2.G(a) - Fireworks

Short description

In this sub-category of *2.G(a) - Other product use: Fireworks* Germany reports NO_x, SO_x, CO, TSP, PM_{10}, $PM_{2.5}$, Cu, Pb and Zn emissions from fireworks.

NFR-Code	Name of Category	Method	AD	EF
2.G(a)	Other Product use: Fireworks	CS	NS and association	D, CS

Methodology

In the year 2019 measurements were made by a finish laboratory for the VPI – Verband der pyrotechnischen Industrie (Association of the pyrotechnical industry) of dust emissions during the burning of fire works. The experiments were made in a container in which the whole fireworks were burned. In 2020 the VPI and the UBA had an intensive information exchange, in which the VPI presented the results of the measurements to the UBA. The different emission factors were discussed and finally based on the expert judgement it was decided which EFs shall be used for the reporting. In the next step the activity data were updated more differentiated. Further a discussion of the other EFs was made, which led to some changes in the EFs. The results are presented below. In February 2021 the VPI has published an article in the paper “Propellants, Explosives, Pyrotechnics” a description of the experiment together with the measurement results[1)].

Activity data

For the calculation of the activity data the following formula is used:

AR = production + import – export – disposal + return of the year before – return of the year

The **production, disposal, return from the year before and return of the year** data are yearly updated by the VPI.

Import and export: For the import and export data statistical data from the statistical federal office of Germany were taken (foreign statistics of federal office of statistics)[2)].

The sold amounts of fireworks have increased strongly from 1990 to 1995. From 1995 to 1997 the emissions were relatively high but decreased from 1997 to 2005. Since then, the emissions have been relatively constant with small fluctuations.

Emission factors

The emission factors of SO_2, CO, NO_x, Cu, Pb and Zn are the Default-EFs derived from the EMEP Guidebook[3)], page 22, table 3-14: Tier 2 emission factor for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of Fireworks.

Table 1: Default emission factors applied, in g/t product

	Default-EF
SO_2	3.020
CO	7.150
NO_x	260
Cu	444
Pb	784
Zn	260

The emission factors for PM_{10}, $PM_{2.5}$ and TSP are measured values from the VPI.

Table 2: Country-specific PM emission factors applied, in g/t product

	PM_{10}		**$PM_{2.5}$**		**TSP**	
	Sylvester-EF	**During the period-EF**	**Sylvester-EF**	**During the period-EF**	**Sylvester-EF**	**During the period-EF**
1990-2004	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
2005	47.509,31	72.317,11	38.129,60	57.167,68	47.509,31	72.317,11
2006	45.793,40	71.986,67	36.930,61	56.906,46	45.793,40	71.986,67
2007	45.174,65	72.071,88	36.615,74	56.973,82	45.174,65	72.071,88
2008	45.955,36	71.471,31	37.390,41	56.499,06	45.955,36	71.471,31
2009	45.701,68	70.204,58	37.132,12	55.497,69	45.701,68	70.204,58
2010	44.826,79	69.253,15	36.536,80	54.745,57	44.826,79	69.253,15
2011	44.068,30	68.877,53	36.121,87	54.448,64	44.068,30	68.877,53
2012	45.566,16	69.993,91	37.527,36	55.331,16	45.566,16	69.993,91
2013	46.098,42	67.212,39	38.026,91	53.132,33	46.098,42	67.212,39
2014	46.621,17	67.680,72	38.595,22	53.502,55	46.621,17	67.680,72
2015	47.474,24	67.313,58	39.383,93	53.212,31	47.474,24	67.313,58
2016	47.523,35	66.094,38	39.539,55	52.248,52	47.523,35	66.094,38
2017	47.853,44	65.938,58	39.907,83	52.125,36	47.853,44	65.938,58
2018	48.270,00	63.519,57	39.713,09	50.213,10	48.270,00	63.519,57
2019	48.085,00	63.217,87	40.033,58	49.974,60	48.085,00	63.217,87

The EMEP Guidebook offers Default-EFs for the pollutants Ar, Hg, Ni and Cr. But the VPI has proofed that these emissions does not occur in Germany. And the VPI has further proofed that Pb emissions does not anymore occur since 2003. See the following explanations:

As and Hg: For As and Hg the members of the VPI have confirmed that Ar and Hg are not anymore used since 1980. Since 2003 the DIN EN 14035:2003 went in force, which did forbit these substances. The actual follow up norm DIN EN 15947-5 was published in February 2016 and describes the german implementation of the harmonized and in the official journal of the European union 2017, C 149/2 published norm EN 15947:2015.

Pb: As the DIN EN 14035:2003 entered into force as from 2003, which did forbid this substance, there

are no Pb-emissions from fireworks from 2003 onwards. The actual follow up norm DIN EN 15947-5 was published in February 2016 and describes the german implementation of the harmonized and in the official journal of the European union 2017, C 149/2 published norm EN 15947:2015.

Cd: The members of the VPI were asked and did explain, that Cd was never used, because it has no pyrotechnical effect. Since 2013 Cd is on the candidates list of the substances of Very High Concern (SVHC), published according article 59, para. 10 of the REACH-ordinance.

Ni: The members of the VPI informed that Ni was never used, because it has no pyrotechnical effect. It is part of the harmonized assessment according the ordinance (EG) Nr. 1272/2008 (CLP). Belonging to this, it is assessed as cancerogen category 2.

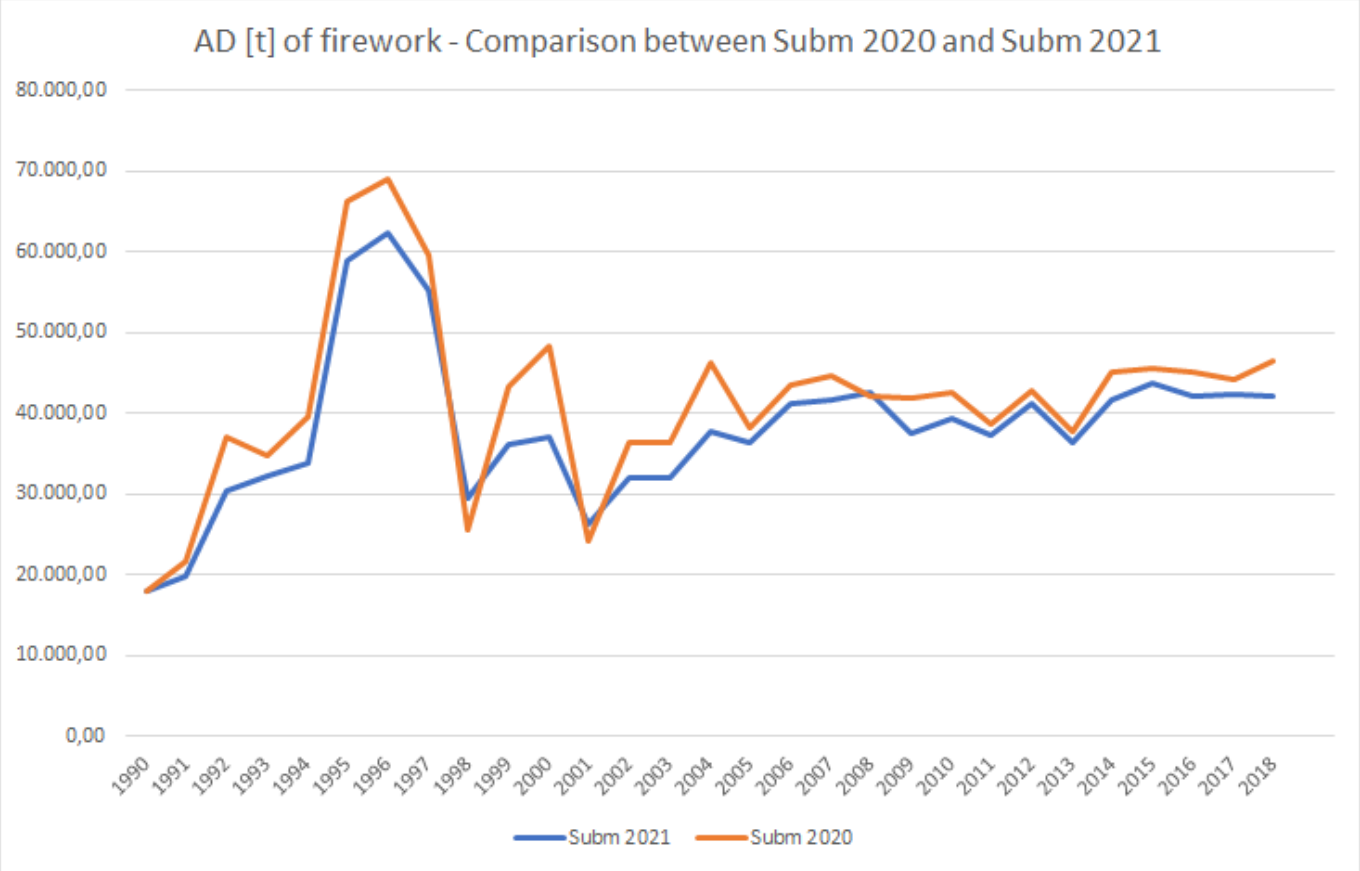
Cr: According the information from the members of the VPI Cr is not anymore used since the beginning of the 1980. Since 2012 (REACH Annex XIV (Ordinance (EU) Nr. 125/2012) Cr was implemented in the REACH Annex XIV. So from that year a permission duty is necessary. So far, none of the fireworks producers has requested for a permission.

Recalculations

Activity data has changed as follows:

Table 3: Change of AD between Submission 2020 and Submission 2021, in t

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Submission 2021	Sylvester	13,939	16,396	24,556	26,172	27,153	51,421	54,413	48,281	24,180	24,693	26,283	21,561	25,994	25,759	29,286	28,856	30,491	33,396	34,461	30,075	31,440	29,795	33,086	29,131	33,241	34,999	32,572	33,936	32,980
	during the year	4,130	3,493	5,903	6,138	6,799	7,447	7,880	6,993	5,220	11,483	10,906	4,741	6,085	6,256	8,545	7,506	10,755	8,235	8,088	7,521	8,007	7,499	8,137	7,247	8,465	8,832	9,487	8,544	9,088
	SUM	**18,069**	**19,889**	**30,458**	**32,310**	**33,951**	**58,869**	**62,293**	**55,274**	**29,400**	**36,175**	**37,188**	**26,303**	**32,079**	**32,016**	**37,832**	**36,362**	**41,247**	**41,631**	**42,550**	**37,595**	**39,446**	**37,294**	**41,223**	**36,378**	**41,706**	**43,830**	**42,059**	**42,480**	**42,068**
Submission 2020		**17,957**	**21,741**	**37,116**	**34,781**	**39,579**	**66,272**	**69,010**	**59,560**	**25,605**	**43,244**	**48,355**	**24,150**	**36,462**	**36,352**	**46,347**	**38,148**	**43,487**	**44,705**	**42,228**	**41,839**	**42,652**	**38,638**	**42,857**	**37,847**	**45,164**	**45,656**	**45,208**	**44,111**	**46,462**
Change		112	-1,852	-6,658	-2,471	-5,628	-7,403	-6,717	-4,286	3,795	-7,069	-11,167	2,153	-4,383	-4,336	-8,516	-1,786	-2,240	-3,073	322	-4,244	-3,206	-1,344	-1,634	-1,469	-3,458	-1,826	-3,149	-1,631	-4,394



The **emissions** from As, Cd, Cr, Hg and Ni were deleted. The VPI proofed that these emissions does not occur. For Pb the emissions are from 2003 onwards changed to NA because the VPI proofed that the usage of Pb is forbidden since 2003 by a DIN Norm. The emissions of CO, Cu, NOx, SO_x, Zn and Pb are changed because of changed AD. The emissions of PM10, PM2.5 and TSP are changed because of changed AD and new EFs from the VPI.

Table 4: Change of emissions between Submission 2020 and Submission 2021, in t

	Pollutant	Source	1990	1995	2000	2005	2010	2015	2016	2017	2018
Subm2020	**As**		**0,024**	**0,088**	**0,064**	**0,051**	**0,057**	**0,061**	**0,060**	**0,059**	**0,062**
Subm2021		**New Years Eve**	NA								
Subm2021		**rest of the year**									
Difference			-0,024	-0,088	-0,064	-0,051	-0,057	-0,061	-0,060	-0,059	-0,062
Subm2020	**Cd**		0,027	0,098	0,072	0,057	0,063	0,068	0,067	0,065	0,069
Subm2021		**New Years Eve**	NA								
Subm2021		**rest of the year**									
Difference			-0,027	-0,098	-0,072	-0,056	-0,063	-0,068	-0,067	-0,065	-0,069
Subm2020	**CO**		128,392	473,843	345,740	272,759	304,960	326,443	323,239	315,392	332,201
Subm2021		**New Years Eve**	99,664	367,662	187,921	206,322	224,792	250,241	232,888	242,640	235,805
Subm2021		**rest of the year**	29,530	53,247	77,976	53,664	57,247	63,145	67,833	61,090	64,979
Difference			0,802	-52,934	-79,843	-12,773	-22,920	-13,057	-22,518	-11,662	-31,417
Subm2020	**Cr**		0,280	1,034	0,754	0,595	0,665	0,712	0,705	0,688	0,725
Subm2021		**New Years Eve**	NA								
Subm2021		**rest of the year**									
Difference			-0,280	-1,034	-0,754	-0,595	-0,665	-0,712	-0,705	-0,688	-0,725
Subm2020	**Cu**		7,973	29,425	21,470	16,938	18,937	20,271	20,072	19,585	20,629
Subm2021		**New Years Eve**	6,189	22,831	11,670	12,812	13,959	15,539	14,462	15,067	14,643
Subm2021		**rest of the year**	1,834	3,307	4,842	3,332	3,555	3,921	4,212	3,794	4,035
Difference			0,050	-3,287	-4,958	-0,793	-1,423	-0,811	-1,398	-0,724	-1,951

	Pollutant	Source	1990	1995	2000	2005	2010	2015	2016	2017	2018
Subm2020	**As**		**0,024**	**0,088**	**0,064**	**0,051**	**0,057**	**0,061**	**0,060**	**0,059**	**0,062**
Subm2020	**Hg**		0,001	0,004	0,003	0,002	0,002	0,003	0,003	0,003	0,003
Subm2021		**New Years Eve**	NA								
Subm2021		**rest of the year**									
Difference			-0,001	-0,004	-0,003	-0,002	-0,002	-0,003	-0,003	-0,003	-0,003
Subm2020	**Ni**		0,539	1,988	1,451	1,144	1,280	1,370	1,356	1,323	1,394
Subm2021		**New Years Eve**	NA								
Subm2021		**rest of the year**									
Difference			-0,539	-1,988	-1,451	-1,144	-1,280	-1,370	-1,356	-1,323	-1,394
Subm2020	**NOx**		4,669	17,231	12,572	9,919	11,089	11,871	11,754	11,469	12,080
Subm2021		**New Years Eve**	3,624	13,370	6,834	7,503	8,174	9,100	8,469	8,823	8,575
Subm2021		**rest of the year**	1,074	1,936	2,835	1,951	2,082	2,296	2,467	2,221	2,363
Difference			0,029	-1,925	-2,903	-0,464	-0,833	-0,475	-0,819	-0,424	-1,142
Subm2020	**Pb**		14,078	51,957	37,911	29,908	33,439	35,795	35,443	34,583	36,426
Subm2021		**New Years Eve**	10,928	24,809	4,755	0,000	0,000	0,000	0,000	0,000	0,000
Subm2021		**rest of the year**	3,238	3,593	1,973	0,000	0,000	0,000	0,000	0,000	0,000
Difference			0,088	-23,555	-31,182	-29,908	-33,439	-35,795	-35,443	-34,583	-36,426
Subm2020	**PM10**			6622	4832	3812	4262	4562	4517	4408	4642
Subm2021		**New Years Eve**		2674	1367	1371	1409	1662	1548	1624	1592
Subm2021		**rest of the year**		468	685	543	554	594	627	563	577
Difference				-3480	-2780	-1898	-2298	-2306	-2342	-2220	-2473
Subm2020	**PM2.5**			3442	2512	1981	2215	2371	2348	2291	2413
Subm2021		**New Years Eve**		2132	1090	1100	1149	1378	1288	1354	1310
Subm2021		**rest of the year**		370	541	429	438	470	496	445	456
Difference				-940	-880	-452	-628	-523	-565	-491	-647

	Pollutant	Source	1990	1995	2000	2005	2010	2015	2016	2017	2018
Subm2020	**As**		**0,024**	**0,088**	**0,064**	**0,051**	**0,057**	**0,061**	**0,060**	**0,059**	**0,062**
Subm2020	**SO2**		54,230	200,141	146,033	115,207	128,808	137,882	136,529	133,214	140,314
Subm2021		**New Years Eve**	42,096	155,292	79,374	87,146	94,947	105,696	98,367	102,486	99,599
Subm2021		**rest of the year**	12,473	22,491	32,935	22,667	24,180	26,671	28,651	25,803	27,446
Difference			0,339	-22,358	-33,724	-5,395	-9,681	-5,515	-9,511	-4,926	-13,270
Subm2020	**TSP**		1972	7279	5311	4190	4684	5014	4965	4845	5103
Subm2021		**New Years Eve**	725	2674	1367	1371	1409	1662	1548	1624	1592
Subm2021		**rest of the year**	259	468	685	543	554	594	627	563	577
Difference			-988	-4137	-3259	-2276	-2721	-2758	-2790	-2657	-2934
Subm2020	**Zn**		4,669	17,231	12,572	9,919	11,089	11,871	11,754	11,469	12,080
Subm2021		**New Years Eve**	3,624	13,370	6,834	7,503	8,174	9,100	8,469	8,823	8,575
Subm2021		**rest of the year**	1,074	1,936	2,835	1,951	2,082	2,296	2,467	2,221	2,363
Difference			0,029	-1,925	-2,903	-0,464	-0,833	-0,475	-0,819	-0,424	-1,142

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

Uncertainties

The uncertainty for the AD is given as 10%.

Planned improvements

No improvements are planned.

[1)] https://onlinelibrary.wiley.com/doi/epdf/10.1002/prep.202000292

[2)] Statistisches Bundesamt (51000-0013): Aus- und Einfuhr (Außenhandel), URL: https://www-genesis.destatis.de/genesis/online/data;sid=D7FC9DA10C87E483A48EA26969FF80CF.GO_1_5?operation=abruftabelleAbrufen&selectionname=51000-0013&levelindex=0&levelid=1552378849838&index=13

[3)] EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook 2019, Copenhagen, 2019.