Category		Title
NFR:	**2.C.5.d**	**Zinc production**
SNAP:	**040309c**	**Zinc production**
ISIC:	**2720**	**Manufacture of basic precious and non-ferrous metals**
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1 Overview

Zinc is produced from various primary and secondary raw materials. The primary processes use sulphidic and oxidic concentrates, while in secondary processes recycled oxidised and metallic products mostly from other metallurgical operations are employed. This chapter includes information on atmospheric emissions during the production of secondary zinc. In practice, a clear distinction of primary and secondary zinc production is often difficult because many smelters use both primary and secondary raw materials.

Zinc production in the western world stood at about 5.2 million tonnes in 1990. Of this, 4.73 million tonnes originate from primary resources (ores), while the balance of 470 000 tonnes was produced from secondary raw materials (Metallgesellschaft, 1994). Nowadays, the majority of zinc production is still primary production but secondary production is increasing in various regions of the world. This increase is as high as 5 % per year in eastern Europe.

The activities relevant for primary zinc production are:

- transport and storage of zinc ores;
- concentration of zinc ores;
- oxidation of zinc concentrates with air (roasting process);
- production of zinc by the electrochemical or the thermal process;
- after-treatment of zinc.

This chapter covers only the process emissions from these activities. Combustion emissions from zinc production are treated in chapter 1.A.2.b.

The most important pollutants emitted from these processes are heavy metals (particularly zinc) and dust.

2 Description of sources

2.1 Process description

Primary zinc is produced from ores which contain 85 % zinc sulphide (by weight) and 8–10 % iron sulphide, with the total zinc concentration about 50 %. The ores also contain metal sulphides such as lead, cobalt, copper, silver, cadmium and arsenic sulphide.

The ores are oxidised with air giving zinc oxide, sulphur oxide and zinc ferro. Chlorine and fluorine are removed from the combustion gas and the sulphur oxide is converted catalytically into sulphuric acid.

A secondary zinc smelter is defined as any plant or factory in which zinc-bearing scrap or zinc-bearing materials, other than zinc-bearing concentrates (ores) derived from a mining operation, are processed (Barbour *et al*., 1978). In practice, primary smelters often also use zinc scrap or recycled dust as input material.

Zinc recovery involves three general operations performed on scrap, namely pre-treatment, melting, and refining. Scrap metal is delivered to the secondary zinc processor as ingots, rejected castings, flashing and other mixed metal scrap containing zinc (USEPA, 1995).

Scrap pre-treatment includes sorting, cleaning, crushing and screening, sweating and leaching. In the sorting operation, zinc scrap is manually separated according to zinc content and any subsequent processing requirements. Cleaning removes foreign materials to improve product quality and recovery efficiency. Crushing facilitates the ability to separate the zinc from the contaminants. Screening and pneumatic classification concentrates the zinc metal for further processing. Leaching with sodium carbonate solution converts dross and skimmings to zinc oxide, which can be reduced to zinc metal (USEPA, 1995).

Pure zinc scrap is melted in kettle, crucible, reverberatory, and electric induction furnaces. Flux is used in these furnaces to trap impurities from the molten zinc. Facilitated by agitation, flux and impurities float to the surface of the melt as dross, and are skimmed from the surface. The remaining molten zinc may be poured into moulds or transferred to the refining operation in a molten state (USEPA, 1995).

Refining processes remove further impurities from clean zinc alloy scrap and from zinc vaporised during the melt phase in retort furnaces. Molten zinc is heated until it vaporises. Zinc vapour is condensed and recovered in several forms, depending upon temperature, recovery time, absence or presence of oxygen, and equipment used during zinc vapour condensation. Final products from refining processes include zinc ingots, zinc dust, zinc oxide, and zinc alloys (USEPA, 1995).

Generally the processes used for the recycling of secondary zinc can be distinguished by the kind of raw materials employed (Rentz *et al*., 1996):

Very poor oxidic residues and oxidic dusts, e.g. from the steel industry, are treated in rotary furnaces (Waelz furnaces), producing metal oxides in a more concentrated form. These concentrated oxides (Waelz oxides) are processed together with oxidic ores in primary thermal zinc smelters, in particular Imperial smelting furnaces, which are in use for combined lead and zinc production. In this case, a clear discrimination between primary and secondary zinc production as well as between zinc and lead production is difficult.

Metallic products prior to smelting are comminuted and sieved to separate metal grains from the oxides. Afterwards the metallic products are melted in melting furnaces, mainly of the induction type or muffle furnaces. Finally the molten zinc is cast and in part refined to high purity zinc in distillation columns.

In New Jersey retorts it is possible to process a large variety of oxidic secondary materials together with metallic materials simultaneously. For charge preparation the oxides are mixed with bituminous or gas coal, briquetted and coked. The briquettes together with the metallic materials are charged into the retorts. The zinc vapours from the retorts are condensed by splash condensing.

2.2 Techniques

2.2.1 Primary zinc production

2.2.1.1 The electrochemical zinc production process

Roasted ores are leached in electrolytic cell acid. The zinc oxide dissolves in the acid solution but the zinc ferro does not. After a separation step the raw zinc sulphate solution goes to the purification process and the insoluble matter to the jarosite precipitation process.

In the jarosite precipitation process, the insoluble matter of the roast is in good contact with solution containing ammonia and iron (which also contains zinc and other metals) from the second leaching process. The iron precipitates, forming the insoluble ammoniumjarosite [$(NH_4)_2Fe_6(SO_4)_4(OH)_{12}$]. After separation the solution containing zinc goes to the first leaching process and the insoluble matter to a second leaching process. The insoluble matter is contacted in the second leaching process with a strong acid solution. The zinc ferro and almost all the other metals dissolve in the strong acid solution. After separation the solution containing zinc and iron is returned to the jarosite precipitation process where the iron and the insoluble matter are removed.

The raw zinc sulphate solution from the first leaching process is purified by adding zinc dust. Because of the addition of the zinc dust, copper, cobalt and cadmium are precipitated as metal. After filtration of the purified zinc sulphate solution the zinc electrolytic is separated from the solution. The electrolytically produced zinc sheets are melted in induction ovens and cast to blocks. The zinc alloys can also be produced by adding low concentrations of lead or aluminium.

Figure 2.1 below shows a generalised process scheme for the electrochemical zinc production process, as described above.

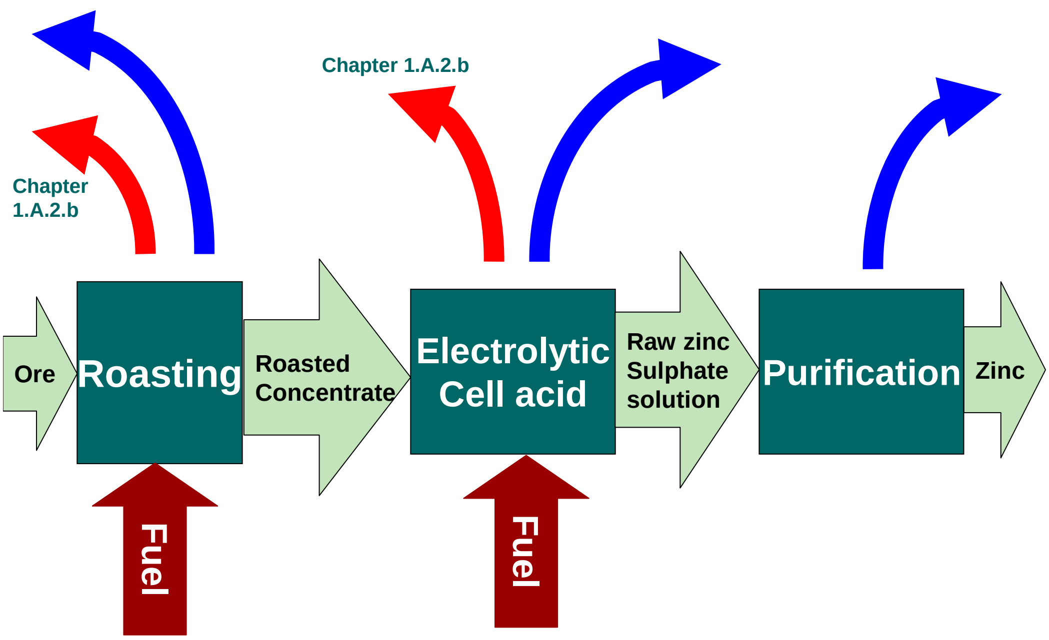

Figure 2.1 Process scheme for source category 2.C.5.d Zinc production, electrochemical zinc production process

2.2.1.2 The thermal smelting zinc production process

Roasted zinc is heated to a temperature of about 1100 °C (a temperature above the boiling point is needed) in the presence of anthracite or cokes. At that temperature zinc oxide is reduced and carbon monoxide is formed from the carbon source. The carbon monoxide reacts with another molecule of zinc oxide and forms carbon dioxide:

ZnO	+	C	$\rightarrow$	Zn(gas) +	CO	Reaction 1
ZnO	+	CO	$\rightarrow$	Zn(gas) +	CO_2	Reaction 2

$CO_2 + C \rightarrow 2CO$ Reaction 3

Because reaction 2 is reversible (at lower temperatures zinc oxide is reformed) the concentration of carbon dioxide has to be decreased. The concentration of carbon dioxide is decreased by reaction with the carbon source.

Finally, the vaporised zinc is condensed by external condensers.

Figure 2.2 gives an overview of the thermal smelting zinc production process.

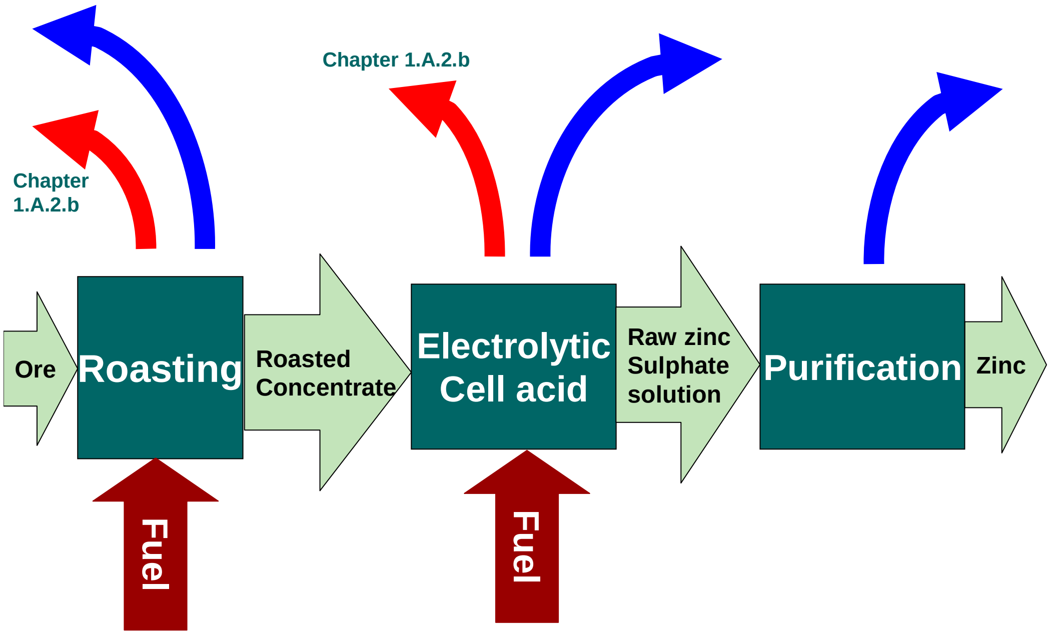

Figure 2.2 Process scheme for source category 2.C.5.d Zinc production, electrochemical zinc production process

2.2.2 Secondary zinc production

A sweating furnace (rotary, reverberatory, or muffle furnace) slowly heats the scrap containing zinc and other metals to approximately 364 °C. This temperature is sufficient to melt zinc but is still below the melting point of the remaining metals. Molten zinc collects at the bottom of the sweat furnace and is subsequently recovered. The remaining scrap metal is cooled and removed to be sold to other secondary processors (USEPA, 1995).

A more sophisticated type of sweating operation involves holding scrap in a basket and heating it in a molten salt bath to a closely controlled temperature. This yields a liquid metal, which separates downwards out of the salt and a remaining solid of the other metals still free from oxidation. By arranging for heating to a sequence of temperatures, related to the melting point of the metals or alloys involved, a set of molten metal fractions with minimum intermixture can be obtained (Barbour *et al*., 1978).

For zinc production in New Jersey retorts the raw materials containing zinc are picked up from the stockpiling area. For some raw materials a charge preparation is carried out, including comminution, sieving, and magnetic separation, so that a metallic and an oxidic fraction is obtained. Furthermore, for some raw materials dechlorination is necessary. The oxidic raw materials, like dusts and zinc drosses are mixed with bituminous coal. Subsequently, the mixture which contains about 40 % zinc is briquetted together with a binding agent, coked at temperatures around 800 °C in an autogenous coking furnace and then charged to the New Jersey retorts together with small amounts of pure metallic materials. By heating with natural gas and waste gases containing carbon monoxide (CO), in the retorts temperatures of around 1 100 °C are achieved, so that the zinc is reduced and vaporised. Subsequently, the vaporised zinc is precipitated in splash-condensers and transferred to the foundry via a holding furnace. Here the so-called selected zinc is cast into ingots. The residues from the retorts are treated in a melting cyclone to produce lead-zinc-mix oxides and slag. Figure 3.1 shows a schematic diagram for secondary zinc production using New Jersey retorts. Potential sources of particulate and heavy metal emissions are indicated. The metallic fraction from charge preparation together with other metallic materials like galvanic drosses, scrap zinc, and scrap alloys are melted. The raw zinc is then sent to a liquation furnace where, in a first refining step, zinc contents of 97.5–98 % are achieved. The melted and refined zinc is also cast into ingots (Rentz *et al*., 1996).

The raw materials for Waelz furnaces are mainly dusts and slurry from electric arc furnaces used in the steel industry, together with other secondary materials containing zinc and lead. For transferring and charging, the dust-like secondary materials are generally pelletized at the steel plant.

After mixing, the pellets containing zinc and lead, coke as reducing agent, and fluxes are charged via a charging sluice at the upper end of the slightly sloped rotary kiln. The rotation and the slope lead to an overlaid translational and rotational movement of the charge. In a counter-current direction to the charge, air as combustion gas is injected at the exit opening of the furnace. At temperatures of around 1 200°C and with residence times of around four hours zinc and lead are reduced and vaporised. The metal vapours are reoxidised in the gas filled space of the furnace and evacuated through the charge opening together with the waste gas. In a cleaning device, the metal oxides are collected again and as filter dust the so-called Waelz oxide with a zinc content of around 55 % and a lead content of around 10 % is generated. The Waelz oxide is subsequently charged into an Imperial smelting furnace which is used for combined primary zinc and lead smelting. The slag from the Waelz furnace is cooled down and granulated in a water bath. Additional oil as fuel is only needed at the start up of the furnace, while in stationary operation the combustion of the metal vapours and carbon monoxide covers the energy demand of the process (Rentz *et al*., 1996). A schematic representation of the Waelz process is depicted in Figure 3.2.

Secondary zinc is sometimes combined with primary material for refining. Various pyrometallurgical refining technologies can be applied, depending on the feed material and product specification. Thermal zinc refining by fractional distillation is possible in rectifying columns at temperatures around 950 °C (Rentz *et al*., 1996).

2.3 Emissions

2.3.1 Primary zinc production

Emissions of particulate matter and heavy metals (zinc and cadmium) take place during the receipt and storage of the zinc ores and during the production. The receipt and storage of the zinc ore take place under a covering to reduce the emission. The emissions during production occur from tanks, ovens and separation equipment. These emissions can be decreased by changing some constructions.

The emission to the atmosphere by the thermal smelting process can be decreased by cleaning the condensed air. The thermal smelting production process leads to increased emission of metals.

Pollutants released are sulphur oxides (SO_x), nitrogen oxides (NO_x), volatile organic gaseous compounds (non-methane VOC and methane (CH_4)), carbon monoxide (CO), carbon dioxide (CO_2), nitrous oxide (N_2O), and ammonia (NH_3). According to the previous EMEP/Corinair Guidebook version (Guidebook 2006) the main relevant pollutant emitted is SO_2.

Each of the two smelting processes (externally heated, electrothermic reduction) generates emissions along the various process steps. More than 90 % of the potential SO_2 emissions from zinc ores is released in roasters. About 93–97 % of the sulphur in the feed is emitted as sulphur oxides. Concentrations of SO_2 in the off-gas vary with the type of roaster operation. Typical SO_2 concentrations for multiple hearth roasters are 4.5–6.5 %, for suspension roasters they are 10–13 % and for fluidised bed roasters they are 7–12 % (USEPA, 1995).

Additional SO_2 is emitted from the sinter plant; the quantity depends on the sulphur content of the calcine feedstock. The SO_2 concentration of sinter plant exhaust gas ranges from 0.1 to 2.4 % (USEPA, 1995).

The energy requirement for the different lead and zinc processes varies to a large extent. It depends on the quality of the feed and the products, the use of latent or waste heat and the production of by-products. Please refer to the Best Available Techniques Reference (BREF) document for additional information (European Commission, 2001).

2.3.2 Secondary zinc production

Among the various process steps the melting furnace operation represents the most important source of atmospheric emissions. In general, continuous and periodical emissions can be distinguished. Continuous emissions are connected with the process as such, whereas periodical emissions occur e.g. during charging, heating, skimming or cleaning operations. The most important factors influencing emissions from scrap pre-treatment and melting are:

- the composition of the raw material, in particular the content of organic and chlorinated compounds which affects the formation of dioxins and furans;
- the utilisation of flux powder;
- the furnace type — direct heating with a mixture of process and combustion waste gases reduces the content of organic compounds released from the bath;
- the bath temperature — a temperature above 600 °C creates significant emissions of zinc oxide;
- the fuel type — in general, natural gas or light fuel oil are used.

Continuous emissions from the melting furnace consist of combustion waste gases and gaseous effluents from the bath. The specific gas flow amounts to about 1 000 m^3 (STP)/Mg zinc produced.

Important periodical emissions often occur with charging and melting of the raw material. Emissions of organic compounds are mainly connected with charging operations. Furnace clearing, fluxing, ash drawing and also cleaning operations are of minor relevance. Tapping is carried out at low temperature and therefore no metal vapours are released.

In zinc distillation a high quality input material is used and therefore, emissions of compounds containing carbon or chlorine are low. Emissions mainly consist of particles containing zinc and zinc oxide and combustion waste gases (Bouscaren and Houllier, 1988).

2.4 Controls

2.4.1 Primary zinc production

Sulphur dioxide emissions from the roasting processes are often recovered at on-site sulphuric acid plants. No sulphur controls are used on the exhaust stream of sinter plants. Extensive desulphurisation before electrothermic retorting results in practically no SO_2 emissions from these devices (USEPA, 1995).

2.4.2 Secondary zinc production

Most of the secondary zinc smelters are equipped with dust removing installations, such as baghouses. In general, emission control systems vary depending on the type of scrap being processed and the products being obtained. A distinction can be made between purely oxidised, mixed oxidised/metallic and purely metallic products.

The control efficiency of dust removing installations is often very high, reaching 99.9 %. Both primary gases and fugitive dust emissions are reduced in baghouses to concentrations below 10 mg/m^3.

Afterburners are reported for non-ferrous-metal industry in the United States of America. Also wet scrubbers may be used.

3 Methods

3.1 Choice of method

Figure 3.1 presents the procedure to select the methods for estimating process emissions from the zinc industry. The basic approach is as follows:

- If detailed information is available: use it.
- If the source category is a key category, a Tier 2 or better method must be applied and detailed input data must be collected. The decision tree directs the user in such cases to the Tier 2 method, since it is expected that it is more easy to obtain the necessary input data for this approach than to collect facility level data needed for a Tier 3 estimate
- The alternative of applying a Tier 3 method, using detailed process modelling is not explicitly included in this decision tree. However, detailed modelling will always be done at facility level and results of such modelling could be seen as “facility data” in the decision tree.

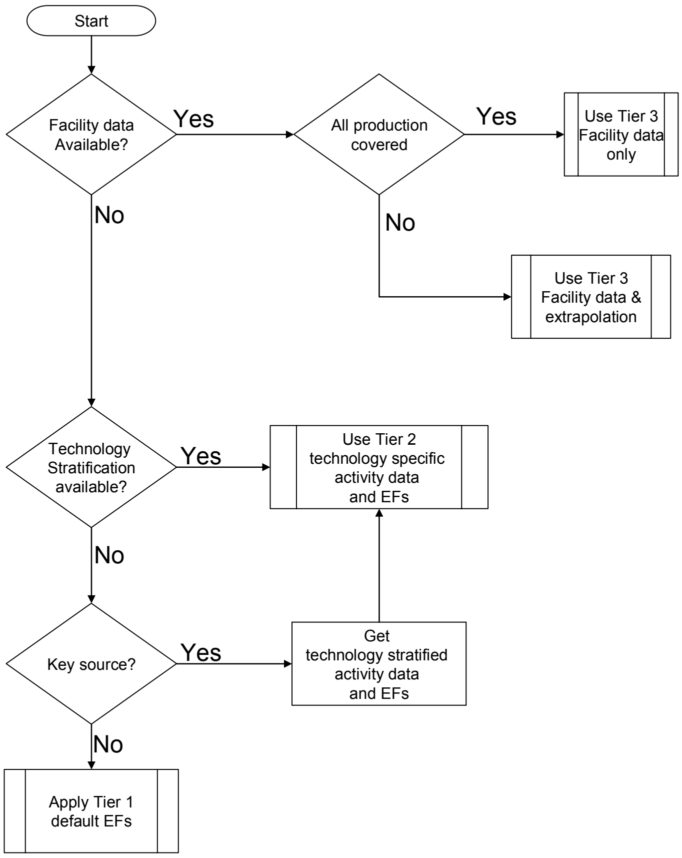

Figure 3.1 Decision tree for source category 2.C.5.d Zinc production

3.2 Tier 1 default approach

3.2.1 Algorithm

The Tier 1 approach for process emissions from primary zinc production uses the general equation:

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \quad (1)$$

Where:

$E_{pollutant}$ = the emission of the specified pollutant

$AR_{production}$ = the activity rate for the zinc production

$EF_{pollutant}$ = the emission factor for this pollutant

This equation is applied at the national level, using annual national total primary zinc production. Information on the production of primary zinc, suitable for estimating emissions using the simpler estimation methodology (Tier 1 and 2) is widely available from United Nations statistical yearbooks or national statistics.

Tier 1 emission factors assume an 'averaged' or typical technology and abatement implementation in the country and integrate all sub-processes in zinc production.

In cases where specific abatement options are to be taken into account a Tier 1 method is not applicable and a Tier 2 or Tier 3 approach must be used.

3.2.2 Default emission factors

The Tier 1 approach needs emission factors for all relevant pollutants, which integrate all sub-processes within the industry from inputting raw materials to the final shipment of the products off site. The default emission factors suggested for this source category are given in Table 3.1.

Emissions of NO_x, SO_x and CO are assumed to originate mainly from combustion and are discussed in chapter 1.A.2.b. All other emissions are assumed to originate primarily from the process and are therefore discussed in the present chapter.

Emission factors in BREF documents are mostly given in ranges. The range is interpreted as the 95 % confidence interval, while the geometric mean of this range is chosen as the value for the emission factor.

Table 3.1 Tier 1 emission factors for source category 2.C.5.d Zinc production

Tier 1 default emission factors					
	Code	Name			
NFR Source Category	2.C.5.d	Zinc production			
Fuel	NA				
Not applicable	Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCP, SCCP				
Not estimated	NOx, CO, NMVOC, SOx, NH3, Cr, Cu, Ni, Se, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
TSP	500	g/Mg zinc	170	1500	Visschedijk et al. (2004)
PM10	400	g/Mg zinc	130	1200	Visschedijk et al. (2004)
PM2.5	300	g/Mg zinc	100	900	Visschedijk et al. (2004)
Pb	14	g/Mg zinc	4.5	28	Theloke et al. (2008)
Cd	2.5	g/Mg zinc	1.1	3.9	Theloke et al. (2008)
Hg	3.8	g/Mg zinc	1.5	6.1	Theloke et al. (2008)
As	0.12	g/Mg zinc	0.06	0.18	Theloke et al. (2008)
Zn	40	g/Mg zinc	15	110	European Commission (2001)
PCB	0.9	g/Mg zinc	0.3	2.8	Theloke et al. (2008)
PCDD/F	5	µg I-TEQ/Mg zinc	0	1000	UNEP (2005)

A conventional plant is assumed, using electrostatic precipitators (ESP), settlers and scrubbers for abatement and having moderate control of fugitive sources. The heavy metal emission factors assume limited control.

3.2.3 Activity data

Information on the production of zinc suitable for estimating emissions using the simpler estimation methodology (Tier 1 and 2) is widely available from United Nations statistical yearbooks or national statistics.

Further guidance is provided in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 3 on Industrial Processes and Product Use (IPPU), chapter 4.7.2.3 ‘Choice of activity statistics’ (IPCC, 2006).

3.3 Tier 2 technology-specific approach

3.3.1 Algorithm

The Tier 2 approach is similar to the Tier 1 approach. To apply the Tier 2 approach, both the activity data and the emission factors need to be stratified according to the different techniques that may occur in the country. The different techniques used in the production of primary zinc are discussed in subsection 2.2.1 of the present chapter.

The Tier 2 approach is as follows:

Stratify zinc production in the country to model the different product and process types occurring in the national zinc industry into the inventory by:

- defining the production using each of the separate product and/or process types (together called 'technologies' in the formulae below) separately; and
- applying technology specific emission factors for each process type:

$$E_{pollutant} = \sum_{technologies} AR_{production,technology} \times EF_{technology,pollutant} \tag{2}$$

where:

$AR_{production,technology}$	=	the production rate within the source category, using this specific technology
$EF_{technology,pollutant}$	=	the emission factor for this technology and this pollutant

A country where only one technology is implemented will result in a penetration factor of 100 % and the algorithm reduces to:

$$E_{pollutant} = AR_{production} \times EF_{technology,pollutant} \tag{3}$$

where:

$E_{pollutant}$	=	the emission of the specified pollutant
$AR_{production}$	=	the activity rate for the zinc production
$EF_{pollutant}$	=	the emission factor for this pollutant

The emission factors in this approach will still include all sub-processes within the industry from inputting raw materials until the produced zinc is shipped to the customers.

3.3.2 Technology-specific emission factors

Applying a Tier 2 approach for the process emissions from zinc production calls for technology-specific emission factors. These are provided in the present subsection. A BREF document for this industry is available at http://eippcb.jrc.es/pages/FActivities.htm. In subsection 4.3.1 of the present chapter emission factors derived from the emission limit values (ELVs) as defined in the BREF document are provided for comparison.

The present subsection provides technology-specific emission factors for the two techniques for primary zinc production described in this chapter; the electrochemical process and the thermal smelting process (see Table 3.3 and Table 3.4). However, not many specific emission factors are available for these two processes.

As for the Tier 1 approach, emissions of NO_x, SO_x and CO are assumed to originate mainly from combustion and are discussed in chapter 1.A.2.b. All other emissions are assumed to originate primarily from the process and are therefore discussed in the present chapter.

Emission factors in the BREF documents are mostly given in ranges. The range is interpreted as the 95 % confidence interval, while the geometric mean of this range is chosen as the value for the emission factor in the tables below.

3.3.2.1 Primary zinc production

Table 3.2 presents an average set of emission factors that can be used for primary zinc production. Table 3.3–Table 3.6 present emission factors for specific technologies in the primary zinc production process. However, data were not available for all pollutants (only for the values referenced in Theloke *et al*., 2008). To complete the tables with emission factors for particulates, typical emission factors for particulates from Table 3.2 have been used. The emission factors presented in the specific technology tables should therefore be handled with care, since emissions of heavy metals and particulates in these tables could not be harmonised. Abatement efficiencies for particulates are provided separately in Table 3.13.

Typical emission factors for Eastern Europe, Caucasus and Central Asia (EECCA) countries are provided in Table 3.7 and Table 3.8 and are based on Kakareka (2008).

Table 3.2 Tier 2 emission factors for source category 2.C.5.d Zinc production, primary zinc production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.C.5.d	Zinc production			
Fuel	NA				
SNAP (if applicable)	040309c	Zinc production			
Technologies/Practices	Primary zinc production				
Region or regional conditions					
Abatement technologies					
Not applicable	Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCB, PCP, SCCP				
Not estimated	NOx, CO, NMVOC, SOx, NH3, As, Cr, Cu, Ni, Se, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB				
Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
TSP	500	g/Mg zinc	170	1500	Visschedijk et al. (2004)
PM10	400	g/Mg zinc	130	1200	Visschedijk et al. (2004)
PM2.5	300	g/Mg zinc	100	900	Visschedijk et al. (2004)
Pb	17	g/Mg zinc	4.9	34	Theloke et al. (2008)
Cd	2.4	g/Mg zinc	0.97	3.9	Theloke et al. (2008)
Hg	5	g/Mg zinc	2	8	Theloke et al. (2008)
Zn	40	g/Mg zinc	15	110	European Commission (2001)

Electrochemical process

Table 3.3 Tier 2 emission factors for source category 2.C.5.d Zinc production, primary zinc production using the electrochemical production process

Tier 2 emission factors						
	Code	Name				
NFR Source Category	2.C.5.d	Zinc production				
Fuel	NA					
SNAP (if applicable)	040309c	Zinc production				
Technologies/Practices	Primary zinc production, Electrochemical process					
Region or regional conditions						
Abatement technologies						
Not applicable	Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCB, PCP, SCCP					
Not estimated	NOx, CO, NMVOC, SOx, NH3, Hg, As, Cr, Cu, Ni, Se, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB					
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**	
			Lower	**Upper**		
TSP	500	g/Mg zinc	170	1500	Visschedijk et al. (2004)	
PM10	400	g/Mg zinc	130	1200	Visschedijk et al. (2004)	
PM2.5	300	g/Mg zinc	100	900	Visschedijk et al. (2004)	
Pb	5	g/Mg zinc	0.5	50	Guidebook (2006)	
Cd	1	g/Mg zinc	0.1	10	Guidebook (2006)	
Zn	100	g/Mg zinc	10	1000	Guidebook (2006)	

Thermal smelting process

Table 3.4 Tier 2 emission factors for source category 2.C.5.d Zinc production, primary zinc production using the thermal smelting process

Tier 2 emission factors						
	Code	Name				
NFR Source Category	2.C.5.d	Zinc production				
Fuel	NA					
SNAP (if applicable)	040309c	Zinc production				
Technologies/Practices	Primary zinc production, Thermal smelting process					
Region or regional conditions						
Abatement technologies						
Not applicable	Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCB, PCP, SCCP					
Not estimated	NOx, CO, NMVOC, SOx, NH3, As, Cr, Cu, Ni, Se, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB					
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**	
			Lower	**Upper**		
TSP	500	g/Mg zinc	170	1500	Visschedijk et al. (2004)	
PM10	400	g/Mg zinc	130	1200	Visschedijk et al. (2004)	
PM2.5	300	g/Mg zinc	100	900	Visschedijk et al. (2004)	
Pb	500	g/Mg zinc	50	2000	Guidebook (2006)	
Cd	100	g/Mg zinc	10	1000	Guidebook (2006)	
Hg	20	g/Mg zinc	5	50	Guidebook (2006)	
Zn	10000	g/Mg zinc	400	16000	Guidebook (2006)	

Best Available Techniques (BAT) production technology

Table 3.5 Tier 2 emission factors for source category 2.C.5.d Zinc production, primary zinc production with BAT technologies in place

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.C.5.d	Zinc production			
Fuel	NA				
SNAP (if applicable)	040309c	Zinc production			
Technologies/Practices	Primary zinc production				
Region or regional conditions					
Abatement technologies	BAT production technologies				
Not applicable	Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCB, PCP, SCCP				
Not estimated	NOx, CO, NMVOC, SOx, NH3, As, Cu, Ni, Se, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
TSP	39	g/Mg zinc	13	120	Visschedijk et al. (2004)
PM10	30	g/Mg zinc	10	90	Visschedijk et al. (2004)
PM2.5	22	g/Mg zinc	7.3	66	Visschedijk et al. (2004)
Pb	31.5	g/Mg zinc	11	95	Theloke et al. (2008)
Cd	4.5	g/Mg zinc	1.5	14	Theloke et al. (2008)
Hg	5	g/Mg zinc	1.7	15	Theloke et al. (2008)
Cr	2.34	g/Mg zinc	0.78	7	Theloke et al. (2008)
Zn	40	g/Mg zinc	15	110	European Commission (2001)

State-of-the-art fabric filters

Table 3.6 Tier 2 emission factors for source category 2.C.5.d Zinc production, primary zinc production with fabric filters

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.C.5.d	Zinc production			
Fuel	NA				
SNAP (if applicable)	040309c	Zinc production			
Technologies/Practices	Primary zinc production				
Region or regional conditions					
Abatement technologies	FF state-of-the-art.				
Not applicable	Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCB, PCP, SCCP				
Not estimated	NOx, CO, NMVOC, SOx, NH3, As, Cu, Ni, Se, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
TSP	39	g/Mg zinc	13	120	Visschedijk et al. (2004)
PM10	30	g/Mg zinc	10	90	Visschedijk et al. (2004)
PM2.5	22	g/Mg zinc	7.3	66	Visschedijk et al. (2004)
Pb	0.0035	g/Mg zinc	0.0012	0.011	Theloke et al. (2008)
Cd	0.0005	g/Mg zinc	0.00017	0.0015	Theloke et al. (2008)
Hg	4.5	g/Mg zinc	1.5	14	Theloke et al. (2008)
Cr	0.00026	g/Mg zinc	0.000087	0.00078	Theloke et al. (2008)
Zn	40	g/Mg zinc	15	110	European Commission (2001)

Typical factors for EECCA countries

Table 3.7 Tier 2 emission factors for source category 2.C.5.d Zinc production, primary zinc production with limited electrostatic precipitation abatement

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.C.5.d	Zinc production			
Fuel	NA				
SNAP (if applicable)	040309c	Zinc production			
Technologies/Practices	Primary zinc production				
Region or regional conditions	EECCA countries				
Abatement technologies	ESP, limited				
Not applicable	Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCB, PCP, SCCP				
Not estimated	NOx, CO, NMVOC, SOx, NH3, Cr, Ni, Se, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB				
Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
TSP	5	kg/Mg zinc	1.3	20	Kakareka (2008)
PM10	4	kg/Mg zinc	1	16	Kakareka (2008)
PM2.5	3	kg/Mg zinc	0.75	12	Kakareka (2008)
Pb	130	g/Mg zinc	75	175	Kakareka (2008)
Cd	25	g/Mg zinc	15	35	Kakareka (2008)
Hg	10	g/Mg zinc	6	14	Kakareka (2008)
As	25	g/Mg zinc	15	35	Kakareka (2008)
Cu	75	g/Mg zinc	45	110	Kakareka (2008)
Zn	2000	g/Mg zinc	1200	2800	Kakareka (2008)

Table 3.8 Tier 2 emission factors for source category 2.C.5.d Zinc production, primary zinc production with electrostatic precipitation abatement

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.C.5.d	Zinc production			
Fuel	NA				
SNAP (if applicable)	040309c	Zinc production			
Technologies/Practices	Primary zinc production				
Region or regional conditions	EECCA countries				
Abatement technologies	ESP, abatement				
Not applicable	Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCB, PCP, SCCP				
Not estimated	NOx, CO, NMVOC, SOx, NH3, Cr, Ni, Se, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB				
Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
TSP	1.5	kg/Mg zinc	0.4	6	Kakareka (2008)
PM10	1.2	kg/Mg zinc	0.3	4.8	Kakareka (2008)
PM2.5	0.9	kg/Mg zinc	0.23	3.6	Kakareka (2008)
Pb	50	g/Mg zinc	30	70	Kakareka (2008)
Cd	5	g/Mg zinc	3	7	Kakareka (2008)
Hg	5	g/Mg zinc	3	7	Kakareka (2008)
As	5	g/Mg zinc	3	7	Kakareka (2008)
Cu	25	g/Mg zinc	15	35	Kakareka (2008)
Zn	500	g/Mg zinc	300	700	Kakareka (2008)

3.3.2.2 Secondary zinc production

Table 3.9 presents an average set of emission factors that can be used for secondary zinc production. Table 3.10, Table 3.11 and Table 3.12 present emission factors for specific technologies within secondary zinc production. However, data were not available for all pollutants (only for the values referenced in Theloke *et al*., 2008). As for primary zinc production, the emission factors for particulates could not be harmonised with the heavy metal emission factors and should therefore be handled with care. Separate abatement efficiencies supplied for particulates are presented below in subsection 3.3.3.

Table 3.9 Tier 2 emission factors for source category 2.C.5.d Zinc production, secondary zinc production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.C.5.d	Zinc production			
Fuel	NA				
SNAP (if applicable)	040309c	Zinc production			
Technologies/Practices	Secondary zinc production				
Region or regional conditions					
Abatement technologies					
Not applicable	Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCP, SCCP				
Not estimated	NOx, CO, NMVOC, SOx, NH3, Cr, Cu, Ni, Se, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
TSP	500	g/Mg zinc	170	1500	Visschedijk et al. (2004)
PM10	400	g/Mg zinc	130	1200	Visschedijk et al. (2004)
PM2.5	300	g/Mg zinc	100	900	Visschedijk et al. (2004)
Pb	5.3	g/Mg zinc	3.2	8.1	Theloke et al. (2008)
Cd	2.8	g/Mg zinc	1.6	4.1	Theloke et al. (2008)
Hg	0.0065	g/Mg zinc	0.0032	0.0097	Theloke et al. (2008)
As	0.48	g/Mg zinc	0.24	0.73	Theloke et al. (2008)
Zn	40	g/Mg zinc	15	110	European Commission (2001)
PCB	3.6	g/Mg zinc	1.2	11	Theloke et al. (2008)
PCDD/F	100	µg I-TEQ/Mg zinc	0.3	1000	UNEP (2005)

BAT production technology

Table 3.10 Tier 2 emission factors for source category 2.C.5.d Zinc production, secondary zinc production with BAT production technologies in place

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.C.5.d	Zinc production			
Fuel	NA				
SNAP (if applicable)	040309c	Zinc production			
Technologies/Practices	Secondary zinc production				
Region or regional conditions					
Abatement technologies	BAT production technologies				
Not applicable	Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCP, SCCP				
Not estimated	NOx, CO, NMVOC, SOx, NH3, Cu, Ni, Se, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
TSP	39	g/Mg zinc	13	120	Visschedijk et al. (2004)
PM10	30	g/Mg zinc	10	90	Visschedijk et al. (2004)
PM2.5	22	g/Mg zinc	7.3	66	Visschedijk et al. (2004)
Pb	58.5	g/Mg zinc	20	180	Theloke et al. (2008)
Cd	31.5	g/Mg zinc	11	95	Theloke et al. (2008)
Hg	0.006	g/Mg zinc	0.002	0.018	Theloke et al. (2008)
As	5.31	g/Mg zinc	1.8	16	Theloke et al. (2008)
Cr	2.34	g/Mg zinc	0.78	7	Theloke et al. (2008)
Zn	40	g/Mg zinc	15	110	European Commission (2001)
PCB	0.0031	g/Mg zinc	0.001	0.0093	Theloke et al. (2008)
PCDD/F	100	µg I-TEQ/Mg zinc	0.3	1000	UNEP (2005)

Electrostatic precipitators

Table 3.11 Tier 2 emission factors for source category 2.C.5.d Zinc production, secondary zinc production with electrostatic precipitators

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.C.5.d	Zinc production			
Fuel	NA				
SNAP (if applicable)	040309c	Zinc production			
Technologies/Practices	Secondary zinc production				
Region or regional conditions					
Abatement technologies	dry ESP				
Not applicable	Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCP, SCCP				
Not estimated	NOx, CO, NMVOC, SOx, NH3, Cu, Ni, Se, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB				
Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
TSP	19	g/Mg zinc	6.3	57	Visschedijk et al. (2004)
PM10	16	g/Mg zinc	5.3	48	Visschedijk et al. (2004)
PM2.5	12	g/Mg zinc	4	36	Visschedijk et al. (2004)
Pb	9.9	g/Mg zinc	3.3	30	Theloke et al. (2008)
Cd	5.3	g/Mg zinc	1.8	16	Theloke et al. (2008)
Hg	0.0057	g/Mg zinc	0.0019	0.017	Theloke et al. (2008)
As	0.9	g/Mg zinc	0.3	2.7	Theloke et al. (2008)
Cr	0.4	g/Mg zinc	0.13	1.2	Theloke et al. (2008)
Zn	40	g/Mg zinc	15	110	European Commission (2001)
PCB	0.0031	g/Mg zinc	0.001	0.0093	Theloke et al. (2008)
PCDD/F	100	µg I-TEQ/Mg zinc	0.3	1000	UNEP (2005)

State-of-the-art fabric filters

Table 3.12 Tier 2 emission factors for source category 2.C.5.d Zinc production, secondary zinc production with state-of-the-art fabric filters

Tier 2 emission factors					
	Code	Name			
NFR Source Category	2.C.5.d	Zinc production			
Fuel	NA				
SNAP (if applicable)	040309c	Zinc production			
Technologies/Practices	Secondary zinc production				
Region or regional conditions					
Abatement technologies	FF state-of-the-art.				
Not applicable	Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex, Toxaphene, HCH, DDT, PCP, SCCP				
Not estimated	NOx, CO, NMVOC, SOx, NH3, Cu, Ni, Se, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB				
Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
TSP	39	g/Mg zinc	13	120	Visschedijk et al. (2004)
PM10	30	g/Mg zinc	10	90	Visschedijk et al. (2004)
PM2.5	22	g/Mg zinc	7.3	66	Visschedijk et al. (2004)
Pb	0.0065	g/Mg zinc	0.0022	0.02	Theloke et al. (2008)
Cd	0.0035	g/Mg zinc	0.0012	0.011	Theloke et al. (2008)
Hg	0.0054	g/Mg zinc	0.0018	0.016	Theloke et al. (2008)
As	0.00059	g/Mg zinc	0.0002	0.0018	Theloke et al. (2008)
Cr	0.00026	g/Mg zinc	0.000087	0.00078	Theloke et al. (2008)
Zn	40	g/Mg zinc	15	110	European Commission (2001)
PCB	0.0031	g/Mg zinc	0.001	0.0093	Theloke et al. (2008)
PCDD/F	100	µg I-TEQ/Mg zinc	0.3	1000	UNEP (2005)

3.3.3 Abatement

A number of add on technologies exist that are aimed at reducing the emissions of specific pollutants. The resulting emission can be calculated by replacing the technology-specific emission factor with an abated emission factor as given in the formula:

$$EF_{technology,abated} = \eta_{abatement} \times EF_{technology,unabated} \quad (4)$$

Where

$EF_{technology, abated}$	=	the emission factor after implementation of the abatement
$\eta_{abatement}$	=	the abatement efficiency
$EF_{technology, unabated}$	=	the emission factor before implementation of the abatement

This section presents default abatement efficiencies for particulates. Abatement efficiencies for particulates are presented in Table 3.13. These efficiencies are related to the older plant technology, using the CEPMEIP emission factors (Visschedijk *et al*., 2004). These abatement efficiencies are used to estimate the particulate emission factors in the Tier 2 tables above.

Table 3.13 Abatement efficiencies ($\eta_{abatement}$) for source category 2.C.5.d Zinc production

Tier 2 Abatement efficiencies					
	Code	Name			
NFR Source Category	2.C.5.b	Lead production			
Fuel	NA	not applicable			
SNAP (if applicable)	040309b	Lead production			
Abatement technology	**Particle size**	**Efficiency**	**95% confidence interval**		**Reference**
		Default Value	**Lower**	**Upper**	
Conventional installation: ESP, settlers, scrubbers; moderate control of fugive sources	particle > 10 µm	91.7%	75.0%	97.2%	Visschedijk (2004)
	10 µm > particle > 2.5 µm	92.0%	76.0%	97.3%	Visschedijk (2004)
	2.5 µm > particle	92.5%	77.5%	97.5%	Visschedijk (2004)
Modern plant (BAT): fabric filters for most emission sources	particle > 10 µm	96.7%	86.7%	99.2%	Visschedijk (2004)
	10 µm > particle > 2.5 µm	96.4%	85.6%	99.1%	Visschedijk (2004)
	2.5 µm > particle	96.0%	84.0%	99.0%	Visschedijk (2004)

3.3.4 Activity data

Information on the production of zinc suitable for estimating emissions using Tier 1 and 2 estimation methodology is widely available from United Nations statistical yearbooks or national statistics.

For a Tier 2 approach these data need to be stratified according to technologies applied. Typical sources for these data might be industrial branch organisations within the country or questionnaires submitted to the individual zinc works.

Further guidance is provided in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 3 on Industrial Processes and Product Use (IPPU), chapter 4.7.2.3 ‘Choice of activity statistics’ (IPCC, 2006).

3.4 Tier 3 emission modelling and use of facility data

3.4.1 Algorithm

There are two different methods to apply emission estimation methods that go beyond the technology-specific approach described above:

- detailed modelling of the zinc production process;
- facility-level emission reports.

3.4.1.1 Detailed process modelling

A Tier 3 emission estimate using process details will make separate estimates for the consecutive steps in the zinc production process.

3.4.1.2 Facility-level data

Where facility-level emission data of sufficient quality (see the guidance chapter on QA/QC in Part A of the Guidebook) are available, it is good practice to use these data. There are two possibilities:

- the facility reports cover all zinc production in the country;
- facility-level emission reports are not available for all zinc plants in the country.

If facility level data cover all zinc production in the country, it is good practice to compare the implied emission factors (reported emissions divided by national zinc production) with the default emission factor values or technology-specific emission factors. If the implied emission factors are outside the 95 % confidence intervals for the values given below, it is good practice to explain the reasons for this in the inventory report

If the total annual zinc production in the country is not included in the total of the facility reports, it is good practice to estimate the missing part of the national total emissions from the source category, using extrapolation by applying:

$$E_{Total,pollutant} = \sum_{Facilities} E_{Facility,pollutant} + \left(National\ Production - \sum_{Facilities} Production_{Facility} \right) \times EF \qquad (5)$$

where:

$E_{total,pollutant}$	=	the total emission of a pollutant for all facilities within the source category
$E_{facility,pollutant}$	=	the emission of the pollutant as reported by a facility
$Production_{total}$	=	the production rate in the source category
$Production_{facility}$	=	the production rate in a facility
$EF_{pollutant}$	=	the emission factor for the pollutant

Depending on the specific national circumstances and the coverage of the facility-level reports as compared to the total national zinc production, it is good practice to choose the emission factor (*EF*) in this equation from the following possibilities, in decreasing order of preference:

- technology-specific emission factors, based on knowledge of the types of technologies implemented at the facilities where facility level emission reports are not available;
- the implied emission factor derived from the available emission reports:

$$EF = \sum_{Facilities} E_{Facility,\,pollutant} \Big/ \sum_{Facilities} Production_{Facility} \qquad (6)$$

- the default Tier 1 emission factor. This option should only be chosen if the facility level emission reports cover more than 90 % of the total national production

3.4.2 Tier 3 emission modelling and use of facility data

Zinc kilns are major industrial facilities and emission data for individual plants might be available through a pollutant release and transfer registry (PRTR) or another emission reporting scheme. When the quality of such data is assured by a well developed QA/QC system and the emission reports have been verified by an independent auditing scheme, it is good practice to use such data. If extrapolation is needed to cover all zinc production in the country either the implied emission factors for the facilities that did report or the emission factors as provided above could be used.

The emission factor for ore handling is calculated with the following formula:

$$E = M_{dust} \cdot M_{ore} \cdot M_{metals} \cdot M_{production,zinc}^{-1} \qquad (7)$$

where:

M_{dust}	=	loss of mass during receipt of ore (weight percentage)
M_{ore}	=	yearly average received mass of zinc ores (tonnes)
M_{metals}	=	average weight percentage of metals in dust
$M_{production,zinc}$	=	total yearly produced mass zinc (tonnes)

The emission factor, summarizing all processes with vaporisation of off-gas containing heavy metal is calculated using:

$$E = F_{gas} \cdot d \cdot C_{metals} \cdot M_{production,zinc}^{-1} \qquad (8)$$

Where:

F_{gas}	=	gas flow of a certain subprocess that emits heavy metals to air (m^3/yr)
d	=	duration of the period of emission of HMs to air (per subprocess) (yr)
C_{metals}	=	average concentration of heavy metals in emitted gas (g/m^3)
$M_{production,zinc}$	=	total yearly produced mass zinc (tonnes)

Emissions can vary widely depending on the ore used and the abatement measures applied. Table 3.14 shows reported emission factors. The emission factors in Table 3.3 and Table 3.4 have been constructed using the data in this table.

Table 3.14 Emission factors for primary zinc production (in g/Mg product) as reported by several countries/authors

	Germany([a])		**Poland([b])**		**Netherlands([c])**	**Pacyna([d,e])**	
Compound	thermal	electrolytic	thermal	electrolytic	electrolytic	Thermal	electrolytic
Cadmium	100	2	13	0.4–29	0.5	500 ([f])	0.2
Lead	450	1	31–1 000	2.3–467	-	1 900	-
Mercury	5–50	-	-	-	-	8	-
Zinc	-	-	420–3 800	47–1 320	120	1 6000	6

Note:

([a]) Jockel and Hartje (1991)

([b]) Hlawiczka *et al*. (1995)

([c]) Matthijsen and Meijer (1992)

([d]) Pacyna (1990a)

([e]) Pacyna (1990b)

([f]) With vertical retort: 200 g/Mg product; with Imperial Smelting Furnace: 50 g/Mg product.

([g]) Limited abatement.

3.4.3 Activity data

Since PRTR generally do not report activity data, such data in relation to the reported facility-level emissions are sometimes difficult to find. A possible source of facility-level activity data might be the registries of emission trading systems.

In many countries national statistics offices collect production data at the facility level but these are in many cases confidential. However, in several countries national statistics offices are part of the national emission inventory systems and the extrapolation, if needed, could be performed at the statistics office, ensuring that the confidentiality of production data is maintained.

4 Data quality

4.1 Completeness

Care must be taken to include all emissions, from combustion as well as from processes. It is good practice to check, whether the emissions, reported as 'included elsewhere' (IE) under source category 2.C.5.d are indeed included in the emission reported under combustion in source category 1.A.2.b.

4.2 Avoiding double counting with other sectors

Care must be taken that the emissions are not double counted in processes and combustion. It is good practice to check that the emissions reported under source category 2.C.5.d are not included in the emission reported under combustion in source category 1.A.2.b.

4.3 Verification

4.3.1 Best Available Technique emission factors

BAT emission limit values are available from the BREF document for the non-ferrous metal industry (European Commission, 2001).

The BREF document describes the technologies necessary to achieve BAT emission levels. For zinc production, no generic emission concentrations are given that may be compared against the Tier 1 estimate. However, some numbers for different techniques and processes are available from the BREF document and may be used for verification purposes.

4.4 Developing a consistent time series and recalculation

No specific issues.

4.5 Uncertainty assessment

No specific issues.

4.5.1 Emission factor uncertainties

The quality class of the emission factors is estimated to be about B. Please refer to the general guidance chapter on uncertainties in Part A of the Guidebook for an explanation of how this relates to the 95 % confidence intervals in the emission factor tables.

4.5.2 Activity data uncertainties

No specific issues.

4.6 Inventory quality assurance/quality control (QA/QC)

No specific issues.

4.7 Gridding

No specific issues.

4.8 Reporting and documentation

No specific issues.

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6 Point of enquiry

Enquiries concerning this chapter should be directed to the relevant leader(s) of the Task Force on Emission Inventories and Projection's expert panel on Combustion and Industry. Please refer to the TFEIP website (www.tfeip-secretariat.org) for the contact details of the current expert panel leaders.