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Reference Document on Best Available Techniques in the Ferrous Metals Processing Industry

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Executive Summary

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EXECUTIVE SUMMARY

This Reference Document on best available techniques in ferrous metals processing 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.

This BREF document consists of 4 Parts (A – D). Parts A to C cover the different industrial sub-sectors of the Ferrous Metals Processing sector: A, Hot and Cold Forming; B, Continuous Coating; C, Batch Galvanizing. This structure was chosen because of the differences in nature and scale of the activities covered by the term FMP.

Part D does not cover an industrial sub-sector. It comprises the technical descriptions of a number of environmental measures which are techniques to be considered in the determination of BAT in more than one sub-sector. This was done to avoid repetition of technical descriptions in the three Chapters 4. These descriptions have to be viewed always in connection with the more specific information, referring to the application in individual sub-sectors, which is given in the relevant Chapter 4.

Part A: Hot and Cold Forming

The hot and cold forming part of the ferrous metal processing sector comprises different manufacturing methods, such as hot rolling, cold rolling and drawing of steel. A great variety of semi-finished and finished products with different lines of production is manufactured. Products are: hot and cold rolled flats, hot rolled long products, drawn long products, tubes and wire.

Hot Rolling

In hot rolling the size, shape and metallurgical properties of steel are changed by repeatedly compressing the hot metal (temperature ranging from 1050 to 1300 C^o) between electrically powered rollers. The steel input for hot rolling varies in form and shape - cast ingots, slabs, blooms, billets, beam blanks - depending on the product to be manufactured. Products obtained from hot rolling are usually classified in two basic types according to their shape: flat and long products.

Total EU production in 1996 of hot rolled (HR) products was 127.8 million tonnes of which flats accounted for 79.2 million tonnes (ca. 62%) [Stat97]. Germany is the largest manufacturer of the flats, with 22.6 million tonnes followed by France with 10.7 million tonnes, Belgium 9.9 million tonnes, Italy 9.7 million tonnes and UK 8.6 million tonnes. The vast majority of HR flat products is wide strip.

The remaining 38 % of HR products are long products with about 48.5 million tonnes in 1996. The two major manufacturing countries are Italy with about 11.5 million tonnes and Germany with 10.3 million tonnes; followed by UK (7 million tonnes) and Spain (6.8 million tonnes). The largest part of the long products sector in tonnage terms is the production of wire rod which stands for roughly a third of the total production followed by reinforcing bars and merchant bars with an approximate share of one quarter of the production each.

In steel tube manufacture, the EU, which produced 11.8 million tonnes in 1996, (20.9 % of total world production) is the largest producer followed by Japan and the U.S. The European steel tube industry has a highly concentrated structure. Five countries – Germany (3.2 million tonnes), Italy (3.2 million tonnes), France (1.4 million tonnes), United Kingdom (1.3 million tonnes) and Spain (0.9 million tonnes) - account for roughly 90 % of total EU production. In some countries, a single company can account for 50 % or more of the national output. In addition to the major integrated steel tube manufacturers (mainly producing welded tubes), there are a relatively large number of small and medium-sized firms that are independent. Some manufacturers, often small in tonnage terms, operating in high value-added markets, concentrate on the manufacture of special dimensions and grades of tubes according to particular customer specifications.

Hot rolling mills usually comprise the following process steps: conditioning of the input (scarfing, grinding); heating to rolling temperature; descaling; rolling (roughing including width reduction, rolling to final dimension and properties) and finishing (trimming, slitting, cutting). They are classified by the type of product that they produce and by their design features: blooming and slabbing mills, hot strip mills, plate mills, bar and rod mills, structural and section mills and tube mills.

The main environmental issues of hot rolling are emissions to air, especially NOx and SOx; the energy consumption of furnaces; (fugitive) dust emissions from product handling, rolling or mechanical surface treatment; oil- and solid-containing effluents and oil-containing wastes.

For NOx emissions of reheating and heat treatment furnaces, industry reported concentrations of 200 – 700 mg/Nm³ and specific emissions of 80 – 360 g/t; while other sources reported up to 900 mg/Nm³ and – with combustion air preheating of up to 1000 °C – of up to more than 5000 mg/Nm³. SO_2 emissions from furnaces depend on the fuel used; ranges were reported from 0.6 – 1700 mg/Nm³ and 0.3 – 600 g/t. The scattering of energy consumption for these furnaces was 0.7 to 6.5 GJ/t; with a typical range being 1 – 3 GJ/t.

As for dust emissions from product handling, rolling or mechanical surface treatment, very few data were submitted referring to the individual processes. The concentration ranges reported were:

- Scarfing: 5 – 115 mg/Nm³
- Grinding: < 30 – 100 mg/Nm³
- Mill stands: 2 – 50 mg/Nm³ and
- Coil handling: approximately 50 mg/Nm³ .

Emissions to water from hot rolling basically comprise oil- and solid-containing effluents in the range of 5 to 200 mg/l total suspended solids and 0.2 – 10 mg/l hydrocarbons. Oil-containing wastes from waste water treatment were reported ranging from 0.4 – 36 kg/t depending on the mill type.

For more details and for emission and consumption data for other process steps of hot rolling, refer to Chapter A.3 where the available data are presented with qualifying information.

The key findings regarding BAT for individual process steps and different environmental issues of hot rolling are summarized in Table 1. All emission figures are expressed as daily mean values. Emissions to air are based on standard conditions of 273 K, 101.3 kPa and dry gas. Discharges to water are indicated as daily mean value of a flow-rate-related 24-hour composite sample or a flow-rate-related composite sample over the actual operating time (for plants not operated in three shifts).

There was consensus in the TWG on the best available techniques and associated emission/consumption levels presented in the table, except where a ‘split view’ is explicitly recorded.

Best Available Techniques / Split views on BAT	BAT-associated emission and consumption levels / Split views on associated levels
Storing and handling of raw materials and auxiliaries	
• Collection of spillages and leakages by suitable measures, e.g. safety pits and drainage.	
• Separation of oil from the contaminated drainage water and reuse of recovered oil.	
• Treatment of separated water in the water treatment plant.	
Machine scarfing	
• Enclosures for machine scarfing and dust abatement with fabric filters.	split view on dust level: < 5 mg/Nm³ < 20 mg/Nm³
• Electrostatic precipitator, where fabric filters cannot be operated because of very wet fume.	split view on dust level: < 10 mg/Nm³ 20 - 50 mg/Nm³
• Separate collection of scale/swarf from scarfing.	
Grinding	
• Enclosures for machine grinding and dedicated booths, equipped with collection hoods for manual grinding and dust abatement by fabric filters.	split view on dust level: < 5 mg/Nm³ < 20 mg/Nm³
All surface rectification processes	
• Treatment and reuse of water from all surface rectification processes (separation of solids).	
• Internal recycling or sale for recycling of scale, swarf and dust.	

Table 1: Key findings regarding BAT and associated emission/consumption levels for hot rolling

Best Available Techniques / Split views on BAT	BAT-associated emission and consumption levels / Split views on associated levels
Re-heating and heat treatment furnaces	
• General measures, e.g. regarding furnace design or operation & maintenance, as described in chapter A.4.1.3.1.	
• Avoiding excess air and heat loss during charging by operational measures (minimum door opening necessary for charging) or structural means (installation of multi-segmented doors for tighter closure).	
• Careful choice of fuel and implementation of furnace automation/control to optimise the firing conditions. - for natural gas - for all other gases and gas mixtures - for fuel oil (< 1 % S)	SO_2 levels: < 100 mg/Nm³ < 400 mg/Nm³ up to 1700 mg/Nm³
Split view: • limitation of sulphur content in fuel to < 1 % is BAT • lower S limit or additional SO_2 reduction measures is BAT	
• Recovery of heat in the waste gas by feedstock pre-heating • Recovery of heat in the waste gas by regenerative or recuperative burner systems • Recovery of heat in the waste gas by waste heat boiler or evaporative skid cooling (where there is a need for steam)	Energy savings 25 - 50 % and NOx reductions potentials of up to 50 % (depending on system).
• Second generation low-NOx burners	NOx 250 - 400 mg/Nm³ (3% O_2) without air pre-heating reported NOx reduction potential of about 65 % compared to conventional.
• Limiting the air pre-heating temperature. Trade-off energy saving vs. NOx emission: Advantages of reduced energy consumption and reductions in SO_2, CO_2 and CO have to be weighed against the disadvantage of potentially increased emissions of NOx	
Split view: • SCR and SNCR are BAT • Not enough information to decide whether or not SCR/SNCR are BAT	achieved levels [1]: SCR: NOx < 320 mg/Nm³ SNCR: NOx < 205 mg/Nm³ , ammonia slip 5 mg/Nm³
• Reduction of heat loss in intermediate products; by minimizing the storage time and by insulating the slabs/blooms (heat conservation box or thermal covers) depending on production layout. • Change of logistic and intermediate storage to allow for a maximum rate of hot charging, direct charging or direct rolling (the maximum rate depends on production schemes and product quality).	
• For new plants, near-net-shape casting and thin slab casting, as far as the product to be rolled can be produced by this technique.	
[1] These are emission levels reported for the one existing SCR plant (walking beam furnace) and the one existing SNCR plant (walking beam furnace).	

Table 1 continued: Key findings regarding BAT and associated emission/consumption levels for hot rolling

Best Available Techniques / Split views on BAT	BAT-associated emission and consumption levels / Split views on associated levels
Descaling	
• Material tracking to reduce water and energy consumption.	
Transport of rolled stock	
• Reduce unwanted energy loss by coil boxes or coil recovery furnaces and heat shields for transfer bars	
Finishing train	
• Water sprays followed by waste water treatment in which the solids (iron oxides) are separated and collected for reuse of iron content.	
• Exhaust systems with treatment of extracted air by fabric filters and recycling of collected dust.	split view on dust level: < 5 mg/Nm³ < 20 mg/Nm³
Levelling and welding	
• Suction hoods and subsequent abatement by fabric filters	split view on dust level: < 5 mg/Nm³ < 20 mg/Nm³
Cooling (machines etc.)	
• Separate cooling water systems operating in closed loops	
Waste water treatment/ scale- and oil-containing process water	
• Operating closed loops with recirculating rates of > 95 %	
• Reduction of emissions by using a suitable combination of treatment techniques (described in detail in Chapters A.4.1.12.2 and D.10.1).	SS: < 20 mg/l Oil: < 5 mg/l (1) Fe: < 10 mg/l Cr_{tot}: < 0.2 mg/l (2) Ni: < 0.2 mg/l (2) Zn: < 2 mg/l
• Recirculation of mill scale collected in water treatment to the metallurgical process • Oily waste/sludge collected should be de-watered to allow for thermal utilisation or safe disposal.	
Prevention of hydrocarbon contamination	
• Preventive periodic checks and preventive maintenance of seals, gaskets, pumps and pipelines. • Use of bearings and bearing seals of modern design for work- and back-up rolls, installation of leakage indicators in the lubricant lines (e.g. at hydrostatic bearings). • Collection and treatment of contaminated drainage water at the various consumers (hydraulic aggregates), separation and use of oil fraction, e.g. thermal utilisation by blast furnace injection. Further processing of the separated water either in the water treatment plant or in dressing plants with ultra filtration or vacuum evaporator.	Reduction in oil consumption by 50-70 %.
[1] oil based on random measurements [2] 0.5 mg/l for plants using stainless steel	

Table 1 continued: Key findings regarding BAT and associated emission/consumption levels for hot rolling

Best Available Techniques / Split views on BAT	BAT-associated emission and consumption levels / Split views on associated levels
Roll shops	
• Use of water-based degreasing as far as technically acceptable for the degree of cleanliness required. • If organic solvents have to be used, preference is to be given to non-chlorinated solvents. • Collection of grease removed from roll trunnions and proper disposal, such as by incineration. • Treatment of grinding sludge by magnetic separation for recovery of metal particles and recirculation into the steelmaking process. • Disposal of oil- and grease-containing residues from grinding wheels, e.g. by incineration. • Deposition of mineral residues from grinding wheels and of worn grinding wheels in landfills. • Treatment of cooling liquids and cutting emulsions for oil/water separation. Proper disposal of oily residues, e.g. by incineration. • Treatment of waste water effluents from cooling and degreasing as well as from emulsion separation in the hot rolling mill water treatment plant. • Recycling of steel and iron turnings into the steelmaking process.	

Table 1 continued: Key findings regarding BAT and associated emission/consumption levels for hot rolling

Cold Rolling

In cold rolling, the properties of hot rolled strip products, e.g. thickness, mechanical and technological characteristics, are changed by compression between rollers without previous heating of the input. The input is obtained in the form of coils from hot rolling mills. The processing steps and the sequence of processing in a cold rolling mill depend on the quality of the steel treated. The following process steps are used for **low alloy and alloy steel (carbon steel)**: pickling; rolling for reduction in thickness; annealing or heat treatment to regenerate the crystalline structure; temper rolling or skin pass rolling of annealed strip to give desired mechanical properties, shape and surface roughness, and finishing.

The process route for **high alloy steel (stainless steel**) involves additional steps to that for carbon steels. The main stages are: hot band annealing and pickling; cold rolling; final annealing and pickling (or bright annealing); skin pass rolling and finishing.

Cold rolled products are mainly strips and sheets (thickness typically 0.16 - 3 mm) with high quality surface finish and precise metallurgical properties for use in high specification products.

Cold rolled wide strip production (sheets and plates) was about 39.6 million tonnes in 1996. [EUROFER CR]. The main producing countries were Germany with about 10.6 million tonnes, France with 6.3 million tonnes, Italy with 4.3, UK with 4.0 million tonnes and Belgium with 3.8 million tonnes.

Cold rolled narrow strip, obtained from cold rolling narrow hot strip or from slitting and cold rolling hot rolled sheet, amounted to about 8.3 millions tonnes in 1994 (2.7 million tonnes of cold rolled and 5.5 million tonnes of slit strip)
The cold rolled strip industry in the EU is both concentrated and fragmented. The largest 10 companies account for 50 % of the production while another 140 companies account for the remaining 50 %. The structure of the sector is marked by national differences in company size and industry concentration. Most of the largest companies are situated in Germany, which dominate the market with about 57 % of EU production (1.57 million tonnes in 1994). The majority of companies, however, can be classified as small or medium-sized enterprises. [Bed95]

In 1994, Germany produced about 35 % of the slit strip, with 1.9 million tonnes, followed by Italy and France each with a production of 0.9 million tonnes.

The main environmental issues of cold rolling are: acidic wastes and waste water; degreaser fume, acidic and oil mist emissions to air; oil-containing wastes and waste water; dust, e.g. from descaling and decoiling; NOx from mixed acid pickling and combustion gases from furnace firing.

As for acid emissions to air from cold rolling, these may arise from pickling and acid regeneration processes. Emissions differ, depending on the pickling process used – basically the acid used. For hydrochloric acid pickling, HCl emissions of 1 – 145 mg/Nm³ maximum (up to 16 g/t) were reported; with the range reported by industry being 10 – < 30 mg/Nm³ (~ 0.26 g/t). For sulphuric acid pickling, H_2SO_4 emissions of 1 –2 mg/Nm³ and 0.05 – 0.1 g/t were reported.

For mixed acid pickling of stainless steel, HF emissions were reported in the range of 0.2 – 17 mg/m³ (0.2 – 3.4 g/t). Additionally to acidic air emissions, NOx is generated. The scattering rang was reported to be 3 - ~ 1000 mg/Nm³ (3 – 4000 g/t specific emission) with doubts being raised on the lower end levels.

Only little data was available for dust emissions from steel handling and descaling operations. Reported ranges for mechanical descaling are 10 – 20 g/t for specific emissions and concentration ranging from < 1 – 25 mg/m³.

For more details and for emission and consumption data for other process steps of cold rolling, refer to Chapter A.3 where the available data are presented with qualifying information.

The key findings regarding BAT for individual process steps and different environmental issues of cold rolling are summarized in Table 2. All emission figures are expressed as daily mean values. Emissions to air are based on standard conditions of 273 K, 101.3 kPa and dry gas. Discharges to water are indicated as daily mean value of a flow-rate-related 24-hour composite sample or a flow-rate-related composite sample over the actual operating time (for plants not operated in three shifts).

There was consensus in the TWG on the best available techniques and associated emission/consumption levels presented in the table, except where a ‘split view’ is explicitly recorded.

Best Available Techniques / Split views on BAT	BAT-associated emission and consumption levels / Split views on associated levels
Decoiling	
• Water curtains followed by waste water treatment in which the solids are separated and collected for reuse of iron content.	
• Exhaust systems with treatment of extracted air by fabric filters and recycling of collected dust.	split view on dust level: < 5 mg/Nm³ < 20 mg/Nm³
Pickling	
General measures to reduce acid consumption and waste acid generation as described in Chapter A.4.2.2.1. should be applied as far as possible, especially the following techniques: • Prevention of steel corrosion by appropriate storage and handling, cooling etc. • Reduction of load on pickling step by mechanical pre-descaling in a closed unit, with an extraction system and fabric filters. • Use of electrolytic pre-pickling. • Use of modern, optimised pickling facilities (spray or turbulence pickling instead of dip pickling). • Mechanical filtration and recirculation for lifetime extension of pickling baths. • Side-stream ion-exchange or electro-dialysis (for mixed acid) or other method for free acid reclamation (described in Chapter D.6.9) for bath regeneration.	
HCl pickling	
• Reuse of spent HCl. • or Regeneration of the acid by spray roasting or fluidised bed (or equivalent process) with recirculation of the regenerate; air scrubbing system as described in Chapter 4 for the regeneration plant; reuse of Fe_2O_3 by-product.	Dust 20 -50 mg/Nm³ HCl 2 – 30 mg/Nm³ SO_2 50 - 100 mg/Nm³ CO 150 mg/Nm³ CO_2 180000 mg/Nm³ NO_2 300 – 370 mg/Nm³
• Totally enclosed equipment or equipment fitted with hoods and scrubbing of extracted air.	Dust 10 - 20 mg/Nm³ HCl 2 – 30 mg/Nm³
H_2SO_4 Pickling	
• Recovery of the free acid by crystallisation; air scrubbing devices for recovery plant.	H_2SO_4 5 - 10 mg/Nm³ SO_2 8 – 20 mg/Nm³
• Totally enclosed equipment or equipment fitted with hoods and scrubbing of extracted air.	H_2SO_4 1 - 2 mg/Nm³ SO_2 8 - 20 mg/Nm³

Table 2: Key findings regarding BAT and associated emission/consumption levels for cold rolling

Best Available Techniques / Split views on BAT	BAT-associated emission and consumption levels / Split views on associated levels
Mixed acid pickling	
• Free acid reclamation (by side-stream ion exchange or dialysis) • or acid regeneration - by spray roasting: - or by evaporation process:	 Dust < 10 mg/Nm³ HF < 2 mg/Nm³ NO_2 < 200 mg/Nm³ HF < 2 mg/Nm³ NO_2 < 100 mg/Nm³
• Enclosed equipment/hoods and scrubbing, and additionally: • Scrubbing with H_2O_2, urea etc. • or NOx suppression by adding H_2O_2 or urea to the pickling bath • or SCR.	for all: NOx 200 - 650 mg/Nm³ HF 2 – 7 mg/Nm³
• Alternative: use of nitric acid-free pickling plus enclosed equipment or equipment fitted with hoods and scrubbing.	
Heating of acids	
• Indirect heating by heat exchangers or, if steam for heat exchangers has to be produced first, by submerged combustion. • Not using direct injection of steam.	
Minimization of waste water	
• Cascade rinsing systems with internal re-use of overflow (e.g. in pickling baths or scrubbing). • Careful tuning and managing of the 'pickling-acid regeneration-rinsing' system.	
Waste water treatment	
• Treatment by neutralisation, flocculation, etc., where acidic water blow-down from the system cannot be avoided.	SS: < 20 mg/l Oil: < 5 mg/l [1] Fe: < 10 mg/l Cr_{tot}: < 0.2 mg/l [2] Ni: < 0.2 mg/l [2] Zn: < 2 mg/l
Emulsion systems	
• Prevention of contamination by regular checking of seals, pipework etc. and leakage control. • Continuous monitoring of emulsion quality. • Operation of emulsion circuits with cleaning and reuse of emulsion to extend lifetime. • Treatment of spent emulsion to reduce oil content, e.g. by ultrafiltration or electrolytic splitting.	
Rolling and tempering	
• Exhaust system with treatment of extracted air by mist eliminators (droplet separator).	Hydrocarbons: 5 – 15 mg/Nm³.
[1] oil based on random measurements [2] for stainless steel < 0.5 mg/l	

Table 2 continued: Key findings regarding BAT and associated emission/consumption levels for cold rolling

Best Available Techniques / Split views on BAT	BAT-associated emission and consumption levels / Split views on associated levels
Degreasing	
• Degreasing circuit with cleaning and reuse of the degreaser solution. Appropriate measures for cleaning are mechanical methods and membrane filtration as described in chapter A.4. • Treatment of spent degreasing solution by electrolytic emulsion splitting or ultrafiltration to reduce the oil content; reuse of separated oil fraction; treatment (neutralisation etc.) of separated water fraction prior to discharge. • Extraction system for degreasing fume and scrubbing.	
Annealing furnaces	
• For continuous furnaces, low NOx burners.	NOx 250–400 mg/Nm³ without air pre-heating, 3 % O_2. Reduction rates of 60 % for NOx (and 87 % for CO)
• Combustion air pre-heating by regenerative or recuperative burners or • Pre-heating of stock by waste gas.	
Finishing/Oiling	
• Extraction hoods followed by mist eliminators and/or electrostatic precipitators or • Electrostatic oiling.	
Levelling and welding	
• Extraction hoods with dust abatement by fabric filters.	split view on dust level: < 5 mg/Nm³ < 20 mg/Nm³
Cooling (machines etc.),	
• Separate cooling water systems operating in closed loops.	
Roll shops	
Refer to BATs listed for roll shops in hot rolling.	
Metallic by-products	
• Collection of scrap from cutting, heads and tails and recirculation into the metallurgical process.	

Table 2 continued: Key findings regarding BAT and associated emission/consumption levels for cold rolling

Wire Drawing

Wire drawing is a process in which wire rods/wires are reduced in size by drawing them through cone-shaped openings of a smaller cross section, called dies. The input is usually wire rod of diameters raging from 5.5 to 16 mm obtained from hot rolling mills in the form of coils. A typical wire drawing plant comprises the following process lines:

- Pre-treatment of the wire rod (mechanical descaling, pickling)
- Dry or wet drawing (usually several drafts with decreasing die sizes)
- Heat treatment (continuous-/discontinuous annealing, patenting, oil hardening)
- Finishing

The European Union has the world largest wire drawing industry, followed by Japan and North America. It produces about 6 million tonnes of wire per year. Including the various wire products, such as barbed wire, grill, fencing, netting, nails etc, the production of the sector reaches more than 7 million tonnes per year. The European wire drawing industry is characterised by a large number of medium sized, specialised companies. The industry's output, however, is dominated by a few large producers. It is estimated that about 5 % of the companies account for 70 % of the industry's output (25 % of the companies for 90 %).

Over the past 10 years, independent wire drawing companies have become increasingly vertically integrated. Approximately 6 % of the wire drawers in Europe are integrated producers representing about 75 % of the total production of steel wire [C.E.T].

The largest producer of steel wire is Germany with 32 % (about 1.09 million tonnes) of EU wire production, followed by Italy (approx. 22 %, 1.2 million tonnes), UK, Benelux (mainly Belgium), France and Spain.

The main environmental aspects of wire drawing are: air emissions from pickling, acidic wastes and waste water; fugitive soap dust (dry drawing), spent lubricant and effluents (wet drawing), combustion gas from furnaces and emissions and lead-containing wastes from lead baths.

For air emissions from pickling, HCl concentrations of 0 - 30 mg/Nm³ were reported. In continuous annealing and patenting lead baths are used. Generating lead containing wastes, 1 - 15 kg/t for continuous annealing and 1 –10 kg/t for patenting. Reported Pb air emissions for patenting are < 0.02 – 1 mg/Nm³ and Pb concentrations in quench water overflow 2 – 20 mg/l.

For more details and for emission and consumption data for other process steps of wire drawing, refer to Chapter A.3 where the available data are presented with qualifying information.

The key findings regarding BAT for individual process steps and different environmental issues of wire drawing are summarized in Table 3. All emission figures are expressed as daily mean values. Emissions to air are based on standard conditions of 273 K, 101.3 kPa and dry gas. Discharges to water are indicated as daily mean value of a flow-rate-related 24-hour composite sample or a flow-rate-related composite sample over the actual operating time (for plants not operated in three shifts).

There was consensus in the TWG on the best available techniques and associated emission/consumption levels presented in the table.

Best Available Techniques	BAT-associated emission and consumption levels
Batch pickling	
• Close monitoring of bath parameters: temperature and concentration. • Operating within the limits given in Part D/Chapter D.6.1 'Open Pickling Bath Operation'. • For of pickling baths with high vapour emission, e.g. heated or concentrated HCl-bath: installation of lateral extraction and possibly treating of the extraction air for both new and existing installations.	HCl 2 – 30 mg/Nm³.
Pickling	
• Cascade Pickling (capacity >15 000 tonne wire rod per year) or • Reclamation of free acid fraction and reuse in pickling plant. • External regeneration of spent acid. • Recycling of spent acid as secondary raw material. • Non-acid descaling, e.g shot blasting, if quality requirements allow it. • Counter current cascade rinsing.	
Dry drawing	
• Enclosing the drawing machine (and connecting to a filter or similar device when necessary), for all new machines with drawing speed ≥ 4 m/s.	
Wet drawing	
• Cleaning and reuse of drawing lubricant. • Treatment of spent lubricant to reduce oil content in the discharge and/or to reduce waste volume, e.g. by chemical breaking, electrolytic emulsion splitting or ultrafiltration. • Treatment of discharge water fraction.	
Dry and wet drawing	
• Closed cooling-water loops. • Not using once-through cooling water systems.	
Batch annealing furnaces, continuous annealing furnaces for stainless steel and furnaces used in oil hardening and tempering	
• Burning of the protective gas purge.	
Continuous annealing of low carbon wire and patenting,	
• Good housekeeping measures, as described in chapter A.4.3.7 for the lead bath. • Separate storage of Pb-containing wastes, protected from rain and wind. • Recycling of Pb-containing wastes in non-ferrous metals industry • Closed loop operation of quench bath.	Pb < 5 mg/Nm³, CO < 100 mg/Nm³ TOC < 50 mg/Nm³.
Oil-hardening lines	
• Evacuation of the oil mist from quench baths and removal of the oil mists, when appropriate.	

Table 3: Key findings regarding BAT and associated emission/consumption levels for wire drawing

Part B: Continuous Hot Dip Coating

In the hot dip coating process, steel sheet or wire is continuously passed through molten metal. An alloying reaction between the two metals takes place, leading to a good bond between coating and substrate.

Metals suitable for the use in hot dip coating are those which have a melting point low enough to avoid any thermal changes in the steel product; for example, aluminium, lead, tin and zinc.

The production of continuous hot dip coating lines in the EU was about 15 Mt in1997. The vast majority of coatings applied in continuous hot dip coating is zinc. Aluminium coatings and, especially, terne coatings played only a minor role.

Galvanized steel	81 %
Galvannealed steel	4 %
Galfan	4 %
Aluminized steel	5%
Aluzinc	5%
Ternex	1 %

In general, **continuous coating lines for sheet** comprise the following steps:
- Surface cleaning by means of chemical and/or thermal treatment
- Heat treatment
- Immersion in a bath of molten metal
- Finishing treatment

Continuous wire galvanizing plants involve the following steps:
- Pickling
- Fluxing
- Galvanizing
- Finishing

Main environmental issues concerning this sub-sector are acidic air emissions, wastes and waste water; air emissions and energy consumption of furnaces, Zinc-containing residues, oil- and chrome-containing waste waters.

For detailed emission and consumption data, refer to Chapter B.3 where the available data are presented with qualifying information.

The key findings regarding BAT for individual process steps and different environmental issues of continuous hot dip galvanizing are summarized in Table 4. All emission figures are expressed as daily mean values. Emissions to air are based on standard conditions of 273 K, 101.3 kPa and dry gas. Discharges to water are indicated as daily mean value of a flow-rate-related 24-hour composite sample or a flow-rate-related composite sample over the actual operating time (for plants not operated in three shifts).

There was consensus in the TWG on the best available techniques and associated emission/consumption levels presented in the table.

Best Available Techniques	BAT-associated emission and consumption levels
Pickling	
• Refer to the BAT chapter of Part A/Cold rolling Mills.	
Degreasing	
• Cascade degreasing. • Cleaning and recirculation of degreasing solution; appropriate measures for cleaning are mechanical methods and membrane filtration as described in chapter A.4. • Treatment of spent degreasing solution by electrolytic emulsion splitting or ultrafiltration to reduce the oil content; reutilisation of separated oil fraction, e.g. thermally; treatment (neutralisation etc.) of the separated water fraction. • Covered tanks with extraction and cleaning of extracted air by scrubber or demister. • Use of squeeze rolls to minimize drag-out.	
Heat treatment furnaces	
• Low-NOx burners. • Air pre-heating by regenerative or recuperative burners. • Pre-heating of strip. • Steam production to recover heat from waste gas.	NOx 250 - 400 mg/Nm³ (3% O_2) without air pre-heating CO 100 - 200 mg/Nm³
Hot dipping	
• Separate collection and recycling in the non-ferrous metals industry for zinc-containing residues, dross or hard zinc.	
Galvannealing	
• Low-NOx burners. • Regenerative or recuperative burner systems.	NOx 250-400 mg/Nm³ (3% O_2) without air pre-heating
Oiling	
• Covering the strip oiling machine or • Electrostatic oiling.	
Phosphating and passivation/chromating	
• Covered process baths. • Cleaning and reuse of phosphating solution. • Cleaning and reuse of passivation solution. • Use of squeeze rolls. • Collection of skinpass/temper solution and treatment in waste water treatment plant.	
Cooling (machines etc.)	
• Separate cooling water systems operating in closed loops.	
Waste water	
• Waste water treatment by a combination of sedimentation, filtration and/or flotation/ precipitation/flocculation. Techniques described in Chapter 4 or equally efficient combinations of individual treatment measures (also described in part D). • For existing continuous water treatment plants which only achieve Zn < 4 mg/l, switch to batch treatment.	SS: < 20 mg/l Fe: < 10 mg/l Zn: < 2 mg/l Ni: < 0.2 mg/l Cr_{tot}: < 0.2 mg/l Pb: < 0.5 mg/l Sn: < 2 mg/l

Table 4: Key findings regarding BAT and associated emission/consumption levels for continuous hot dip galvanizing

Aluminizing of Sheet

Most BAT are the same as for hot dip galvanising. However, there is no need for a waste water treatment plant as only cooling water is discharged.

BAT for heating:
Gas firing. Combustion control system

Lead-Tin Coating of Sheet

Best Available Techniques	BAT-associated emission and consumption levels
Pickling	
Enclosed tanks and venting to a wet scrubber, treatment of waste water from the scrubber and pickling tank.	HCl < 30 mg/Nm³ (1)
Nickel plating	
• Enclosed process, ventilated to a wet scrubber.	
Hot dipping	
• Air knives to control coating thickness.	
Passivation	
• A no-rinse system and hence no rinse waters.	
Oiling	
• Electrostatic oiling machine.	
Waste water	
• Waste water treatment by neutralising with sodium hydroxide solution, flocculation/precipitation. • Filter cake de-watering and disposed to landfill.	
[1] daily mean values, standard conditions of 273 K, 101.3 Pa and dry gas	

Table 5: Key findings regarding BAT and associated emission/consumption levels for continuous lead-tin coating of sheet

Coating of Wire

The key findings regarding BAT for individual process steps and different environmental issues of wire coating are summarized in Table 6. All emission figures are expressed as daily mean values. Emissions to air are based on standard conditions of 273 K, 101.3 kPa and dry gas. Discharges to water are indicated as daily mean value of a flow-rate-related 24-hour composite sample or a flow-rate-related composite sample over the actual operating time (for plants not operated in three shifts).

There was consensus in the TWG on the best available techniques and associated emission/consumption levels presented in the table.

Best Available Techniques	BAT-associated emission and consumption levels
Pickling	
• Enclosed equipment or equipment fitted with hoods and scrubbing of extracted air. • Cascade pickling for new installations above a capacity of 15 000 tonne/year per line. • Recovery of free acid fraction. • External regeneration of spent acid for all installations. • Reuse of spent acid as secondary raw material.	HCl 2 - 30 mg/Nm³.
Water consumption	
Cascaded rinsing, possibly in combination with other methods to minimize water consumption, for all new and all large installations (> 15 000 tonne/year).	
Waste water	
• Waste water treatment by physico-chemical treatment (neutralisation, flocculation, etc.).	SS: < 20 mg/l Fe: < 10 mg/l Zn: < 2 mg/l Ni: < 0.2 mg/l Cr_{tot}: < 0.2 mg/l Pb: < 0.5 mg/l Sn: < 2 mg/l
Fluxing	
• Good housekeeping with special focus on reducing iron carry-over and bath maintenance. • Regeneration of flux baths on site (side-stream iron removal). • External reutilisation of spent flux solution.	
Hot dipping	
• Good housekeeping measures as described in Chapter B.4	Dust < 10 mg/Nm³ Zinc < 5 mg/Nm³
Zn-containing wastes	
• Separate storage and protection form rain and wind, and reuse in the non-ferrous metals industry.	
Cooling water (after the zinc bath)	
• Closed loop or reuse of this relatively pure water as make-up water for other applications.	

Table 6: Key findings regarding BAT and associated emission/consumption levels for wire coating

Part C: Batch Galvanizing

Hot dip galvanizing is a corrosion protection process in which iron and steel fabrications are protected from corrosion by coating them with zinc. Prevalent in batch hot dip galvanizing is job galvanizing - also referred to as general galvanizing - in which a great variety of input materials are treated for different customers. The size, amount and nature of the inputs can differ significantly. Galvanizing of pipes or tubes which is carried out in semi- or fully-automatic special galvanizing plants is usually not covered by the term job galvanizing.

The items to be coated in batch galvanizing plants are steel fabrications, such as nails, screws and other very small items; lattice grates, construction parts, structural components, light poles and many more. In some cases tubes are also galvanized in conventional batch coating plants. Galvanized steel is used in construction, transport, agriculture, power transmission and everywhere that good corrosion protection and long life are essential.

The sector operates with short lead times and short order books to give enhanced service to customers. Distribution issues are important, and so plants are located close to market concentrations. Consequently, the industry consists of a relatively large number of plants (about 600 all over Europe), servicing regional markets in order to minimize distribution costs and increase economic efficiency. Only a few 'niche' operators are prepared to transport certain classes of fabrication for longer distances in order to exploit their special expertise or plant capability. Opportunities for these specialist operators are limited.

In 1997 the tonnage of galvanized steel was about 5 million. The largest share was produced by Germany with 1.4 million tonnes and 185 galvanizing plants (in 1997). Second largest producer was Italy with 0.8 million tonnes (74 plants), followed by UK and Ireland with 0.7 million tonnes (88 plants) and France 0.7 million tonnes (69 plants).

Batch galvanizing usually comprises the following process steps:

- Degreasing
- Pickling
- Fluxing
- Galvanizing (melt metal coating)
- Finishing

A galvanizing plant, essentially, consists of a series of treatment or process baths. The steel is moved between tanks and dipped into the baths by overhead cranes.

The main environmental issues for batch galvanizing are emissions to air (HCl from pickling, and dust and gaseous compounds from the kettle); spent process solutions (degreasing solutions, pickling baths and flux baths), oily wastes (e.g. from cleaning of degreasing baths) and zinc-containing residues (filter dust, zinc ash, hard zinc).

For detailed emission and consumption data, refer to Chapter .3 where the available data are presented with qualifying information.

The key findings regarding BAT for individual process steps and different environmental issues of batch galvanising are summarized in Table 7. All emission figures are expressed as daily mean values. Emissions to air are based on standard conditions of 273 K, 101.3 kPa and dry gas. Discharges to water are indicated as daily mean value of a flow-rate-related 24-hour composite sample or a flow-rate-related composite sample over the actual operating time (for plants not operated in three shifts).

There was consensus in the TWG on the best available techniques and associated emission/consumption levels presented in the table.

Best Available Techniques	BAT-associated emission and consumption
Degreasing	
• Installation of a degreasing step, unless items are totally grease free. • Optimum bath operation to enhance efficiency, e.g. by agitation. • Cleaning degreasing solutions to extend lifespan (by skimming, centrifuge, etc.) and recirculation, reutilization of oily sludge or • 'Biological degreasing' with in situ cleaning (grease and oil removal from degreaser solution) by bacteria.	
Pickling + stripping:	
• Separate pickling and stripping unless a downstream process for the recovery of values from "mixed" liquors is installed on site or is available through a specialist external contractor. • Reuse of spent stripping liquor (external or internal e.g. to recover fluxing agent). In case of combined pickling and stripping: • Recovery of values from "mixed" liquors, e.g. use for flux production, recovery of acid for re-use in the galvanizing industry or for other inorganic chemicals	
HCl pickling	
• Close monitoring of baths parameters: temperature and concentration. • Operating within the limits given in Part D/Chapter D.6.1 'Open Pickling Bath Operation'. • If heated or higher concentrated HCl-baths are used: installation of extraction unit and treatment of extracted air (e.g. by scrubbing). • Special attention to actual pickling effect of 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. • Not using spent pickle liquor for neutralisation • Not using spent pickling liquor for emulsion splitting	HCl 2 – 30 mg/Nm^3
Rinsing	
• Good drainage between pre-treatment tanks. • Implementation of rinsing after degreasing and after pickling. • Static rinsing or rinsing cascades. • Reuse of rinse water to replenish preceding process baths. Waste water-free operation (in exceptional cases where waste water is generated, waste water treatment is required).	

Table 7: Key findings regarding BAT and associated emission/consumption levels for batch galvanizing

Best Available Techniques	BAT-associated emission and consumption
Fluxing	
• Control of bath parameters and the optimised amount of flux used are also important to reduce emission further down the process line. • For flux baths: internal and external flux bath regeneration.	
Hot dipping	
• Capture of emissions from dipping by enclosure of the pot or by lip extraction and dust abatement by fabric filters or wet scrubbers. • Internal or external reuse of dust, e.g. for flux production. The recovery system should ensure that dioxins, which may occasionally be present at low concentration due to upset conditions in the plant, do not build up as the dusts are recycled.	Dust < 5 mg/Nm³
Zn-containing wastes	
• Separate storage and protection form rain and wind, and reuse of contained values in the non-ferrous or other sectors.	

Table 7 continued: Key findings regarding BAT and associated emission/consumption levels for batch galvanizing