

## 2.G(a) - Fireworks

### Short description

In this sub-category of 2.G(a) - Other product use: Fireworks Germany reports NO<sub>x</sub>, SO<sub>x</sub>, CO, TSP, PM<sub>10</sub>, PM<sub>2.5</sub>, 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<sup>1)</sup>.

### Activity data

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

$$AR = \text{production} + \text{import} - \text{export} - \text{disposal} + \text{return of the year before} - \text{return of the year}$$

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)<sup>2)</sup>.

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<sub>2</sub>, CO, NO<sub>x</sub>, Cu, Pb and Zn are the Default-EFs derived from the EMEP Guidebook<sup>3)</sup>, 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
<b>SO<sub>2</sub></b>	3.020
<b>CO</b>	7.150
<b>NO<sub>x</sub></b>	260
<b>Cu</b>	444
<b>Pb</b>	784
<b>Zn</b>	260

The emission factors for PM<sub>10</sub>, PM<sub>2.5</sub> and TSP are measured values from the VPI.

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

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

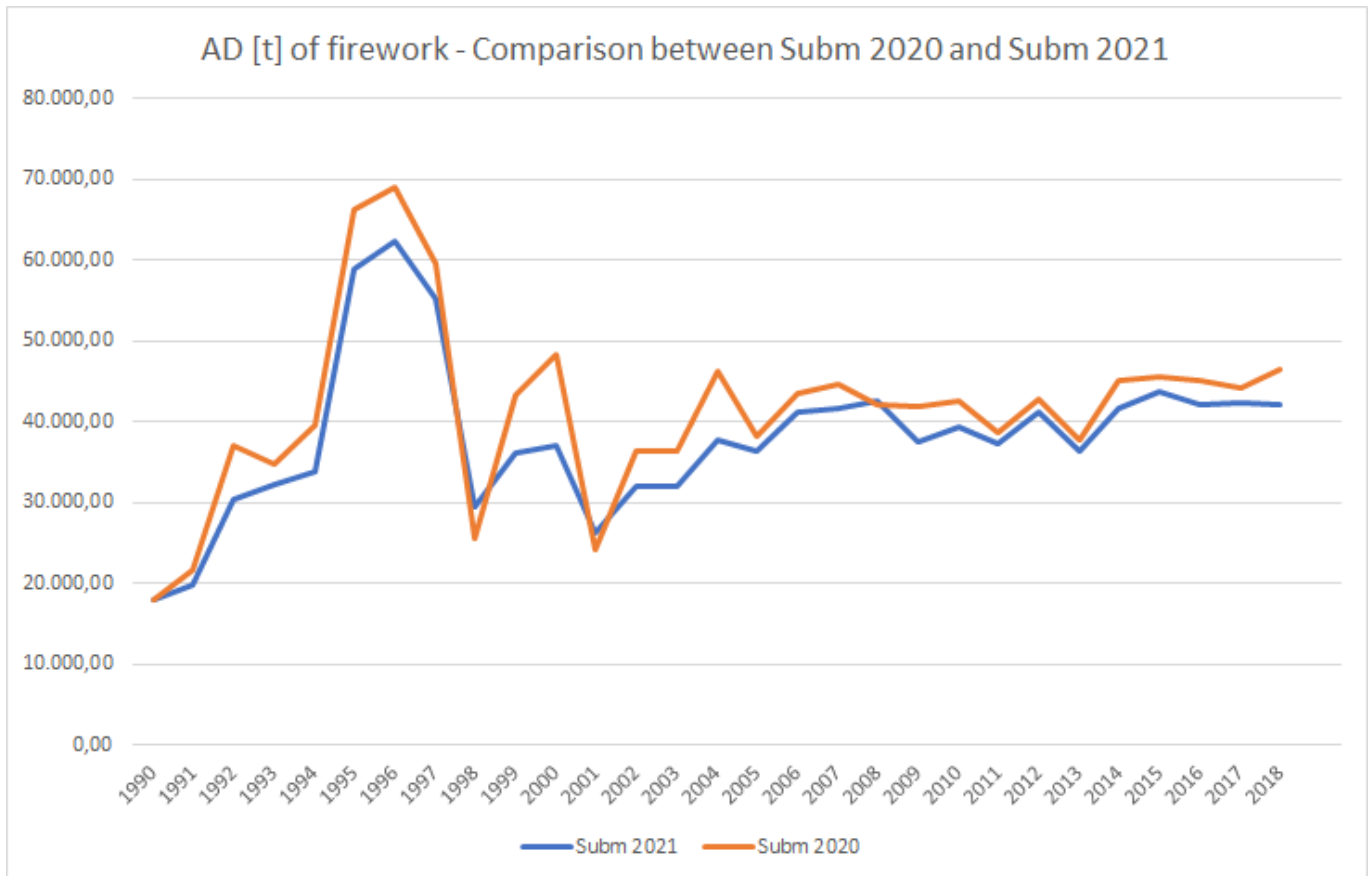
**Cr:** According the information from the members of the VPI Cr is not anymore used since the beginning of the 1980. Since 2012 (REACH Annex XIV (Ordinance (EU) Nr. 125/2012) Cr was implemented in the REACH Annex XIV. So from that year a permission duty is necessary. So far, none of the fireworks producers 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
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
Submission 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	37.189	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 proved that these emissions does not occur. For Pb the emissions are from 2003 onwards changed to NA because the VPI proved that the usage of Pb is forbidden since 2003 by a DIN Norm. The emissions of CO, Cu, NOx, SOx, 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	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Subm2021		rest of the year	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
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	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Subm2021		rest of the year	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
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	CO	New Years Eve	99,664	367,662	187,921	206,322	224,792	250,241	232,888	242,640	235,805
Subm2021	CO	rest of the year	29,530	53,247	77,976	53,664	57,247	63,145	67,833	61,090	64,979
Difference	CO		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

	Pollutant	Source	1990	1995	2000	2005	2010	2015	2016	2017	2018
Subm2021	Cr	New Years Eve	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Subm2021	Cr	rest of the year	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Difference	Cr		-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	Cu	New Years Eve	6,189	22,831	11,670	12,812	13,959	15,539	14,462	15,067	14,643
Subm2021	Cu	rest of the year	1,834	3,307	4,842	3,332	3,555	3,921	4,212	3,794	4,035
Difference	Cu		0,050	-3,287	-4,958	-0,793	-1,423	-0,811	-1,398	-0,724	-1,951
Subm2020	Hg		0,001	0,004	0,003	0,002	0,002	0,003	0,003	0,003	0,003
Subm2021	Hg	New Years Eve	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Subm2021	Hg	rest of the year	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Difference	Hg		-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	Ni	New Years Eve	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Subm2021	Ni	rest of the year	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Difference	Ni		-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	NOx	New Years Eve	3,624	13,370	6,834	7,503	8,174	9,100	8,469	8,823	8,575
Subm2021	NOx	rest of the year	1,074	1,936	2,835	1,951	2,082	2,296	2,467	2,221	2,363
Difference	NOx		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	Pb	New Years Eve	10,928	24,809	4,755	0,000	0,000	0,000	0,000	0,000	0,000
Subm2021	Pb	rest of the year	3,238	3,593	1,973	0,000	0,000	0,000	0,000	0,000	0,000
Difference	Pb		0,088	-23,555	-31,182	-29,908	-33,439	-35,795	-35,443	-34,583	-36,426
Subm2020	PM 10			6621,880	4831,660	3811,760	4261,760	4561,980	4517,210	4407,540	4642,450
Subm2021	PM 10	New Years Eve		2674,040	1366,770	1370,940	1409,330	1661,540	1547,920	1623,940	1591,930
Subm2021	PM 10	rest of the year		467,684	684,878	542,776	554,482	594,480	627,051	563,379	577,266
Difference	PM 10			-3480,155	-2780,016	-1898,047	-2297,944	-2305,961	-2342,246	-2220,222	-2473,257
Subm2020	PM 2.5			3442,160	2511,570	1981,410	2215,330	2371,390	2348,120	2291,110	2413,220
Subm2021	PM 2.5	New Years Eve		2132,080	1089,760	1100,280	1148,700	1378,390	1287,870	1354,300	1309,730
Subm2021	PM 2.5	rest of the year		369,711	541,405	429,072	438,326	469,945	495,692	445,359	456,337

	Pollutant	Source	1990	1995	2000	2005	2010	2015	2016	2017	2018
<b>Difference</b>	<b>PM 2.5</b>			-940,363	-880,408	-452,067	-628,305	-523,057	-564,557	-491,450	-647,158
<b>Subm2020</b>	<b>SO2</b>		54,230	200,141	146,033	115,207	128,808	137,882	136,529	133,214	140,314
<b>Subm2021</b>	<b>SO2</b>	<b>New Years Eve</b>	42,096	155,292	79,374	87,146	94,947	105,696	98,367	102,486	99,599
<b>Subm2021</b>	<b>SO2</b>	<b>rest of the year</b>	12,473	22,491	32,935	22,667	24,180	26,671	28,651	25,803	27,446
<b>Difference</b>	<b>SO2</b>		0,339	-22,358	-33,724	-5,395	-9,681	-5,515	-9,511	-4,926	-13,270
<b>Subm2020</b>	<b>TSP</b>		1972,210	7278,630	5310,860	4189,810	4684,440	5014,430	4965,230	4844,680	5102,890
<b>Subm2021</b>	<b>TSP</b>	<b>New Years Eve</b>	724,864	2674,040	1366,770	1370,940	1409,330	1661,540	1547,920	1623,940	1591,930
<b>Subm2021</b>	<b>TSP</b>	<b>rest of the year</b>	259,370	467,684	684,878	542,776	554,482	594,480	627,051	563,379	577,266
<b>Difference</b>	<b>TSP</b>		-987,973	-4136,909	-3259,218	-2276,095	-2720,622	-2758,415	-2790,261	-2657,359	-2933,693
<b>Subm2020</b>	<b>Zn</b>		4,669	17,231	12,572	9,919	11,089	11,871	11,754	11,469	12,080
<b>Subm2021</b>	<b>Zn</b>	<b>New Years Eve</b>	3,624	13,370	6,834	7,503	8,174	9,100	8,469	8,823	8,575
<b>Subm2021</b>	<b>Zn</b>	<b>rest of the year</b>	1,074	1,936	2,835	1,951	2,082	2,296	2,467	2,221	2,363
<b>Difference</b>	<b>Zn</b>		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.

<sup>1)</sup> <https://onlinelibrary.wiley.com/doi/epdf/10.1002/prep.202000292>

<sup>2)</sup> Statistisches Bundesamt (51000-0013): Aus- und Einfuhr (Außenhandel), URL: [https://www-genesis.destatis.de/genesis/online/data;sid=D7FC9DA10C87E483A48EA26969FF80CF.GO\\_1\\_5?operation=abrufabelleAbrufen&selectionname=51000-0013&levelindex=0&levelid=1552378849838&index=13](https://www-genesis.destatis.de/genesis/online/data;sid=D7FC9DA10C87E483A48EA26969FF80CF.GO_1_5?operation=abrufabelleAbrufen&selectionname=51000-0013&levelindex=0&levelid=1552378849838&index=13)

<sup>3)</sup> EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook 2019, Copenhagen, 2019.