treatment is generally required. Pre-treatment processes for Irish industry often involve pre-treatment for secondary production from scrap metals. These include the removal of organic contaminants (e.g. oil, grease, paint, other coatings) by heating, crushing and screening (to remove metallic inclusions from more friable non-metallic portion), milling, etc. All the methods concerned yield a more controlled and reliable feed for the main process. The process chosen depends on the nature and quality of the scrap ultimately used and particularly the degree of contamination, which also determines the degree to which pollution abatement measures are required (see BREF Section 2.5).

With respect to the galvanising process (see FM BREF Section C2.2), items require preparation by inspection to ensure they are ready for galvanising and may need to be abrasive blast cleaned. Also as a galvanising plant essentially consists of a series of treatment or process baths the steel fabrications must first be attached by means of hooks or steel wire to cranes or jigs so that they can be moved between tanks and dipped into the baths. Small components are loaded into perforated baskets, which are attached to the jigs.

Crushing, milling and size reduction: Crushing, milling and size reduction is carried out to reduce the size of residues or raw materials so that it is suitable either for sale or further processing. Wet or dry materials may be crushed or milled with the specific equipment used being determined by the raw materials to be dealt with. Drosses, slags and other furnace residues are normally prepared for recycling by first crushing or milling to free the metallic intrusions and then screening with the metal concentrating in the larger fractions. Milling is also used to increase the active surface of the material for reaction in subsequent processes. Granulation is used to produce small particles, which can be used as shot blasting material, road fill or reprocessed to recover the metal content. This process has the potential to form fine dusts and aerosols (see BREF Section 2.5.1.3).

De-coating and de-oiling: Typically these processes are performed on secondary raw materials to reduce the organic content of feed to main processes. Washing and pyrolysis are used while centrifuging can be employed to recover oil from swarf or turnings. This reduces the load on the thermal system as major variations in organic content cause both inefficient combustion in certain furnaces and produce gases with residual organic compounds. The presence of coatings can also significantly reduce the melt rate. Both types of contaminant can create significant emissions of smoke, dioxins and metals dusts unless gas collection and combustion systems are adequately robust to deal with them (see BREF Section 2.5.1.9).

Oil and some coatings may be removed in a swarf dryer or a rotary furnace can be used at low temperature to volatilise oil and water and operated with a high temperature afterburner to eliminate organic products. Mechanical stripping is also commonly used to remove insulation from cables and coatings from other materials.

For galvanising, *degreasing* is used to remove traces of coolants and lubricants using alkaline baths containing surfactants. Efficiency is determined by concentration, bathing temperature and immersion time with normal operating temperatures of between 30° and 70°C. Acidic degreasing can also be used using diluted strong inorganic acids such as hydrochloric acid or phosphoric acid with additives. Solvents may also be employed for this purpose.

Leaching procedures: Leaching can be used with acids or acid-base mixtures to remove metals from complex matrices or ores or to concentrate precious metals that are used to coat catalysts (see BREF Section 2.5.1.11).

Separation techniques: Such processes remove impurities from raw materials prior to their use and are most frequently used for secondary raw materials. For example, air classification and shaking or vibration can be used to separate out metals from less dense materials such as plastic and fibres of electronic scrap (see BREF Section 2.5.1.12).

Pickling: Pickling is a process where the surface of items is prepared for galvanising by removing surface oxidation products (e.g. rust) and millscale (from steel rolling process). Diluted hydrochloric acid is used in a series of baths with different acid concentrations ranging from 2% to 16%. To prevent excessive pickling and to protect steel pickling vats, pickling inhibitors (e.g. hexamethylenetetramine) may be added to the bath. Sometimes 15% sulphuric acid may be used at 40°C in combination with pickling inhibitors. Fume suppressants may also be used. Articles may also be degreased in pickling tanks but this leads to an increase in pickling time, greater volumes of pickling waste and increased consumption of zinc (see FM BREF Section C2.5).

Two basic plant layouts are derived from the design of the pre-treatment section, i.e. open and closed. Plants with open pre-treatment locate pre-treatment vats and the other process operations in one bay with pickling baths operated at room temperature to avoid air emissions and the associated corrosion of installations. Galvanising plants with dedicated, tightly enclosed pre-treatment sections are designed to operate pickling baths at elevated temperatures to reduce the number of pickling vats and pickling time.

Rinsing: This is a very important step in galvanising as it prevents carryover of iron salts on the surface of the work piece prolonging the life of subsequent treatment baths. One or two water baths may be used which may be heated (see FM BREF Section C2.7).

Fluxing: Once items have been degreased, pickled and rinsed they are fluxed prior to hot dipping. The purpose of fluxing is to prevent oxidation of a work piece before it is dipped and to enable liquid zinc to wet the surface of the steel. Ammonium chloride-containing fluxes decompose into ammonium and hydrochloric acid providing an additional pickling effect. Zinc chloride may also be used but zinc ammonium chloride, a mixture of zinc chloride and ammonium chloride is most commonly employed (see FM BREF Section C2.8).

4.1.1.3 Pyrometallurgical extraction/production

There are several processes or combinations of processes employed to produce and melt metals. Furnaces are used for a variety of purposes and include cupolas, electric arc, induction, hearth or reverberatory and crucible. A single type of furnace can be employed for a range of purposes with the two most important factors determining furnace choice, the capacity for gas and fume collection and applicability to the type and variability of raw material used.

Smelting and melting: For secondary raw materials smelting and melting are often carried out in fossil fuel fired furnaces including rotary and static bath furnaces. Rotary furnaces are difficult to seal making elimination of fugitive emissions to air difficult but are very efficient at mixing metal and flux and so is the furnace of choice for handling low grades of scrap. Static bath furnaces can handle larger items and can be sealed more effectively. For all fossil-fuel fired furnaces, gas is the preferred fuel as it is easier to burn efficiently and does not carry the risk of land contamination due to spillage (see BREF Sections 2.6.1 & 2.6.2).

Melting processes for clean metal such as ingots or very clean scrap can employ the furnaces described above but the most frequently used is the electric induction furnace. Such furnaces are simple crucibles or channels heated by alternating electric currents passing through an external electrical coil. They are widely used to melt both scrap and pure ingot metals and have the advantage of being relatively simple to enclose so minimising fugitive emissions to the air. They may be horizontal or vertical, cylindrical, refractory-lined vessels. They may also be designed for complete enclosure. They are used for small melting capacities of up to 30 tonnes and are most commonly used for copper, brass, zinc and aluminium. They may also be used to “hold” molten metal for alloying and casting. The refractory lining is usually made of silica, alumina or magnesia and breaks down over time to become part of the slag (see BREF Section 2.6.4.1).

Reverberatory furnaces are used in batch melting of non-ferrous metals. The hearth can be heated by electric or natural gas methods and are used to produce small quantities of metal. Indirectly heated kettles are heated externally by combustion gases from oil or gas combustion, electricity or by thermal fluid for lower temperatures. Contact with a direct flame is avoided to prevent local hot spots at the base of the crucible and good temperature control can be achieved in the melt to prevent oxidation and vapourisation of the metal. Such kettles are mainly used for clean lead, lead alloys and zinc and its alloys (see BREF Section 2.6.4.7).

Refining: When thermal smelting techniques are used the metal produced contains impurities as a proportion of the other metals present in the concentrate. The selected refining techniques depend on the reactivity of the metal concerned and its relative reactivity compared to the impurity. More reactive metals can be removed by blowing air or oxygen through the melt so oxidising the most reactive components. The unwanted oxide can then be removed as a fume with the exhaust gases or as a solid dross or slag. Other materials may also be added to purify metals such as sodium nitrate in the extraction of lead from scrap. Less reactive metals are typically removed by electrolytic processes (see BREF Section 2.6.6).

Alloying: Alloys can be manufactured by addition of other metals in the charge for smelting furnaces or after the molten metal has been transferred to alloying or casting furnaces.

Hot Dipping: The fluxed steel fabrications produced during the galvanisation process are slowly lowered into a bath of molten zinc (98.5% zinc is usually the lowest grade

used) at a temperature of 440° to 475°C. The steel reacts with the zinc to form a coating consisting of a series of zinc-iron alloy layers topped by a layer of pure zinc. Immersion periods vary from several minutes to half an hour. The kettle enclosed by the furnace casing is installed in a pit or at floor level with access platforms and heated normally externally by gas or oil-fired burners.

Drosses, skimmings, fluxes and slags: When metals melt, oxides tend to form and accumulate on the surface while involatile impurities also float combining with the oxides to form a dry dusty layer called dross. Fluxes may be added that melt on the metal surface or which react with impurities in the metal to minimise the rate of oxidation and facilitate removal of drosses. For some operations the dross, with or without flux, is removed from the molten metal surface by raking or scraping it off into dross trays. If sufficient flux has been added to combine with the dross to form a liquid layer on the metal surface this is referred to as a slag, which is removed by tapping from the furnace as a fluid (see BREF Sections 2.11.1 & 4.3.7 for examples).

Moulding and casting: The first step in metal casting involves the creation of a mould into which the molten metal is poured and cooled. The materials used to make the cast depend on the type of metal being cast and the desired shape of the final product. Sand is the most common moulding material (used for expendable mould casting) but other materials such as metals, investment materials and other compounds such as gypsum may be used. Permanent mould casting requires a set-up time in the order of weeks to prepare a steel tool. Steel cavities are coated with refractory wash of acetylene soot before processing to allow easy removal of the work piece and promote longer tool life (see BREF Section 4.3.6 for example).

Once melted, the metal is tapped from the furnace and poured into a ladle or directly into a mould and allowed to cool. The moulding is then separated from castings either manually or mechanically or by washing.

4.1.1.4 Electrochemical processes

In electroplating, an electrolytic cell is used consisting of a cathode which is formed by the item to be plated and an inert anode typically of the same metal to be plated, are placed in an aqueous electrolyte containing the metal solution. When an electrical current is passed through the cell, metal ions in the solution are attracted to the item. The plating most commonly used is of a single metallic element. It is generally carried out to improve the appearance or corrosion resistance of a surface by electrodepositing a thin surface of the desired metal onto it, e.g. chromium, zinc (see BREF Section 2.6.6).

4.1.1.5 Hydrometallurgical extraction

Acids and alkalis may be added to dissolve out the metal content of a variety of ores and concentrates before refining and electro-winning. The material to be leached is normally in the form of an oxide. The solutions produced are treated in a number of ways to refine and win the metals. The solutions that are produced are treated in a number of ways to refine and win the metals or metal compounds. Where appropriate, it is standard practice to return the depleted solutions to the leaching stage to conserve acids and alkaline solutions. Metals can also be extracted from aqueous solutions with the use of certain organic solvents that are insoluble in water (see BREF Section 2.6.7).

4.1.1.6 Finishing

Machining, rolling, extruding, etc. are carried out after melting and casting. For castings that have cooled, unwanted appendages are removed by oxygen torch, abrasive saw, friction cutting tool and so on. They may also be encapsulated in molten alloy (e.g. tin and bismuth) before cutting after which the alloy can be melted off the part. Parts or fabrications may then be subjected to abrasive blast cleaning (sand blasting or shot blasting) or tumbling to remove any remaining mould or scale, burr removal, finishing, etc. Powder coating may also be applied using electrostatic spray or conventional fluidised bed systems. The pieces are then placed in an oven where the powder particles melt and coalesce to form a continuous film.

Galvanised fabrications freshly withdrawn from the zinc bath are cleaned of excess zinc by wiping, rattling or dusting and are then cooled and inspected. Small surface imperfections are repaired and the fabrications are removed from the jigs and made ready for dispatch. After hot dip coating some steel products are quenched (boshed) in water to give them special properties. As protection against white rust, the products may be covered with oil emulsions or may be "passivated".

The choice of passivation depends upon further process requirements or particular end uses of the product. Chromic acids or salts may be added to the quench water. Phosphate treatments and complex oxide treatments are sometimes used. Organic powder coatings, which are made of polymers and resins, may be applied (by electrostatic spray or conventional fluidised bed technologies) and heated to above the powder melting point.

For galvanising fasteners and small components, a perforated steel basket containing the components is immersed in liquid zinc in the usual way. When the basket is withdrawn from the liquid zinc it is placed into a centrifuge system, which removes excess zinc coating, by centrifugal force. The galvanised components are ejected from the basket and cooled, while the basket is returned to the process. For galvanised tubes and pipes, surplus zinc is removed after withdrawal from the zinc bath, using compressed air for the outside surface and steam for the inside surfaces (see FM BREF Section C2.10).

4.2 RISK TO THE ENVIRONMENT

4.2.1 Introduction

In this section, the major sources of emission to air and water are identified, as are the principal sources of waste from the sector. The identified list of sources is not all encompassing and neither will every plant falling within an individual sector have every one of the emissions, which are associated with the sector as a whole.

The main environmental issues associated with the pyrometallurgical production of non-ferrous metals from secondary raw materials are related to the off-gases from the various furnaces and transfers that contain dust, metals and in some process steps, acid gases. Some of the off-gases may be dioxins due to the presence of small amounts of chlorine in the secondary raw materials. The recovery of solid wastes, recycling and disposal is also an important issue.

4.2.2 Emissions to Air

By volume, gaseous waste is the largest waste source from the industry, arising at all stages including the storage and handling of the raw materials, pre-treatment, pyrometallurgical, hydrometallurgical, core and mould preparation, casting, knock-out and finishing with the exact nature of the processes involved determining the characteristics of the air pollutants produced. Fugitive and unscheduled emissions including particulates, vapours and odours can arise during receipt, storage and handling of raw materials, building losses through open doors, windows, vents and ventilation systems and waste handling. In some processes, fugitive emissions may be more important than those that are captured and abated from process emissions. In this respect, transfer of materials is especially important.

Organic air emissions largely arise from scrap contaminated with plastics, lubricants or solvents and from unreacted components of solvents and catalysts, arising principally from the core and mould-making steps. Metal emissions from induction furnaces are very small while the core and mould-making processes produce insignificant levels of metal emissions. As regards the pouring process the hotter the temperature the greater the amount of emissions produced.

The principal atmospheric emissions for different processes in the industry are given in Table 2.

Table 2: Summary of sources and emissions to air.

| Process stage | Component in off-gas |
|--|--|
| Materials handling and storage | Particulates, metals and metal oxides, process chemical vapours |
| Pre-treatment | Particulates (metals and metal oxides, plastic, etc.) VOCs, dioxins, chlorides, acid vapours, solvents |
| Smelting and melting | Particulates (metals and metal oxides) VOCs, dioxins Sulphur oxides, nitrogen oxides Carbon monoxide VOCs Fluorides, chlorides Ammonia Oils |
| Refining and alloying | Particulates, metals and metal oxides Sulphur oxides |
| Electrochemical processes | VOCs |
| Hydrometallurgical extraction/production | Particulates Acid mists and vapours VOCs Ammonia Hydrogen sulphide Chlorine Iodine Sulphur oxides Nitrogen oxides Carbon monoxide |
| Moulding and casting | Particulates, metals and metal oxides VOCs, dioxins |

| | |
|----------------|--|
| | Acid vapours Sulphur oxides Nitrogen oxides Carbon monoxide |
| Finishing | Particulates, metals and metal oxides, chlorides |
| Waste handling | Particulates and metals Carbon monoxide VOCs |

4.2.3 Emissions to Water

Liquid pollution constitutes a small proportion of the total waste stream except where extensive finishing is carried out using processes such as burring so volumes of liquid waste are generally relatively small and do not pose a large pollution problem. Diffuse sources include bund drainage, spills, pipework leaks, drips, splashes, contaminated runoff from raw materials stored in the open and cleaning and maintenance operations. The principal process emissions generally arise from wet scrubber air emission systems and are outlined in Table 3 below.

Table 3: Summary of sources and emissions to water

| Process stage | Wastewater component |
|--------------------------------|---|
| Materials handling and storage | Contaminated runoff (oils, metals, etc. depending on material concerned) |
| Pre-treatment | Acids, metals and metal oxides, spent process liquors, rinse waters, coolants, oils |
| Pyrometallurgical extraction | Contaminated cooling waters (e.g. oils, greases) Effluent from abatement systems (e.g. metals and metal oxides from wet scrubbers) |
| Hydrometallurgical extraction | Sulphates, sulphides, Ammonia, nitrates Phosphorus Phenols, solvents Mineral oils Metals |
| Mould preparation | Metals, mould rinse water |
| Casting and finishing | Metals and metal oxides, acids, coolants, oils, zyglo rinse water |

4.2.4 Wastes

The waste products produced by the industry directly relate to the type of metal, furnace and moulding technology used. The main sources are slags and drosses from melting operations, casting wastes and insulation and refractory materials from maintenance operations (Table 4). Ores and concentrates contain quantities of metals besides the principal target metal that tend to concentrate in the process residues. Other potential sources of waste include contaminated equipment and protective clothing and finishing wastes.

Table 4: Summary of waste produced

| Source | Waste |
|--|--|
| Pre-treatment, e.g. separation, pickling, etc. | Plastics, metals, acids, oils Spent process liquors and sludges (e.g. degreasing, pickling, etc.) |
| Pyrometallurgical extraction | Spent refractory and furnace linings Drosses, skimmings, slags, ashes, sludges (i.e. metals and metal oxides) Abatement systems waste (e.g. metal and metal oxide dusts and sludges) |
| Hydrometallurgical extraction | Filter cake |
| Electrochemical processes | Electrolyte and thickener underflow slurry Electrolyte cell cleanings Spent anodes and cathodes |
| Moulding and casting | Revert material, gypsum sludge, oil sludge |
| Finishing | Dusts, metals (e.g. swarf, filings, turnings, etc.) Spent blasting grit |
| Contaminated equipment | Process chemical containers, protective equipment, metals, jiggling wire and strapping |

4.2.5 Receipt, Storage and Handling of Raw Materials

Air: This stage of the manufacturing process can result in emissions of particulates and metals from ores, concentrates, residues, scrap, etc. as well as process chemical vapours released during handling operations.

Water: Raw materials such as ores, concentrates, slags or drosses stored in the open can lead to contaminated surface water runoff which may contain ammonia, dissolved salts, sulphides, metals and other suspended solids while spills may occur during loading/unloading and/or transfer of liquids.

4.2.6 Pre-Processing and Pre-Treatment

Air: Significant amounts of particulates and metals are produced during crushing, milling and separation processes. VOCs and dioxins may also be produced by pre-treatment of scrap metal. Leaching processes can result in the production of sulphur dioxide and acid mists while acid fumes and solvents may be released by degreasing and pickling operations carried out during the galvanising of steel.

Water: Oils and coolants may be produced by pre-treatment of scrap metal such as swarf.

Waste: Waste material such as plastics and dusts are produced after separation processes. Spent acid, alkaline and solvent degreasing liquors, stripping liquors (containing waste acids, zinc and iron chloride), pickling liquors, rinsing waste water, metal sludges (metals and metal oxides) and spent fluxing solutions (ammonium chloride, zinc ammonium chloride) are produced by the degreasing, pickling, stripping and rinsing stages of galvanisation. Used alkaline degreasing baths contain sodium hydroxide, carbonates, phosphates, silicates, surfactants and free and emulsified oil and grease while acidic degreasing baths include oils and greases, diluted hydrochloric and/or phosphoric acid, emulsifiers and corrosion protection inhibitors.

4.2.7 Pyrometallurgical Extraction/Production

Air: Particulates, metals and metal compounds are produced during melting and removal of drosses and skimmings, as well as VOCs and dioxins where secondary production is carried out using scrap with oils and/or plastics. Fugitive releases occur

particularly in processes where metal is transferred so careful attention is required. Chlorine or fluorine used for removal of hydrogen and magnesium (de-magging) in secondary aluminium production can result in the release of aluminium chloride, HCl, HF and fluorides. Metal fumes may be released by melting lead and lead alloys. Galvanising kettles produce zinc oxide and water vapour and as a result of the use of fluxes (generally ZAC), zinc chloride, ions of chlorine, ammonia and ammonium chloride. Also where degreasing is inefficient, the resultant low temperature combustion in the zinc bath can result in dioxin production. Fuel combustion releases particulates, oxides of sulphur and nitrogen and carbon dioxide while incomplete combustion releases carbon monoxide.

Water: Effluent contaminated with metals and their compounds is produced where wet scrubbing is used for treatment of hot waste gases. Cooling water is usually recycled.

Waste: For most metal recovery operations there usually remains a significant portion of unusable waste in the drosses, skimmings, slag especially where lower quality grades of scrap are used. Alloying and refining operations also produce quantities of dross and ashes. Metal and metal compound sludges may be produced by wet scrubbing and substantial quantities of dust waste can be collected by filtration systems. Hot dip galvanising wastes include hard zinc or dross (95% to 98% zinc), zinc ash (zinc oxide, zinc chloride, aluminium oxide) and squirts, which can be either recycled in the process or sent away for recovery or disposal. Other potential waste includes scrap plant items and solid wastes which arise when furnaces are rebuilt.

4.2.8 Moulding and Casting

Air: Particulates are released during mould and core forming and depending on the mould type, VOCs, dioxins, sulphur dioxide, carbon monoxide and particulates may be emitted during core and mould curing and drying.

Water: Water used for rinsing or as a coolant can be contaminated by metals and oils.

Waste: Spent moulds and other casting related waste.

4.2.9 Electrochemical Processes

Air: Particulates and metals may be emitted by handling of fine powders and acid mists and H₂S by leaching stages.

Waste: Wastes include filter cake, ore slurry, electrolytic cell cleanings (precipitates) and spent anodes and cathodes.

4.2.10 Hydrometallurgical Extraction

Air: Potential atmospheric emissions include metal ore dusts, hydrogen sulphide and acid mists in the production of manganese dioxide. The production of precious metal salts results in the production of emissions including particulates, acids (including hydrochloric, acetic and hydrobromic), chlorine, iodine, VOCs, ammonia, sulphur and nitrogen oxides, and carbon monoxide.

Water: Remnant solids and metals are filtered for treatment and disposal in lagoon storage facilities. A range of potential pollutants are generated by precious metal salt production, i.e. sulphates, sulphides, ammonia, nitrates, phosphorus, phenols, solvents and mineral oils.

Waste: Filter cake composed of remnant solids and metals filtered from the neutralisation of the manganese ore-sulphuric acid mix with limestone is stored in lagoon storage facilities.

4.2.11 Finishing

Air: Removal of excess zinc from galvanised tube surfaces by blowing with air or steam can result in emissions of zinc and zinc-containing dusts. Removal of gates, risers, etc., grinding, sawing, sand or shotblasting can all give rise to particulates, metals, sand and vapours.

Water: Deburring operations produce water contaminated with zinc and/or aluminium metal oxides and surfactants while wet dust extraction associated with finishing processes produces aluminium sludge.

Waste: Metal fragments such as swarf, turnings and grindings contaminated with coolants and cutting oils arises from operations such as broaching, grinding, etc. Waste jigging and strapping is produced by the galvanising process.

4.2.12 Noise

Noise and vibration can arise from the movement and storage of raw materials and products, large fans and air filtration systems, grinding and milling operations, casting installations, venting of steam and use of pumps. This can potentially create a nuisance to site neighbours and the environment. Noise can either be continuous or intermittent depending on the operation of equipment.

4.3 CONTROL TECHNIQUES

The existing or possible measures for eliminating, reducing and controlling emissions from the surface treatment of metals and plastics are described in this Section. References to more detailed descriptions in the BREF document are given.

4.3.1 General Preventative Methods

4.3.1.1 Management Systems

Effective management is important in achieving good environmental performance. It is an important component of BAT and forms part of the definition of techniques given in Article 2 of the Directive (see BREF Section 2.3):

- An effective management system includes and significant management policy and commitment (see BREF Section 2.3),
- Effective environmental management systems incorporate design and maintenance elements which include for the assessment of the effects of existing plant and any new or substantially changed processes on the degree of protection of air, water and land as follows (see BREF Section 2.3.2),
- Effective environmental management systems incorporate a training element (see BREF Section 2.3.3).

4.3.2 Techniques for Prevention and Minimisation of Resource Consumption

4.3.2.1 Minimisation of Energy Use

The main uses of energy on a non-ferrous metal installation include; furnace operation, scrap pre-treatment, metal melting, extrusion, rolling, mould making, heat treatment, post casting activities, heating, lighting and power in installation buildings, pumps, air treatment and wastewater treatment processes.

The applicant should quantify the energy consumption at the installation by the source of energy, i.e. electricity, gas and fuel.

The applicant can demonstrate that in the design of the installation and in any treatment processes energy efficiency and recovery has been considered, the following general techniques (see BREF Section 2.11.1) could include the following:

- The use of basic, low cost physical energy efficiency techniques, such as insulation, containment methods (such as seals and self-closing doors), and avoidance of unnecessary discharge of heated water or air (for example, by fitting simple control systems such as timers and sensors), gravity feed systems;
- The consideration of energy saving opportunities in process buildings, control rooms and offices required for the activity, e.g. insulation;
- The consideration of energy recovery techniques such as (see BREF Section 2.11.1):
 - Production of steam and electricity from the heat raised in waste heat boilers;
 - the use of the heat of reaction to smelt or roast concentrates or melt scrap metals in a converter
 - the use of hot process gases to dry feed materials
 - pre-heating of a furnace charge using the energy content of furnace gases or hot gases from another source
 - the use of recuperative burners or the pre-heating of combustion air
 - the use as a fuel gas of CO produced
 - the heating of leach liquors from hot process gases or liquors
 - the use of plastic contents in some raw materials as a fuel, provided that good quality plastic cannot be recovered and VOCs and dioxins are not emitted
 - the use of low-mass refractories where practicable
 - the use of oxygen is recognised to have advantages in many cases and reduces the overall gas volume, allows autogenic operation and can allow smaller abatement plant
 - process optimisation to minimise hot metal transfers,
- Use of oxygen enriched air or oxygen in the burners reduces energy consumption by allowing autogenic smelting or the complete combustion of carbonaceous material reducing waste gas volumes allowing smaller fans to be used (see BREF Section 2.11.1),
- Furnace lining material can also influence the energy balance of a melting operation. In this case low mass refractories are reported to have a beneficial effect by reducing the thermal conductivity and storage in an installation. This factor must be balanced with the durability of the furnace lining and metal infiltration into the lining and may not be applicable in all cases (see BREF Section 2.11.1).

The applicant should demonstrate that they are using purchasing, operating and maintenance procedures to optimise the energy use in the installation by:

- Ensuring energy efficient equipment is purchased, including lighting, pumps, etc.;
- Ensuring equipment is serviced and maintained regularly;
- Ensuring equipment is switched off, if safe to do so, when not in use;
- Ensuring on-site vehicle movements are minimised and engines are switched off when not in use;

- Reviewing equipment requirements on a regular basis;
- Setting time of operation of high-energy equipment to off-peak periods, where possible;
- Setting key performance indicators on an annual basis; and
- Installing power consumption indicators on fans associated with extraction systems.

The applicant should review energy consumption on an annual basis and examine options for:

- Optimisation of energy supply;
- Optimising/reducing energy consumption;
- Optimising heat and energy recovery.

Many of the aspects of energy efficiency are likely to be delivered through management techniques, operating and maintenance procedures, which overlap and form part of the EMS for the activity.

4.3.2.2 Minimisation of Water Use

The most frequent uses of water in the non-ferrous metals industry is as a coolant and in gas scrubbing systems. Reducing water use may be a valid environmental (or economic) aim in itself and there are distinct benefits to be gained from reducing the water used, in particular:

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

Techniques and methods for the reuse of water are already successfully used in the non-ferrous metal industry to minimise the amount of liquid effluent that has to be discharged as wastewater. Recycling and reuse techniques are process-integrated measures. Recycling involves recirculation of the liquid to the process where it has been generated. Reuse of an effluent means the re-circulation of one source of water for another purpose, e.g. surface run-off may be reused as cooling water. For all non-ferrous operations, the following techniques on minimisation of water use can be considered:

- Develop diagram of the water circuits with indicative flows and prepare a mass balance for water use that will reveal where reductions can be made;
- Review water consumption on an annual basis by completing a water efficiency audit;
- Closed circuit cooling systems should be used where possible;
- Water should be recycled within the process from which it issues, by treating it first if necessary. Where this is not practicable, it should be recycled to another part of the process, which has a lower water quality requirement;
- While treated effluent quality can vary, it can be recycled selectively, when the quality is adequate, reverting to discharge when the quality falls below that

- which the system can tolerate. The Operator should identify where treated water from the effluent treatment plant could be used and justify where it is not;
- Where water is used in cleaning and washing down, use should be minimised by:
 - Vacuuming, scraping or mopping in preference to hosing down;
 - Evaluating the scope for re-using wash water;
 - Trigger controls on all hoses, hand lances and washing equipment;
 - Drainage systems should be designed to avoid contamination of roof and surface water. Where possible this should be retained for use. That which cannot be used should be discharged separately.

4.3.2.3 Minimisation of the Use of Raw Materials

Installations should be operated in such a way that materials are used efficiently, including minimising their use and their impact by selection. For all non-ferrous operations, the following techniques on minimisation raw material use can be considered

- Maintain a detailed inventory of raw materials used on-site;
- Have procedures for the regular review of new developments in raw materials and the implementation of any suitable ones which are less hazardous;
- Quality assurance procedures for the control of the content of raw materials;
- Demonstrate the steps which have been, or may be, taken to:
 - Reduce the amount of flux required by improving the quality of raw materials;
 - Substitute less harmful materials or those which can be more readily abated and when abated lead to substances which in themselves are more readily dealt with;
 - Understand the fate of by-products and contaminants and their environmental impact;
- As part of the installation design, specify materials with minimal environmental impact should be selected and used;
- Have operational procedures to determine the most suitable material for use, thus preventing use of materials that may have an unacceptable environmental impact in their manufacture, end-use and ultimate disposal.

4.3.3 Preventative Methods for Specific Unit Operations

4.3.3.1 Materials Handling and Storage

For all non-ferrous metal operations the following techniques on materials handling and storage can be considered (see BREF Section 2.4.3):

- Demonstrate that in the design of the installation and in any treatment processes delivery, storage and handling of raw materials in an environmentally responsible manner has been considered, including hazardous material segregation, material compatibility issues, requirements due to specific chemical properties such as flammability including a risk assessment to determine the risk of pollution associated with on-site storage of raw materials;
- Provide impermeable surfaces with appropriate chemical resistance in all storage areas;

- Provide ventilation as appropriate if flammable substances are to be handled, to prevent the build-up of flammable vapours;
- Exhaust air from the building or storage tanks should pass through VOC-removal processes prior to discharge to atmosphere;
- Ensure only compatible raw materials are stored within the same storage area/bay (See UK HSE – Chemical Warehousing – the storage of packaged dangerous substances, HS(G)71);
- Impervious bunds designed, operated and tested in accordance with the *EPA IPC Guidance Note on Storage and Transfer of Materials for Scheduled Activities, 2004*;
- *Storage areas* designed, operated and tested in accordance with the *EPA IPC Guidance Note on Storage and Transfer of Materials for Scheduled Activities, 2004*;
- Storage areas are covered to prevent water ingress where possible;
- The tank and bund should also be covered to prevent ingress of rainwater, which, if it accumulates, would reduce the capacity of the bund to contain tank losses and also complicate the possible recovery of any losses from the bund;
- Tank contents should be displayed and associated alarms used;
- Use of leak detection systems and alarms;
- Control mechanisms incorporated into the site drainage system such as shut-off valves, which can stop or divert the flow of material;
- The use of planned deliveries and automatic control systems to prevent over filling of storage tanks;
- Ensure there are written procedures for the acceptance and storage of all raw materials, which clearly set out the selection of suitable storage areas for wastes;
- Ensure adequate emergency procedures for all raw materials on-site, e.g. provision of spillage kits, absorbent materials or containment booms and staff training in spillage management procedures;
- Lock valves when tanks are not in use;
- Delivery points should be contained within the bund to collect spilled material;
- Back venting of displaced gases to the delivery vehicle should be practised to reduce emissions of VOCs;
- Use of automatic resealing of delivery connections to prevent spillage;
- Storage of material that can release oil on concreted areas that have curbs or other containment devices;
- Transfer conveyors and pipelines placed in safe, open areas above ground so that leaks can be detected quickly and damage from vehicles and other equipment can be prevented. If buried pipelines are used their course can be documented and marked and safe excavation systems adopted;
- Use of well designed, robust pressure vessels for gases (including LPGs) with pressure monitoring of the tanks and delivery pipe-work to prevent rupture and leakage;
- Gas monitors should be used in confined areas and close to storage tanks;
- Where required, sealed delivery, storage and reclamation systems can be used for dusty materials and silos can be used for day storage;
- Sealing agents (such as molasses and PVA) can be used where appropriate and compatible to reduce the tendency for material to form dust;

- Enclosed conveyors with well designed, robust extraction and filtration equipment can be used on delivery points, silos, pneumatic transfer systems and conveyor transfer points to prevent the emission of dust;
- Non-dusty, non-soluble material can be stored on sealed surfaces with drainage and drain collection;
- Swarf, turnings and other oily material should be stored under cover to prevent washing away by rain water;
- Rationalised transport systems can be used to minimise the generation and transport of dust within a site;
- The use of wheel and body washes or other cleaning systems to clean vehicles used to deliver or handle dusty material. Local conditions will influence the method, e.g. ice formation;
- Planned campaigns for road sweeping;
- Inventory control and inspection systems to prevent spillages and identify leaks;
- Material sampling and assay systems incorporated into the materials handling and storage system to identify raw material quality and plan the processing method. These systems should be designed and operated to same high standards as the handling and storage systems;
- 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;
- Sand is delivered in bulk and discharged directly to silo via pneumatic conveyor. Specialist sands may arrive in bags;
- 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;
- Refractories, release agents and other minor deliveries are stored indoors;
- Liquid binders, resins and catalysts are delivered in drums, or by bulk container or road or rail tanker. They are stored in their delivery containers or, in the case of road and rail tankers, discharged direct into dedicated storage;
- Scrap is stored in segregated piles to keep different grades and alloy compositions separate;
- The operator should ensure that deliveries are carried out in such a way so as to avoid noise, spillage, leaks and dusty emissions, in particular, those arising from accidents during materials transfer;
- Bunded areas, sealed floors and oil interceptors should be used to prevent emissions to water where contamination of secondary raw materials, e.g. oils, acids, organic matter, could be washed into drainage systems;
- 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;
- All dusty or potentially dusty raw materials, including new or reclaimed dry sand, should be stored in purpose built silos, in confined storage areas within buildings, or in fully enclosed containers / packaging. Where the storage is open within a building, then suitable precautions should be taken to prevent wind whipping;

- External above ground conveyors for dusty materials should be fitted with protection against wind whipping. Transfer points should be enclosed and ducted to suitable arrestment equipment;
- Transport of dusty materials should be carried out so as to prevent or minimise airborne particulate matter emissions. Double handling of dusty materials should be avoided;
- 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;
- Liquid spillage should be cleaned by addition of absorbent or by run-off to contained drainage systems;
- A high standard of housekeeping should be maintained.

4.3.3.2 Pre-Processing and Transfer of Raw Materials

Ores, concentrates and secondary raw materials are sometimes in a form that cannot be used directly in the main process. Drying may be needed for control or safety reasons. The material size may need to be increased or decreased to promote reactions or reduce oxidation. Reducing agents such as coal or coke and fluxes or other slag forming materials may need to be added to control the metallurgical process. Coatings may need to be removed to avoid process abatement problems and improve melting rates. All of these techniques are used to produce a more controllable and reliable feed for the main process and are also used in precious metal recovery to assay the raw material so that toll recovery charges can be calculated.

For all non-ferrous metal operations the following techniques on transfer operations can be considered (see BREF Section 2.5.3):

- Use of pre-treatment and transfer processes with well designed robust extraction and abatement equipment to prevent the emission of dust and other material. The design of this equipment should take account of the nature of the emissions, the maximum rate of emissions and all of the potential sources;
- Use of enclosed conveying systems for dusty materials. These systems should be provided with extraction and abatement equipment where dust emissions are possible;
- Processes that “flow” directly into the following process if possible to minimise handling and conserve heat energy;
- The use of good design and construction practices and adequate maintenance;
- Use of wet grinding, blending and pelletising systems if other techniques for the control of dust are not possible or appropriate;
- The presence of oils, plastics and chlorine compounds in the feed material should be avoided to reduce the generation of dioxins during incomplete combustion or by de-novo synthesis with the following techniques:
 - Oil removal from feed (e.g. thermal de-coating and de-oiling processes followed by afterburning to destroy any organic material in the off-gas),
 - Use of milling and grinding techniques with good dust extraction and abatement. The resulting particles can be treated to recover valuable metals using density or pneumatic separation,
 - Elimination of plastic by stripping cable insulation (e.g. possible cryogenic techniques to make plastics friable and easily separable);

- Sufficient blending of material to provide a homogenous feed in order to promote steady-state conditions;
- Thermal cleaning and pyrolysis systems (e.g. swarf drying and de-coating) that use robust after-burning equipment to destroy combustion products, e.g. VOCs and dioxins. The gases should be held at a temperature greater than 850 °C (1,100 °C if there is more than 1% halogenated organic material), in the presence of at least 6% oxygen for a minimum of 2 seconds. Lower residence times may also result in the complete destroying of VOCs and dioxins but this should be demonstrated on a local level. Gases should be cooled rapidly through the temperature window of dioxin reformation;
- To reduce the impact of VOCs, washing processes to remove oil or other contaminants should use benign solvents. Efficient solvent and vapour recovery systems should be used;
- Steel belt, up-draught or fully enclosed down-draft sintering processes are techniques to be considered. Steel belt sintering has several advantages for certain metal groups and can minimise gas volumes, reduce fugitive emissions and recover heat;
- Off gas extraction systems should prevent fugitive emissions;
- The use of rotary kilns with wet ash quenching for the processes involving the volume reduction of material such as photographic film. Smaller installations may use a moving grate furnace. In both cases the combustion gases should be cleaned to remove dust and acid gases if they are present;
- If required to minimise the generation of smoke and fumes and to improve the melting rates, separation processes should be designed to produce clean materials that are suitable for recovery processes;
- Collection and treatment of liquid effluents before discharge from the process to remove non-ferrous metals and other components.

4.3.3.3 Metal Production and Process Control Techniques

For all non-ferrous metal operations the following techniques in metal production and associated process control can be considered (where appropriate) (see BREF Section 2.6):

- Operators, engineers and others should be continuously trained and assessed in the use of operating instructions, the use of the modern control techniques described and the significance of the actions to be taken when alarms are given. Levels of supervision are optimised to take advantage of the above and to maintain operator responsibility;
- Hazard and operability studies carried out at the design stages for all process changes;
- Robust maintenance systems;
- Sampling and analysis of raw materials is commonly used to control plant conditions. Good mixing of different feed materials should be achieved to get optimum conversion efficiency and reduce emissions and rejects;
- Feed weighing and metering systems are used extensively. Loss in weight silos, belt weighers and scale weighers are used extensively for this purpose;
- Microprocessors are used to control material feed-rate, critical process and combustion conditions and gas additions. Several parameters are measured to allow processes to be controlled, alarms are provided for critical parameters;
 - On-line monitoring of temperature, furnace pressure (or depression) and gas volume or flow is used,

- Gas components (O₂, SO₂, CO) are monitored,
 - On-line monitoring of vibration is used to detect blockages and possible equipment failure,
 - On-line monitoring of the current and voltage of electrolytic processes,
 - On-line monitoring of emissions to control critical process parameters;
- Process gases are collected using sealed or semi-sealed furnace systems. Interactive, variable speed fans are used to ensure that optimum gas collection rates are maintained and can minimise energy costs (see BREF Section 2.6.8);
 - Monitoring and control of the temperature of melting furnaces to prevent the production of metal and metal oxide fume by overheating (see BREF Section 2.6.8);
 - Solvent vapours are collected and recovered as far as possible. Further removal of solvent vapours is practised to prevent the emission of VOC and odours (see BREF Section 2.6.8);
 - Slag, metal and matte are analysed on the basis of samples taken at intervals. On-line analysis of these streams is an emerging technique;
 - Achieve good extraction using automatic controls for dampers so that it is possible to target the extraction effort to the source of fume without using too much energy. The controls enable the extraction point to be changed automatically during different stages of the process. For example, charging and tapping of furnaces do not usually occur at the same time and so the charging and tapping points can be designed to be close together so that only one extraction point is needed (see BREF Section 2.7.2.1);
 - The extraction point is also designed to allow good access to the furnace and give a good rate of extraction. The hooding is constructed robustly and is maintained adequately;
 - The use of sealed furnaces can contain gases and prevent fugitive emissions. Furnace sealing still relies on sufficient gas extraction rates to prevent pressurisation of the furnace;
 - The use of sealed charging systems for the furnaces to prevent fugitive emissions during furnace opening. Examples are the use of charging skips that seal against a furnace feed door and the use of through-hood charging systems (see BREF Sections 2.7.2.1 & 4.3.4);
 - New and rebuilt furnaces with charge doors fitted with sealed charging systems where secondary scrap or flux is being used, as they prevent fugitive emissions during charging. If sealed furnaces are not available for example when retrofitting an existing open furnace, maximum sealing to contain furnace gases can be used (see BREF Section 4.3.4);
 - Maintenance of the collector hood the ducts, the filter system and the fan with regular inspection and preventative maintenance programmes to ensure that collection or extraction rates remain at the designed level (see BREF Section 2.7.2.1);
 - Good cleaning and maintenance of gas-fired heating burner systems;
 - Waste moulds and cores should be segregated from other waste to facilitate reclamation;
 - Use of oxygen enrichment in combustion systems to allow auto-thermal oxidation of sulphide based ores, to increase the capacity or melting rate of particular furnaces and to provide discrete oxygen rich areas in a furnace to allow complete combustion separately from a reducing zone (see BREF Section 2.8.1.8);

- Pre-selection or treatment of the feed material to minimise the amount of precursors or organic matter is therefore a very important measure to prevent the formation of dioxins;
- 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 potential dioxin emission can be minimised by (see BREF Section 2.8.1.6):
 - Secondary chamber (afterburner) interlocked with primary chamber such that the primary chamber cannot be used until the afterburner is up to temperature,
 - Temperature in the secondary chamber continuously monitored and maintained at $> 850^{\circ}\text{C}$,
 - Secondary chamber designed to achieve a residence time of at least two seconds,
 - Secondary chamber designed to achieve an oxygen level within the combustion chamber of $>6\%$,
 - Continuous indicative monitor for particulate matter and particulate matter concentration maintained at less than 20 mg/m^3 ,
 - Where gases from the secondary chamber are filtered or scrubbed prior to emission in order to achieve the emission limit for particulate matter of 20 mg/m^3 , then the gases should be cooled quickly (quick quench, within about two seconds) through the *de novo* synthesis temperature zone of $250 - 650^{\circ}\text{C}$,
 - Sufficient oxygen needs to be present in the hot gases and oxygen injection can be used to ensure complete combustion;
- Emissions from casting and cooling should be contained where necessary (to minimise fugitive emissions);
- Mould cooling should not take place outside of buildings, except for moulds made only of metal;
- Consumption of binder chemicals should be minimised;
- Working managed to control draughts;
- Casting knockout areas contained, extracted and exhausted.

4.3.3.4 Galvanising Control Techniques

For all non-ferrous metal operations involving galvanising, the following techniques should be considered.

- For degreasing operations in batch galvanising plants, the following techniques should be considered (see FM BREF Section C.4.2):
 - Installation of a degreasing step, unless items are totally grease-free which is rarely the case in job galvanising,
 - Optimum bath operation to enhance efficiency, e.g. by agitation,
 - Cleaning of degreasing solutions to extend lifetime (by skimming, centrifuge, etc.) and recirculation; reuse of oily sludge,
 - 'Biological degreasing' with in situ cleaning (grease and oil removal from degreaser solution) by bacteria,
 - Reduction of carry over to pickling bath;
- For pickling and stripping the following techniques should be considered (see FM BREF Section C.4.2):

- Close monitoring of bath temperature and concentration parameters,
 - If heated concentrated HCl-baths are used, installation of an extraction unit and treatment of the extraction air (e.g. by scrubbing) are considered BAT,
 - Special attention to the actual pickling effect of the bath and use of pickling inhibitors to avoid over-pickling,
 - Recovery of free-acid fraction from spent pickle liquor or external regeneration of pickling liquor,
 - Zn removal from acid,
 - Use of spent pickle liquor for flux production,
 - Operate both pickling and stripping in separate treatment vessels,
 - Capture of emissions from pickling and abatement,
 - Enclosed pre-treatment section (Degreasing/Pickling/Air Extractions and Abatement);
- Good drainage between pre-treatment tanks is advocated with rinsing after degreasing and after pickling to avoid carry-over into subsequent process baths and thus to prolong the lifetime of these baths is essential. The following techniques should be considered (see FM BREF Section C.4.4):
 - Static rinsing or rinsing cascades,
 - Reuse of rinse water to replenish preceding process baths,
 - Waste water-free-operation;
 - For fluxing the following techniques should be considered (see FM BREF Section C.4.5):
 - Control of bath parameters and the optimised amount of flux used,
 - Iron removal from flux bath solution (using, e.g. H₂O₂, electrolytic oxidation or ion exchange) or, if installation of a regeneration unit is not possible, regeneration by externals is possible;
 - During hot dipping the following techniques should be considered (see FM BREF Section C.4.6):
 - Capture of emissions from hot dipping by enclosure of the pot or by lip extraction followed by dust abatement,
 - Use of smoke reduced flux agent,
 - Internal or external reuse of collected dust for flux production. As this dust may occasionally contain dioxins at low concentration due to upset conditions in the plant (badly degreased items being galvanised), only recovery processes yielding fluxing agents free of dioxins are BAT,
 - Reduced generation of hard zinc,
 - Reduced generation of splashes,
 - Re-use of zinc ash,
 - Heat recovery from galvanising kettle heating for hot water or drying air;
 - For all Zn-containing wastes (dross, hard zinc, and splashes/squirts), separate storage and protection from rain and wind, and reuse in the non-ferrous metals industry or other sectors to recover the valuable substances they contain should be considered.

4.3.4 Techniques for the Prevention and Minimisation of Emissions

4.3.4.1 Minimisation of Emissions to Air

For all non-ferrous metal operations, the following techniques for minimisation of fugitive air emissions should be considered (see BREF Sections 2.7 & 2.8):

- Covering of skips and vessels;
- Avoidance of outdoor or uncovered stockpiles (where possible), where unavoidable, use of sprays, binders, stockpile management techniques, windbreaks, etc.;
- Wheel and road cleaning;
- Closed conveyors, pneumatic conveying (noting the higher energy needs), minimising drops;
- Regular housekeeping, external surfaces of the process building, ancillary plant and open yards and storage areas should be inspected at least annually and cleaned if necessary to prevent the accumulation of dusty material in circumstances where the dust may become wind entrained;
- Cleaning operations should be carried out by methods which minimise emissions of particulate matter to air;
- Good housekeeping measures should be employed to minimise fugitive releases of solvents;
- Containers should be covered when not in use;
- Piping directly from bulk tanks avoiding losses that occur when transferring between containers;
- Sealing of furnaces and reactors (see BREF Section 2.7.2.1);
- Minimise open molten metal transfers:
 - Use dust extraction system to remove dust and particulates from working areas/buildings;
- Enclosed buildings can be designed to have a negative air pressure to prevent odour emissions from doorways;
- Prevent or minimise the use of malodorous materials (see BREF Section 2.14);
- Vent systems chosen to minimise breathing emissions (e.g. pressure/vacuum valves) and, where relevant, should be fitted with knock-out pots and appropriate abatement equipment;
- When transferring fuel or other volatile liquids, the following techniques should be employed:
 - Subsurface filling via filling pipes extended to the bottom of the container,
 - The use of vapour balance lines that transfer the vapour from the container being filled to the one being emptied, or,
 - An enclosed system with extraction to suitable abatement plant.

4.3.4.2 Minimisation of Emissions to Water

For all non-ferrous metal operations, the following techniques for minimisation of water emissions should be considered in conjunction with measures outlined in section 5.3.2 of this document (see BREF Section 2.9):

- Measures implemented to minimise the contamination risk of process or surface water, surface water should not drain directly into a surface watercourse without interception, passing through a silt trap and oil interceptor

before final discharge (European Standard prEN 858 – Installations for the separation of light liquids);

- Regular interceptor cleaning and maintenance procedures implemented;
- Roads and hardstanding areas impermeable (i.e. a recognised sealed surface, e.g. asphalt or concrete, that is not readily permeable to liquids) and designed to direct rainfall/surface run-off to the surface water drainage system with an interceptor before the drainage point. Where there are permeable areas such as grass or landscaping adjacent to impermeable surfaces, there should be kerbing to prevent run-off from the impermeable surfaces onto this ground;
- The installation designed and operated so as to prevent spillage or escape of substances that could pollute the surface or groundwater system with suitable emergency procedures as per the EPA Guidance Note on Storage and Transfer of Materials for Scheduled Activities.

4.3.4.3 Minimisation of Noise Emissions

For all non-ferrous metal operations, the following techniques for minimisation of noise emissions should be considered (see BREF Section 2.13):

- Identify the nearest noise sensitive sites that are likely to be sensitive to high noise levels. Noise baseline monitoring and impact predictions in accordance with BS 5228, or ISO 9613-2 should be carried out prior to the development commencing, in order to assess the effect noise will have on sensitive locations;
- New plant can be specified with low noise and vibration levels. Good maintenance can prevent equipment such as fans and pumps from becoming un-balanced. The interconnections between equipment can be designed to prevent or minimise the transmission of noise;
- Buildings may need to be constructed with acoustic cladding insulation;
- Adequate maintenance of any parts of plant or equipment whose deterioration may give rise to increases in noise (e.g. maintenance of bearings, air handling plant, the building fabric as well as specific noise attenuation measures associated with plant, equipment or machinery);
- Noisy plant and equipment not used for long periods of time and at inappropriate times;
- Patterns of raw material delivery are monitored to ensure that vehicle movements are avoided during specific periods;
- Noisy plant and equipment are located away from residential areas and are enclosed where possible;
- Regular monitoring of noise levels carried out;
- Noise complaints are recorded and investigated;
- Noisy activities should be carried on indoors where possible;
- Ensure building doors are kept closed;
- Maintain site roads to reduce noise and vibration from vehicle movements;
- Selection of equipment that conforms to EU Noise Standards.

4.3.4.4 Solid Waste Minimisation

For all non-ferrous metal operations, the following techniques for minimisation of solid waste should be considered (see BREF Section 2.10):

- Ongoing identification and implementation of waste prevention opportunities. Particular attention should be paid to impurities in raw materials, which will be concentrated within particular waste streams; (see BREF Section 2.4.1.2);

- 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;
- Minimisation of residues from the metallurgical process using techniques such as (see BREF Section 2.10.3.1):
 - Cleaner raw materials leads to reduced generation of solids,
 - Appropriate storage and handling to minimise wetting,
 - Generation of skimmings can be minimised by optimising operation of the furnace,
 - Minimise spent linings and refractories by careful construction of the brick lining of the furnace, continuous use of the furnace and thus minimisation of the variations in temperature, short impact time of the fluxing agents, avoidance of aggressive fluxing agents, careful cleaning of furnaces and crucibles, reduction of furnace agitation (rotation);
- Minimisation of residues arising from the abatement system using techniques such as (see BREF Section 2.10.3.2):
 - Sealed furnace develops far less flue dust than a semi closed or an open furnace,
 - Metal laden dust can normally be recycled to the smelter or sold for further beneficial use to other non-ferrous metal facilities,
 - Flue dust and sludge may be processed in a variety of pyrometallurgical or hydrometallurgical processes,
 - Gypsum (CaSO_4) produced in the SO_2 scrubber can sometimes be recycled to the dryer as part of the furnace flux feed depending on the process used,
 - Quantity of spent filter bags may be decreased by using modern filter materials that are more robust;
- Reduction of residue generated by the effluent treatment using techniques such as (see BREF Section 2.10.3.3):
 - Avoidance of thermally loaded cooling water to the environment can be reduced by the use of different kinds of cooling systems, such as closed cooling systems, quasi closed systems and open cycle cooling techniques (cooling towers),
 - If a closed cooling cycle (e.g. air-coolers) is used the release of cooling water can be minimised,
 - The amount of wastewater that is generated by a wet scrubber can be reduced if the treated water is recycled back to the scrubber;
- Reduction of other residues arising from the production of non-ferrous metals using techniques such as (see BREF Section 2.10.3.4):
 - Regular maintenance, repairs and preventive maintenance can minimise oil loss by leakage and increases the intervals between the oil change,
 - Use of oil filtration, which gives an extension of the service life. For example by-pass filters may be installed to continuously clean a small part of the oil;
- Recycling and reuse of residues from non-ferrous metal smelting processes (see BREF Section 2.10.3.5).

4.3.5 Techniques for Treatment Abatement and Disposal

4.3.5.1 Air Emissions

For all non-ferrous metal operations, techniques to minimise the formation of air emissions as outlined above in section 5.5.1 should be considered, then the following general techniques should be considered for any remaining emissions (see BREF Section 2.8):

- 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;
- Hot emissions take place from the minimum practicable number of stacks, in order to obtain maximum advantage from thermal buoyancy, if practicable a multi-flue stack should be used;
- Stack heights are sufficient to ensure adequate dispersion under normal conditions, 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;
- Demonstrate 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;
- Emissions of water vapour are free from droplet fallout, 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;
- Flues and ductwork are cleaned to prevent accumulation of materials, as part of the routine maintenance programme;
- Exhaust gases discharged through a stack achieve an exit velocity greater than 15 m / sec during normal operating conditions to achieve adequate dispersion;
- 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;
- Power consumption indicators on fans associated with extraction systems;
- Temperature monitoring on exhausts from furnaces and after-burners;
- Process control techniques on collection and abatement equipment including (see BREF Section 2.9.2.3):
 - Reagent metering systems,
 - Microprocessor control of reagent feed and plant performance is used,
 - On-line monitoring of temperature, pressure drop, particulates or other pollutants emitted, EP current and voltage and scrubber liquor flow and pH,
 - Alarms provided to indicate operational problems such as pump failure,
 - Operators and maintenance personnel trained and assessed in the use of operating instructions and the use of the modern control techniques described;
- Characteristics of the emission, concentration and variability considered in the choice and design of abatement equipment.

Dust/Fine Particulates

The following techniques correctly designed, constructed and sized for the application can be considered for the removal of dust/particulates from the various processes used by the non-ferrous metals industry:

- Electrostatic precipitators (see BREF Sections 2.8.3.2.1 & 2.8.1.1.1);
- Wet electrostatic precipitator (see BREF Sections 2.8.3.2. & 2.8.1.1.2);
- Cyclones (see BREF Sections 2.8.3.2. & 2.8.1.1.3);
- Fabric or bag filters, particular attention to the choice of filter material and the reliability of the mounting and sealing system (see BREF Sections 2.8.3.2.21 & 2.8.1.1.4);
- Ceramic filters (see BREF Sections 2.8.3.2.3 & 2.8.1.1.5);
- Wet scrubbers when the nature of the dust or the gas temperature precludes the use of other techniques or when the dust is particularly suitable for removal in a scrubber. Their use can also be considered when gases need to be removed simultaneously with dust or when they form part of a chain of abatement techniques for example in de-dusting prior to a sulphuric acid plant (see BREF Sections 2.8.3.2.4 & 2.8.1.1.6).

Total Carbon and VOCs

The following techniques correctly designed, constructed and sized for the application can be considered for the removal of total carbon and VOCs from the various processes used by the non-ferrous metals industry:

- After burners and scrubbers (see BREF Sections 2.8.1.5, 2.8.3.2.5 & 2.8.1.1.7),
- Bio-filters and reactors (see BREF Section 2.8.1.5),
- Activated carbon traps and chiller / condenser systems (see BREF Section 2.8.1.5).

Dioxins

The following techniques correctly designed, constructed and sized for the application can be considered for the removal of dioxins from the various processes used by the non-ferrous metals industry (see BREF Section 2.8.1.6):

- Activated carbon can be injected into the gas stream where dioxins are absorbed onto the surface. High efficiency dust filtration is then used to remove the dust and dioxins (see BREF Section 2.8.1.6);
- Dioxins may be also absorbed onto other particulate matter and can be removed using high efficiency dust filtration. The collected dusts may have high dioxin concentrations and may need to be disposed of or treated carefully (see BREF Section 2.8.1.6);
- Catalytic oxidation systems are also available for the destruction of dioxins and it has been reported that fabric filters that incorporate a catalytic layer are used (see BREF Section 2.8.1.6);
- Afterburners and flares (see BREF Sections 2.8.1.5, 2.8.3.2.5 & 2.8.1.1.7);
- High Efficiency Dust Removal, dioxins can be absorbed on the particulate matter with large surface area, collected dust must be treated in high temperature furnaces to destroy PCDD/PCDF and recover metals (see BREF Section 2.17.5);
- Afterburners and quenching used at a minimum temperature of 950°C to ensure full combustion of organic compounds. This stage is to be followed by rapid quenching of hot gases to temperatures below 250°C. Oxygen injection in the upper portion of the furnace will promote complete combustion (see BREF Section 2.17.5).

Inorganic Process Gases

Gases such as NH₃, SO₂, HF, HCl and NO_x are produced in several processes. The following techniques correctly designed, constructed and sized for the application can be considered for the removal of inorganic gases from the various processes used by the non-ferrous metals industry:

- Gas scrubbing systems (see BREF Sections 2.8.1.2 & 2.8.3.3);
- Wet scrubbers (see BREF Sections 2.8.3.3.1 & 2.8.1.2.1);
- Dry or semidry scrubber (see BREF Sections 2.8.3.3.2 & 2.8.1.2.2);
- Gas recovery systems (see BREF Section 2.8.1.3);
- Sulphur capture (see BREF Sections 2.8.1.4 & 2.8.3.5).

Odour

Having taken into account the techniques presented in Section 5.5.1 on minimisation of air emissions, the following techniques correctly designed, constructed and sized for the application can be considered for the removal of odour from the various processes used by the non-ferrous metals industry (see BREF Section 2.14):

- Enclosed buildings can be designed to have a negative air pressure to prevent odour emissions from doorways;
- Treat them possibly by afterburning or filtration. The use of biological media such as peat or similar material that acts as a substrate for suitable biological species has been successful in removing odours (see BREF Section 2.14).

4.3.5.2 Wastewater

The technique for wastewater treatment or a combination of the different treatment methods can only be chosen on a site by site basis by taking into account the site specific factors. The most important factors to decide, which in a specific case would be the best solution in order to minimise the amount of wastewater and the concentration of the pollutants are (see BREF Section 2.9.4):

- The process where the wastewater is generated;
- The amount of water;
- The pollutants and their concentrations;
- The level of clean up required, i.e. local or regional water quality standards;
- The availability of water resources.

For all non-ferrous metal operations techniques to minimisation of the quantity and load of waste water generated using the measures outlined in section 5.5.2 should be applied and then treatment of any remaining wastewater using the following technique considered, correctly designed, constructed and sized for the application:

- Effluent streams kept separate as treatment will be more efficient, the properties of dissimilar waste streams should be used where possible to avoid adding further chemicals, e.g. neutralising waste acid and alkaline streams;
- Wastewater treatment techniques correctly designed, constructed and sized for the application:
 - Chemical precipitation (see BREF Section 2.9.2.2.1),
 - Sedimentation (see BREF Section 2.9.2.2.2),
 - Filtration (see BREF Section 2.9.2.2.3),
 - Electrolysis (see BREF Section 2.9.2.2.4),
 - Reverse osmosis (see BREF Section 2.9.2.2.5),
 - Ion exchange (see BREF Section 2.9.2.2.6),

- Activated carbon (see BREF Section 2.9.2.2.7);
- Wastewater treatment process control techniques including (see BREF Section 2.9.2.3):
 - Reagent metering systems,
 - Microprocessor control of reagent feed and plant performance,
 - On-line monitoring of temperature, turbidity, pH, conductivity, REDOX, TOC, individual metals and flow is used,
 - Operators, maintenance personnel trained and assessed in the use of operating instructions and the use of the process control techniques;
- Concentrated effluents pre-treated as necessary before discharge into the final effluent treatment system (see BREF Section 7.3.2 for example).

4.3.5.3 Noise & Vibration

Having taken into account the measures outlined in section 5.5.3 on noise minimisation, the following techniques correctly designed, constructed and sized for the application should be considered for the noise abatement from the various processes used by the non-ferrous metals industry (see BREF Section 2.13):

- The use of embankments to screen the source of noise,
- The enclosure of noisy plant or components in sound absorbing structures,
- The use of anti-vibration supports and interconnections for equipment,
- The orientation of noise emitting machinery,
- The change of the frequency of the sound,
- Use of acoustic screens around fixed/mobile plant and equipment,
- Fit silencing equipment to plant, e.g. baffles/muffles.

5. BEST AVAILABLE TECHNIQUES FOR THE NON FERROUS METAL INDUSTRY

5.1 INTRODUCTION

As explained in Section 2, this Guidance Note identifies BAT but obviously does so in the absence of site-specific information. Accordingly, it represents the requirements expected of any new activity covered by the Note, and ultimately the requirements expected of existing facilities, but exclude additional requirements, which may form part of the granting of a licence for a specific site.

The technical feasibility of the measures listed below has been demonstrated by various sources. Used singly, or in combination, the measures represent BAT solutions when implemented in the appropriate circumstances. These circumstances depend on nature of process, plant scale, fuels used, etc.

5.2 GENERAL PREVENTATIVE METHODS

5.2.1 Management Systems

Effective management is important in achieving good environmental performance. It is an important component of BAT and forms part of the definition of techniques given in Article 2 of the Directive a For BAT a management system includes the following elements (see BREF Section 2.3 for details):

- A management policy and commitment;
- Incorporates design and maintenance elements which include for the assessment of the effects of existing plant and any new or substantially changed processes on the degree of protection of air, water and land as follows;
- A training element.

5.3 TECHNIQUES FOR PREVENTION AND MINIMISATION OF RESOURCE CONSUMPTION

5.3.1 Minimisation of Energy Use

The applicant should demonstrate that in the design of the installation and in any treatment processes energy efficiency and recovery has been considered, such BAT measures are:

- The use of basic, low cost physical energy efficiency techniques, such as insulation, containment methods (such as seals and self-closing doors), and avoidance of unnecessary discharge of heated water or air (for example, by fitting simple control systems such as timers and sensors), gravity feed systems;
- The consideration of energy recovery techniques such as those outlined in BREF Section 2.11.1,

- The applicant should demonstrate that they are using purchasing, operating and maintenance procedures to optimise the energy use in the installation (see Section 4.3.2.1 of this document);
- The applicant should quantify the energy consumption review energy consumption on an annual basis and examine options for:
 - Optimisation of energy supply;
 - Optimising/reducing energy consumption;
 - Optimising heat and energy recovery.

Many of the aspects of energy efficiency are likely to be delivered through management techniques, operating and maintenance procedures, which overlap and form part of the EMS for the activity.

5.3.2 Minimisation of Water Use

For all non-ferrous operations, BAT for minimisation of water use is (see BREF Section 2.17.7):

- Consideration and application of appropriate factors listed in Section 4.3.2.2 of this document;
- Closed circuit cooling systems should be used where possible with system monitoring to detect leaks;
- Water should be recycled within the process from which it issues, by treating it first if necessary. Where this is not practicable, it should be recycled to another part of the process, which has a lower water quality requirement;
- Drainage systems should be designed to avoid contamination of roof and surface water. Where possible this should be retained for use. That which cannot be used should be discharged separately.

5.3.3 Minimisation of the Use of Raw Materials

For all non-ferrous operations, BAT for minimisation of materials use to ensure they are used efficiently, including minimising their use and their impact by selection is:

- Consideration and application of appropriate factors listed in Section 4.3.2.3 of this document;
- Maintain a detailed inventory of raw materials used on-site;
- Have procedures for the regular review of new developments in raw materials and the implementation of any suitable ones which are less hazardous;
- As part of the installation design, specify materials with minimal environmental impact should be selected and used.

5.4 PREVENTATIVE METHODS FOR SPECIFIC UNIT OPERATIONS

5.4.1 Materials Handling and Storage

For all non-ferrous metal operations BAT is to do the following (see BREF Sections 2.17.1 & 3.4.1):

- Consideration and application of appropriate factors listed in Section 4.3.3.1 of this document;
- Tank contents should be displayed and associated alarms used;
- Use of leak detection systems and alarms;
- Control mechanisms incorporated into the site drainage system such as shut-off valves, which can stop or divert the flow of material;

- The use of planned deliveries and automatic control systems to prevent over filling of storage tanks;
- Delivery points should be contained within the bund to collect spilled material;
- Back venting of displaced gases to the delivery vehicle should be practised to reduce emissions of VOCs;
- Use of automatic resealing of delivery connections to prevent spillage;
- Storage of material that can release oil on concreted areas that have curbs or other containment devices;
- Transfer conveyors and pipelines placed in safe, open areas above ground so that leaks can be detected quickly and damage from vehicles and other equipment can be prevented. If buried pipelines are used their course can be documented and marked and safe excavation systems adopted;
- Use of well designed, robust pressure vessels for gases (including LPGs) with pressure monitoring of the tanks and delivery pipe-work to prevent rupture and leakage;
- Gas monitors should be used in confined areas and close to storage tanks;
- Where required, sealed delivery, storage and reclamation systems can be used for dusty materials and silos can be used for day storage;
- Sealing agents (such as molasses and PVA) can be used where appropriate and compatible to reduce the tendency for material to form dust;
- Enclosed conveyors with well designed, robust extraction and filtration equipment can be used on delivery points, silos, pneumatic transfer systems and conveyor transfer points to prevent the emission of dust;
- Non-dusty, non-soluble material can be stored on sealed surfaces with drainage and drain collection;
- Swarf, turnings and other oily material should be stored under cover to prevent washing away by rain water;
- Rationalised transport systems can be used to minimise the generation and transport of dust within a site;
- The use of wheel and body washes or other cleaning systems to clean vehicles used to deliver or handle dusty material. Local conditions will influence the method, e.g. ice formation;
- Planned campaigns for road sweeping;
- Inventory control and inspection systems to prevent spillages and identify leaks;
- Material sampling and assay systems incorporated into the materials handling and storage system to identify raw material quality and plan the processing method. These systems should be designed and operated to same high standards as the handling and storage systems;
- Following delivery, handling is kept to a minimum;
- A high standard of housekeeping should be maintained.

5.4.2 Pre-Processing and Transfer of Raw Materials

For all non-ferrous metal operations BAT in pre-processing and transfer operations is (see BREF Section 2.17):

- Consideration and application of appropriate factors listed in Section 4.3.3.2 of this document;
- Use of pre-treatment and transfer processes with well designed robust extraction and abatement equipment to prevent the emission of dust and other material. The design of this equipment should take account of the nature of the emissions, the maximum rate of emissions and all of the potential sources;

- Use of enclosed conveying systems for dusty materials. These systems should be provided with extraction and abatement equipment where dust emissions are possible;
- The use of good design and construction practices and adequate maintenance;
- The presence of oils, plastics and chlorine compounds in the feed material should be avoided to reduce the generation of dioxins during incomplete combustion or by de-novo synthesis with the following techniques;
- Sufficient blending of material to provide a homogenous feed in order to promote steady-state conditions;
- Gases should be cooled rapidly through the temperature window of dioxin reformation;
- Off gas extraction systems should prevent fugitive emissions.

5.4.3 Metal Production and Process Control Techniques

For all non-ferrous metal operations BAT in metal production and associated process control is to do the following (see BREF Sections 2.17.2, 2.17.3 & 2.17.5):

- Consideration and application of appropriate factors listed in Section 4.3.3.3 of this document;
- Operators, engineers and others should be continuously trained and assessed in the use of operating instructions, the use of the modern control techniques described and the significance of the actions to be taken when alarms are given. Levels of supervision are optimised to take advantage of the above and to maintain operator responsibility (see BREF Section 2.17.2);
- Adequate maintenance systems;
- Sampling and analysis of raw materials is commonly used to control plant conditions. Good mixing of different feed materials should be achieved to get optimum conversion efficiency and reduce emissions and rejects (see BREF Section 2.17.2);
- Feed weighing and metering systems are used extensively. Loss in weight silos, belt weighers and scale weighers are used extensively for this purpose (see BREF Section 2.17.2);
- Microprocessors are used to control material feed-rate, critical process and combustion conditions and gas additions. Several parameters are measured to allow processes to be controlled, alarms are provided for critical parameters (see BREF Section 2.17.2):
 - On-line monitoring of temperature, furnace pressure (or depression) and gas volume or flow is used,
 - Gas components (O₂, SO₂, CO) are monitored,
 - On-line monitoring of vibration is used to detect blockages and possible equipment failure,
 - On-line monitoring of the current and voltage of electrolytic processes,
 - On-line monitoring of emissions to control critical process parameters;
- The use of sealed furnaces can contain gases and prevent fugitive emissions. Furnace sealing still relies on sufficient gas extraction rates to prevent pressurisation of the furnace (see BREF Section 2.17.3);
- Pre-selection or treatment of the feed material to minimise the amount of precursors or organic matter is therefore a very important measure to prevent the formation of dioxins (see BREF Section 2.17.5).

5.4.4 Galvanising

For all non-ferrous metal operations involving galvanising, BAT is to do the following (see FM BREF Section C.5).

- Consideration and application of appropriate factors listed in Section 4.3.3.4 of this document;
- For degreasing operations in batch galvanising plants, the following techniques are considered BAT:
 - Installation of a degreasing step, unless items are totally grease-free which is rarely the case in job galvanising,
 - Optimum bath operation to enhance efficiency, e.g. by agitation,
 - Cleaning of degreasing solutions to extend lifetime (by skimming, centrifuge, etc.) and recirculation; reuse of oily sludge,
 - 'Biological degreasing' with in situ cleaning (grease and oil removal from degreaser solution) by bacteria;
- For pickling and stripping the following techniques are considered to be BAT:
 - Close monitoring of bath temperature and concentration parameters,
 - If heated concentrated HCl-baths are used, installation of an extraction unit and treatment of the extraction air (e.g. by scrubbing) are considered BAT,
 - Special attention to the actual pickling effect of the bath and use of pickling inhibitors to avoid over-pickling,
 - Recovery of free-acid fraction from spent pickle liquor or external regeneration of pickling liquor,
 - Zn removal from acid,
 - Use of spent pickle liquor for flux production;
- Good drainage between pre-treatment tanks is advocated with rinsing after degreasing and after pickling to avoid carry-over into subsequent process baths and thus to prolong the lifetime of these baths is essential. BAT is:
 - Static rinsing or rinsing cascades,
 - Reuse of rinse water to replenish preceding process baths,
 - Waste water-free-operation;
- For fluxing the following techniques are considered BAT:
 - Control of bath parameters and the optimised amount of flux used,
 - Iron removal from flux bath solution (using, e.g. H₂O₂, electrolytic oxidation or ion exchange) or, if installation of a regeneration unit is not possible, regeneration by externals is possible. Both internal and external flux bath regeneration are considered BAT;
- During hot dipping the following techniques are considered to be BAT:
 - Capture of emissions from hot dipping by enclosure of the pot or by lip extraction followed by dust abatement;
 - Internal or external reuse of collected dust for flux production. As this dust may occasionally contain dioxins at low concentration due to upset conditions in the plant (badly degreased items being galvanised), only recovery processes yielding fluxing agents free of dioxins are BAT;
- For all Zn-containing wastes (dross, hard zinc, and splashes/squirts), separate storage and protection from rain and wind, and reuse in the non-ferrous metals

industry or other sectors to recover the valuable substances they contain are considered to be BAT.

5.5 TECHNIQUES FOR THE PREVENTION AND MINIMISATION OF EMISSIONS

5.5.1 Minimisation of Emissions to Air

For all non-ferrous metal operations, BAT for minimisation of fugitive air emissions is as follows:

- Consideration and application of appropriate factors listed in Section 4.3.4.1 of this document;
- Wheel and road cleaning (see BREF Section 2.17.1);
- Sealing of furnaces and reactors (see BREF Section 2.7.2.1);
- Minimise open molten metal transfers (see BREF Section 2.17.3):
 - Use dust extraction system to remove dust and particulates from working areas/buildings.

5.5.2 Minimisation of Emissions to Water

For all non-ferrous metal operations, BAT for minimisation of water emissions is as follows:

- Consideration and application of appropriate factors listed in Section 4.3.4.2 of this document;
- Measures implemented to minimise the contamination risk of process or surface water, surface water should not drain directly into a surface watercourse without interception, passing through a silt trap and oil interceptor before final discharge (European Standard prEN 858 – Installations for the separation of light liquids) (see BREF Section 2.17.1);
- Roads and hardstanding areas impermeable (i.e. a recognised sealed surface, e.g. asphalt or concrete, that is not readily permeable to liquids) and designed to direct rainfall/surface run-off to the surface water drainage system with an interceptor before the drainage point. Where there are permeable areas such as grass or landscaping adjacent to impermeable surfaces, there should be kerbing to prevent run-off from the impermeable surfaces onto this ground (see BREF Section 2.17.1).

5.5.3 Minimisation of Noise Emissions

For all non-ferrous metal operations, BAT for minimisation of noise emissions is as follows:

- Consideration and application of appropriate factors listed in Section 4.3.4.3 of this document.

5.5.4 Solid Waste Minimisation

The following Best Available Techniques correctly designed, constructed and sized for the application can be used for waste minimisation from the various processes used by the non-ferrous metals industry:

- Consideration and application of appropriate factors listed in Section 4.3.4.4 of this document;
- Monitoring of materials usage and reporting against key performance measures;
- Minimisation of residues arising from the abatement system using techniques described in BREF Section 2.10.3.2;
- Reduction of residue generated by the effluent treatment using techniques such as described in BREF Section 2.10.3.3;
- Reduction of other residues arising from the production of non-ferrous metals using techniques such as described in BREF Section 2.10.3.4;
- Recycling and reuse of residues from non-ferrous metal smelting processes using techniques such as described in BREF Section 2.10.3.5.

5.6 TECHNIQUES FOR TREATMENT, ABATEMENT AND DISPOSAL

5.6.1 Air Emissions

For all non-ferrous metal operations, BAT is to minimise the formation of air emissions as outlined above in Section 5.5.1, then the following general techniques should be considered in the determination of BAT for any remaining emissions:

- Consideration and application of appropriate abatement techniques listed in Section 4.3.5.1 of this document and BREF Section 2.8;
- 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;
- Characteristics of the emission, concentration and variability considered in the choice and design of abatement equipment.

5.6.1.1 Dust/Fine Particulates

The following Best Available Techniques correctly designed, constructed and sized for the application can be used for the removal of dust/particulates from the various processes used by the non-ferrous metals industry:

- Electrostatic precipitators (see BREF Sections 2.8.3.2.1 & 2.8.1.1.1);
- Wet electrostatic precipitator (see BREF Sections 2.8.3.2. & 2.8.1.1.2),
- Cyclones (see BREF Sections 2.8.3.2. & 2.8.1.1.3);
- Fabric or bag filters, particular attention to the choice of filter material and the reliability of the mounting and sealing system (see BREF Sections 2.8.3.2.21 & 2.8.1.1.4);
- Ceramic filters (see BREF Sections 2.8.3.2.3 & 2.8.1.1.5);
- Wet scrubbers when the nature of the dust or the gas temperature precludes the use of other techniques or when the dust is particularly suitable for removal in a scrubber. Their use can also be considered when gases need to be removed simultaneously with dust or when they form part of a chain of abatement techniques for example in de-dusting prior to a sulphuric acid plant (see BREF Sections 2.8.3.2.4 & 2.8.1.1.6).

5.6.1.2 Total Carbon and VOCs

The following Best Available Techniques correctly designed, constructed and sized for the application can be used for the removal of total carbon and VOCs from the various processes used by the non-ferrous metals industry:

- After burners and scrubbers (see BREF Sections 2.8.1.5, 2.8.3.2.5 & 2.8.1.1.7);
- Bio-filters and reactors (see BREF Section 2.8.1.5);
- Activated carbon traps and chiller / condenser systems (see BREF Section 2.8.1.5).

5.6.1.3 Dioxins

Minimise the formation of air emissions as outlined above in Section 5.5.1, then the following Best Available Techniques correctly designed, constructed and sized for the application can be used for the removal of dioxins from the various processes used by the non-ferrous metals industry (see BREF Section 2.17.5):

- Activated carbon can be injected into the gas stream where dioxins are absorbed onto the surface. High efficiency dust filtration is then used to remove the dust and dioxins;
- Catalytic oxidation systems are used to destroy the dioxins;
- The use of afterburners and flares;
- High efficiency dust filtration, dioxins can be absorbed on the particulate matter with large surface area, collected dust must be treated in high temperature furnaces to destroy PCDD/PCDF and recover metals;
- Afterburners and quenching used at a minimum temperature of 950°C to ensure full combustion of organic compounds. This stage is to be followed by rapid quenching of hot gases to temperatures below 250°C. Oxygen injection in the upper portion of the furnace will promote complete combustion.

5.6.1.4 Inorganic Process Gases

Gases such as NH₃, SO₂, HF, HCl and NO_x are produced in several processes. The following Best Available Techniques correctly designed, constructed and sized for the application can be used for the removal of inorganic gases from the various processes used by the non-ferrous metals industry:

- Gas scrubbing systems (see BREF Sections 2.8.1.2 & 2.8.3.3);
- Wet scrubbers (see BREF Sections 2.8.3.3.1 & 2.8.1.2.1);
- Dry or semidry scrubber (see BREF Sections 2.8.3.3.2 & 2.8.1.2.2);
- Gas recovery systems (see BREF Section 2.8.1.3);
- Sulphur capture (see BREF Sections 2.8.1.4 & 2.8.3.5).

5.6.1.5 Odour

Having taken into account the techniques presented in Section 5.5.1 on minimisation of air emissions, the following Best Available Technique correctly designed, constructed and sized for the application can be used for the removal of odour from the various processes used by the non-ferrous metals industry:

- Consideration and application of appropriate abatement techniques listed in Section 4.3.5.1 of this document.

5.6.2 Wastewater

For all non-ferrous metal operations BAT is minimisation of the quantity and load of waste water generated using the measures outlined in section 5.5.2 and then treatment of any remaining wastewater using the following Best Available Techniques correctly designed, constructed and sized for the application:

- Initial treatment focuses on precipitation of metals and their compounds using one or more stages followed by the removal of the precipitate by sedimentation

or filtration. The technique will vary depending on the combination of pollutants (see BREF Section 2.17.7);

- Effluent streams kept separate as treatment will be more efficient, the properties of dissimilar waste streams should be used where possible to avoid adding further chemicals, e.g. neutralising waste acid and alkaline streams;
- Appropriate wastewater treatment techniques correctly designed, constructed and sized for the installation as discussed in Section 4.3.5.2 of this document;
- Appropriate wastewater treatment process control techniques as discussed in Section 4.3.5.2 of this document;
- Concentrated effluents pre-treated as necessary before discharge into the final effluent treatment system by appropriate means as discussed in Section 4.3.5.2 of this document.

5.6.3 Noise & Vibration

Having taken into account the measures outlined in section 5.5.3 on noise minimisation, the following Best Available Techniques should be considered:

- Consideration and application of appropriate abatement techniques listed in Section 4.3.5.3 of this document.

Further information on a number of waste gas and wastewater treatment techniques can be found in the BREF document on *Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector*, EIPPCB, February 2003.

6. BAT ASSOCIATED EMISSION LEVELS

6.1 EMISSION LEVELS FOR DISCHARGES TO AIR

The BAT-associated emission levels for emissions to air given below in Table 6.1

All parameters will not be relevant to every installation and will depend on the type of substances and processes in use at the installation, and other site-specific factors.

Table 6.1 BAT Associated Emission Levels for Emissions to Air

| Constituent Group or Parameter Note 1 | Class | Emission Level (mg/m ³) ^{Note 2} | Mass Flow Threshold (g/hr) ^{Note 3} |
|--|---|--|---|
| Carcinogenic Substances (Note 3) | Class I (limits set for class total) <ul style="list-style-type: none"> - arsenic and its compounds (except for arsine), as As - benzo(a)pyrene - cadmium and its compounds, as Cd - water-soluble compounds of cobalt, as Co - chromium (VI) compounds (except for barium chromate and lead chromate), as Cr | 0.05 | 0.15 |
| | Class II (limits set for class total) <ul style="list-style-type: none"> - acrylamide - acrylonitrile - dinitrotoluenes - ethylene oxide - nickel and its compounds (except for nickel metal, nickel alloys, nickel carbonate, nickel hydroxide, nickel tetracarbonyl) as Ni - 4-vinyl-1,2-cyclohexane-diepoxy | 0.5 | 1.5 |
| | Class III (limits set for class total) <ul style="list-style-type: none"> - benzene - bromoethane - 1,3-butadiene - 1,2-dichloroethane - 1,2-propylene oxide (1,2-epoxy propane) - styrene oxide - o-toluidine - trichloroethane - vinyl chloride | 1 | 2.5 |

| | | | |
|--|--|------|------|
| Vaporous or Gaseous Inorganic Substances | Class I (limits set on a per substance basis) <ul style="list-style-type: none"> - arsine - cyanogen chloride - phosgene - phosphine | 0.5 | 2.5 |
| | Class II (limits set on a per substance basis) <ul style="list-style-type: none"> - bromine and its gaseous compounds, as Hydrogen bromide - chlorine - hydrocyanic acid - fluorine and its gaseous compounds, as HF - hydrogen sulphide | 3 | 15 |
| | Class III (limits set on a per substance basis) <ul style="list-style-type: none"> - ammonia - gaseous inorganic compounds of chlorine, as HCl | 30 | 150 |
| | Class IV (limits set on a per substance basis) <ul style="list-style-type: none"> - sulphur oxides (sulphur dioxide and sulphur trioxide), as SO₂ - nitrogen oxides (nitrogen monoxide and nitrogen dioxide), as NO₂ - nitrogen monoxide and nitrogen dioxide, as NO₂ (thermal or catalytic post-combustion facilities) - Carbon monoxide | 350 | 1800 |
| Inorganic Dust Particles (Note 4) | Class I (limits set on a per substance basis) <ul style="list-style-type: none"> - mercury and its compounds, as Hg - thallium and its compounds, as Tl | 0.05 | 0.25 |
| | Class II (limits set for class total) <ul style="list-style-type: none"> - cobalt and its compounds, as Co - nickel and its compounds, as Ni - selenium and its compounds, as Se - tellurium and its compounds, as Te | 0.5 | 2.5 |

| | | | |
|--|---|---------------------------------------|--------|
| | Class III (limits set for class total) <ul style="list-style-type: none"> - antimony and its compounds, as Sb - chromium and its compounds, as Cr - easily soluble cyanides (e.g. NaCN), as CN - easily soluble fluorides (e.g. NaF), as F - copper and its compounds, as Cu - manganese and its compounds, as Mn - vanadium and its compounds, as V - tin and its compounds, as Sn - Other substances with risk phrases R40, R62 or R63 | 1 | 5 |
| Lead | | 0.5 - 2 | 2.5 |
| Zinc | | 5 | |
| Total Particulates | | 10 | |
| Dioxins | | 0.1 - 0.5 (I TEQ)(ng/m ³) | |
| Volatile Organic Compound (VOCs)(as C) | | 50 | 500 |
| Other | | | Note 5 |

Note 1 Where a substance falls into more than one category in Table 6.1, the lower emission limit value applies.

Note 2 Unless stated as otherwise.

Note 3: The Mass Flow Threshold is calculated in g/hr or kg/hr and is determined to be the maximum emission, which can occur over any one-hour period of plant operation. Where the Mass Flow in the raw gas exceeds the mass flow threshold given in the Table, abatement will be required to reduce the emission to below the appropriate emission level or mass flow threshold.

Note 4: Where substances of several classes are present, in addition to the above limit, the sum of Classes I & II shall not exceed the Class II limit and the sum of Classes I & III, II & III or I, II & III shall not exceed the Class III limit.

Note 5: Any relevant polluting substances as specified in Schedule to S.I. No. 394 of 2004: EPA (Licensing)(Amendment) Regulations, 2004.

6.2 EMISSION LEVELS FOR DISCHARGES TO WATER

The following table sets out emission levels that are achievable using BAT for wastewater treatment. However establishing emission limit values within a licence for direct discharges to surface water from wastewater treatment plant and stormwater discharges must ensure that the quality of the receiving water is not impaired or that the current Environmental Quality Standards (EQS) are not exceeded.

All discharges to sewer are subject to approval from the Water Services Authority.

Compliance with the Water Framework Directive (2000/60/EC) is required where relevant, in particular Article 16.

Table 6.2: BAT Associated Emission Limits for Discharges to Water*

| Constituent Group or Parameter | Emission Level | Percentage Reduction ³ | Notes |
|--|----------------|-----------------------------------|-------|
| pH | 6 - 9 | - | |
| Toxicity | 1 TU | | 1 |
| BOD ₅ | 25mg/l | >91 - 99% | |
| COD | 100 - 500mg/l | >75% | |
| Suspended Solids | 10 - 35mg/l | | |
| Total Ammonia (as N) | 10 mg/l | | |
| Total Nitrogen (as N) | 5 - 25mg/l | >80% | 2, 4 |
| Total Phosphorus (as P) | 2mg/l | >80% | 4 |
| Oils Fats and Greases | 10mg/l | | |
| Mineral Oil (from interceptor) | 20mg/l | | |
| Mineral Oil (from biological treatment) | 1.0mg/l | | |
| Phenols | | | 5 |
| Metals | | | 5, 6 |
| Organohalogens | | | 5 |
| Priority Substances (as per Water Framework Directive) | | | 5 |
| Cyanides | | | 5 |
| Other | | | 5, 7 |

* All values refer to daily averages based on a 24-hour flow proportional composite sample, except where stated to the contrary and for pH, which refers to continuous values. Levels apply to effluent prior to dilution by uncontaminated streams, e.g. storm water, cooling water, etc.

* Temperature measured downstream of a point of thermal discharge must not exceed the unaffected temperature by more than 1.5°C in salmonid waters and 3°C in cyprinid waters (Freshwater Fish Directive 79/659/EEC).

Note 1: The number of toxic units (TU) = 100/x hour EC/LC50 in percentage vol/vol so that higher TU values reflect greater levels of toxicity. For test regimes where species death is not easily detected, immobilisation is considered equivalent to death.

Note 2: Total Nitrogen means the sum of Kjeldahl Nitrogen, Nitrate-N and Nitrite-N.

Note 3: Reduction in relation to influent load.

Note 4: Limits will depend on the sensitivity of the receiving waterbody.

Note 5: BAT associated emissions levels are highly dependent on production process, wastewater matrix and treatment. These parameters shall be considered on a site-specific basis when setting emission limit values.

Note 6: PARCOM recommendation 92/4 applies to a wastewater emission from the electroplating industry discharging to water or public sewer. Where the sum of metals specified in combined is < 200g/day prior to treatment, their emission level values may be increased fourfold. Applies to activities other

than printed circuit board manufacture. Applies to wastewater streams specially treated (PARCOM).

Note 7: Any relevant polluting substances as specified in Schedule to S.I. No. 394 of 2004: EPA (Licensing)(Amendment) Regulations, 2004.

7. COMPLIANCE MONITORING

The methods proposed for monitoring the emissions from these sectors are set out below. Licence requirements may vary from those stated below due to site location considerations, and scale of the operation.

7.1 MONITORING OF EMISSIONS TO AIR

- Stack sampling periodically, as required by licence, taking account of the nature, magnitude and variability of the emission and the reliability of the control techniques.
- Continuous monitoring on main emissions where technically feasible (e.g. Particulates).
- Monitor solvent / VOC usage by annual mass balance reports and use to determine fugitive emissions.
- Annual monitoring of boiler stack emissions for SO_x, NO_x, CO and particulates, as required by the licence, taking account of the nature, magnitude and variability of the emission and the reliability of the controls.
- Monitoring of boiler combustion efficiency in accordance with the manufacturer's instructions at a frequency determined by the Agency.
- Periodic monitoring for other parameters as determined by the Agency.

7.2 MONITORING OF AQUEOUS EMISSIONS

- For uncontaminated cooling waters, continuous monitoring of temperature and flow.
- Establish existing conditions prior to start-up, of key emission constituents, and salient flora and fauna.
- Daily, or where deemed necessary, continuous monitoring of flow and volume. Continuous monitoring of pH. Monitoring of other relevant parameters as deemed necessary by the Agency (such as BOD, COD, metals, etc.), taking account of the nature, magnitude and variability of the emission and the reliability of the control techniques.
- Monitoring of influent and effluent from the wastewater treatment plant to establish percentage BOD reduction and an early warning of any difficulties in the wastewater treatment plant, or unusual loads.
- The potential for the treated effluent to have tainting and toxic effects should be assessed and if necessary measured by established laboratory techniques.
- Periodic biodegradability checks where appropriate on effluents to municipal waste treatment plants, both prior to start-up and thereafter.

7.3 MONITORING OF EMISSIONS TO GROUNDWATER

There should be no direct emissions to groundwater, including during extraction and treatment of groundwater.

7.4 MONITORING OF SOLID WASTE

- The recording in a register of the types, quantities, date and manner of disposal/recovery of all wastes.
- Leachate testing of sludges and other material as appropriate being sent for landfilling.
- Annual waste minimisation report showing efforts made to reduce specific consumption together with material balance and fate of all waste materials.

Appendix 1

PRINCIPAL REFERENCES

BREF 2001, European Commission Reference Document on Best Available Techniques in the Non Ferrous Metals Industries. See: <http://eippcb.jrc.es/>

BREF 2004, European Commission IPPC Reference Document on BAT in the Smitheries and Foundries Industry

EPA Publications

- EPA (Environmental Protection Agency) 2004 *Guidance Note on Storage and Transfer of Materials for Scheduled Activities*.
- EPA (Environmental Protection Agency) 1995 *Guidance Notes for Noise in Relation to Scheduled Activities*.
- EPA (Environmental Protection Agency) *Guidance Note For Noise in Relation to Scheduled Activities - 2ND Edition (2006)*.
- EPA (Environmental Protection Agency) 1996 *Integrated Pollution Control BATNEEC*.
- *Guidance Note for the Chemical Sector*.
- EPA (Environmental Protection Agency) 2001 *Parameters for Water Quality, Interpretation and Standards*.
- EPA (Environmental Protection Agency) *Parameters for Water Quality Objectives and Standards 2001*.
- EPA (Environmental Protection Agency) 1997 *Environmental Quality Objectives and Environmental Quality Standards - the aquatic environment, a discussion document*.
- BATNEEC Guidance Note, Class 3.3, Ferrous Metal Foundries (Draft 3).
- BATNEEC Guidance Note, Class 3.4, Recovery or Processing of Non-Ferrous Metals (Draft 3).
- Integrated Pollution Prevention and Control (IPPC) *Technical Guidance for Non-ferrous Metals and the Production of Carbon and Graphite*.
- BAT Guidance Notes for the Waste Sector: *Transfer Activities (Draft November 2004)*.

Appendix 2

GLOSSARY OF TERMS AND ABBREVIATIONS

| | |
|-----------------|---|
| BAT | Best Available Techniques |
| BATNEEC | Best Available Techniques Not Entailing Excessive Cost |
| BOD | Biochemical Oxygen Demand |
| BREF | Reference Document on Best Available Techniques in the Non Ferrous Metals Industries, published by the European Commission, December 2001 |
| °C | Degree Celsius |
| CO | Carbon monoxide |
| CO ₂ | Carbon dioxide |
| COD | Chemical Oxygen Demand |
| DMEA | Dimethylethylamine |
| EIA | Environmental Impact Assessment |
| EIS | Environmental Impact Statement |
| ELV | Emission Limit Value |
| EMP | Environmental Management Programme |
| EMS | Environmental Management System |
| EPA | Environmental Protection Agency |
| EQO | Environmental Quality Objective |
| EQS | Environmental Quality Standard |
| FM | Ferrous Metals |
| FM BREF | Reference document on Best Available Techniques in the Ferrous Metals Industries, published by the European Commission, December, 2001 |
| IPC | Integrated Pollution Control; as established by the EPA Act of 1992 |
| IPPC | Integrated Pollution Prevention and Control |
| mg | Milligram |
| NFM | Non Ferrous Metals |
| Nm ³ | Normal cubic metre (101.3 kPa, 273 K) |
| NO _x | Nitrogen oxides |
| POE | Protection of the Environment Act 2003 |
| TEA | Triethylamine |
| US EPA | United States Environmental Protection Agency |
| WMA | Waste Management Act |
| VOC | Volatile Organic Compounds |