Appendix 2.3 - Heavy Metal Exhaust Emissions From Mobile Sources

Road Transport

For heavy-metal exhaust emissions (other then lead from leaded gasoline), tier1 values have been derived from tier1 default values provided in the 2019 EMEP/EEA Guidebook.

Table 1: Tier1 default emisison factors applied to road vehicles

=	= **Pb**	= **Cd**	= **Hg**	= **As**	= **Cr**	= **Cu**	= **Ni**	= **Se**	= **Zn**				
=									= [g/TJ]				
~ Diesel oil	> 0.012	> 0.001	> 0.123	> 0.002	> 0.198	> 0.133	> 0.005	> 0.002	> 0.419				
~ Biodiesel	**1**		> 0.013	> 0.001	> 0.142	> 0.003	> 0.228	> 0.153	> 0.005	> 0.003		> 0.483	
~ Gasoline fuels	> 0.051	> 2.10	> 0.196	> 0.007	> 8.96	> 357	> 14.7	> 2.09	> 208				
~ CNG	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE				
~ LPG	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE				
~ Biogas	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE				
1													

In contrast to the 2013 GB, the July 2017 version of the 2016 GB provides separate values for Hm from fuel combustion (icluding engine wear) and the unintended co-incineration of lube oil. The latter are reported in NFR 2.D as emissions from product use. (*Note: This country-specific approach has been discussed and accepted at both the 2018 TFEIP meeting and the 2018 NEC review.*)

Screenshot of EMEP/EEA GB 2016 (2013), chapter 1.A.3.b, Table 3-104: Heavy metal emission factors for all vehicle categories in mg/kg fuel: gallery size="medium" : GB2016(2013)_default-EF(HM).JPG gallery

Unfortunately, the July 2017 version of the 2016 GB does no longer include default values for HM emissions from CNG and LPG. Furthermore, no such values are available for biogas.

Screenshot of EMEP/EEA GB 2016 (July 2017), chapter 1.A.3.b, Table 3.77: Heavy metal emission factors for all vehicle categories in ppm/wt fuel: gallery size="medium" : GB2016(July2017)_default-EF(HM)_from_fuels.JPG gallery

Screenshot of EMEP/EEA GB 2016, chapter 1.A.3.b, Table 3.78: Heavy metal emission factors for all vehicle categories in ppm/wt lubricant gallery size="medium" : GB2016(July2017)_default-EF(HM)_from_lubricants.JPG gallery

+ Non-road Mobile Machinery in 1.A.2.g vii, 1.A.4.a.ii,1.A.4.b.i, 1.A.4.c.ii and 1.A.5.b i

Without country-specific information, tier1 values are applied.

However, instead of using the emission factors provided in (EMEP/EEA, 2016) [1], Table 3-1 Tier 1 emission factors for off-road machinery, EF for exhaust HMs from GB chapter 1.A.3.b.i, 1.A.3.b.ii, 1.A.3.b.iii, 1.A.3.b.iv, page 93 ff are applied here, too in order to allow for the separate reporting of emissions from fuel and enigine wear and the unintended co-incineration of lube oil. Here, separate tier1 default EFs are provided there in tables 3.77 and 3.78 of the GB chapter for road transport.

Heavy-metal emissions from lubricants (as far as not used in 2-stroke mix) are reported under NFR 2.G as emissions from product use.

(Note: Until submission 2017, the EMEP/EEA default EFs provided for NRMM were used in the German inventory. As these EFs do not differentiate between fuel combustion and lubricant co-incineration, the inventory compiler decided to apply the more specific EFs from road transport to NRMM in 1.A.2.g vii, 1.A.4.a ii, b ii and c ii and 1.A.5.b, too. This country-specific approach has been discussed and accepted at both the 2018 TFEIP meeting and the 2018 NEC review.)

Table 2: Tier1 default emission factors applied to NRMM, in g/TJ

=	= **Pb**	= **Cd**	= **Hg**	= **As**	= **Cr**	= **Cu**	= **Ni**	= **Se**	= **Zn**		
~ Diesel oil	> 0.012	> 0.001	> 0.123	> 0.002	> 0.198	> 0.133	> 0.005	> 0.002	> 0.419		
~ Biodiesel	**1**		> 0.013	> 0.001	> 0.142	> 0.003	> 0.228	> 0.153	> 0.005	> 0.003	> 0.483
~ Gasoline fuels - 4-stroke	> 0.037	> 0.005	> 0.200	> 0.007	> 0.145	> 0.103	> 0.053	> 0.005	> 0.758		
~ Gasoline fuels - 2-stroke	**2**		> 0.051	> 2.10	> 0.196	> 0.007	> 8.96	> 357	> 14.7	> 2.09	> 208
~ LPG (1.A.4.a ii only)	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE	= NE		
1											
2											

+ Railways

Table 3: Tier1 default emission factors applied to railway vehicles, in g/TJ

=	= **Pb**	= **Cd**	= **Hg**	= **As**	= **Cr**	= **Cu**	= **Ni**	= **Se**	= **Zn**												
~ Diesel oil	> 1.21	**2**		> 0.23	**1**		> 0.12	**1**		> 0.002	**2**	> 1.16	**2**	> 39.57	**2**	> 1.63	**2**	> 0.23	**2**	> 23.28	**2**
~ Biodiesel	**3**		> 0.01	> 0.001	> 0.14	> 0.003	> 0.23	> 0.15	> 0.01	> 0.003	> 0.48										
~ Lignite Briquettes									= NE												
~ Raw Lignite									= NE												
~ Hard Coal									= NE												
~ Hard Coal Coke									= NE												
1																					
2																					

3																												

(*NOTE: Assuming that biodiesel contains far less HMs than fossil diesel oil, similar values are applied to all mobile sources using this biogenic fuel.*)

As the EMEP/EEA GB 2016 does not provide specific defaults for **Pb, Hg and As**, the EF applied here has been derived from chapter: 1.A.3.b i-iv - Road transport: exhaust emissions: tier1 value for diesel vehicles.

gallery size="medium" : GB2016_EF_NE+NA_1.A.3.c.png gallery

+ Inland Vessels and Ships in 1.A.3.d ii

Table 4: Tier1 default emission factors applied to inland ships and vessels, in g/TJ

=	= **Pb**	= **Cd**	= **Hg**	= **As**	= **Cr**	= **Cu**	= **Ni**	= **Se**	= **Zn**				
~ Diesel oil	> 1.21	> 0.233	> 0.123	> 0.002	> 1.16	> 39.6	> 1.63	> 0.233	> 23.3				
~ Biodiesel	**1**		> 0.013	> 0.001	> 0.142	> 0.003	> 0.23	> 0.15	> 0.005	> 0.003		> 0.48	
1													

+ Maritime Vessels and Ships in 1.A.3.d i, 1.A.3.d ii, 1.A.4.c iii and 1.A.5.b iii

The following table provides the tier1 EF applied for HMs from ships and vessels in both civil and military operation in NFR categories 1.A.3.d i -International Maritime Navigation, 1.A.3.d ii - National Navigation (Shipping), 1.A.4.c iii -Fisheryand 1.A.5.b iii - Other: Military Navigation.

Table 4: Tier1 default emission factors applied to maritime ships and vessels in g/TJ

=	= **Pb**	= **Cd**	= **Hg**	= **As**	= **Cr**	= **Cu**	= **Ni**	= **Se**	= **Zn**				
=									= [g/TJ]				
~ Heavy Fuel oil	**1**		> 4.46	> 0.50	> 0.50	> 16.9	> 17.8	> 31.0	> 793	> 5.20		> 29.7	
~ Diesel oil	**2**		> 3.03	> 0.23	> 0.70	> 0.93	> 1.16	> 20.5	> 23.3	> 2.33		> 27.9	
~ Biodiesel	**3**		> 0.013	> 0.0013	> 0.142	> 0.003	> 0.23	> 0.15	> 0.005	> 0.003		> 0.48	
1													
2													
3													

(*NOTE: Assuming that biodiesel contains far less HMs than fossil diesel oil, similar values are applied to all mobile sources using this biogenic fuel.*)

+ Aircraft in 1.A.3.a and 1.A.5.b ii

The EMEP/EEA GB 2016 (July 2017) does not provide specific defaults for HM emissions from the combustion of jet kerosene and aviation gasoline, stating that for for aviation gasoline these emissions are *not estimated* (NE):

gallery size="medium" : GB2016(July2017)_EF_NA+NE_Avgas.PNG gallery

Therefore, the inventory compiler decided to apply the tier1 EF from gasoline fuel used in non-road mobile machinery here, too. Although the Party assumes that HM emissions are also likely to occur from the combustion of jet kerosene, no gap-filling is carried out for this fuel. Instead, all HM emission from jet kerosene are reported as *not estimated* (NE).

Table 5: Tier1 default emisison factors applied to aircraft, in g/TJ

	= **Pb**	= **Cd**	= **Hg**	= **As**	= **Cr**	= **Cu**	= **Ni**	= **Se**	= **Zn**				
~ Kerosene									= NE				
~ Aviation gasoline	> 9,481	**1**		> 0.005	> 0.200	> 0.007	> 0.145	> 0.103	> 0.053	> 0.005		> 0.758	
1													

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bibliography : 1 : EMEP/EEA, 2016: EMEP/EEA air pollutant emission inventory guidebook 2016; Copenhagen, July 2017. bibliography

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1) (bibcite 1)