

1 Task 5: Updates to PM fugitive emissions (2A7a, b, c, 2C5f)

2

3 Introduction

4 The scope of the present discussion paper is to propose updates to the present EF for the NFR categories
5 2.A.7.a Quarrying and mining of minerals other than coal, 2.A.7.b Construction and demolition, 2.A.7.c
6 Storage, handling and transport of mineral products, and 2.C.5.f Storage, handling and transport of metal
7 products.

8 Survey

9 The survey presents the EFs given in the GB, EFs applied in national inventories, and the outcome of the
10 literature search. Detailed information applied by selected countries is presented in annex.

11 The NRF tables have been screened for all the countries reporting to CLRTAP. The overall result is
12 presented in annex and a summary is presented in table 0. The IIR from selected countries have been
13 reviewed with the aim of identifying national EF applied with the sectors 2.A.7.a, b, c, and 2.C.5.f.

Table 0 Fugive TSP emissions have been included in national inventories for these countries with marking of the specific sectors included.

	2A7a PM2.5	2A7b PM2.5	2A7c PM2.5	2C5f PM2.5
Austria			IE	NA
Belgium		NE	IE	IE
Czech Republic				
Cyprus				NO
Estonia			NA	NA
Finland				
France			IE	NE
Germany	NA		IE	IE
Hungary			NA	NE
Norway			IE	IE
Poland	IE		IE	NA
Switzerland		NO	NO	NO
Slovakia		NA	NA	IE
Sweden			IE	NE
UK				NO

14

15 2.A Mineral products

16

17 2.A.7.a Quarrying and mining of minerals other than coal

18 Table 1 presents the EFs given in the GB. However, studies of the original source as well as the database
19 behind (CEPMEIP) shows that the figures given in the GB are a factor 1000 lower than the original source.
20 The EFs should be 70, 40, and 4 g/Mg mineral.

Table 1 Tier 1 default emission factors for 2.A.7.a Quarrying and mining of minerals other than coal.

Pollutant	EF g/Mg mineral	95% confidence		Reference
		Lower	Upper	
TSP	0.07	0.005	1	Visschedijk et al. (2004)
PM ₁₀	0.04	0.005	0.25	Visschedijk et al. (2004)
PM _{2.5}	0.004	0.00075	0.025	Visschedijk et al. (2004)

1 The Tier 1 EFs seems to be based on an average of operations with low emission level and operations with
2 high emission level. Visschedijk et al. (2004) present EFs for quarrying of a number of minerals e.g. bauxite,
3 copper, iron, manganese, and zinc under low and high emission levels; see annex 3. Austria study applies
4 national EFs and the EFs vary from 25.1 g TSP/Mg for tungsten ore to 525 g TSP/Mg for sand (Anderl et al.,
5 2011).

6 WRAP (2006) do not present specific EFs for quarrying and mining of minerals, however they present an
7 equation for calculation EFs:

$$EF = k \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} [kg PM_{10}/Mg]$$

8 where:

9 k = particle size multiplier (0.0016; dimensionless)

10 U = mean wind speed (m/s)

11 M = material moisture content (%)

12 WRAP suppose the PM_{2.5}/PM₁₀ to be 0.1 from aggregate handling and storage piles, and 0.15 from transfer
13 of aggregate by buckets and conveyors. The same equation may be used for 2:A.7.c Storage, handling and
14 transport of minerals. The methodology presented by WRAP seems very complex and is not assessed to be
15 applicable in the GB.

16 **2.A.7.b Construction and demolition**

17 Table 2 presents the EFs given in the GB.

Table 2 Tier 1 default emission factors for 2.A.7.b Construction and demolition.

Pollutant	EF g/m ² /year	95% confidence		Reference
		Lower	Upper	
TSP	162	123	2150	Visschedijk et al. (2004)
PM ₁₀	81.2	12.3	538	Visschedijk et al. (2004)
PM _{2.5}	8.12	1.23	53.8	Visschedijk et al. (2004)

18

19 The Tier 1 EFs seems to be an average of EFs for construction-related activities, dwellings and utilities
20 (Visschedijk et al., 2004). The two EFs are reported to be 220 and 120 g/m²/year, respectively.

21 Detailed studies of emission of TSP from construction and demolition has been performed on behalf of US
22 EPA and reported in AP-42 (US EPA, 20zz). A general EF has been determined to 2.69 Mg/hectare/month
23 equals to 3228 g/m²/year. Furthermore, AP-42 provides EFs for a number of specific processes; see annex 3
24 for details. The EFs published by US-EPA has been further developed Western Regional Air Partnership's
25 (WRAP). WRAP (2006) propose as a general EF for PM₁₀ 0.11 ton/acre¹/month and as worst case 0.42
26 ton/acre/month. These EFs equals to 326 and 1245 g PM₁₀/m²/year, respectively. In addition to the general
27 EFs propose a number of more detailed EFs for general construction operations; see annex 3 for further
28 details (WRAP, 2006). WRAP (2006) do also propose specific EFs for different construction activities; see
29 table 2a.

¹ 1 acre = 4046.9 m².

Table 2a

Process	Emission	
Residential construction	$E = (0.032 \text{ tons PM}_{10}/\text{acre}/\text{month}) \times B \times f \times m$	B = the number of houses constructed f = building to acres conversion factor m = the duration of construction activity in month
Non-residential construction	$E = (0.19 \text{ tons PM}_{10}/\text{acre}/\text{month}) \times \$ \times f \times m$	\$ = dollars spent on non-residential construction in millions f = dollars to acres conversion factor m = duration of construction activity in month
Road construction	$(0.42 \text{ tons PM}_{10}/\text{acre}/\text{month}) \times M \times f \times d$	M = miles of new roadway constructed f = miles to acres conversion factor d = duration of roadway construction activity in month

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2 **2.A.7.c Storage, handling and transport of mineral products**

3 Table 3 presents the EFs given in the GB. However, studies of the original source as well as the database
4 behind (CEPMEIP) show that the figures given in the GB are related to cement only. For storage and
5 handling of other products the EFs for TSP are 25, 40, 100, and 200 for clay, kaolin, fertiliser, and bauxite,
6 respectively; see annex 3.

Table 3 Tier 2 emission factors for 2.A.7.c Storage, handling and transport of mineral products.

Pollutant	EF g/Mg product	95% confidence		Reference
		Lower	Upper	
TSP	10	1	100	Visschedijk et al. (2004)
PM ₁₀	5	1	25	Visschedijk et al. (2004)
PM _{2.5}	0.5	0.1	2.5	Visschedijk et al. (2004)

7

8 WRAP (2006) do not present specific EFs for storage, handling and transport of mineral products, however
9 they present an equation for calculation EFs:

$$EF = k \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \quad [kg PM_{10}/Mg]$$

10 where:

11 k = particle size multiplier (0.0016; dimensionless)

12 U = mean wind speed (m/s)

13 M = material moisture content (%)

14 WRAP suppose the PM_{2.5}/PM₁₀ to be 0.1 from aggregate handling and storage piles, and 0.15 from transfer
15 of aggregate by buckets and conveyors. The same equation may be used for 2.A.7.a quarrying and mining
16 of minerals. The methodology presented by WRAP seems very complex and is not assessed to be applicable
17 in the GB.

18 **2.C Metal production**

19

20 **2.C.5.f Storage, handling and transport of metal products**

21 Table 4 presents the EFs given in the GB.

Table 4 Tier 2 emission factors for 2.C.5.f Storage, handling and transport of metal products.

Pollutant	EF g/Mg Metal product	95% confidence		Reference
		Lower	Upper	
TSP	1000	100	10000	Expert judgment
PM ₁₀	ni	ni	ni	
PM _{2.5}	ni	ni	ni	

1

2 So far, no relevant information on storage, handling and transport of metal products has been found. The
3 search continues.

4 **Recommendations**

5 Consistent units: g/Mg, g/m²/year

6 2.A.7.a: CEPMEIP and the national study of TSP emissions from Austria (cited in Anderl et al., 2011) is
7 proposed to be included in development of a worst case Tier1 EF and Tier 2 EFs covering different
8 operations.

9 2.A.7.b: CEPMEIP is proposed to be used in development of a worst case Tier 1 EF and Tier 2 EFs covering
10 different processes.

11 2.A.7.c Develop a tier 1 EF (worst case) and additional tier 2 EFs to represent other processes than storage
12 of cement.

13 2.C.5.f Further search on storage, handling and transport of metal products.

14 **References**

15 Anderl, M., Haider, S., Köther, T., Pazdernik, K., Purzner, M., Stranner, G., Poupa, S., Wieser, M., and
16 Zechmeister, A. 2011. Austria's Informative Inventory Report (IIR) 2011 - Submission under the UNECE
17 Convention on Long-range Transboundary Air Pollution. Report REP-0307, Umweltbundesamt, Vienna,
18 Austria.

19 Belgium 2012. Informative Inventory Report about Belgium's annual submission of air emission data
20 reported in February 2012 under the Convention on Long Range Transboundary Air Pollution CLRTAP.

21 CEPMEIP. The Co-ordinated European Programme on Particulate Matter Emission Inventories, Projections
22 and Guidance (CEPMEIP). Available at: <http://www.air.sk/tno/cepmeip/>

23 CITEPA 2011. Organisation et Methodes des Inventaires Nationaux des Emissions Atmospheriques en
24 France 8^{ème} édition, OMINEA - mise „à jour février 2011. Centre Interprofessionnel Technique d'Etudes de
25 la Pollution Atmosphérique. Available at: <http://citepa.org/publications/Inventaires.htm>.

26 CPA 2012. Informative Inventory Report (IIR) 2012 Norway. Air Pollutant Emissions 1980-2010. Submission
27 under the UNECE Convention on Long-range Transboundary Air Pollution. Climate and Pollution Agency,
28 Norway.

29 Passant, N.R., Murrells, T.P., Misra, A., Pang, Y., Walker, H.L., Whiting, R., Walker, C., Webb, N.C.J.,
30 MacCarthy, J. 2012. UK Informative Inventory Report (1980 to 2010).

31 Swedish EPA 2012. Informative Inventory Report 2012 Sweden - Submitted under the Convention on Long-
32 Range Transboundary Air Pollution. Swedish Environmental Protection Agency.

1 SYKE 2012. Air Pollutant Emissions in Finland 1980–2010, Informative Inventory Report to the Secretariat of
2 the UNECE Convention on Long-Range Transboundary Air Pollution. Finnish Environment Institute,
3 Consumption and Production Centre, Environmental Performance Division, Air Emissions Team.

4 Umweltbundesamt 2012. German Informative Inventory Report (IIR). Available at: [http://iir-
6 de.wikidot.com/welcome:welcome](http://iir-
5 de.wikidot.com/welcome:welcome)

6 US EPA (20zz). AP-42

7 Visschedijk, A., Pacyna, J., Pulles, T., Zandveld, P., and Denier van der Gon, H. 2004. Coordinated European
8 particulate matter emission inventory program (CEPMEIP). In: Dilara, P. et al. (eds.) Proceedings of the PM
9 emission inventories scientific workshop, Lago Maggiore, Italy, 18 October 2004, EUR 21302 EN, JRC 2004,
10 pp. 1163-174.

11 WRAP 2006. WRAP Fugitive Dust Handbook. Western Governors' Association. Denver, Colorado.

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	1B1a			1B1b			2A7a			2A7b			2A7c			2C5f			6A		
	PM2.5	PM10	TSP	PM2.5	PM10	TSP	PM2.5	PM10	TSP	PM2.5	PM10	TSP	PM2.5	PM10	TSP	PM2.5	PM10	TSP	PM2.5	PM10	TSP
Austria				IE	IE	IE							IE	IE	IE	NA	NA	NA			
Belgium	NO	NO	NO							NE	NE	NE	IE	IE	IE	IE	IE	IE	NE	NE	NE
Bulgaria	NA	NA	NA	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	NE	NE	NA	NA	NA
Czech Republic																					
Cyprus	NO	NO	NO	NO	NO	NO										NO	NO	NO	NE	NE	NE
Denmark				NO	NO	NO	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Estonia				NA	NA								NA	NA	NA	NA	NA	NA	NA	NA	
Finland	NA	NA	NA																		
France	NA	NA	NA										IE	IE	IE	NE	NE	NE	NA	NA	NA
Germany	NE	NE	NE				NA	NA	NA				IE	IE	IE	IE	IE	IE	NA	NA	NA
Greece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hungary													NA	NA	NA	NE	NE	NE	NE	NE	NE
Iceland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NR	NR	NR	NR	NR	NR	NO	NO	NO	NR	NR	NR
Ireland	NA	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA
Italy																					
Latvia	NO	NO	NO	NO	NO	NO	NE	NE	NE	NE	NE	NE	NE	NE	NE	NO	NO	NO	NE	NE	NE
Lichtenstein	NO	NO	NO	NO	NO	NO													NO	NO	NO
Lithuania	NO	NO	NO	NO	NO	NO	NE	NE	NE	NE	NE	NE	NE	NE	NE	NO	NO	NO	NE	NE	NE
Malta	NO	NO	NO	NO	NO	NO	NO	NO	NO	NE	NE	NE	NE	NE	NE	NO	NO	NO	NE	NE	NE
Netherlands	IE	IE	IE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	IE	IE	IE	NO	NO	NO
Norway	NA	NA	NA	NA	NA	NA							IE	IE	IE	IE	IE	IE	NA	NA	NA
Poland							IE	IE	IE				IE	IE	IE	NA	NA	NA	NA	NA	NA
Portugal	0	0	0	0	0	0	IE	IE	IE	IE	IE	IE	IE	IE	IE	NO	NO	NO	NE	NE	NE
Romania	NA		NA	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Switzerland				NO	NO	NO							NO	NO	NO	NO	NO	NO			
Slovakia	NA	NA	NA	IE	IE	IE				NA	NA	NA	NA	NA	NA	IE	IE	IE	NA	NA	NA
Slovenia				NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA	NA	NA
Spain							NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			
Sweden	NO	NO	NO	NA	NA	NA							IE	IE	IE	NE	NE	NE	NE	NE	NE
Turkey	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UK	NA	NA	NA													NO	NO	NO	NA	NA	NA

Annex 2 National EF for TSP, PM₁₀ and PM_{2.5}

NFR	Process	Unit	TSP	PM ₁₀	PM _{2.5}	PM _{1.0}	Reference
Austria							
2.A.7.a	Magnesite	g/Mg	216.20	101.61	10.81	-	Anderl et al. 2011
	Sand	g/Mg	525.00	246.75	26.25		
	Gravel	g/Mg	135.00	63.45	6.75		
	Silicates	g/Mg	191.00	89.77	9.55		
	Dolomite	g/Mg	141.90	66.00	6.60		
	Limestone	g/Mg	141.90	66.00	6.60		
	Basaltic rocks	g/Mg	141.90	66.00	6.60		
	Iron ore	g/Mg	216.78	104.70	30.43		
	Tungsten ore	g/Mg	25.12	11.86	3.75		
	Gypsum, anhydride	g/Mg	85.60	40.23	4.28		
	Lime	g/Mg	122.70	110.43	79.76		
	Cement	g/Mg	21.80	19.62	17.44		
	Cement and lime milling	g/Mg	7.75	6.98	6.20		
	Rye flour	g/Mg	43.59	20.62	6.50		
	Wheat flour	g/Mg	43.59	20.62	6.50		
	Sunflower and rapeseed grist	g/Mg	24.76	11.85	3.79		
	Wheat bran and grist	g/Mg	10.90	5.16	1.63		
	Rye bran and grist	g/Mg	10.90	5.16	1.63		
	Concentrated feeding stuff	g/Mg	30.28	14.32	4.51		
2.A.7.b	Construction and demolition	g/m ²	173.40	86.70	8.67		
Belgium							
2.A.7.a		ni	ni	ni	ni		
Finland							
2.A.7.a	Copper ore	g/Mg	50.86	25.00	3.75		SYKE 2012 from CEPMEIP
	Zinc ore	g/Mg	50.86	25.00	3.75		from CEPMEIP
2.A.7.b	Construction-related activities (dwellings)	g/m ²	215.15	107.58	10.76		from CEPMEIP
	Construction-related activities (utilities)	g/m ²	122.69	61.34	6.13		from CEPMEIP
2.A.7.c	Storage & Handling - aluminoxide	g/Mg					from CEPMEIP
	S&H - bentonite	g/Mg					from CEPMEIP
	S&H - clay	g/Mg					from CEPMEIP
	S&H - cement	g/Mg					from CEPMEIP
	S&H - fly ash	g/Mg					from CEPMEIP
	S&H - kaolin	g/Mg					from CEPMEIP
2.C.5.f	Storage, Handling and Transport of metal products	g/Mg	200.00	94.00	8.00		from CEPMEIP
France							
2.A.7.a	Quarrying	g/Mg	160	64%	45%	nd	CITEPA 2011
2.A.7.b	Public work and building sites	g/m ²	120	18.6%	6.2%	2.2%	
Germany							
2.A.7.b		g/m ²	0.0001828 ²	0.0000914	0.0000092		German IIR
Norway							
2.A.7.a	Quarrying, ore mines	g/Mg	ni/1 ³	ni/0.49	ni/0.07		CPA 2012
	Mining and extraction of stones and minerals	g/Mg	160,00	60,00	0,00		from personal comm.
2.A.7.b	Building and construction	g/m ₂	979,00 ⁴	152,00	52,00		from personal comm.
Sweden							
							Swedish EPA 2012

² 0.1828 kg/million m² (German IIR).

³ No information on emission only on the particle size distribution.

⁴ 9.79 tonne/hectare/year (CPA, 2012).

2.A.7.a,b,c

ni ni ni ni

UK

2.A.7.a,b,c

ni ni ni ni

Passant et al. 2012
from US EPA 2009Annex 3 ZZZ for TSP, PM₁₀ and PM_{2.5}

NFR	Process	Unit	TSP	PM ₁₀	PM _{2.5}	PM _{1.0}	Reference
EF Database CEPMEIP							CEPMEIP, Visschedijk et al., 2004
2.A.7.a	Quarrying and mining of minerals other than coal						
	Bauxite mining, medium	g/Mg	50.9	25.0	3.75		
	Bauxite mining, medium high - high	g/Mg	102	50,0	5.00		
	Copper mining, low - medium	g/Mg	50.9	25.0	3.75		
	Copper mining, medium high - high	g/Mg	102	50,0	5.00		
	Iron mining, low - medium	g/Mg	50.9	25.0	3.75		
	Iron mining, medium high - high	g/Mg	102	50,0	5.00		
	Manganese mining, medium	g/Mg	50.9	25.0	3.75		
	Manganese mining, high	g/Mg	102	50,0	5.00		
	Zinc ore mining, low - medium	g/Mg	50.9	25.0	3.75		
	Zinc ore mining, medium high - high	g/Mg	102	50,0	5.00		
2.A.7.b	Construction and demolition						
	Dwellings	g/m ² /år	220	110	11.0		
	Utilities	g/m ² /år	120	61.0	6.10		
2.A.7.c	Storage, handling and transport of mineral products						
	Storage and handling, alumina	g/Mg	200	40.0	7.99		
	Storage and handling, bauxite	g/Mg	200	80.0	7.99		
	Storage and handling, bentonite	g/Mg	40.0	12.8	1.60		
	Storage and handling, clay	g/Mg	25.0	7.99	0.99		
	Storage and handling, cement	g/Mg	10.0	5.00	0.50		
	Storage and handling, fly ash	g/Mg	100	32.0	4.00		
	Storage and handling, iron ore	g/Mg	200	94.0	7.99		
	Storage and handling, kaolin	g/Mg	40.0	12.8	1.60		
	Storage and handling, phosphates	g/Mg	40.0	12.8	1.60		
	Storage and handling, barley	g/Mg	100	25.0	4.00		
	Storage and handling, beans	g/Mg	100	25.0	4.00		
	Storage and handling, maize	g/Mg	100	25.0	4.00		
	Storage and handling, millet	g/Mg	100	25.0	4.00		
	Storage and handling, oats	g/Mg	100	25.0	4.00		
	Storage and handling, peas	g/Mg	100	25.0	4.00		
	Storage and handling, rye	g/Mg	100	25.0	4.00		
	Storage and handling, sorghum	g/Mg	100	25.0	4.00		
	Storage and handling, soy	g/Mg	100	25.0	4.00		
	Storage and handling, wheat	g/Mg	100	25.0	4.00		
US EPA Database AP-42							US EPA (20xx)
2.A.7.b	Construction and demolition						
I. Demolition and debris removal	1. Demolition of buildings or other (natural) obstacles such as trees, boulders etc.		To be included				
	a. Mechanical dismemberment ("headache ball") of existing structures		na				
	b. Implosion of existing structures		na				
	c. Drilling and blasting of soils						
	d. General land clearing						

NFR	Process	Unit	TSP	PM ₁₀	PM _{2.5}	PM _{1.0}	Reference
	2. Loading of debris into trucks						
	3. Truck transport of debris						
	4. Truck unloading of debris						
II. Site preparation (earth removal)	1. Bulldozing						
	2. Scrapers unloading topsoil						
	3. Scrapers in travel						
	4. Scrapers removing topsoil						
	5. Loading of excavated material into trucks						
	6. Truck dumping of fill material, road base, or other materials						
	7. Compiling						
	8. Motor grading						
III. General construction	1. Vehicular traffic						
	2. Portable plants						
	a. Crushing						
	b. Screening						
	c. Material transfers						
	3. Other operations						
WRAP							WRAP (2006)
2.A.7.a	Quarrying and mining of other minerals than coal						
Copper ore	Crushing	g/Mg	3222 - 4333 ⁵	1450 - 1950 ⁶			
	Open pit overburden removal	g/Mg	0.41	0.15			
	Drill/blasting	g/Mg	0.50	0.40			
	Loading	g/Mg	25.0	11.0			
	Truck dumping	g/Mg	20.0	16.0			
	Transfer/conveying	g/Mg	75.5	40.0			
	Storage	g/Mg	1000	350			
Iron ore	Mining	g/Mg	220	90.0			
Lead ore	Crushing	g/Mg	3000	2550			
Zinc ore	Crushing	g/Mg	3026	1150			
Sand and gravel	Mining	g/Mg	50	14.5			
2.A.7.b	Construction and demolition						
	Level 1: Only area and duration known						
		ton/acre/month		0.11			
	Worst case	ton/acre/month		0.42			
	Level 2: Amount of earth moving known, in addition to total project area and duration						
	Level 3: More detailed information available on duration of earth moving and other material movement						
	Level 4: Detailed information on number of units and travel distances						

⁵ Calculated from PM₁₀/TSP relation.

⁶ Calculated from lb/tonne.

