Task 2: Review of consistence between EFs for: PM, HMs, POPs and BC (2A, 2B, 2C, 2D, 2F)

Introduction

The present paper present and discuss the available emission factors (EFs) within the NFR category 2 Industrial emissions for primarily particulate matter (TSP, PM_{10} and $PM_{2.5}$) and heavy metals (Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn); secondarily for POP and BC with the aim of identifying inconsistences between the different groups of pollutants. Identified inconsistences between different datasets related to the same category will also be commented. As far as possible the literature behind the outlying EFs will be surveyed. So far, the references are cited directly from the GB and it is indicated that they are "cited from GB".

Consistence analysis

The consistence analysis has been performed in the following steps:

1. Evaluation of the relationship between emission of TSP, PM_{10}, and $PM_{2.5}$.
2. Evaluation of the relationship between emission of TSP and the total amount of emitted heavy metals.
3. Evaluation of the relationship between EFs for similar processes e.g. Tier 1, Tier 2 (different technologies and different abatement methodologies).
4. Evaluation of EFs for POPs.

The main results are summarised in the individual chapters with the original references cited from the GB. The complete analysis is presented in annexes. Some of the references have been obtained for further examination if found relevant. For some of the processes new literature has been identified in order to propose new and more consistent EFs. For discussions of EF for BC please refer to task 1.

2A1-4

The following processes are included in this section:

- 2.A.1 Cement production
- 2.A.2 Lime production
- 2.A.3 Limestone and dolomite use
- 2.A.4 Soda ash production and use

The results of the evaluation are presented in table 1. The GB does not present EFs for POPs and BC for the sectors 2.A.1 Cement production, 2.A.2 Lime production, 2.A.3 Limestone and dolomite use, and 2.A.4 Soda ash production and use.

Table 1

		Tier	Technology	Abatement	TSP g/Mg raw material	TSP g/Mg product	PM10/ TSP %	PM2.5/ TSP %	Referen-ce
2.A.1	Cement production	1	No information	No information	-	220	91	50	1
		2	Wet kiln	ESP2, 98.9%	-	600	85	30	2
		2	Dry kiln	ESP2, 99.5%	-	2500	52	38	2
2.A.2	Lime production	1	No information	No information	-	590	41	8,5	3,4
		2	Some types of lime kiln	Uncontrolled	-	9000	39	7,8	3,4
		2	Some types of lime kiln	Controlled	-	400	50	7,5	3,4
2.A.3	Limestone and dolomite use	1	No information	No information	ni	-	na	na	
2.A.4	Soda ash production and use	1	No information	No information	-	100	na	na	5

1. European Commission (2007b).
2. Kakareka (2008).
3. European Commission (2001).
4. Visschedijk et al. (2004).
5. European Commission (2007a).

For 2.A.1 Cement production there is a remarkable inconsistence between the EFs (TSP) for Tier 1 (220 g/Mg product) and Tier 2 exemplified with the two different technologies (600 g/Mg product; wet process and 2500 g/Mg product; dry process) supplied with ESP2, 98.9-99.5% efficiency. The Tier 1 EF does not represent a worst case estimate. The Tier 1 and Tier 2 EFs are proposed to be re-investigated and if possible derived from the same reference. The latest BREF is proposed to be included as well as a general literature survey. Kakareka will be contacted regarding documentation of the EFs for wet and dry kiln cement production.

For 2.A.2 Lime production there is a similar inconsistence. The GB present the following EFs (TSP) for Tier 1 (590 g/Mg product) and Tier 2 exemplified with different technologies (9000 g/Mg product; uncontrolled and 400 g/Mg product; controlled). The Tier 1 EF does not represent a worst case estimate. As for cement production the Tier 1 and Tier 2 EFs are proposed to be re-investigated and if possible derived from the same reference. The latest BREF is proposed to be included as well as a general literature survey.

2A5-6

The following processes are included in this section:

- 2.A.5 Asphalt roofing
- 2.A.6 Road paving with asphalt

The results of the evaluation are presented in table 2. The GB does not present EFs for POPs and BC for the sectors 2.A.5 Asphalt roofing and 2.A.6 Road paving with asphalt.

Table 2

		Tier	Technology	Abatement	TSP g/Mg shingle	TSP g/Mg asphalt	PM10/ TSP %	PM2.5/ TSP %	Referen-ce
2.A.5	Asphalt roofing	1	No information	ni	600	-	na	na	1
		2	Dip saturator, drying-in drum section, wet looper and coater	uncontrolled	600	-	na	na	1
		2	Spray/dip saturator, drying-in drum section, wet looper, coater and storage tanks	uncontrolled	1600	-	na	na	1
2.A.6	Road paving with asphalt	1	No information	ni	-	14000	21	2,9	2
		2	Batch Mix Hot Mix Plant	uncontrolled	-	15000	13	0,7	2
		2	Drum Mix Hot Mix Plant	uncontrolled	-	13000	23	5,4	2

1. US EPA (1995).
2. US EPA (2004).

For 2.A.5 Asphalt roofing there is an inconsistency between the Tier 1 EF (600 g TSP/Mg shingle) and one of the Tier 2 EF (1600 Mg TSP/Mg shingle). The Tier 1 EF is proposed to be adjusted to reflect an average EF.

For 2.A.6 there seems to be consistency between the different Tiers.

2A7a-f

The following processes are included in this section:

- 2.A.7.a Quarrying and mining of minerals other than coal
- 2.A.7.b Construction and demolition
- 2.A.7.c Storage, handling and transport of mineral products
- 2.A.7.d Other Mineral products

The results of the evaluation are presented in table 3. The GB does not present EF for POPs and BC for the sectors 2.A.7.a Quarrying and mining of minerals other than coal, 2.A.7.b Construction and demolition, 2.A.7.c Storage, handling and transport of mineral products, and 2.A.7.d Other Mineral products.

Table 3

		Tier	Technology	Abatement	TSP g/Mg raw material	TSP g/Mg product	TSP g/m²/ year	∑HM g/Mg product	∑HM/ TSP %	Refe-rence
2.A.7.a	Quarrying and mining of minerals other than coal	1	No information	ni	0,07	-	-	ni	-	1
2.A.7.b	Construction and demolition	1	No information	ni	-	-	162	ni	-	1
2.A.7.c	Storage, handling and transport of mineral products	1	No information	ni	-	ni	-	ni	-	
		2	No information	ni	-	10	-	ni	-	1
2.A.7.d	Other Mineral products	1	Glass	ni	-	300	-	3,9	1,3	1
		2	Flat glass	abated furnaces (primary/secondary methods)	-	130	-	1,9	1,5	1,2,3
		2	Container glass	primary measures; without secondary abatement	-	280	-	5,4	1,9	1,2
		2	Continuous filament glass fibres	primary abatement methods; no secondary abatement	-	100	-	ni	-	1,2
		2	Glass wool (except binding)	ni	-	670	-	ni	-	1,2
		2	Other glass (lead crystal glass)	filters in operation	-	10	-	10	100	1,4
		2	Water glass	ni	-	200	-	ni	-	1,2

1. Visschedijk et al. (2004)
2. European Commission (2008).
3. Rivet (2008).
4. Beerkens (2008).

For 2.A.7.a, b, and c no inconsistencies have been identified. However, the EFs for 2.A.7.a are a factor 1000 to low according to the original reference (Visschedijk et al., 2004).

For 2.A.7.d Other mineral products (various glass products) almost the same distribution between TSP, PM_{10} and $PM_{2.5}$ has been found for the different types of glass. For most of the glass types ∑HM constitute < 5% of TSP, however, for *Other glass* (lead crystal glass) ∑HM (only lead) constitute 100%. The high share of lead seems unreliable. The EF for *Other glass* is proposed to be re-investigated.

2B

The following processes are included in this section:

- 2.B.1 Ammonia production
- 2.B.2 Nitric acid production
- 2.B.3 Adipic acid production
- 2.B.4 Carbide production
- 2.B.5.a Other chemical industry

The results of the evaluation are presented in table 4. For many processes there is no information on EFs for TSP available and therefore, only selected results for sector 2.B.4 Carbide production and 2.B.5.a Other

chemical industry are presented in table 4. The GB does not present EF for POPs and BC for the sector 2.B Chemical industry.

Table 4

		Tier	Technology	Abatement	TSP g/Mg raw material	g/Mg product	PM10/ TSP %	PM2.5/ TSP %	Referencer
2.B.4	Carbide production	1	No information	ni	-	100	na	na	1
		2	CaC_2 production without the usage of furnace gas	Various, dedusting	-	49	na	na	1
		2	CaC_2 production without the usage of furnace gas (e.g. lime kiln)	Various, dedusting	-	80,9	na	na	1
2.B.5.a	Ammonium sulphate	2	No information	Uncontrolled	-	60	na	na	2
	Ammonium nitrate	2	No information	Uncontrolled	-	200	na	na	2
	Ammonium phosphate	2	No information	ni	-	300	80	60	3
	Urea	2	No information	ni	-	1500	80	60	2
	Carbon black	2	Furnace black process (conventional process)	ni	-	300	na	na	1
	Titanium dioxide	2	Chloride process	ni	-	200	na	na	1
		2	Sulphate process	ni	-	300	na	na	1
	Phosphate fertilizers	2	No information	ni	-	300	80	60	3
	Polyethylene Low Density	2	No information	ni	-	31	na	na	4
	Polyethylene High Density	2	No information	ni	-	97	na	na	4
	Polyvinylchloride	2	Suspension PVC process (S-PVC)	ni	-	263	38	1,9	3
		2	Emulsion PVC process (E-PVC)	ni	-	263	38	1,9	3
	Polypropylene	2	No information	ni	-	1500	na	na	2
	Styrene	2	No information	ni	-	ni	na	na	5
	Polystyrene	2	Production of General purpose polystyrene (GPPS)	ni	-	4	na	na	5
		2	High impact polystyrene (HIPS)	ni	-	4	na	na	5
		2	Expandable polystyrene (EPS)	ni	-	30	na	na	4

1. IPPC BREF LVIC SAO.
2. US EPA AP42.
3. Visschedijk et al. (2004)
4. IPPC BREF Polymers.
5. Guidebook (2006)

For 2.B Chemical industry no inconsistencies have been identified.

2C1-3

The following processes are included in this section:

- 2.C.1 Iron and steel production
- 2.C.2 Ferroalloys production
- 2.C.3 Aluminium production

The results of the evaluation are presented in table 5. Information on HCB, PCDD/F and PAH is also presented for 2.C.1 Iron and steel production and 2.C.3 Aluminium production.

Table 5

		Tier	Technology	Abatement	TSP g/Mg raw material	g/Mg product	∑HM g/Mg raw material	g/Mg product	∑HM/ TSP %	PM10/ TSP %	PM2.5 / TSP %	Reference
2.C.1	Iron and steel production	1	No information	ni	-	300	-	13,9	4,6	60	47	1,2,3,4
		2	Sinter production	ni	200	-	3,79	-	1,9	50	40	1,2,3,4
		2	Pellet production	ni	50	-	0,053	-	0,1	80	50	1,2,3,4
		2	Sinter and pelletizing plants	wFGD (state-of-the-art)	200	-	1,28	-	0,6	50	40	1,2,3,4
		2	Sinter and pelletizing plants	Virgin activated carbon injection (SIC) & fabric filter	200	-	6,98	-	3,5	50	40	1,2,3,4
		2	Sinter and pelletizing plants	Simultaneous control of SO2, NOxand Hg (SICs)	200	-	14,1	-	7,0	50	40	1,2,3,4
		2	Sinter and pelletizing plants	Dry ESP	200	-	0,13	-	0,1	50	40	1,2,3,4
		2	Blast furnace charging	ni	50	-	2,39	-	4,8	80	50	1,2,3,4
		2	Blast furnace charging	Heat recovery	50	-	2,57	-	5,1	80	50	1,2,3,4
		2	Blast furnace charging	Dry ESP	50	-	0,09	-	0,2	80	50	1,2,3,4
		2	Blast furnace charging	Fabric filter with medium efficiency	50	-	0,19	-	0,4	80	50	1,2,3,4
		2	Blast furnace charging	wSV (medium)	50	-	0,24	-	0,5	80	50	1,2,3,4
		2	Open hearth furnace steel plant	ni	1000	-	351	-	35	80	60	3,5,6,7
		2	Open hearth furnace steel plant	Limited control (95-96%)	700	-	18,2	-	2,6	81	54	7
		2	Basic oxygen furnace steel plant	ni	-	35	-	10,9	31	91	80	1,2,3,4
		2	Basic oxygen furnace steel plant	Limited control (97.5%)	-	500	-	27,4	5,5	94	92	4,7
		2	Electric furnace steel plant	ni	-	30	-	7,29	24	80	70	1,3,7
		2	Basic oxygen furnace steel plant	Dry ESP	-	30	-	3,64	12	80	70	1,3,7
		2	Basic oxygen furnace steel plant	wSV (medium)	-	30	-	5,85	20	80	70	1,3,7
		2	Electric furnace steel plant	Dry ESP	-	30	-	3,79	13	80	70	1,3,7
		2	Electric furnace steel plant	Fabric filter (optimized)	-	30	-	3,67	12	80	70	1,3,7
		2	Electric furnace steel plant	Fabric filter (retrofitted)	-	30	-	5,84	20	80	70	1,3,7

		Tier	Technology	Abatement	TSP g/Mg raw material	TSP g/Mg product	∑HM g/Mg raw material	∑HM g/Mg product	∑HM/ TSP %	PM10/ TSP %	PM2.5 / TSP %	Reference
		2	Electric furnace steel plant	High (>99%, bag filter)	-	200	-	3,88	1,9	80	70	7
		2	Cold rolling mills	ni	-	96		ni	na	na	na	1
		2	Hot rolling mills	ni	-	9		ni	na	na	na	1
2.C.2	Ferroalloys production	1	No information	ni	-	1000		ni	na	na	na	8
2.C.3	Aluminium production	1	No information	ni	-	3000	-	ni	na	67	33	2,9
		2	Electrolysis, pre-baked anodes	ni	-	4000	-	ni	na	80	35	2,9
		2	Electrolysis, Soderberg anodes	ni	-	4000	-	ni	na	80	35	2,9
		2	Secondary aluminium production	ni	-	2000	-	ni	na	70	28	2

1. European Commission (2001a).
2. Visschedijk et al. (2004).
3. Theloke et al. (2008).
4. Guidebook (2006).
5. US EPA (1986).
6. Wessely (1993).
7. Kakareka (2008).
8. Air & Waste (1992).
9. European Commission (2001b).

For 2.C.1 Iron and steel production a number of inconsistencies have been identified.

EFs for *Blast furnace charging* are presented in a number of variations (3-8 – 3-12; no abatement, heat recovery, dry ESP, fabric filter, and wSV (medium), however, the same EFs are presented for TSP, PM_{10} and $PM_{2.5}$. I.e. the different abatement technologies are not reflected in the TSP emission. The abatement is reflected on the emission of heavy metals. The EFs for TSP are proposed to be re-investigated and revised to reflect the different abatement levels.

EFs for *Basic oxygen furnace steel plant* are presented without and with abatement technologies (limited control, 97.5%, dry ESP, and wSV (medium)) and the EFs for TSP are 35, 500, 30, and 30 g TSP/Mg product, respectively. The same tendency can be seen for heavy metals but with a minor difference. The sources for the EFs are different and this fact may be an explanation. The sources to the EFs for TSP and heavy metals are proposed to be re-investigated.

EFs Electric furnace steel plant are also presented without and with abatement technologies (3-17, 3-20 – 3-23; no abatement, dry ESP, fabric filter (optimised), fabric filter (retrofitted), and high (>99%, bag filter)). The EFs for TSP are 30, 30, 30, 30, and 200 g TSP/Mg product. The EFs on the same level (30 g TSP/Mg product) do not reflect the different abatement technologies and the last EF (200 g TSP/Mg product) is totally outlying even as the process is supplied with a bag filter with 99% efficiency. The sources for the EFs for TSP are proposed to be re-investigated.

For 2.C.2 Ferroalloys production information is scarce and therefore no inconsistences have been identified.

For 2.C.3 Aluminium production there is no information on emission of heavy metals, and the distribution between TSP, PM_{10}, and $PM_{2.5}$ is nearly similar for the different processes.

Table 6

		Tier	Technology	Abatement	PCB mg/Mg raw material	PCB mg/Mg product	PCDD/F µg/Mg raw material	PCDD/F µg/Mg product	∑ 4 PAH g/Mg raw material	∑ 4 PAH g/Mg product	HCB mg/Mg raw material	HCB mg/Mg product
2.C.1	Iron and steel production	1	No information	ni	-	6	-	2	-	3	-	0,03
		2	Sinter production	ni	3,6	-	1,8	-	0,32	-	0,032	-
		2	Pellet production	ni	3,6	-	0,0057	-	0,19	-	0,032	-
		2	Sinter and pelletizing plants	wFGD (state-of-the-art)	-	-	6	-	0,30	-	0,032	-
		2	Sinter and pelletizing plants	Virgin activated carbon injection (SIC) & fabric filter	1,5	-	6	-	0,30	-	0,032	-
		2	Sinter and pelletizing plants	Simultaneous control of SO2, NOxand Hg (SICs)	1,7	-	6	-	0,30	-	0,032	-
		2	Sinter and pelletizing plants	Dry ESP	1,7	-	6	-	0,30	-	0,032	-
		2	Blast furnace charging	ni	2	-	0,002	-	2,5	-	-	-
		2	Blast furnace charging	Heat recovery	1,9	-	0,002	-	2,5	-	-	-
		2	Blast furnace charging	Dry ESP	1,9	-	0,002	-	2,5	-	-	-
		2	Blast furnace charging	Fabric filter with medium efficiency	1,9	-	0,002	-	2,5	-	-	-
		2	Blast furnace charging	wSV (medium)	1,9	-	0,002	-	2,5	-	-	-
		2	Open hearth furnace steel plant	ni	-	-	-	-	-	-	-	-
		2	Open hearth furnace steel plant	Limited control (95-96%)	-	-	-	-	-	-	-	-
		2	Basic oxygen furnace steel plant	ni	-	3,6	-	0,008	-	0,0001	-	-
		2	Basic oxygen furnace steel plant	Limited control (97.5%)	-	3,6	-	0,008	-	0,0001	-	-
		2	Electric furnace steel plant	ni	-	8	-	0,8	-	16	-	-
		2	Basic oxygen furnace steel plant	Dry ESP	-	2,6	-	0,8	-	16	-	-
		2	Basic oxygen furnace steel plant	wSV (medium)	-	2,6	-	0,8	-	16	-	-
		2	Electric furnace steel plant	Dry ESP	-	1,9	-	0,8	-	16	-	-
		2	Electric furnace steel plant	Fabric filter (optimized)	-	1,9	-	0,8	-	16	-	-
		2	Electric furnace steel plant	Fabric filter (retrofitted)	-	1,9	-	0,8	-	16	-	-
		2	Electric furnace steel plant	High (>99%, bagfilter)	-	3,6	-	2	-	-	-	-
		2	Cold rolling mills	ni	-	-	-	-	-	-	-	-
		2	Hot rolling mills	ni	-	-	-	-	-	-	-	-
2.C.3	Aluminium production	1	No information	ni	-	-	-	5	-	21	-	-
		2	Electrolysis, pre-baked anodes	ni	-	-	-	-	-	115	-	-
		2	Electrolysis, Soderberg anodes	ni	-	-	-	-	-	3,75	-	-
		2	Secondary aluminium production	ni	-	-	-	35	-	-	-	5000

No inconsistencies have been identified for the EFs for PCB.

The EFs for PCDD/F shows inconsistence with a factor 1000 difference between different EFs. These EFs are proposed to be reinvestigated.

The EFs for ∑ 4 PAH are found to be of the same order of magnitude except for two processes (basic oxygen furnace steel plants with no abatement or limited control (97.5%)) These EFs are proposed to be reinvestigated.

Only few EFs are given for HCB and the EF for secondary aluminium production is identified as an outlier (factor 1000). This EF is proposed to be investigated.

A number of the presented EFs for PCB and PCDD/F attributed to Theloke et al. (2008), however, the study by Theloke et al. only includes heavy metals. The original source to these EFs is proposed to be identified.

2C5a-f

The following processes are included in this section:

- 2.C.5.a Copper production
- 2.C.5.b Lead production
- 2.C.5.c Nickel production
- 2.C.5.d Zinc production
- 2.C.5.e Other metal production
- 2.C.5.f Storage, handling and transport of metal products

The results are presented in table 7. The are no relevant data for 2.C.5.e Other metal production, 2.C.5.f Storage, handling and transport of metal products. Information on HCB, PCDD/F and PAH is also presented for 2.C.5.a Copper production, 2.C.5.b Lead production, and 2.C.5.d Zinc production.

1 **Table 7**

		Tier	Technology	Abatement	TSP g/Mg product	Sum heavy metals g/Mg product	HM/ TSP %	PM10/ TSP %	PM2.5/ TSP %	Reference
2.C.5.a	Copper production	1	No information	ni	400	310	77,5	80	60	1,2,3
		2	Primary copper production	ni	400	366	91,5	80	60	1,2,3
		2	Primary copper production, traditional method	ESP, limited control (98%)	45000	14830	33,0	80	60	4
		2	Primary copper production, traditional method	ESP, abatement (>99%)	5000	971	19,4	80	60	4
		2	Secondary copper production	ni	320	141	44,3	81	59	1,2,3
		2	Secondary copper production, traditional method	Limited control	1500	542	36,1	80	60	4
2.C.5.b	Lead production	1	No information	ni	500	333	66,6	80	40	1,2,3
		2	Primary lead production	ni	500	14,0	2,8	80	40	2,3
		2	Primary lead production	BAT production technologies	29	144	497,2	97	69	2,3
		2	Primary lead production	dry ESP	29	24,5	84,5	97	69	2,3
		2	Primary lead production	FF state-of-the-art	29	0,91	3,2	97	69	2,3
		2	Primary lead production	virgin activated carbon injection (SIC)+FF+FGD	29	0,12	0,4	97	69	2,3
		2	Primary lead production, traditional method	ESP, limited control	2500	1743	69,7	80	64	4
		2	Primary lead production, traditional method	ESP, >99% efficiency	500	232	46,4	80	60	4
		2	Secondary lead production	ni	500	434	86,9	80	40	2,3
		2	Secondary lead production	BAT production technologies	29	5257	18128	97	69	2,3
		2	Secondary lead production	dry ESP	29	899	3103,1	97	69	2,3
		2	Secondary lead production	FF state-of-the-art.	29	0,59	2,0	97	69	2,3
		2	Secondary lead production	ESP, limited control	1500	901	60,1	80	67	4
2.C.5.c	Nickel production	1	No information	ni	660	42	6,4	0	0	1
2.C.5.d	Zinc production	1	No information	ni	500	60,4	12,1	80	60	1,2,3
		2	Primary zinc production	ni	500	64,4	12,9	80	60	1,2,3
		2	Primary zinc production, Electrochemical process	ni	500	106	21,2	80	60	2,5
		2	Primary zinc production, Thermal smelting process	ni	500	10620	2124	80	60	2,5
		2	Primary zinc production	BAT production technologies	39	83,3	213	77	56	1,2,3
		2	Primary zinc production	FF state-of-the-art	39	44,5	114	77	56	1,2,3
		2	Primary zinc production	ESP, limited	5000	2265	45,3	80	60	4
		2	Primary zinc production	ESP, abatement	1500	590	39,3	80	60	4
		2	Secondary zinc production	ni	500	48,5	9,7	80	60	1,2,3
		2	Secondary zinc production	BAT production technologies	39	137	353	77	56	1,2,3
		2	Secondary zinc production	dry ESP	19	56,5	297	84	63	1,2,3
		2	Secondary zinc production	FF state-of-the-art	39	40,0	102	77	56	1,2,3

1. European Commission (2001b).
2. Visschedijk et al. (2004).
3. Theloke et al. (2008).
4. Kakareka (2008).
5. Guidebook (2006)

2

For 2.C.5.a Copper production the EFs for TSP and HMs covering the EECCA countries are identified as outliers. The EFs for TSP emission from primary copper production supplied with ESP (98-99% efficiency) are 10 to 100 times higher than EFs based on the EU BREF document. The EFs for TSP is proposed to be re-investigated and documentation of the EFs from the EECCA countries will be included if possible.

For 2.C.5.b Lead production the same picture can be seen for EFs covering the EECCA countries. These EFs will be re-investigated. As indicated in table 7 the amount of heavy metals exceeds the amount of TSP. The heavy metals are normally emitted as particles and therefore these the amount of heavy metals should be ≤ the amount of particulate matter. The sources to the emissions are proposed to be re-investigated and if possible the same source to TSP and heavy metals will be applied. Furthermore, the same EF for TSP has been used for primary and secondary lead production supplied with different flue gas cleaning methodologies (29 g/Mg product).The EF are proposed to be revised to reflect the flue gas cleaning methodologies and also to follow the tendency in EFs for heavy metals.

For 2.C.5.c Nickel production no inconsistences have been identified.

For 2.C.5.d Zinc production the same picture can be seen for EFs covering the EECCA countries. These EFs will be re-investigated. The amount of heavy metals constitutes 102 to 2124% of the amount of TSP. The sources to the emissions are proposed to be re-investigated and if possible the same source to TSP and heavy metals will be applied. Furthermore, the same EF for TSP has been used for primary and secondary lead production supplied with different flue gas cleaning methodologies (39 g/Mg product).The EF are proposed to be revised to reflect the flue gas cleaning methodologies and also to follow the tendency in EFs for heavy metals.

Table 8

		Tier	Technology	Abatement	PCB mg/Mg product	PCDD/F µg/Mg product	∑ 4 PAH g/Mg product	HCB mg/Mg product
2.C.5.a	Copper production	1	No information	ni	900	5	-	-
		2	Primary copper production	ni	-	0,01	-	-
		2	Primary copper production, traditional method	ESP, limited control (98%)	-	0,01	-	-
		2	Primary copper production, traditional method	ESP, abatement (>99%)	-	0,01	-	-
		2	Secondary copper production	ni	3700	50	-	-
		2	Secondary copper production, traditional method	Limited control	3700	200	-	-
2.C.5.b	Lead production	1	No information	ni	1900	5	-	-
		2	Primary lead production	ni	-	0,5	-	-
		2	Primary lead production	BAT production technologies	-	0,5	-	-
		2	Primary lead production	dry ESP	-	0,5	-	-
		2	Primary lead production	FF state-of-the-art	-	0,5	-	-
		2	Primary lead production	virgin activated carbon injection (SIC)+FF+FGD	-	0,5	-	-
		2	Primary lead production, traditional method	ESP, limited control	-	0,5	-	-
		2	Primary lead production, traditional method	ESP, >99% efficiency	-	0,5	-	-
		2	Secondary lead production	ni	3200	8	-	-
		2	Secondary lead production	BAT production technologies	-	8	-	-
		2	Secondary lead production	dry ESP	3,1	8	-	-
		2	Secondary lead production	FF state-of-the-art.	3,1	8	-	-
		2	Secondary lead production	ESP, limited control	-	20	-	-
2.C.5.d	Zinc production	1	No information	ni	900	5	-	-
		2	Primary zinc production	ni	-	-	-	-
		2	Primary zinc production, Electrochemical process	ni	-	-	-	-
		2	Primary zinc production, Thermal smelting process	ni	-	-	-	-
		2	Primary zinc production	BAT production technologies	-	-	-	-
		2	Primary zinc production	FF state-of-the-art	-	-	-	-
		2	Primary zinc production	ESP, limited	-	-	-	-
		2	Primary zinc production	ESP, abatement	-	-	-	-
		2	Secondary zinc production		3600	100	-	-
		2	Secondary zinc production	ni	3,1	100	-	-
		2	Secondary zinc production	dry ESP	3,1	100	-	-
		2	Secondary zinc production	FF state-of-the-art	3,1	100	-	-

The EFs for PCB shows significant inconsistences with a factor 1000 difference between two groups of EFs. The difference cannot explicitly be attributed to primary/secondary metal production. These EFs are proposed to be reinvestigated.

Regarding PCDD/F the EFs covering secondary metal production are up to more than a factor 1000 higher than primary production, however, this relation is expected.

2D1-3 + 2F

The following processes are included in this section:

- 2.D.1 Pulp and paper
- 2.D.2 Food and drink
- 2.D.3 Wood processing

The results of the evaluation are presented in table 9. The GB does not present EFs for POPs and BC for the sectors 2.D.1 Pulp and paper, 2.D.2 Food and drink, and 2.D.3 Wood processing.

Table 9

		Tier	Technology	Abatement	TSP g/Mg	PM10/TSP %	PM2.5/TSP %	Reference
2.D.1	Pulp and paper	1	No information	ni	1000	80	60	1,2
		2	Paper pulp (kraft process)	scrubber and electrostatic precipitator	1000	80	60	1,2
		2	Paper pulp (acid sulfite process)	scrubber and electrostatic precipitator	1000	75	67	1,2
2.D.2	Food and drink	1	No information	ni	ni	na	na	
		2	Handling of agricultural products (grains, soja)	uncontrolled	ni	na	na	
		2	General	na	ni	na	na	
2.D.3	Wood processing	1			1000	na	na	3

1. European Commission (2001c).
2. US EPA (1985).
3. US EPA (1995a)

For the sectors 2.D.1 Pulp and paper, 2.D.2 Food and drink, and 2.D.3 Wood processing no inconsistences have been identified.

Recommendations

- Application of consistent units within the same groups of substances (e.g. g TSP/Mg product, mg PCB/Mg product, and µg I-TEQ (PCDD/F)/Mg product).
- Proposal of Tier 1 EFs to express worst case scenario.
- Reinvestigation of identified outliers.
- Identification of references in cases where EFs are attributed a wrong reference.
- Integration of information from EECCA countries with information West European countries in order to develop common EF.

References

Air & Waste Management Association, 1992. Air Pollution Engineering Manual. Buonicore, A.J. and Davis, W.T. (eds). ISBN 0-442-00843-0. Van Nostrand Reinhold, NY. Cited from GB

Beerkens, R.G.C., 2008. Personal communication. Cited from GB.

European Commission, 2001. Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques (BREF) in the Cement and Lime Manufacturing Industries, December 2001. Cited from the GB.

European Commission, 2001a. Integrated Pollution Prevention and Control (IPPC), Best Available Techniques Reference Document on the Production of Iron and Steel, December 2001. Cited from GB.

European Commission, 2001b. Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques (BREF) in the Non-Ferrous Metal Industries. December 2001. Cited from GB

European Commission, 2001c. Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques (BREF) in the Pulp and Paper Industry. December 2001. Cited from GB

European Commission, 2007a. Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques (BREF) in Large Volume Inorganic Chemicals – Solids and others industry, August 2007. Cited from the GB.

European Commission, 2007b. Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques (BREF) in the Cement and Lime Manufacturing Industries. Draft September 2007. Available at http://eippcb.jrc.es. [Accessed 5 August 2009] Cited from the GB.

European Commission, 2008. Integrated Pollution Prevention and Control (IPPC), Revised reference Document on Best Available Technologies (BREF) in the Glass Manufacturing Industry, draft. European Commission, February 2008. Cited from GB.

Guidebook, 2006. EMEP/CORINAIR Emission Inventory Guidebook, version 4 (2006 edition). European Environmental Agency, Technical report No. 11/2006. Cited from GB.

Kakareka, 2008. Personal communication. Institute for problems of use of natural resources and ecology, Belarusian National Academy of Sciences, Minsk. Cited from the GB.

Rivet, F., 2008. Personal communication. Cited from GB

Theloke, J., Kummer, U., Nitter, S., Geftler, T. and Friedrich, R., 2008. Überarbeitung der Schwermetallkapitel im CORINAIR Guidebook zur Verbesserung der Emissionsinventare und der Berichterstattung im Rahmen der Genfer Luftreinhaltekonvention. Report for Umweltbundesamt, April 2008. Cited from GB

US EPA, 1985. 'A Compilation of Air Pollutant Emission Factors. Volume 1: Stationary Point and Area Sources. Section 10.1 Chemical Wood Pulping'. In: Compilation of Air Pollutant Emission Factors (AP-42) Fourth Edition, plus supplements. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

US EPA (1986), AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources 1995 (Chapter 12.5). Cited from GB

US EPA, 1993. Compilation of Air Pollutant Emission Factors (AP42), Volume 1: Stationary Point and Area Sources, Fifth Edition. United States Environment Protection Agency. Available at: www.epa.gov/ttn/chief/ap42. Cited from GB.

US EPA, 1995. 'Asphalt roofing'. In: AP-42 Fourth Edition. United States Environment Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. Cited from the GB.

EPA, 1995a. Compilation of Air Pollutant Emission Factors (AP-42) CD-ROM. United States Environmental Protection Agency. Cited from GB

US EPA, 2004. '11.1 Hot Mix Asphalt Plants'. Supplement to: Compilation of Air Pollutant Emission Factors. Volume I: Stationary Point and Area Sources. AP-42, 4th Edition. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. Cited from the GB.

Visschedijk, A.J.H., Pacyna, J., Pulles, T., Zandveld, P. and Denier van der Gon, H., 2004. 'Coordinated European Particulate Matter Emission Inventory Program (CEPMEIP)'. In: P. Dilara et al. (eds.), Proceedings of the PM emission inventories scientific workshop, Lago Maggiore, Italy, 18 October 2004. EUR 21302 EN, JRC, pp. 163–174.

Wessely R., Hlawiczka S. (1993) 'Metal emission factors from open hearth furnace steel plant'. In: Hlawiczka, S., Metal emission to the air in Poland. Inst. Ecol. Ind. Areas, report, Katowice (in Polish). Cited from GB.

		Tier	Technology	Abatement	TSP g/Mg raw material	TSP g/Mg product	PM10 g/Mg raw material	PM10 g/Mg product	PM2.5 g/Mg raw material	PM2.5 g/Mg product	PM10/TSP %	PM2.5/TSP %
2.A.1	Cement production	1			-	220	-	200	-	110	91	50
		2	Wet kiln	ESP2, 98.9%	-	600	-	510	-	180	85	30
		2	Dry kiln	ESP2, 99.5%	-	2500	-	1300	-	940	52	38
2.A.2	Lime production	1			-	590	-	240	-	50	41	8,5
		2	Some types of lime kiln	Uncontrolled	-	9000	-	3500	-	700	39	7,8
		2	Some types of lime kiln	Controlled	-	400	-	200	-	30	50	7,5
2.A.3	Limestone and dolomite use	1	No information	ni	ni	-	ni	-	ni	-	na	na
2.A.4	Soda ash production and use	1	No information	ni	-	100	-	ni	-	ni	na	na

		Tier	Technology	Abatement	TSP g/Mg shingle	TSP g/Mg asphalt	PM10 g/Mg shingle	PM10 g/Mg asphalt	PM2.5 g/Mg shingle	PM2.5 g/Mg asphalt	PM10/TSP %	PM2.5/TSP %
2.A.5	Asphalt roofing	1	Dip saturator, drying-in drum section, wet looper and coater	uncontrolled	600	-	ni	-	ni	-	na	na
		2	Spray/dip saturator, drying-in drum section, wet looper, coater and storage tanks	uncontrolled	600	-	ni	-	ni	-	na	na
		2			1600	-	ni	-	ni	-	na	na
2.A.6	Road paving with asphalt	1			-	14000	-	3000	-	400	21	2,9
		2	Batch Mix Hot Mix Plant	uncontrolled	-	15000	-	2000	-	100	13	0,7
		2	Drum Mix Hot Mix Plant	uncontrolled	-	13000	-	3000	-	700	23	5,4

		Tier	Technology	Abatement	TSP g/Mg raw material	g/Mg product	g/m2/year	PM10 g/Mg raw material	g/Mg product	g/m2/year	PM2.5 g/Mg raw material	g/Mg product	g/m2/year	Sum heavy metals g/Mg product	HM/ TSP %
2.A.7.a	Quarrying and mining of minerals other than coal	1	No information	ni	0,07	-	-	0,04	-	-	0,004	-	-	ni	-
2.A.7.b	Construction and demolition	1	No information	ni	-	-	162	-	-	81,2	-	-	8,12	ni	-
2.A.7.c	Storage, handling and transport of mineral products	1	No information	ni	-	ni	-	-	ni	-	-	ni	-	ni	-
		2	No information	ni	-	10	-	-	5	-	-	0,5	-	ni	-
2.A.7.d	Other Mineral products	1	Glass	ni	-	300	-	-	270	-	-	240	-	3,9	1,3
		2	Flat glass	abated furnaces (primary/secondary methods)	-	130	-	-	120	-	-	100	-	1,9	1,5
		2	Container glass	primary measures; without secondary abatement	-	280	-	-	250	-	-	220	-	5,4	1,9
		2	Continuous filament glass fibres	primary abatement methods; no secondary abatement	-	100	-	-	90	-	-	70	-	ni	-
		2	Glass wool (except binding)	ni	-	670	-	-	590	-	-	520	-	ni	-
		2	Other glass	filters in operation	-	10	-	-	9	-	-	8	-	10	100
		2	Water glass	ni	-	200	-	-	180	-	-	160	-	ni	-

		Tier	Technology	Abatement	TSP g/Mg raw material	TSP g/Mg product	PM10 g/Mg raw material	PM10 g/Mg product	PM2.5 g/Mg raw material	PM2.5 g/Mg product	PM10/ TSP %	PM2.5/ TSP %
2.B.1	Ammonia production	1			-	ni	-	ni	-	ni	na	na
		2	Steam reforming, conventional as well as advanced processes		-	ni	-	ni	-	ni	na	na
		2	Partial oxidation	Various (auxiliary boiler, superheater, post combustion)	-	ni	-	ni	-	ni	na	na
2.B.2	Nitric acid production	1			-	ni	-	ni	-	ni	na	na
		2	Low Pressure process		-	ni	-	ni	-	ni	na	na
		2	Low Pressure process		-	ni	-	ni	-	ni	na	na
		2	Medium Pressure process		-	ni	-	ni	-	ni	na	na
		2	High pressure process		-	ni	-	ni	-	ni	na	na
		2	Direct strong acid process		-	ni	-	ni	-	ni	na	na
		2	Low, medium and high pressure processes	Catalytic Reduction	-	ni	-	ni	-	ni	na	na
		2	Low, medium and high pressure processes	Extended absorption	-	ni	-	ni	-	ni	na	na
2.B.3	Adipic acid production	1			-	ni	-	ni	-	ni	na	na
		2	No information		-	ni	-	ni	-	ni	na	na
2.B.4	Carbide production	1			-	100	-	ni	-	ni	na	na
		2	CaC2 production without the usage of furnace gas	various, dedusting	-	49	-	ni	-	ni	na	na
		2	CaC2 production without the usage of furnace gas (e.g. lime kiln)	various, dedusting	-	80,9	-	ni	-	ni	na	na
2.B.5.a	Other chemical industry	1			-	50	-	ni	-	ni	na	na

	Tier	Technology	Abatement	TSP g/Mg raw material	TSP g/Mg product	PM10 g/Mg raw material	PM10 g/Mg product	PM2.5 g/Mg raw material	PM2.5 g/Mg product	PM10/ TSP %	PM2.5/ TSP %
Sulfuric acid	2	Contact process without inter-mediate absorption (single absorption)		-	ni	-	ni	-	ni	na	na
	2	Contact process with inter-mediate absorption (double absorption)		-	ni	-	ni	-	ni	na	na
	2	Contact process with inter-mediate absorption (double absorption)		-	ni	-	ni	-	ni	na	na
	2	Wet contact process (98% and 78 % sulphuric acid)		-	ni	-	ni	-	ni	na	na
	2	Wet/dry contact process with intermediate condensation/ absorption		-	ni	-	ni	-	ni	na	na
Ammonium sulphate	2	No information	Uncontrolled	-	60	-	ni	-	ni	na	na
Ammonium nitrate	2	No information	Uncontrolled	-	200	-	ni	-	ni	na	na
Ammonium phosphate	2	No information		-	300	-	240	-	180	80	60
Urea	2	No information		-	1500	-	1200	-	900	80	60
Carbon black	2	Furnace black process (conventional process)		-	300	-	ni	-	ni	na	na
Titanium dioxide	2	Chloride process		-	200	-	ni	-	ni	na	na
	2	Sulphate process		-	300	-	ni	-	ni	na	na
Graphite		No information		-	ni	-	ni	-	ni	na	na
Chlorine production		Mercury cell		-	ni	-	ni	-	ni	na	na
		Diaphragm cell process		-	ni	-	ni	-	ni	na	na
		Membrane cell process		-	ni	-	ni	-	ni	na	na
Phosphate fertilizers		No information		-	300	-	240	-	180	80	60
Ethylene		No information		-	ni	-	ni	-	ni	na	na
1,2 dichloroethane + vinylchloride (balanced		Balanced process, DCE unit	Unabated	-	ni	-	ni	-	ni	na	na

	Tier	Technology	Abatement	TSP g/Mg raw material	TSP g/Mg product	PM10 g/Mg raw material	PM10 g/Mg product	PM2.5 g/Mg raw material	PM2.5 g/Mg product	PM10/ TSP %	PM2.5/ TSP %
process)											
		Balanced process, vinylchloride production	Unabated	-	ni	-	ni	-	ni	na	na
Polyethylene Low Density		No information		-	31	-	ni	-	ni	na	na
PolyethyleneHigh Density		No information		-	97	-	ni	-	ni	na	na
Polyvinylchloride		Suspension PVC process (S-PVC)		-	263	-	100	-	5	38	1,9
		Emulsion PVC process (E-PVC)		-	263	-	100	-	5	38	1,9
Polypropylene		No information		-	1500	-	ni	-	ni	na	na
Styrene		No information		-	ni	-	ni	-	ni	na	na
Polystyrene		Production of General purpose polystyrene (GPPS)		-	4	-	ni	-	ni	na	na
		High impact polystyrene (HIPS)		-	4	-	ni	-	ni	na	na
		Expandable polystyrene (EPS)		-	30	-	ni	-	ni	na	na
Styrene butadiene		SB polymer in general		-	ni	-	ni	-	ni	na	na
Styrene-butadiene latex		Emulsion polymerisation		-	ni	-	ni	-	ni	na	na
Styrene-butadiene rubber (SBR)		No information		-	ni	-	ni	-	ni	na	na
Acrylonitrile Butadiene Styrene (ABS) resins		No information		-	ni	-	ni	-	ni	na	na
Ethylene oxide		No information		-	ni	-	ni	-	ni	na	na

		Tier	Technology	Abatement	TSP g/Mg raw material	TSP g/Mg product	PM10 g/Mg raw material	PM10 g/Mg product	PM2.5 g/Mg raw material	PM2.5 g/Mg product	PM10/ TSP %	PM2.5/ TSP %
	Formaldehyde		Formaldehyde, silver proces	Unabated	-	ni	-	ni	-	ni	na	na
			Formaldehyde, oxide proces	Unabated	-	ni	-	ni	-	ni	na	na
			Formaldehyde, silver proces	Thermal or catalytic incineration	-	0,5	-	ni	-	ni	na	na
	Ethylbenzene		No information		-	ni	-	ni	-	ni	na	na
	Phtalic anhydride		Using o-xylene as feed		-	ni	-	ni	-	ni	na	na
			Using naphtalene as feed		-	ni	-	ni	-	ni	na	na
	Acrylonitrile		No information		-	ni	-	ni	-	ni	na	na
	Glyoxylic acid		No information		-	ni	-	ni	-	ni	na	na
	Pesticide production		No information		-	ni	-	ni	-	ni	na	na

		Tier	Technology	Abatement	TSP g/Mg raw material	TSP g/Mg product	PM10 g/Mg raw material	PM10 g/Mg product	PM2.5 g/Mg raw material	PM2.5 g/Mg product	Sum heavy metals g/Mg raw material	Sum heavy metals g/Mg product	HM/TSP %	PM10/ TSP %	PM2.5/ TSP %
2.C.1	Iron and steel production	1			-	300	-	180	-	140	-	13,85	4,6	60	47
		2	Sinter production		200	-	100	-	80	-	3,79	-	1,9	50	40
		2	Pellet production		50	-	40	-	25	-	0,053	-	0,1	80	50
		2	Sinter and pelletizing plants	wFGD (state-of-the-art)	200	-	100	-	80	-	1,28	-	0,6	50	40

Tier	Technology	Abatement	TSP g/Mg raw material	TSP g/Mg product	PM10 g/Mg raw material	PM10 g/Mg product	PM2.5 g/Mg raw material	PM2.5 g/Mg product	Sum heavy metals g/Mg raw material	Sum heavy metals g/Mg product	HM/TSP %	PM10/ TSP %	PM2.5/ TSP %
2	Sinter and pelletizing plants	Virgin activated carbon injection (SIC) & fabric filter	200	-	100	-	80	-	6,98	-	3,5	50	40
2	Sinter and pelletizing plants	Simultaneous control of SO2, NOxand Hg (SICs)	200	-	100	-	80	-	14,1	-	7,0	50	40
2	Sinter and pelletizing plants	Dry ESP	200	-	100	-	80	-	0,131	-	0,1	50	40
2	Blast furnace charging		50	-	40	-	25	-	2,39	-	4,8	80	50
2	Blast furnace charging	Heat recovery	50	-	40	-	25	-	2,57	-	5,1	80	50
2	Blast furnace charging	Dry ESP	50	-	40	-	25	-	0,09	-	0,2	80	50
2	Blast furnace charging	Fabric filter with medium efficiency	50	-	40	-	25	-	0,19	-	0,4	80	50
2	Blast furnace charging	wSV (medium)	50	-	40	-	25	-	0,24	-	0,5	80	50
2	Open hearth furnace steel plant		1000	-	800	-	600	-	351,50	-	35,2	80	60
2	Open hearth furnace steel plant	Limited control (95-96%)	700	-	570	-	380	-	18,21	-	2,6	81	54
2	Basic oxygen furnace steel plant		-	35	-	32	-	28	-	10,92	31,2	91	80
2	Basic oxygen furnace steel plant	Limited control (97.5%)	-	500	-	470	-	460	-	27,38	5,5	94	92
2	Electric furnace steel plant		-	30	-	24	-	21	-	7,29	24,3	80	70
2	Basic oxygen furnace steel plant	Dry ESP	-	30	-	24	-	21	-	3,64	12,1	80	70
2	Basic oxygen furnace steel plant	wSV (medium)	-	30	-	24	-	21	-	5,85	19,5	80	70

		Tier	Technology	Abatement	TSP g/Mg raw material	TSP g/Mg product	PM10 g/Mg raw material	PM10 g/Mg product	PM2.5 g/Mg raw material	PM2.5 g/Mg product	Sum heavy metals g/Mg raw material	Sum heavy metals g/Mg product	HM/TSP %	PM10/ TSP %	PM2.5/ TSP %
		2	Electric furnace steel plant	Dry ESP	-	30	-	24	-	21	-	3,79	12,6	80	70
		2	Electric furnace steel plant	Fabric filter (optimized)	-	30	-	24	-	21	-	3,67	12,2	80	70
		2	Electric furnace steel plant	Fabric filter (retrofitted)	-	30	-	24	-	21	-	5,84	19,5	80	70
		2	Electric furnace steel plant	High (>99%, bagfilter)	-	200	-	160	-	140	-	3,88	1,9	80	70
		2	Cold rolling mills		-	96	-	ni	-	ni		ni	na	na	na
		2	Hot rolling mills		-	9	-	ni	-	ni		ni	na	na	na
2.C.2	Ferroalloys production	1			-	1000	-	ni	-	ni		ni	na	na	na
2.C.3	Aluminium production	1			-	3000	-	2000	-	1000	-	ni	na	67	33
		2	Electrolysis, pre-baked anodes		-	4000	-	3200	-	1400	-	ni	na	80	35
		2	Electrolysis, Soderberg anodes		-	4000	-	3200	-	1400	-	ni	na	80	35
		2	Secondary aluminium production		-	2000	-	1400	-	550	-	ni	na	70	28

		Tier	Technology	Abatement	TSP g/Mg product	PM10 g/Mg product	PM2.5 g/Mg product	Sum heavy metals g/Mg product	HM/TSP %	PM10/TSP %	PM2.5/TSP %
2.C.5.a	Copper production	1			400	320	240	310,023	77,5	80	60
		2	Primary copper production		400	320	240	366,031	91,5	80	60

		Tier	Technology	Abatement	TSP g/Mg product	PM10 g/Mg product	PM2.5 g/Mg product	Sum heavy metals g/Mg product	HM/TSP %	PM10/TSP %	PM2.5/TSP %
		2	Primary copper production, traditional method	ESP, limited control (98%)	45000	36000	27000	14830	33,0	80	60
		2	Primary copper production, traditional method	ESP, abatement (>99%)	5000	4000	3000	971	19,4	80	60
		2	Secondary copper production		320	260	190	141,83	44,3	81	59
		2	Secondary copper production, traditional method	Limited control	1500	1200	900	542	36,1	80	60
2.C.5.b	Lead production	1			500	400	200	333,16	66,6	80	40
		2	Primary lead production		500	400	200	14,012	2,8	80	40
		2	Primary lead production	BAT production technologies	29	28	20	144,18	497,2	97	69
		2	Primary lead production	dry ESP	29	28	20	24,498	84,5	97	69
		2	Primary lead production	FF state-of-the-art virgin activated carbon injection	29	28	20	0,915358	3,2	97	69
		2	Primary lead production	(SIC)+FF+FGD	29	28	20	0,115358	0,4	97	69
		2	Primary lead production, traditional method	ESP, limited control	2500	2000	1600	1743	69,7	80	64
		2	Primary lead production, traditional method	ESP, >99% efficiency	500	400	300	232	46,4	80	60
		2	Secondary lead production		500	400	200	434,6	86,9	80	40
		2	Secondary lead production	BAT production technologies	29	28	20	5257,3	18128,6	97	69
		2	Secondary lead production	dry ESP	29	28	20	899,9	3103,1	97	69
		2	Secondary lead production	FF state-of-the-art.	29	28	20	0,58646	2,0	97	69
		2	Secondary lead production	ESP, limited control	1500	1200	1000	901	60,1	80	67
2.C.5.c	Nickel production	1			660			42	6,4	0	0
2.C.5.d	Zinc production	1			500	400	300	60,42	12,1	80	60
		2	Primary zinc production		500	400	300	64,4	12,9	80	60
		2	Primary zinc production, Electrochemical process		500	400	300	106	21,2	80	60

	Tier	Technology	Abatement	TSP g/Mg product	PM10 g/Mg product	PM2.5 g/Mg product	Sum heavy metals g/Mg product	HM/TSP %	PM10/TSP %	PM2.5/TSP %
	2	Primary zinc production, Thermal smelting process		500	400	300	10620	2124,0	80	60
	2	Primary zinc production	BAT production technologies	39	30	22	83,34	213,7	77	56
	2	Primary zinc production	FF state-of-the-art	39	30	22	44,504	114,1	77	56
	2	Primary zinc production	ESP, limited	5000	4000	3000	2265	45,3	80	60
	2	Primary zinc production	ESP, abatement	1500	1200	900	590	39,3	80	60
	2	Secondary zinc production		500	400	300	48,5865	9,7	80	60
	2	Secondary zinc production	BAT production technologies	39	30	22	137,656	353,0	77	56
	2	Secondary zinc production	dry ESP	19	16	12	56,5057	297,4	84	63
	2	Secondary zinc production	FF state-of-the-art	39	30	22	40,01599	102,6	77	56

		Tier	Technology	Abatement	TSP g/Mg	PM10 g/Mg	PM2.5 g/Mg	PM10/TSP %	PM2.5/TSP %
2.D.1	Pulp and paper	1			1000	800	600	80	60
		2	Paper pulp (kraft process)	scrubber and electrostatic precipitator	1000	800	600	80	60
		2	Paper pulp (acid sulfite process)	scrubber and electrostatic precipitator	1000	750	670	75	67
2.D.2	Food and drink	1			ni	ni	ni	na	na
		2	Handling of agricultural products (grains, soja)	uncontrolled	ni	24	ni	na	na
		2	General	na	ni	ni	ni	na	na
2.D.3	Wood processing	1			1000	ni	ni	na	na