1.A.3.d i (i) - International maritime navigation

Short description

Under NFR category **1.A.3.d i (i)**, emissions from international maritime navigation fuelling in and starting form German harbours are reported.

Category Code	Method	AD	EF
1.A.3.d i (i)	T1, T2, T3	NS, M	CS, M

Key Category	SO_2	NO_x	NH_3	NMVOC	CO	BC	Pb	Hg	Cd	Diox	PAH	HCB	TSP	PM_{10}	$PM_{2.5}$
1.A.3.d i (i)	*not included in key category analysis*														

T = key source by Trend **L** = key source by Level

Methods	
D	Default
RA	Reference Approach
T1	Tier 1 / Simple Methodology *
T2	Tier 2*
T3	Tier 3 / Detailed Methodology *
C	CORINAIR
CS	Country Specific
M	Model

* as described in the EMEP/CORINAIR Emission Inventory Guidebook - 2007, in the group specific chapters.

AD - Data Source for Activity Data	
NS	National Statistics
RS	Regional Statistics
IS	International Statistics
PS	Plant Specific data
AS	Associations, business organisations
Q	specific questionnaires, surveys

EF - Emission Factors	
D	Default (EMEP Guidebook)
C	Confidential
CS	Country Specific
PS	Plant Specific data

Methodology

Activity data

Primary fuel delivery data (primary activity data, PAD) for *international maritime navigation* is included in line 6 - 'International Deep-Sea Bunkers' of the National Energy Balances (NEB) (AGEB, 2019) [1)] together with respective data for IMO-registered ships used in *national maritime transport* (see 1.A.3.d ii (a)]), *fishing* (see 1.A.4.c iii]) and *military navigation* (see 1.A.5.b iii]).

The AD applied for *international maritime navigation* therefore represents the remains of primary fuel delivery data from NEB line 6 minus the modelled consumption data estimated for non-IMO ships in *1.A.3.d ii (a)*, *1.A.4.c iii* and *1.A.5.b iii*:

math AD_\text{ 1.A.3.d i} = PAD_\text{ NEB line 6} - AD_\text{ 1.A.3.d ii (a) - IMO} - AD_\text{ 1.A.4.c iii - IMO} - AD_\text{ 1.A.5.b iii - IMO} math

Table 1: Annual fuel consumption, in terajoules

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Diesel Oil	12.748	12.919	13.664	11.993	15.817	17.524	13.105	14.412	16.662	15.370	12.594	12.414	13.674	33.088	28.093	22.924	15.213	18.327
Heavy fuel oil	68.484	56.323	60.984	78.182	78.257	96.625	96.017	85.865	86.934	86.687	81.171	71.364	67.670	57.850	74.837	58.781	39.380	26.601
Σ 1.A.3.d ii	**81.232**	**69.242**	**74.648**	**90.175**	**94.074**	**114.149**	**109.122**	**100.277**	**103.596**	**102.057**	**93.765**	**83.778**	**81.344**	**90.938**	**102.930**	**81.705**	**54.592**	**44.928**

source: own estimates based on [2)]

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Consumption of heavy oil has been increasing since 1984 as a result of high petroleum prices, global increases in transports and increasing maritime use of diesel engines that can run on heavy oil. The emissions fluctuations that occurred in the navigation sector in 1992 and 1996 were caused by trade and oil crises.

Emission factors

For **main pollutants** and **particulate matter**, modelled emission factors are available from (Deichnik, K. (2019)) [3)].

Here, for **sulphur dioxide** and **particulate matter**, annual values are available representing the impact of fuel sulphur legislation. In addition, regarding SO,,x,,, the increasing operation of so-called scrubbers in order to fullfil emission limits especially within SECA areas is reflected for heavy fuel oil.

Table 2: Annual country-specific emission factors, in kg/TJ

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
DIESEL OIL																		
NH_3	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,33	0,32	0,32	0,32	0,32
NMVOC	48,7	48,7	48,7	48,7	48,7	48,7	48,7	48,7	48,7	48,7	48,7	48,4	48,0	44,8	44,7	45,0	45,2	45,2
NO_x	1.070	1.070	1.070	1.070	1.070	1.070	1.070	1.069	1.069	1.069	1.069	1.073	1.077	1.151	1.132	1.157	1.128	1.128
SO_x	465,5	419,0	232,8	186,2	186,2	186,2	139,7	69,8	69,8	65,2	54,5	52,6	50,5	40,7	40,6	40,7	40,8	40,8
BC^1	109,2	98,6	54,7	43,8	43,8	43,8	32,8	16,4	16,4	15,4	15,3	15,2	15,2	16,3	16,9	16,9	16,5	16,5
$PM_{2.5}$	352,4	318,0	176,5	141,2	141,3	141,3	105,9	53,0	53,0	49,6	49,5	49,1	49,1	52,7	54,5	54,5	53,1	53,1
PM_{10}	377,1	340,3	188,9	151,0	151,2	151,2	113,3	56,7	56,7	53,0	53,0	52,5	52,6	56,4	58,3	58,3	56,9	56,9

TSP[2]	377,1	340,3	188,9	151,0	151,2	151,2	113,3	56,7	56,7	53,0	53,0	52,5	52,6	56,4	58,3	58,3	56,9	56,9
CO	127	128	128	128	128	128	128	128	128	128	128	127	128	134	139	138	136	136
HEAVY FUEL OIL																		
NH_3	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,35	0,33	0,33	0,34	0,35	0,35
NMVOC	36,6	36,6	36,6	36,6	36,6	36,6	36,6	36,6	36,6	36,6	36,6	37,6	37,8	30,0	36,8	30,4	28,3	28,3
NO_x	1.379	1.378	1.378	1.378	1.378	1.378	1.378	1.378	1.378	1.377	1.379	1.382	1.393	1.348	1.245	1.360	1.503	1.503
SO_x	1.319	1.332	1.323	1.336	744	742	742	744	496	496	496	496	506	47,5	49,3	46,4	49,8	49,8
BC[1]	57,4	58,0	57,6	58,2	32,4	32,3	32,3	32,4	21,6	21,6	21,6	22,1	22,4	18,1	24,7	18,3	14,7	14,7
$PM_{2.5}$	479	483	480	485	270	269	269	270	180	180	180	184	187	151	205	153	123	123
PM_{10}	526	532	528	533	297	296	296	297	198	198	198	203	206	166	226	168	135	135
TSP[2]	526	532	528	533	297	296	296	297	198	198	198	203	206	166	226	168	135	135
CO	162	162	162	162	162	162	162	162	162	162	162	162	167	165	198	167	134	134

[1] estimated from f-BCs as provided in [4)]: f-BC (HFO) = 0.12, f-BC (MDO/MGO) = 0.31 as provided in [5)], chapter: 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii Navigation, Tables 3-1 & 3-2
[2] ratios $PM_{2.5}$: PM_{10} : TSP derived from the tier1 default EF as provided in [6)], chapter: 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii Navigation, Tables 3-1 & 3-2

> **NOTE:** For the country-specific emission factors applied for particulate matter, no clear indication is available, whether or not condensables are included.
>
> For information on the **emission factors for heavy-metal and POP exhaust emissions**, please refer to Appendix 2.3 - Heavy Metal (HM) exhaust emissions from mobile sources and Appendix 2.4 - Persistent Organic Pollutant (POP) exhaust emissions from mobile sources.

Discussion of emission trends

NFR 1.A.3.d i is **not considered in the key category analysis**.

Emission trends for unregulated pollutants (such as **NH_3**, **NO_x**, **NMVOC** and **CO**, all **HM** and **POPs**) with only slight changes in the annual over-all IEFs applied, follow the trends in fuel consumption and the shares of diesel and heavy fuel oil:

On the other hand, the emission trends for **SO_x** and **PM**, both depending on the fuel's sulphur content, follow not only the trends in fuel consumption but do also reflect fuel-sulphur legislation:

Recalculations

Resulting from changes in the fuel consumption data computed within [7)] for *domestic* maritime navigation, the **activity data** for 2017 for *international* maritime navigation have been reviesed.

Table 3: Revised fuel consumption data 2017, in terajoules

=	= **Diesel oil**	= **Heavy fuel oil**	= **over-all consumption**
~ Submission 2020	> 22,924	> 58,781	> 81,828
~ Submission 2019	> 23,165	> 58,781	> 82,069
~ absolute change	> -241	> 0.00	> -241
~ relative change	> -1.04%	> 0.00%	> -0.29%

In contrast, all country-specific and default **emission factors applied remain unrevised** compared to last year's submission.

For more information on recalculated emission estimates for Base Year and 2018, please see the pollutant-specific recalculation tables following chapter 8.1 - Recalculations.

Uncertainties

Uncertainty estimates for **activity data** of mobile sources derive from research project FKZ 360 16 023: “Ermittlung der Unsicherheiten der mit den Modellen TREMOD und TREMOD-MM berechneten Luftschadstoffemissionen des landgebundenen Verkehrs in Deutschland” by Knörr et al. (2009) [8)].

Planned improvements

Besides routine maintenance and further development of the BSH model, no improvements are planned.

FAQs

[1)] (bibcite 1)
[2)] (bibcite 2)
[3)] (bibcite 2)
[4), 6)] EMEP/EEA (2019): EMEP/EEA air pollutant emission inventory guidebook 2019, URL: https://www.eea.europa.eu/publications/emep-eea-guidebook-2019; Copenhagen, 2019.
[5)] (bibcite 2)
[7)] (bibcite 2)
[8)] (bibcite 5)