EUROPEAN COMMISSION
DIRECTORATE-GENERAL JRC
JOINT RESEARCH CENTRE
Institute for Prospective Technological Studies (Seville)
Technologies for Sustainable Development
European IPPC Bureau

Integrated Pollution Prevention and Control (IPPC)

Best Available Techniques Reference Document on the Production of Iron and Steel

March 2000

Executive Summary

World Trade Center, Isla de la Cartuja s/n, E-41092 Seville - Spain
Telephone: direct line (+34-95)4488-284. Fax: 4488-426.
e.mail eippcb@jrc.es
Internet: http://eippcb.jrc.es

Executive summary

This Reference Document on best available techniques in the Iron and Steel Industry reflects an information exchange carried out according to Article 16(2) of Council Directive 96/61/EC. The document has to be seen in the light of the preface, which describes the objectives of the document and its use.

Scope
It covers the environmental aspects of iron and steel making in integrated steelworks (sinter plants, pelletisation plants, coke oven plants, blast furnaces and basic oxygen furnaces including continuous or ingot casting) and electric arc furnace steelmaking. Ferrous metal processing downstream to casting is not covered in this document.

Submitted information
The most important environmental issues of iron and steelmaking relate to emissions to air and to solid wastes/by-products. Wastewater emissions from coke oven plants, blast furnaces and basic oxygen furnaces are the most relevant emissions to water in this sector.

It is no surprise, therefore, that there is good information available on these aspects but only limited information is available about noise/vibration emissions and related measures to minimise them. The same is for soil pollution, health & safety and also for natural aspects. Inaddition, little information is available on the sampling methods, analysis methods, time intervals, computation methods and reference conditions used as a basis for the data submitted.

Structure of the document
The overall structure of this BREF is characterised by three main parts:

- General information on the sector
- Information on integrated iron and steelworks
- Information on electric arc furnace steelmaking

The general information includes statistical data about iron and steel production in the EU, the geographical distribution, economic and employment aspects together with rough assessment of the environmental significance of the sector. Because of the complexity of integrated steelworks an overview is given (chapter 3) before providing a full information set for the main production steps which are:

- sinter plants (chapter 4)
- pelletisation plants (chapter 5)
- coke oven plants (chapter 6)
- blast furnaces (chapter 7)
- basic oxygen steelmaking incl. casting (chapter 8)

A full information set means all the information for these production steps according to the General Outline for IPPC BAT Reference Documents. Such a “plant wise” compilation of information is made to assist the use of the document in practice.

Electric arc furnace steelmaking differs totally from integrated steelworks and is therefore presented in a separate chapter (chapter 9).

Finally, to complete the picture, information is submitted on new/alternative ironmaking techniques (chapter 10)

Chapter 11 contains the conclusions and recommendations.

General information
Iron and steel are important products that are widely used. The production of crude steel in the European Union stood at 155.3 million tonnes in 1999, equivalent to about 20% of world production.
In the EU about two thirds of crude steel are produced via the blast furnace route at 40 sites and one third is produced in 246 electric arc furnaces.
In 1995, around 330,000 people were employed in the iron and steel industry, with large numbers working in dependent industries such as construction, car manufacturing, mechanical engineering etc.

Production of iron and steel
The iron and steel industry is a highly material and energy intensive industry. More than half of the mass input becomes outputs in the form of off-gases and solid wastes/by-products. The most relevant emissions are those to air. Those from sinter plants dominate the overall emissions for most of the pollutants. Although big efforts have been made to reduce emissions, the contribution of the sector to the total emissions to air in the EU is considerable for a number of pollutants, especially for some heavy metals and PCDD/F. The rate of reuse and recycling of solid wastes/by-products has been increased dramatically in the past but considerable amounts are still disposed to landfills.

The information on the main production plants in integrated steelworks (see above) and for electric arc furnace steelmaking, begins with a concise description of applied processes and techniques in order to achieve a proper understanding of both the environmental problems and the further information.

The emission and consumption data characterise in detail the input and output mass streams structured according to the media of air, water and soil and also to energy and noise aspects (for sinter plants: table 4.1; for pelletisations plants: table 5.1; for coke oven plants: tables 6.2 and 6.3; for blast furnaces: table 7.1; for basic oxygen steelmaking and casting: table 8.2). All these data derive from existing installations and are very necessary for the evaluation of the described techniques to consider in the determination of BAT. The description of these techniques follows a certain structure (description of the technique, main achieved levels, applicability, cross-media effects, reference plants, operational data, driving force, economics, reference literature) and ends up in conclusions as to what is considered as BAT. These conclusions are based upon expert judgement in the TWG.

BAT for sinter plants (chapter 4)

Sinter, as a product of an agglomeration process of iron-containing materials, represents a major part of the burden of blast furnaces. The most relevant environmental issues are the off-gas emissions from the sinter strand, which contains a wide range of pollutants such as dust, heavy metals, SO_2, HCl, HF, PAHs and organochlorine compounds (such as PCB and PCDD/F). Thus most of the described techniques to consider in the determination of BAT refer to the reduction of emissions to air. The same applies to the conclusions; therefore the most important parameters are dust and PCDD/F.
For sinter plants, the following techniques or combination of techniques are considered as BAT.

1. Waste gas de-dusting by application of:
   - Advanced electrostatic precipitation (ESP) (moving electrode ESP, ESP pulse system, high voltage operation of ESP …) *or*
   - electrostatic precipitation plus fabric filter *or*
   - pre-dedusting (e.g. ESP or cyclones) plus high pressure wet scrubbing system.

   Using these techniques dust emission concentrations < 50 mg/Nm^3 are achieved in normal operation. In case of application of a fabric filter, emissions of 10-20 mg/Nm^3 are achieved.

2. Waste gas recirculation, if sinter quality and productivity are not significantly affected, by applying:
   - recirculation of part of the waste gas from the entire surface of the sinter strand, *or*
   - sectional waste gas recirculation
3. Minimising of PCDD/F emissions, by means of:
   - Application of waste gas recirculation;
   - Treatment of waste gas from sinter strand;
     - use of fine wet scrubbing systems, values < 0.4 ng I-TEQ/Nm^3 have been achieved.
     - Fabric filtration with addition of lignite coke powder also achieves low PCDD/F emissions (> 98 % reduction, 0.1 – 0.5 ng I-TEQ/Nm^3. – this range is based on a 6 hours random sample and steady state conditions).
4. Minimisation of heavy metal emissions
   - Use of fine wet scrubbing systems in order to remove water-soluble heavy metal chlorides, especially lead chloride(s) with an efficiency of > 90% or a bag filter with lime addition;
   - Exclusion of dust from last ESP field from recycling to the sinter strand, dumping it on a secure landfill (watertight sealing, collection and treatment of leachate), possibly after water extraction with subsequent precipitation of heavy metals in order to minimise the quantity to dump.
5. Minimisation of solid waste
   - Recycling of by-products containing iron and carbon from the integrated works, taking into account the oil content of the single by-products (< 0.1 %).
   - For solid wastes generation, the following techniques are considered BAT in descending order of priority:
   - Minimising waste generation
   - Selective recycling back to the sinter process
   - Whenever internal reuse is hampered, external reuse should be aimed at
   - If all reuse is hampered, controlled disposal in combination with the minimisation principle is the only option.
6. Lowering the hydrocarbon content of the sinter feed and avoidance of anthracite as a fuel.

   Oil contents of the recycled by-products/residues < 0.1% are achievable.
7. Recovery of sensible heat:

   Sensible heat can be recovered from the sinter cooler waste gas and is feasible in some cases to recover it from the sinter grate waste gas. The application of waste gas recirculation can also be considered a form of sensible heat recovery.
8. Minimisation of SO_2 emissions by, for example:
   - Lowering the sulphur input (use of coke breeze with low sulphur content and minimisation of coke breeze consumption, use of iron ore with low sulphur content); with these measures emission concentrations < 500 mg SO_2/Nm^3 can be achieved.
   - With wet waste gas desulphurisation, reduction of SO_2 emissions > 98% and SO_2 emission concentrations < 100 mg SO_2/Nm^3 are achievable.

     Due to the high cost wet waste gas desulphurisation should only be required in circumstances where environmental quality standards are not likely to be met.
9. Minimisation of NO_x emissions by, for example:
   - waste gas recirculation
   - waste gas denitrification, applying
   - regenerative activated carbon process
   - selective catalytic reduction

     Due to the high cost waste gas denitrification is not applied except in circumstances where environmental quality standards are not likely to be met.

10. Emissions to water (not cooling water)
    These are only relevant when rinsing water is used or when wet waste gas treatment system is employed. In these cases, the effluent water to the receiving environment should be treated by heavy metal precipitation, neutralisation and sand filtration. TOC concentrations < 20 mg C/l and heavy metal concentrations < 0.1 mg/l (Cd, Cr, Cu, Hg, Ni, Pb, Zn) are achieved.
    When the receiving water is fresh, attention has to be paid to salt content.
    Cooling water can be recycled.

In principle the techniques mentioned in points 1 - 10 are applicable to both new and existing installations considering the preface

BAT for pelletisation plants (chapter 5)

Pelletisation is another process to agglomerate iron-containing materials. While sinter is practically always produced at the steelworks site for various reasons, pellets are mainly produced at the site of the mine or its shipping port. Therefore in the EU there is only one pelletisation plant as part of an integrated steelworks and four stand-alone plants. Also for these plants, emissions to air dominate the environmental issues. As a consequence, most of the described techniques to consider in the determination of BAT refer to emissions to air and the conclusions as well.
For pelletisation plants, the following techniques or combination of techniques are considered as BAT.

1. Efficient removal of particulate matter, SO_2, HCl and HF from the induration strand waste gas, by means of:
   - Scrubbing *or*
   - Semi-dry desulphurisation and subsequent de-dusting (e.g. gas suspension absorber (GSA)) *or a*ny other device with the same efficiency.

   Achievable removal efficiency for these compounds are:
   - Particulate matter: >95%; corresponding to achievable concentration of < 10 mg dust/Nm^3
   - SO_2: >80%; corresponding to achievable concentration of < 20 mg SO_2/Nm^3
   - HF: >95%; corresponding to achievable concentration of < 1 mg HF/Nm^3
   - HCl: >95%; corresponding to achievable concentration of < 1 mg HCl/Nm^3
2. Emissions to water from scrubbers are minimised by means of water cycle closure, heavy metal precipitation, neutralisation and sand filtration.
3. Process-integrated NO_x abatement;
   Plant design should be optimised for recovery of sensible heat and low-NO_x emissions from all firing sections (induration strand, where applicable and drying at the grinding mills).
   In one plant, of the grate-kiln type and using manetite ore emissions < 150 g NO_x/t pellets are achieved. In other plants (existing or new, of the same or other type, using the same or other raw materials), solutions have to be tailor-made and the possible NO_x emission level might vary from site to site.
4. Minimisation of end-of-pipe NO_x emissions by means of end-of-pipe techniques:
   Selective Catalytic Reduction or any other technique with a NO_x reduction efficiency of at least 80%.
   Due to high cost waste gas denitrification should only be considered in circumstances where environmental quality standards are otherwise not likely to be met; to date there are no de-NOx systems in operation at any commercial pelletisation plant.

5. Minimising solid waste/by-products
   The following techniques are considered BAT in descending order of priority:
   - Minimising waste generation
   - Effective utilisation (recycling or reuse) of solid wastes/by-products
   - Controlled disposal of unavoidable wastes/by-products.
6. Recovery of sensible heat;
   Most pelletisation plants already have a high rate of energy recovery. For further improvements, tailor-made solutions are usually necessary.

In principle the techniques listed in points 1 - 6 are applicable to both new and to existing installations considering the preface.

BAT for coke oven plants (chapter 6)

Coke is needed as the primary reducing agent in blast furnaces. Also for coke oven plants, emissions to air are most significant. However, many of these are fugitive emissions from various sources such as leakages from lids, oven doors and leveller doors, ascension pipes and emissions from certain operations like coal charging, coke pushing and coke quenching. In addition, fugitive emissions arise from the coke oven gas treatment plant. The main point source for emissions to air is the waste gas from the underfiring systems. Because of this special emission situation, detailed information is compiled in order to provide an adequate understanding. Consequently most of the techniques to consider in the determination of BAT refer to the minimisation of emissions to air. Emphasis has been placed on smooth and undisturbed operation as well as on maintenance of coke ovens, which appears to be essential.
Desulphurisation of coke oven gas is a measure of high priority to minimise SO_2 emissions, not only at coke oven plants themselves but also at other plants where the coke oven gas is used as a fuel.
Wastewater disposal is another major issue for coke oven plants. Detailed information provides a clear picture together with described techniques in order to minimise emissions to water.
The conclusions reflect the above mentioned issues. Therefore it has to be noted that coke dry quenching is not considered generally as BAT but only under certain circumstances.

For coke oven plants, the following techniques or combination of techniques are considered as BAT.

1. General:
   - Extensive maintenance of oven chambers, oven doors and frame seals, ascension pipes, charging holes and other equipment (systematic programme carried out by specially trained maintenance personnel);
   - Cleaning of doors, frame seals, charging holes and lids and ascension pipes after handling.
   - Maintaining a free gas flow in the coke ovens.
2. Charging:
   - Charging with charging cars.
     From an integrated point of view, "smokeless" charging or sequential charging with double ascension pipes or jumper pipes are the preferred types, because all gases and particulate matter are treated as part of coke oven gas treatment. If however the gases are extracted and treated outside the coke oven, charging with land-based treatment of the extracted gases is the preferred method. Treatment should consist of efficient evacuation and subsequent combustion and fabric filtration Emissions of particulate matter < 5 g/t coke are achievable.

3. Coking:
   A combination of the following measures:
   - Smooth, undisturbed coke oven operation, avoiding strong temperature fluctuations;
   - Application of spring-loaded flexible-sealing doors or knife edged doors (in case of ovens ≤5m high and good maintenance) achieving:
     <5% visible emissions (frequency of any leaks compared to the total number of doors) from all doors in new plants *and*
     <10% visible emissions from all doors in existing plants.
   - Water-sealed ascension pipes, achieving <1% visible emissions (frequency of any leaks compared to the total number of ascension pipes) from all pipes;
   - Luting charging holes with clay-suspension (or other suitable sealing material), achieving <1% visible emissions (frequency of any leaks compared to the total number of holes) from all holes;
   - Levelling doors equipped with sealing package achieving <5% visible emissions.
4. Firing:
   - Use of desulphurized COG
   - Prevention of leakage between oven chamber and heating chamber by means of regular coke oven operation *and*
   - Repair of leakage between oven chamber and heating chamber *and*
   - incorporation of low-NO_x techniques in the construction of new batteries, such as stage combustion (emissions in the order of 450 – 700 g/t coke and 500-770 mg/Nm^3 respectively are achievable in new/modern plants).
   - Due to the high cost, flue gas denitrification (e.g. SCR) is not applied except in new plants under circumstances where environmental quality standards are not likely to be met.
5. Pushing:
   - Extraction with an (integrated) hood on coke transfer machine and land-based extraction gas treatment with fabric filter and usage of one point quenching car to achieve less than 5 g particulate matter/t coke (stack emission).
6. Quenching:
   - Emission minimised wet quenching with less than 50 g particulate matter/t coke (determined according VDI method). The use of process-water with significant organic load (like raw coke oven wastewater, wastewater with high content of hydrocarbons etc.) as quenching water is avoided.
   - Coke dry quenching (CDQ) with recovery of sensible heat and removal of dust from charging, handling and sieving operations by means of fabric filtration. With respect to present energy prices in the EU, "instrument/operational cost-environmental benefit"- consideration sets strong limitations on the applicability of CDQ. In addition a use of recovered energy must be available.
7. Coke oven gas desulphurisation:
   - Desulphurisation by absorption systems (H_2S content grid gas 500-1000 mg H_2S/Nm^3) *or*
   - Oxidative desulphurisation (< 500 mg H_2S/Nm^3),
     provided that cross-media effects of toxic compounds are abated to a large extent.

8. Gas-tight operation of gas treatment plant:
   All measures to enable virtually gas-tight operation of the gas treatment plant should be considered like:
   - Minimising the number of flanges by welding piping connections wherever possible;
   - Use of gas-tight pumps (e.g. magnetic pumps);
   - Avoiding emissions from pressure valves in storage tanks, by means of connection of the valve outlet to the coke oven gas collecting main (or by means of collecting the gases and subsequent combustion).

9. Wastewater pre-treatment:
   - Efficient ammonia stripping, using alkalis.
     Stripping efficiency should be related to subsequent wastewater treatment. Stripper effluent NH_3 concentrations of 20 mg/l are achievable;
   - Tar removal.
10. Wastewater treatment:
    Biological wastewater treatment with integrated nitrification/denitrification achieving:

-	COD removal:	> 90%
-	Sulphide:	< 0.1 mg/l
-	PAH (6 Borneff):	< 0.05 mg/l
-	CN^-:	< 0.1 mg/l
-	Phenols:	< 0.5 mg/l
-	Sum of NH_4^+, NO_3^- and NO_2^-:	< 30 mgN/l
-	Suspended solids:	< 40 mg/l

    These concentrations are based on a specific wastewater flow of 0.4 m^3/t coke.

In principle the techniques listed under points 1 - 10 are applicable to new as well as to existing installations considering the preface except low-NOx techniques (only for new plants).

BAT for blast furnaces (chapter 7)

The blast furnace remains by far the most important process to produce pig iron from iron containing materials. Because of the high input of reducing agents (mainly coke and coal) this process consumes most of the overall energy input of an integrated steelworks.
Relevant emissions to all media occur and these are described in detail. Therefore the techniques described to consider in the determination of BAT cover all these aspects including minimisation of energy input. The subsequent conclusions are mainly concerned with the reduction of dust from the cast house, treatment of wastewater from blast furnace gas scrubbing, reuse of slag and dusts/sludges and finally the energy input minimisation and the reuse of blast furnace gas.
For blast furnaces, the following techniques or combination of techniques are considered as BAT.

1. Blast furnace gas recovery;
2. Direct injection of reducing agents;
   e.g. a pulverised coal injection of 180 kg/t pig iron is already proven, but higher injection rates could be possible.
3. Energy recovery of top BF gas pressure where prerequisites are present;
4. Hot stoves
   - emission concentration of dust <10 mg/Nm^3 and of NO_x<350 mg/Nm^3 (related to an oxygen content of 3%) can be achieved
   - energy savings where design permits
5. Use of tar-free runner linings;
6. Blast furnace gas treatment with efficient de-dusting;
   Coarse particulate matter is preferably removed by means of dry separation techniques (e.g. deflector) and should be reused. Subsequently fine particulate matter is removed by means of:
   - a scrubber *or*
   - a wet electrostatic precipitator *or*
   - any other technique achieving the same removal efficiency;

   A residual particulate matter concentration of < 10 mg/Nm^3 is possible.

7. Cast house de-dusting (tap-holes, runners, skimmers, torpedo ladle charging points);
   Emissions should be minimised by covering the runners and evacuation of the mentioned emission sources and purification by means of fabric filtration or electrostatic precipitation. Dust emission concentrations of 1-15 mg/Nm^3 can be achieved. Regarding fugitive emissions 5-15 g dust/t pig iron can be achieved; thereby the capture efficiency of fumes is important.
   Fume suppression using nitrogen (in specific circumstances, e.g. where the design of the casthouse allows and nitrogen is available).
8. Treatment of blast furnace gas scrubbing wastewater:
   a. Reuse of scrubbing water as much as possible;
   b. Coagulation/sedimentation of suspended solids (residual suspended solids < 20 mg/l can be achieved as an annual average, a single daily value up to 50 mg/l may occur);
   c. Hydrocyclonage of sludge with subsequent reuse of the coarse fraction when grain size distribution allows reasonable separation.
9. Minimising slag treatment emissions and slag to landfill;
   Slag treatment preferably by means of granulation where market conditions allow.
   Condensation of fume if odour reduction is required.
   Whenever pit slag is produced, forced cooling with water should be minimised or avoided where possible and where space restrictions allow.
10. Minimising solid waste/by-products.
    For solid wastes, the following techniques are considered BAT in descending order of priority:
    a. Minimising solid waste generation
    b. Effective utilisation (recycling or reuse) of solid wastes/by-products; especially recycling of coarse dust from BFgas treatment and dust from cast house de-dusting, complete reuse of slag (e.g. in the cement industry or for road construction)
    c. Controlled disposal of unavoidable wastes/by-products (fine fraction of sludge from BFgas treatment, part of the rubble)

In principle the techniques listed as points 1 - 10 are applicable to both new and existing installations considering the preface.

BAT for basic oxygen steelmaking and casting (chapter 8)

The objective of oxygen steelmaking is to oxidise the undesirable impurities still contained in the hot metal from blast furnaces. It includes the pre-treatment of hot metal, the oxidation process in the basic oxygen furnace, secondary metallurgical treatment and casting (continuous and/or ingot). The main environmental issues are emissions to air from various sources as described and various solid waste/by-products which are also described. In addition wastewater arises from wet de-dusting (when applied) and from continuous casting. Consequently the techniques to consider in the determination of BAT cover these aspects as well as the recovery of basic oxygen furnace gas. The conclusions are mainly concerned with minimisation of dust emissions from the different sources and measures to reuse/recycle solid waste/by-products, wastewater from wet de-dusting and the recovery of basic oxygen furnace gas.
For basic oxygen steelmaking and casting, the following techniques or combination of techniques are considered as BAT.

1. Particulate matter abatement from hot metal pre-treatment (including hot metal transfer processes, desulphurisation and deslagging), by means of:
   - Efficient evacuation;
   - Subsequent purification by means of fabric filtration or ESP.

   Emission concentrations of 5-15 mg/Nm^3 are achievable with bag filters and 20-30 mg/Nm^3 with ESP.

2. BOF gas recovery and primary de-dusting, applying:
   - Suppressed combustion *and*
   - Dry electrostatic precipitation (in new and existing situations) *or*
   - Scrubbing (in existing situations).

   Collected BOF gas is cleaned and stored for subsequent use as a fuel. In some cases, it may not be economical or, with regard to appropriate energy management, not feasible to recover the BOF gas. In these cases, the BOF gas may be combusted with generation of steam. The kind of combustion (full combustion or suppressed combustion) depends on the local energy management.

   Collected dusts and/or sludges should be recycled as much as possible. Note the usually high zinc content of the dust/sludge. Special attention should be paid to the emissions of particulate matter from the lance hole. This hole should be covered during oxygen blowing and, if necessary, inert gas injected into the lance hole to dissipate the particulate matter.
3. Secondary de-dusting, applying:
   - Efficient evacuation during charging and tapping with subsequent purification by means of fabric filtration or ESP or any other technique with the same removal efficiency. Capture efficiency of about 90% can be achieved. Residual dust content of 5-15 mg/Nm^3 in case of bag filters and of 20-30 mg/Nm^3 in case of ESP can be achieved. Note the usually high zinc content of the dust.
   - Efficient evacuation during hot metal handling (reladling operations), deslagging of hot metal and secondary metallurgy with subsequent purification by means of fabric filtration or any other technique with the same removal efficiency. For these operations emission factors below 5 g/t LS are achievable.

   Fume suppression with inert gas during reladling of hot metal from torpedo ladle (or hot metal mixer) to charging ladle in order to minimise fume/dust generation.
4. Minimisation/abatement of emissions to water from primary wet de-dusting of BOF gas applying the following measures:
   - Dry BOF gas cleaning can be applied when space permits;
   - Recycling of scrubbing water as much as possible (e.g. by means of CO_2 injection in case of suppressed combustion systems);
   - Coagulation and sedimentation of suspended solids; 20 mg/l suspended solids can be achieved.
5. Abatement of emissions to water from direct cooling at the continuous casting machines by:
   - Recycling of process and cooling water as much as possible;
   - Coagulation and sedimentation of suspended solids;
   - Removal of oil using skimming tanks or any other effective device;
6. Minimisation of solid waste

   For solid waste generation, the following techniques are considered BAT in descending order of priority:
   - Minimising waste generation
   - Effective utilisation (recycling or reuse) of solid wastes/by-products; especially recycling of BOF slag and coarse and fine dust from BOF gas treatment
   - Controlled disposal of unavoidable wastes

In principle the techniques according to items 1 - 6 are applicable to new as well as to existing installations (if there are no other indications) considering the preface.

BAT for electric steelmaking and casting (chapter 9)

The direct smelting of iron-containing materials, mainly scrap is usually performed in electric arc furnaces which need considerable amounts of electric energy and causes substantial emissions to air an solid wastes/by-products mainly filter dust and slags. The emissions to air from the furnace consist of a wide range of inorganic compounds (iron oxide dust and heavy metals) and organic compounds such as the important organochlorine compounds chlorobenzenes, PCB and PCDD/F. The techniques to consider in the determination of BAT reflect this and focus on these issues. In the conclusions, regarding emissions to air, dust and PCDD/F are the most relevant parameters. Scrap preheating is also considered as BAT just as reuse/recycling of slags and dusts.

For electric steelmaking and casting, the following techniques or combination of techniques are considered as BAT.

1. Dust collection efficiency
   - With a combination of direct off gas extraction (4th or 2nd hole) and hood systems *or*
   - dog-house and hood systems *or*
   - total building evacuation

   98% and more collection efficiency of primary and secondary emissions from EAF are achievable.
2. Waste gas de-dusting by application of:
   - Well-designed fabric filter achieving less than 5 mg dust/Nm^3 for new plants and less than 15 mg dust/Nm^3 for existing plants, both determined as daily mean values.

   The minimisation of the dust content correlates with the minimisation of heavy metal emissions except for heavy metals present in the gas phase like mercury.
3. Minimising of organochlorine compounds, especially PCDD/F and PCB emissions, by means of:
   - appropriate post-combustion within the off gas duct system or in a separate post-combustion chamber with subsequent rapid quenching in order to avoid de novo synthesis *and/or*
   - injection of lignite powder into the duct before fabric filters.

   Emission concentrations of PCDD/F 0.1 - 0.5 ng I-TEQ/Nm^3 are achievable.
4. Scrap preheating (in combination with 3.) in order to recover sensible heat from primary off gas
   - With scrap preheating of part of the scrap about 60 kWh/t can be saved, in case of preheating the total scrap amount up to 100 kWh/t liquid steel can be saved. The applicability of scrap preheating depends on the local circumstances and has to be proved on a plant by plant basis. When applying scrap preheating it has to be taken care of possibly increased emissions of organic pollutants.
5. Minimising solid waste/by-products

   For solid wastes, the following techniques are considered BAT in descending order of priority:
   - Minimisation of waste generation
   - Waste minimisation by recycling of EAF slags and filter dusts; depending on local circumstances filter dust can be recycled to the electric arc furnace in order to achieve a zinc enrichment up to 30%. Filter dust with zinc contents of more than 20% can be used in the non-ferrous metal industry.
   - Filter dusts from the production of high alloyed steels can be treated to recover alloying metals.

- For solid wastes, which can not be avoided or recycled, the generated quantity should be minimised. If all minimisation/reuse is hampered, controlled disposal is the only option.

6. Emissions to water
   - Closed loop water cooling system for the cooling of furnace devices.
   - Wastewater from continuous casting
     - Recycling of cooling water as much as possible
     - Precipitation/sedimentation of suspended solids
     - Removal of oil in shimming tanks or any other effective device.

In principle the techniques according to items 1 - 6 are applicable to new as well as to existing installations considering the preface.

Level of consensus

This BREF enjoys a high level of consensus. No split views had to be noted during TWG and IEF discussions. There is a broad agreement on the documen