

1.A.5.b iii - Military Navigation

Short description

In sub-category *1.A.5.b iii - Other, Mobile (including Military)* emissions from military navigation are reported.

Method	AD	EF	Key Category Analysis
T1, T2	NS, M	D, M, CS, T1, T3	see superordinate chapter

Methodology

Activity Data

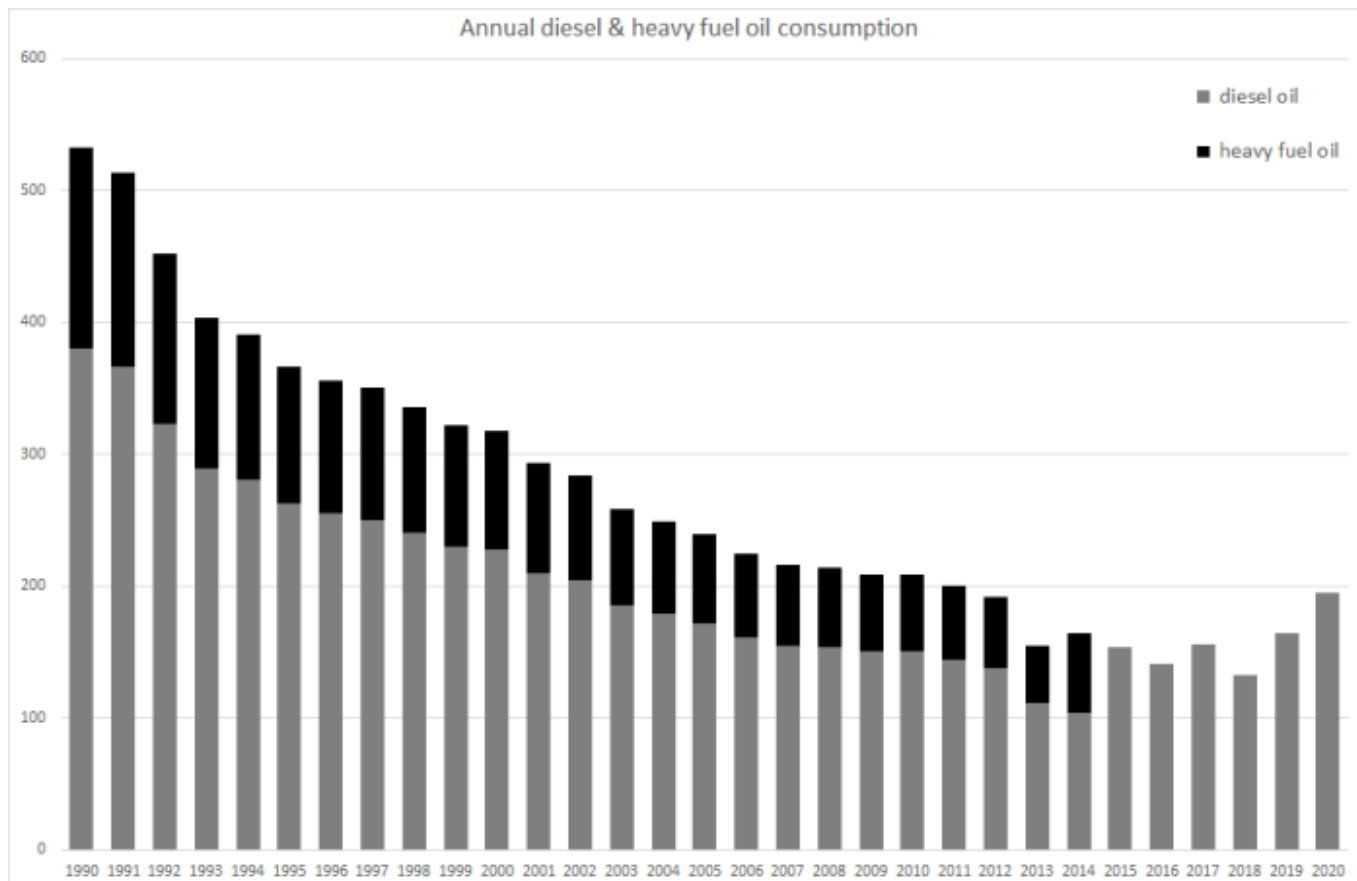
Primary fuel data for national military waterborne activities is included in NEB lines 6 ('International Deep-Sea Bunkers') and 64 ('Coastal and Inland Navigation') for IMO and non-IMO ships respectively.

The annual shares used within NFR 1.A.5.b iii are therefore calculated within (Deichnik, K. (2021))¹⁾, where ship movement data (AIS signal) allows for a bottom-up approach providing the needed differentiation.

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	2020
Diesel Oil	380	263	228	171	161	155	154	150	150	144	138	111	104	154	141	156	133	164	195
Heavy Fuel Oil	152	104	90	67	63	61	61	59	59	56	54	44	61	0	0	0	0	0	0
Σ 1.A.5.b iii	532	366	318	239	225	216	214	209	209	200	192	155	165	154	141	156	133	164	195

source: Deichnik, K. (2021): BSH model 2021



Emission factors

The emission factors applied here, are derived from different sources and therefore are of very different quality.

For the main pollutants, country-specific implied values are used, that are based on tier3 EF included in (Deichnik (2021)) which mainly relate on values from the EMEP/EEA guidebook 2019²⁾. These modelled IEFs take into account the ship specific information derived from AIS data as well as the mix of fuel-qualities applied depending on the type of ship and the current state of activity.

Table 2: Annual country-specific implied emission factors¹ for diesel fuels, in kg/TJ

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
DIESEL OIL																			
NH₃	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
NM VOC	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	40.0	39.4	34.2	34.1	34.1	36.2	35.5
NO_x	1,228	1,228	1,228	1,228	1,228	1,228	1,228	1,228	1,228	1,228	1,228	1,221	1,227	1,286	1,294	1,298	1,252	1,265	1,265
SO_x	466	419	233	186	186	186	140	69.8	69.8	65.2	60.3	56.7	53.7	37.2	37.2	37.2	37.2	37.2	37.2
BC	111	99.8	55.4	44.3	44.3	44.3	33.3	16.6	16.6	15.5	15.5	15.5	15.8	15.9	15.2	14.8	16.1	15.3	15.3
PM_{2.5}	358	322	179	143	143	143	107	53.6	53.6	50.1	50.1	50.1	51.0	51.2	49.1	47.8	51.9	49.3	49.3
PM₁₀	383	344	191	153	153	153	115	57.4	57.4	53.6	53.6	53.6	54.6	54.8	52.5	51.1	55.5	52.7	52.7
TSP	383	344	191	153	153	153	115	57.4	57.4	53.6	53.6	53.6	54.6	54.8	52.5	51.1	55.5	52.7	52.7
CO	140	140	140	140	140	140	140	140	140	140	140	139	142	148	144	141	148	142	142
HEAVY FUEL OIL																			
NH₃	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.35	NA				
NM VOC	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	27.0	28.6	NA					
NO_x	1,468	1,468	1,468	1,468	1,468	1,468	1,468	1,468	1,468	1,468	1,468	1,488	1,496	NA					
SO_x	1,319	1,332	1,323	1,336	744	742	742	744	496	496	496	495	506	NA					
BC	42,3	42,7	42,4	42,9	23,9	23,8	23,8	23,8	15,9	15,9	15,9	14,9	16,3	NA					
PM_{2.5}	353	356,0	354	357	199	198	198	199	132	133	133	124	136	NA					
PM₁₀	388	392	389	393	219	218	218	219	146	146	146	137	150	NA					
TSP	388	392	389	393	219	218	218	219	146	146	146	137	150	NA					

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
CO	154	154	154	154	154	154	154	154	154	154	154	148	157				NA		

¹ due to lack of better information: similar EF are applied for fossil and biodiesel

² ratio PM_{2.5} : PM₁₀ : TSP derived from the tier1 default EF as provided in ³⁾

³ estimated from a BC-fraction of 0.31 as provided in ⁴⁾, chapter: 1.A.3.d.i, 1.A.3.d.ii, 1.A.4.c.iii Navigation, Table 3-2



With respect to the emission factors applied for particulate matter, given the circumstances during test-bench measurements, condensables are most likely included at least partly. ¹⁾



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



As only NFR 1.A.5.b as a whole is taken into account within the key category analysis, this country-specific sub-sector is not considered separately.

Recalculations

Activity data have been revised widely after a correction of the underlying model.

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
DIESEL OIL																		
Submission 2022	380	263	228	171	161	155	154	150	150	144	138	111	104	154	141	156	133	164
Submission 2021	983	665	563	410	383	366	360	349	347	330	313	302	332	273	359	489	436	558
absolute change	-602	-402	-335	-238	-222	-211	-207	-199	-197	-186	-176	-190	-228	-119	-218	-333	-303	-394
relative change	-61,3%	-60,5%	-59,5%	-58,2%	-57,9%	-57,6%	-57,3%	-57,0%	-56,7%	-56,4%	-56,1%	-63,1%	-68,7%	-43,5%	-60,7%	-68,1%	-69,6%	-70,6%
HEAVY FUEL OIL																		
Submission 2022	152	104	90,4	67,4	63,4	61,0	60,5	59,0	59,0	56,5	54,0	43,9	60,5					
Submission 2021	0	0	0	0	0	0	0	0	0	0	0	0	0					
absolute change	152	104	90,4	67,4	63,4	61,0	60,5	59,0	59,0	56,5	54,0	43,9	60,5					
relative change																		
OVER-ALL FUEL CONSUMPTION																		
Submission 2022	532	366	318	239	225	216	214	209	209	200	192	155	165	154	141	156	133	164
Submission 2021	983	665	563	410	383	366	360	349	347	330	313	302	332	273	359	489	436	558
absolute change	-451	-298	-245	-171	-158	-150	-146	-140	-138	-130	-122	-146	-168	-119	-218	-333	-303	-394
relative change	-45,9%	-44,9%	-43,5%	-41,7%	-41,3%	-40,9%	-40,5%	-40,1%	-39,7%	-39,3%	-38,9%	-48,5%	-50,5%	-43,5%	-60,7%	-68,1%	-69,6%	-70,6%

In addition, several **emission factors** for diesel oil have been revised within the underlying model.

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AMMONIA																		
Submission 2022	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33
Submission 2021	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,32	0,33	0,33	0,33	0,33
absolute change	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00
relative change	0,35%	0,35%	0,35%	0,35%	0,35%	0,35%	0,35%	0,35%	0,35%	0,35%	0,35%	0,29%	0,46%	4,23%	1,04%	0,98%	0,58%	-0,18%
NMVOC																		
Submission 2022	39,6	39,6	39,6	39,6	39,6	39,6	39,6	39,6	39,6	39,6	39,6	40,0	39,4	34,2	34,1	34,1	36,2	35,5
Submission 2021	41,4	41,4	41,4	41,4	41,4	41,4	41,4	41,4	41,4	41,4	41,4	41,6	41,1	47,7	37,4	38,0	39,1	38,2
absolute change	-1,81	-1,81	-1,81	-1,81	-1,81	-1,81	-1,81	-1,81	-1,81	-1,81	-1,81	-1,58	-1,70	-13,45	-3,25	-3,86	-2,90	-2,71
relative change	-4,37%	-4,37%	-4,37%	-4,37%	-4,37%	-4,37%	-4,37%	-4,37%	-4,37%	-4,37%	-4,37%	-3,79%	-4,15%	-28,2%	-8,68%	-10,17%	-7,41%	-7,09%
NITROGEN OXIDES																		
Submission 2022	1228	1228	1228	1228	1228	1228	1228	1228	1228	1228	1228	1221	1227	1286	1294	1298	1252	1265
Submission 2021	1106	1106	1106	1106	1106	1106	1106	1106	1106	1106	1106	1105	1098	1011	1119	1124	1117	1134
absolute change	122	122	122	122	122	122	122	122	122	122	122	116	129	275	175	174	135	131
relative change	11,0%	11,0%	11,0%	11,0%	11,0%	11,0%	11,0%	11,0%	11,0%	11,0%	11,0%	10,5%	11,7%	27,2%	15,6%	15,4%	12,1%	11,5%
SULPHUR OXIDES																		
Submission 2022	465,5	419,0	232,8	186,2	186,2	186,2	139,7	69,8	69,8	65,2	60,3	56,7	53,7	37,2	37,2	37,2	37,2	37,2
Submission 2021	465,5	419,0	232,8	186,2	186,2	186,2	139,7	69,8	69,8	65,2	59,4	55,9	53,4	40,0	38,7	38,8	39,3	39,2
absolute change	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,96	0,75	0,33	-2,80	-1,46	-1,57	-2,12	-2,04
relative change	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	1,62%	1,35%	0,61%	-7,00%	-3,76%	-4,05%	-5,39%	-5,21%
BLACK CARBON																		
Submission 2022	110,86	99,78	55,43	44,34	44,34	44,34	33,26	16,63	16,63	15,52	15,52	15,53	15,82	15,87	15,21	14,81	16,08	15,28
Submission 2021	109,23	98,31	54,62	43,69	43,69	43,69	32,77	16,38	16,38	15,29	15,29	15,28	16,07	19,60	16,31	15,18	15,82	14,83
absolute change	1,63	1,47	0,81	0,65	0,65	0,65	0,49	0,24	0,24	0,23	0,23	0,25	-0,25	-3,73	-1,11	-0,37	0,26	0,44
relative change	1,49%	1,49%	1,49%	1,49%	1,49%	1,49%	1,49%	1,49%	1,49%	1,49%	1,49%	1,67%	-1,55%	-19,1%	-6,78%	-2,43%	1,67%	2,98%
PARTICULATE MATTER																		
Submission 2022	357,62	321,86	178,81	143,05	143,05	143,05	107,29	53,64	53,64	50,07	50,07	50,10	51,04	51,18	49,06	47,78	51,88	49,28
Submission 2021	352,36	317,13	176,18	140,95	140,95	140,95	105,71	52,85	52,85	49,33	49,33	49,28	51,85	63,23	52,63	48,96	51,03	47,85
absolute change	5,25	4,73	2,63	2,10	2,10	2,10	1,58	0,79	0,79	0,74	0,74	0,82	-0,81	-12,05	-3,57	-1,19	0,85	1,43
relative change	1,49%	1,49%	1,49%	1,49%	1,49%	1,49%	1,49%	1,49%	1,49%	1,49%	1,49%	1,67%	-1,55%	-19,05%	-6,78%	-2,43%	1,67%	2,98%
CARBON MONOXIDE																		
Submission 2022	140	140	140	140	140	140	140	140	140	140	140	139	142	148	144	141	148	142
Submission 2021	136	136	136	136	136	136	136	136	136	136	136	136	142	158	148	139	142	137
absolute change	3,65	3,65	3,65	3,65	3,65	3,65	3,65	3,65	3,65	3,65	3,65	3,56	0,28	-9,74	-3,74	1,99	5,15	5,71
relative change	2,68%	2,68%	2,68%	2,68%	2,68%	2,68%	2,68%	2,68%	2,68%	2,68%	2,68%	2,62%	0,20%	-6,16%	-2,53%	1,43%	3,62%	4,18%



For **pollutant-specific information on recalculated emission estimates for Base Year and 2019**, please see the recalculation tables following chapter [8.1 - Recalculations](#).

Uncertainties

See [superordinate chapter](#) on NFR 1.A.5.b.

Planned improvements

A **routine revision** of the underlying model is planned for the next annual submission.

¹⁾ Deichnik (2021): Deichnik, K.: Aktualisierung und Revision des Modells zur Berechnung der spezifischen Verbräuche und Emissionen des von Deutschland ausgehenden Seeverkehrs. from Bundesamts für Seeschifffahrt und Hydrographie (BSH); Hamburg, 2021.

^{2), 3), 4)} EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook 2019, Copenhagen, 2019.

¹⁾
During test-bench measurements, temperatures are likely to be significantly higher than under real-world conditions, thus reducing condensation. On the contrary, smaller dilution (higher number of primary particles acting as condensation germs) together with higher pressures increase the likeliness of condensation. So over-all condensables are very likely to occur but different to real-world conditions.