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Integrated Pollution Prevention and Control

Reference Document on Best Available Techniques in the Smitheries and Foundries Industry

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EXECUTIVE SUMMARY

The Smitheries and Foundries BREF (Best Available Techniques reference document) reflects an information exchange carried out under Article 16(2) of Council Directive 96/61/EC. This executive summary is intended to be read in conjunction with the BREF's Preface, which explains the structure of the document, its objectives, usage and legal terms. The executive summary describes the main findings, the principal BAT conclusions and the associated emission/consumption levels. It can be read and understood as a stand-alone document but, as a summary, it does not present all the complexities of the full BREF text. It is therefore not intended as a substitute for the full BREF text in BAT decision making.

Scope of this BREF

This document reflects the exchange of information on the activities covered by Annex I, categories 2.3 (b), 2.4 and 2.5 (b) of the IPPC Directive, i.e.

"2.3. Installations for the processing of ferrous metals:
(b) smitheries with hammers the energy of which exceeds 50 kilojoule per hammer, where the calorific power used exceeds 20 MW
2.4. Ferrous metal foundries with a production capacity exceeding 20 tonnes per day
2.5. Installations
(b) for the 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."

After comparing the above descriptions to the actual capacitites of existing installations in Europe, the TWG outlined a working scope, which covered the following:

- the casting of ferrous materials, e.g. lamellar cast iron, malleable and nodular iron, steel
- the casting of non-ferrous materials, e.g. aluminium, magnesium, copper, zinc, lead and their alloys.

Smitheries were excluded from this document's scope since no European smitheries were reported which met the conditions stated in Annex I 2.3.(b). This document therefore only discusses foundry processes. Cadmium, titanium and precious metals foundries, as well as bell casting and art casting foundries were also excluded on capacity grounds. Continuous casting (into sheets and slabs) has already been covered in the BREF documents related to iron and steel production and non-ferrous metal industries, and therefore, it is not dealt with in this document. In covering non-ferrous metals in this document, the process is considered to start with the melting of ingots and internal scrap or with liquid metal.

From a process point of view, the following foundry process steps are covered in this document:

- pattern making
- raw materials storage and handling
- melting and metal treatment
- mould and core production, and moulding techniques
- casting or pouring and cooling
- shake-out
- finishing
- heat treatment.

The foundry industry

Foundries melt ferrous and non-ferrous metals and alloys and reshape them into products at or near their finished shape through the pouring and solidification of the molten metal or alloy into a mould. The foundry industry is a differentiated and diverse industry. It consists of a wide range of installations, from small to very large; each with a combination of technologies and unit operations selected to suit the input, size of series and types of product produced by the specific installation. The organisation within the sector is based on the type of metal input, with the main distinction being made between ferrous and non-ferrous foundries. Since castings in general are semi-finished products, foundries are located close to their customers.

The European foundry industry is the third largest in the world for ferrous castings and second largest for non-ferrous. The annual production of castings in the enlarged European Union amounts to 11.7 million tonnes of ferrous and 2.8 million tonnes of non-ferrous castings. Germany, France and Italy are the top three production countries in Europe, with a total annual production of over two million tonnes of castings each. In recent years, Spain has taken over the fourth position from Great Britain, with both having a production of over one million tonnes of castings. Together, the top five countries produce more than 80 % of the total European production. Although the production volume has remained relatively stable over the past few years, there has been a decline in the total number of foundries (now totalling around 3000 units), which is also reflected in the employment numbers (now totalling around 260000 people). This can be explained by progressive upscaling and automation in the foundry units. However, the foundry industry is predominantly still an SME industry, with 80 % of companies employing less than 250 people.

The main markets served by the foundry industry are the automotive (50 % of market share), general engineering (30 %) and construction (10 %) sectors. A growing shift of the automotive industry towards lighter vehicles has been reflected in a growth in the market for aluminium and magnesium castings. While iron castings mostly (i.e. >60 %) go to the automotive sector, steel castings find their market in the construction, machinery and valve making industries.

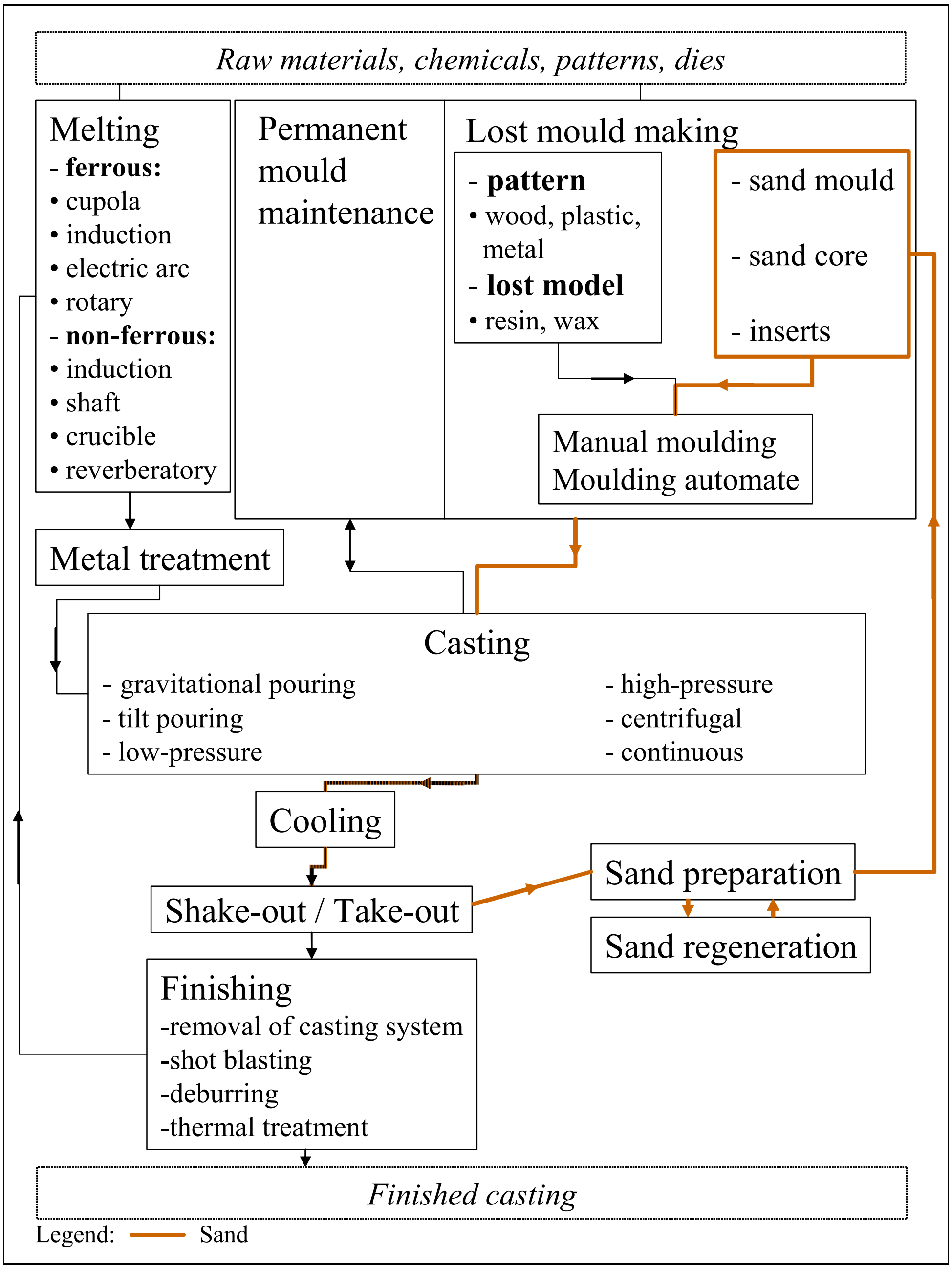
The foundry process

A general flow chart of the foundry process is depicted in the figure below. The process can be divided into the following major activities:

- melting and metal treatment: the melting shop
- preparation of moulds and cores: the moulding shop
- casting of the molten metal into the mould, cooling for solidification and removing the casting from the mould: the casting shop
- finishing of the raw casting: the finishing shop.

Various process options can be taken, depending on the type of metal, size of series and type of product. Generally, the main division within the sector is based on the type of metal (ferrous or non-ferrous) and the type of moulding used (lost moulds or permanent moulds). While any combination is possible, typically ferrous foundries largely use lost moulds (i.e. sand moulding) and non-ferrous foundries mainly use permanent moulds (i.e. die-casting). Within each of these basic process options a variety of techniques exist according to the type of furnace used, the moulding and core-making system (green sand or various chemical binders) applied, and the casting system and finishing techniques applied. Each of those have their own technical, economic and environmental properties, advantages and disadvantages.

Chapters 2, 3 and 4 of this document follow a process-flow approach to describe the various operations, from pattern making to finishing and heat treatment. Applied techniques are described, emission and consumption levels given and techniques to minimise the environmental impact are discussed. The structure of Chapter 5 is based on a distinction between the type of metal and the type of moulding.



The foundry process

Key environmental issues

The foundry industry is a major player in the recycling of metals. Steel, cast iron and aluminium scrap is remelted into new products. Most possible negative environmental effects of foundries are related to the presence of a thermal process and the use of mineral additives. Environmental effects therefore are mainly related to the exhaust and off-gases and to the re-use or disposal of mineral residues.

Emissions to air are the key environmental concern. The foundry process generates (metal-laden) mineral dusts, acidifying compounds, products of incomplete combustion and volatile organic carbons. Dust is a major issue, since it is generated in all process steps, in varying types and compositions. Dust is emitted from metal melting, sand moulding, casting and finishing. Any dust generated may contain metal and metal oxides.

The use of cokes as fuels, or the heating of crucibles and furnaces with gas or oil-fired burners can cause emissions of combustion products, such as NO_x and SO_2. Additionally, the use of cokes and the presence of impurities (e.g. oil, paint, …) in scrap can cause the production of some products of incomplete combustion or recombination (such as PCDD/F) and dust.

In the making of moulds and cores, various additives are used to bind the sand. In binding the sand and pouring the metal, reaction and decomposition products are generated. These include inorganic and organic (e.g. amines, VOCs) compounds. The generation of decomposition products (mainly VOCs) further continues during the casting cooling and de-moulding operations. These products can also cause an odour nuisance.

In the foundry process, emissions to air will typically not be limited to one (or several) fixed point(s). The process involves various emission sources (e.g. from hot castings, sand, hot metal). A key issue in emission reduction is not only to treat the exhaust and off-gas flow, but also to capture it.

Sand moulding involves the use of large sand volumes, with sand-to-liquid-metal weight ratios generally ranging from 1:1 up to 20:1. The used sand can be regenerated, re-used or disposed of. Additional mineral residues such as slag and dross are generated in the melting stage when removing impurities from the melt. These can be either re-used or disposed of.

Since foundries deal with a thermal process, energy efficiency and management of the generated heat are important environmental aspects. However, due to the high amount of transport and handling of the heat carrier (i.e. the metal) and its slow cooling, the recovery of heat is not always straightforward.

Foundries may have a high water consumption e.g. for cooling and quenching operations. In most foundries, water management involves an internal circulation of water, with a major part of the water evaporating. The water is generally used in the cooling systems of electric furnaces (induction or arc) or cupola furnaces. In general, the final volume of waste water is very small. Nevertheless, when wet dedusting techniques are used, the generated waste water requires special attention. In (high) pressure die-casting, a waste water stream is formed, which needs treatment to remove organic (phenol, oil) compounds before its disposal.

Consumption and emission levels

A general overview of the inputs and outputs of the foundry process is given in the figure below. The ‘Casting’ step mentioned in the centre of the picture covers also all necessary moulding operations. The major input streams are metal, energy, binders and water. The key emissions are dust, amines and VOCs, and for specific furnace types also SO_2, dioxins and NO_x.

The melting stage uses 40 – 60 % of the energy input. For a certain metal type, the energy use is dependent on the type of furnace used. The melting energy input ranges from 500 to 1200 kWh/t metal charge for ferrous metals and from 400 to 1200 kWh/t metal charge for aluminium.

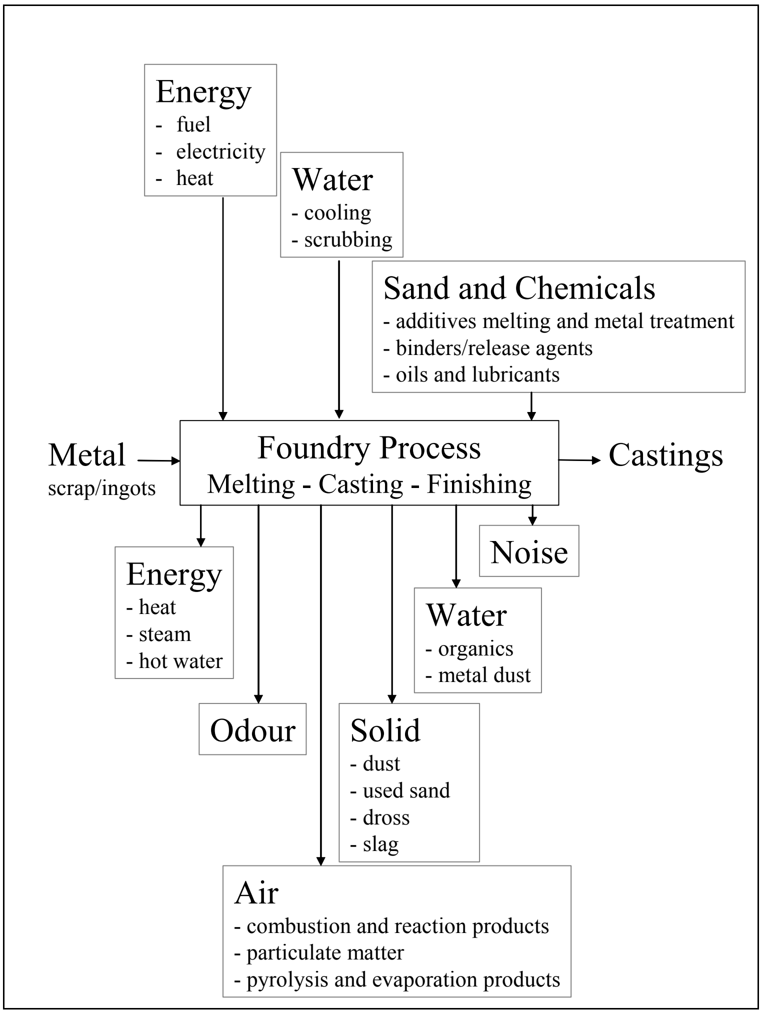
The amounts and types of binders, chemicals and sand used are very dependent on the type of casting made, especially regarding its size and shape, as well as whether serial or batch wise production is used.

Water consumption is largely dependent on the type of furnace used, the type of flue-gas cleaning applied and the casting method applied.

Dust is generated in each of the process steps, albeit with different levels of mineral oxides, metals and metal oxides. Dust levels for metal melting range from below detection limit, for certain non-ferrous metals, to above 10 kg/tonne, for the cupola melting of cast iron. The high amount of sand used in lost mould casting results in dust emissions during the various moulding stages.

Amines are used as a catalyst in the most commonly used core-making system. This results in guided emissions from the core-shooting machines and diffuse emissions from core-handling.

Volatile organic compounds emissions (mainly solvents, BTEX and to a lesser extent phenol, formaldehyde, etc.) result from the use of e.g. resins, organic solvents, or organic-based coatings in moulding and core-making. Organic compounds are thermally decomposed during metal pouring and are emitted further during shake-out and cooling. Emission levels between 0.1 – 1.5 kg/tonne of casting are presented in this document.



Mass stream overview of the foundry process

Techniques to consider in the determination of BAT

The minimisation of emissions, efficient raw material and energy usage, optimum process chemical utilisation, the recovering and recycling of waste and the substitution of harmful substances are all important principles of the IPPC Directive. For foundries the focal points are air emissions, the efficient use of raw materials and energy, and waste reduction, in conjunction with any recycling and re-use options.

The environmental issues as mentioned above are addressed by using a variety of process-integrated and end-of-pipe techniques. Over 100 techniques for pollution prevention and control are presented in this document, ordered under the following 12 thematic headings, which are largely based on the process flow:

1. *Raw material storage and handling*: Materials storage and handling techniques aim at the prevention of soil and water pollution and optimisation of the internal recycling of scrap metal.
2. *Metal melting and molten metal treatment*: For each furnace type, different techniques may be considered for optimisation of the furnace efficiency and minimisation of any residue production. These mainly involve in-process measures. Environmental considerations can also be taken into account in the selection of the furnace type. Special attention is paid to cleaning of the aluminium melt and the melting of magnesium, due to the high pollution potential of the products used until recently (HCE and SF_6).
3. *Mould- and core-making, including sand preparation*: Best practice measures and techniques for minimising the consumption may be applied for each type of binder system and for die-casting release agents. For the reduction of VOCs and odour emissions from lost mould systems, water-based coatings and inorganic solvents may be considered. While water-based coatings are commonly used, the applicability of inorganic solvents in core-making is still limited. Another approach is the use of different moulding methods. However, those techniques are used only in specific fields of application.
4. *Metal casting*: In order to improve the efficiency of the casting process, measures aimed at increasing the metal yield (i.e. the mass ratio of molten metal over finished casting) may be considered.
5. *Fume, flue-gas and exhaust air capture and treatment*: Dealing with the emissions to air in all the different foundry stages requires an adequate capture and treatment system to be in place. According to the unit operation, various techniques may be considered, depending on the type of compounds emitted, the off-gas volume and the ease of capture. Techniques applied for off-gas capture play an important role in the reduction of fugitive emissions. Additionally, for fugitive emissions, good practice measures may be considered.
6. *Waste water prevention and treatment*: In many cases, waste water can be prevented or minimised by taking in-process measures. Waste water that cannot be prevented, will contain mineral or metal dust, amines, suphates, oil or lubricants, depending on its source within the process. The applicable treatment techniques differ for each of these compounds.
7. *Energy efficiency:* Metal melting consumes 40 – 60 % of the energy input of a foundry. Energy efficiency measures should therefore take both the melting and the other processes (e.g. air compression, plant actuation, hydraulics) into account. The need for furnace and off-gas cooling generates a hot water or hot air stream, which may allow an internal or external utilisation of the heat.
8. *Sand: regeneration, recycling, re-use and disposal:* Since foundries make intensive use of sand as an inert primary material, the regeneration or re-use of this sand is an important point of consideration as part of its environmental performance. Various techniques are applied for regeneration of the sand (i.e. treatment and internal re-use as moulding sand), the selection of which depends on the binder type and the sand flow compostion. If sand is not regenerated, then external re-use may be considered in order to prevent the need for its disposal. Its application in various areas has been demonstrated.
9. *Dust and solid residues: treatment and re-use:* In-process techniques and operational measures may be considered for the minimisation of dust and residues. The collected dusts, slags and other solid residues may find an internal or external re-use.
10. *Noise reduction:* Various foundry activities are point sources of noise. For foundries near housing, this may cause a nuisance to the neighbours. The setting up and implementation of a noise reduction plan, covering both general and source-specific measures, may therefore be considered.
11. *Decommissioning*: The IPPC Directive requests attention be paid to consideration of the possible pollution upon decommissioning of the plant. Foundries present a specific risk for soil pollution at this stage. There are a number of general measures, which apply more widely than just to foundries, which may be considered to prevent pollution at the decommissioning stage.
12. *Environmental management tools*: Environmental management systems are a useful tool to aid the prevention of pollution from industrial activities in general. Their presentation is therefore a standard part of each BREF document.

BAT for foundries

The BAT chapter (Chapter 5) identifies those techniques that the TWG considered to be BAT in a general sense for the foundry industry, based upon the information in Chapter 4 and taking account of the Article 2(11) definition of "best available techniques" and the considerations listed in Annex IV to the Directive. The BAT chapter does not set or propose emission limit values but suggests emission levels that are associated with the use of BAT.

During the information exchange by the TWG, many issues were raised and discussed. A selection of these are highlighted in this summary.The following paragraphs summarise the key BAT conclusions relating to the most relevant environmental issues.

The BAT elements will need to be adapted to the foundry type. A foundry basically consists of a melting shop and a casting shop, both with their own supply chain. For lost mould casting this supply chain includes all activities related to moulding and core-making. In the BAT chapter, a distinction is made between the melting of either ferrous or non-ferrous metal, and for casting in either lost or permanent moulds. Each foundry may be classified as a combination of a particular melting with an associated moulding class. BAT is presented for each class. Generic BAT, which are common to all foundries, are also presented.

<u>Generic BAT</u>
Some BAT elements are generic and apply for all foundries, regardless of the processes they utilise and the type of products they produce. These concern material flows, finishing of castings, noise, waste water, environmental management and decommissioning.

BAT is to optimise the management and control of internal flows, in order to prevent pollution, prevent deterioration, provide adequate input quality, allow recycling and re-use and to improve the process efficiency. The BREF refers to storage and handling techniques covered in the Storage BREF, but also adds some foundry specific BAT related to storage and handling, such as the storage of scrap on an impermeable surface with a drainage and collection system (although applying a roof can reduce the need for such a system), the separate storage of incoming materials and residues, the use of recyclable containers, optimisation of the metal yield, and good practice measures for molten metal transfer and ladle handling.

BAT are given for finishing techniques that generate dust and for heat treatment techniques. For abrasive cutting, shot blasting and fettling, BAT is to collect and treat the finishing off-gas using a wet or dry system. For heat treatment, BAT is to use clean fuels (i.e. natural gas or low-level sulphur content fuel), automated furnace operation and burner/heater control and also to capture and evacuate the exhaust gas from heat treatment furnaces.

Concerning noise reduction, BAT is to develop and implement a noise reduction strategy, with general and source-specific measures, being applicable, such as using enclosure systems for high-noise unit operations such as shake-out and using additional measures depending on and according to local conditions.

BAT for waste water management includes prevention, separation of the waste water types, maximising internal recycling and applying an adequate treatment for each final flow. This includes techniques utilising e.g. oil interceptors, filtration or sedimentation.

Fugitive emissions arise from uncontained sources (transfers, storage, spills) and the incomplete evacuation of contained sources. BAT is to apply a combination of measures concerning material handling and transport and to optimise exhaust gas capture and cleaning through one or more capture techniques. Preference is given to collection of the fume nearest to the source.

BAT is to implement and adhere to an Environmental Management System (EMS) that incorporates, as appropriate to individual circumstances, features concerning e.g. the commitment of top management, planning, establishing and implementing procedures, performance checking with corrective actions and reviews.

BAT is to apply all necessary measures to prevent pollution upon decommissioning. These include minimisation of the risks during the design stage, implementation of an improvement programme for existing installations and development and utilisation of a site closure plan for new and existing installations. In these measures, at least the following process parts are considered: tanks, vessels, pipework, insulation, lagoons and landfills.

Ferrous metal melting

For the operation of cupola furnaces, BAT includes techniques which can give increased efficiency, such as divided blast operation, oxygen enrichment, continuous blowing or long campaign operation, good melting practice measures, and control of the coke quality. BAT is to collect, cool and dedust the off-gas, and to apply post combustion and heat recovery under specific conditions. Several dedusting systems are BAT but wet dedusting is preferable when melting with basic slag and in some cases as one of the measures to prevent and minimise dioxin and furan emissions. Industry has expressed doubts on the implementation of secondary measures for dioxin and furan abatement that have only been proven in other sectors and in particular questions their applicability for smaller foundries. For cupolas, BAT for residue management includes minimising slag forming, pretreating the slags in order to allow their external re-use and collecting and recycling coke breeze.

For the operation of electric arc furnaces, BAT includes applying reliable and efficient process controls to shorten the melting and treatment time, using the foamy slag practice, efficiently capturing the furnace off-gas, cooling the furnace off-gas and dedusting using a bag filter. BAT is to recycle the filter dust into the EAF furnace.

For the operation of induction furnaces, BAT is to melt clean scrap; use good practice measures for the charging and operation; use medium frequency power and, when installing a new furnace, to change any mains frequency furnace to medium frequency; to evaluate the possibility of waste heat recuperation and under specific conditions to implement a heat recovery system. For exhaust capture and treatment from induction furnaces, BAT is to use a hood, lip extraction or cover extraction on each induction furnace to capture the furnace off-gas and maximise the off-gas collection during the full working cycle; to use dry flue-gas cleaning; and to keep dust emissions below 0.2 kg/tonne molten iron.

For the operation of rotary furnaces, BAT is to implement a combination of measures to optimise furnace yield and to use an oxyburner. BAT is to collect the off-gas close to the furnace exit, apply post combustion, cool it using a heat-exchanger and then to apply dry dedusting. For the prevention and minimisation of dioxin and furan emissions, BAT is to use a combination of specified measures. Similarly to the situation with cupola furnaces, industry has expressed doubts on the implementation of secondary measures for dioxin and for an abatement that have only been proven in other sectors and in particular questions their applicability for smaller foundries.

The actual metal treatment applied depends on the type of product made. BAT is to collect the exhaust gas from AOD converters using a roof canopy and to collect and treat the off-gas from nodularisation, using a bag filter. BAT is also to make the MgO-dust available for recycling.

Non-ferrous metal melting

For the operation of induction furnaces for melting aluminium, copper, lead and zinc, BAT is to use good practice measures for the charging and operation; to use medium frequency power and, when installing a new furnace, change any mains frequency furnace to medium frequency; to evaluate the possibility of waste heat recuperation and under specific conditions to implement a heat recovery system. For exhaust capture from these furnaces, BAT is to minimise emissions and if needed to collect the off-gas, maximising the off-gas collection during the full working cycle and applying dry flue-gas cleaning.

For the other furnace types, BAT mainly focuses on the efficient collection of furnace off-gas and/or the reduction of fugitive emissions.

For non-ferrous metal treatment, BAT is to use an impeller station for the degassing and cleaning of aluminium. BAT is to use SO_2 as a covering gas for magnesium melting in installations with an annual output of 500 tonnes and more. For small plants (<500 tonnes Mg parts output/year) BAT is to use SO_2 or to minimise the use of SF_6. In the case where SF_6 is used, the BAT associated consumption level is <0.9 kg/tonne casting for sand casting and <1.5 kg/tonne casting for pressure die-casting.

Lost mould casting

Lost mould casting involves moulding, core-making, pouring, cooling and shake-out. This includes the production of green sand or chemically-bonded sand moulds and chemically-bonded sand cores. BAT elements are presented in three categories: green sand moulding, chemical sand moulding and pouring/cooling/shake-out.

For green sand preparation, BAT items deal with exhaust capture and cleaning and the internal or external recycling of the captured dust. In line with the goal of minimising waste for disposal, BAT is to apply a primary regeneration of green sand. Regeneration ratios of 98 % (monosand) or 90 – 94 % (green sand with incompatible cores) are associated with the use of BAT.

For chemically-bonded sand, the proposed BAT cover a variety of techniques, and deal with a broad range of environmental issues. BAT is to minimise the binder and resin consumption and sand losses, to minimise fugitive VOC emissions by capturing the exhaust gas from core-making and core handling, and to use water-based coatings. The use of alcohol-based coatings is BAT in a limited number of applications, where water-based coatings cannot be applied. In this case, the exhaust should be captured at the coating stand, whenever this is feasible. A specific BAT is given for amine-hardened urethane-bonded (i.e. cold-box) core preparation, to minimise amine emissions and optimise amine recovery. For these systems both aromatic and non-aromatic solvents are BAT. BAT is to minimise the amount of sand going to disposal, primarily by adopting a strategy of regeneration and/or re-use of chemically-bonded sand (as mixed or monosand). In the case of regeneration, the BAT conditions are given in the table below. Regenerated sand is re-used only in compatible sand systems.

Sand type	**Technique**	**Regeneration ratio[1] (%)**
Cold setting monosand	Simple mechanical regeneration	75 – 80
Silicate monosand	Heating and pneumatic treatment	45 – 85
Monosands of cold-box, SO_2, hot-box, croning Mixed organic sands	Cold mechanical or thermal regeneration	in cores: 40 – 100 in moulds: 90 – 100
Mixed green and organic sand	Mechanical-thermal-mechanical treatment, grinding or pneumatic chafing	in cores: 40 – 100 in moulds: 90 – 100
(1) mass of regenerated sand/total mass of sand used		

BAT for chemically-bonded sand regeneration (mixed and monosand)

Alternative moulding methods and inorganic binders are considered to have a promising potential for minimisation of the environmental impacts of moulding and casting processes.

Pouring, cooling and shake-out generate emissions of dust, VOCs and other organic products. BAT is to enclose pouring and cooling lines and provide exhaust extraction, for serial pouring lines, and to enclose the shake-out equipment, and treat the exhaust gas using wet or dry dedusting.

Permanent mould casting

Due to the different nature of the process, the environmental issues for permanent mould casting require a different focus than those for lost mould techniques, with water as a more prominent item. Emissions to air are in the form of an oil mist, rather than the dust and combustion products encountered in the other processes. BAT therefore focusses on prevention measures involving minimisation of the water and release agent consumption. BAT is to collect and treat run-off water and leakage water, using oil interceptors and distillation, vacuum evaporation or biological degradation. If oil mist prevention measures do not allow a foundry to reach the BAT associated emission level, BAT is to use hooding and electrostatic precipitation for the exhaust of HPDC machines.

BAT for chemically-bonded sand preparation is analogous to the elements mentioned for lost mould casting. BAT for used sand management is to enclose the de-coring unit and to treat the exhaust gas using wet or dry dedusting. If a local market exists, BAT is to make the sand from de-coring available for recycling.

BAT associated emission levels

The following emission levels are associated to the BAT measures stated above.

Activity	Type	Parameter	Emission level (mg/Nm³)
Finishing of castings		Dust	5 – 20
Ferrous metal melting	General	Dust (1) PCDD/PCDF	5 – 20 ≤ 0.1 ng TEQ/Nm³
	Hot Blast Cupola	CO SO_2 NO_x	20 – 1000 20 – 100 10 – 200
	Cold Blast Cupola	SO_2 NO_x NM - VOC	100 – 400 20 – 70 10 – 20
	Cokeless Cupola	NO_x	160 – 400
	Electric Arc Furnace	NO_x CO	10 – 50 200
	Rotary Furnace	SO_2 NO_x CO	70 – 130 50 – 250 20 – 30
Non-ferrous metal melting	General	Dust	1 – 20
	Aluminium melting	Chlorine	3
	Shaft furnace for Al	SO_2 NO_x CO VOC	30 – 50 120 150 100 – 150
	Hearth type furnace for Al	SO_2 NO_x CO TOC	15 50 5 5
Moulding and casting using lost moulds	General	Dust	5 – 20
	Core shop	Amine	5
	Regeneration units	SO_2 NO_x	120 150
Permanent mould casting	General	Dust Oil mist, measured as total C	5 - 20 5 - 10
(1) the emission level of dust depends on the dust components, such as heavy metals, dioxins, and its mass flow.			

Emissions to air associated with the use of BAT for the various foundry activities

All associated emission levels are quoted as an average over the practicable measuring period. Whenever continuous monitoring is practicable, a daily average value is used. Emissions to air are based on standard conditions**,** i.e. 273 K, 101.3 kPa and dry gas.

While the BAT reference documents do not set legally binding standards, they are meant to give information for the guidance of industry, Member States and the public on achievable emission and consumption levels when using specified techniques. The appropriate limit values for any specific case will need to be determined taking into account the objectives of the IPPC Directive and the local considerations.

Emerging techniques

Some new techniques for minimisation of the environmental impacts are currently still in the research and development phase or are only just beginning to enter the market these are considered to be emerging techniques. Five of these techniques are discussed in Chapter 6, namely: the use of low combustible materials in cupola melting, the recycling of metal-bearing filter dust, amine recovery by waste-gas permeation, the separate spraying of release agent and water in aluminium die-casting, and inorganic binder material for core-making. The latter technique was especially pointed out by the TWG as promising, although the current limited scale of testing and implementation does not allow it to be yet incorporated as a technique to consider in the selection of BAT.

Concluding remarks on the exchange of information

Information exchange
The BREF document is based on more than 250 sources of information. Foundry research institutes provided an important share of this information and played an active role in the information exchange. Local BAT notes from various Member States gave the information exchange a firm basis. The majority of the documents provided in the information exchange dealt with processes and techniques as applied in ferrous foundries. Throughout the writing of the BREF the non-ferrous foundry processes have been underrepresented. This is reflected in a lower level of detail in the BAT conclusions for non-ferrous foundries.

Level of consensus
A good general level of consensus was reached on the conclusions and no split views were recorded. The industry representation added a comment, expressing their doubt on the ease of implementation of secondary measures for dioxin abatement.

Recommendations for future work
The information exchange and the result of this exchange, i.e. this document, present an important step forward in achieving the integrated prevention and control of pollution from the foundry industry. Future work could continue this purpose by focusing on the collection and assessment of information that was not provided during this information exchange. In particular, in future work should cover in more detail the following topics:

- *Techniques for VOC abatement*: There is a need for data and information on methods applied for the efficient capture and treatment of VOC-laden exhaust gases from foundries. The use of alternative binder and coating materials may prove to be an important prevention measure in this respect
- *Waste water treatment*: There is a need for data from a broad range of water treatment systems in foundries, this should also show emission levels in relation to the inputs and treatment techniques applied

- *Melting of non-ferrous metals*: Emission data for non-ferrous foundries are presented in this document only for some specific installations. There is a need for more complete information on both guided and fugitive emissions from non-ferrous metal melting in foundries. This should be based on operational practice and expressed both as emission levels and mass flows..
- *Economic data for BAT techniques*: There is a lack of economic information for many of the techniques presented in Chapter 4. This information needs to be collected from projects dealing with the implementation of the presented techniques.

Suggested topics for R&D projects

The information exchange has also exposed some areas where additional useful knowledge could be gained from research and development projects. These relate to the following subjects:

- *Dioxin monitoring and abatement:* There is a need for a better understanding of the influence of process parameters on the formation of dioxins. This requires the monitoring of dioxin emissions for various installations and under varying conditions. Additionally, there is a need for research on the use and effectiveness of secondary measures for dioxin abatement in the foundry industry
- *Mercury emissions:* The high volatility of mercury may cause gaseous emissions, which are not related to dust. In view of the implementation of a European policy on mercury emissions, there is a need for research into the emissions of mercury from melting processes in general and from (non-ferrous) foundries in particular
- *Oxygas burners and their use in cupola furnaces:* The TWG reported that new applications have been set-up as a result of ongoing research. There is scope for further research and development here, to bring this technique up to a development level that allows its further dissemination.
- *Alternative replacement gases for SF_6 in magnesium melting*: Alternative cover gases to replace SF_6 such as HFC-134a and Novec612 have been developed and successfully tested but have not found industrial implementation. These gases may present an alternative for the substitution by SO_2. There is a need for research and demonstration projects that provide knowledge on the protective properties, decomposition behaviour and emission pattern of these compounds. This should allow a clearer indication of the applicability and may support industrial implementation.

The EC is launching and supporting, through its RTD programmes, a series of projects dealing with clean technologies, emerging effluent treatment and recycling technologies and management strategies. Potentially these projects could provide a useful contribution to future BREF reviews. Readers are therefore invited to inform the EIPPCB of any research results which are relevant to the scope of this document (see also the preface of this document).