

2.G(a) - Fireworks

Fireworks

Short description

In this sub-category of 2.G(a) - *Other product use: Fireworks* Germany reports NO_x, SO_x, CO, TSP, PM₁₀, PM_{2.5}, Cu, Pb and Zn emissions from fireworks.

NFR-Code	~ Name of Category	~ Method	~ AD	~ EF	~ Key Category
= 2.G(a)	= Other Product use: Fireworks	= CS	= NS and association	= D, CS	= see superordinate chapter]

Method

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.

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)¹⁾. 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 SO₂, CO, NO_x, Cu, Pb and Zn are the Default-EFs derived from the EMEP Guidebook²⁾, 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.

Pollutants	Unit	Default-EF
SO ₂	g/t product	3.020
CO	g/t product	7.150

Pollutants	Unit	Default-EF
NOx	g/t product	260
Cu	g/t product	444
Pb	g/t product	784
Zn	g/t product	260

The emission factors for PM₁₀, PM_{2.5} and TSP are measured values from the VPI. The VPI plans to publish the results in a peer reviewed Journal. The Link will be added here.

Pollutant	PM₁₀	PM₁₀	PM 2.5	PM 2.5	STB	STB
	Sylvester-EF	During the period-EF	Sylvester-EF	During the period-EF	Sylvester-EF	During the period-EF
	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]
1990	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1991	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1992	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1993	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1994	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1995	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1996	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1997	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1998	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1999	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
2000	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
2001	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
2002	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
2003	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
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:

AR and Hg: For Ar 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

The **activity data** has changed as follows:

Table 1: Change of AD between Submission 2020 and Submission 2021

Subm2020	AR	t	Unit	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
		t		17.956,90	21.740,70	37.115,80	34.781,10	39.578,70	66.271,80	69.009,60	59.560	25.604,70	43.244,30	48.355,30	24.149,60	36.461,80	36.351,70	46.347,10	38.148,13	43.487,27	44.704,70	42.228,13	41.839,47	42.651,70	38.637,53	42.856,67	37.846,70	45.164,10	45.656,30	45.208,30	44.110,70	46.461,70
Subm2021	Firework, Sylvester, Firework, during the year	t		13.939	16.395,80	24.555,50	26.172,30	27.152,60	51.421,30	54.412,70	48.281,20	24.179,80	24.692,50	26.282,70	21.561,30	25.993,60	25.759,40	29.286,30	28.856,20	30.491,40	33.396,30	34.461,40	30.074,50	31.439,50	29.795	33.085,50	29.130,70	33.240,60	34.998,70	32.571,70	33.935,70	32.979,70
Subm2021	Sum	t		4.130,10	3.493,40	5.902,70	6.138	6.798,60	7.447,20	7.880,40	6.992,50	5.220,20	11.482,80	10.905,70	4.741,20	6.085	6.256,30	8.545,20	7.505,50	10.755,40	8.235,10	8.088,30	7.520,70	8.006,60	7.499	8.137,30	7.247,10	8.465,40	8.831,50	9.487,20	8.544	9.088
Difference		t		18.069,10	19.889,20	30.458,20	32.310,30	33.951,20	58.868,50	62.293,10	55.273,70	29.400,00	36.175,30	37.188,40	26.302,50	32.078,60	32.015,70	37.831,50	36.361,70	41.246,80	41.631,40	42.549,70	37.595,20	39.446,10	37.294,00	41.222,80	36.377,80	41.706,00	43.830,20	42.058,90	42.479,70	42.067,70
		t		112,20	-1.851,50	-6.657,60	-2.470,80	-5.627,50	-7.403,30	-6.716,50	-4.286,30	3.795,30	-7.069,00	-11.166,90	-2.152,90	-4.383,20	-4.336,00	-8.515,60	-1.786,43	-2.240,47	-3.073,30	321,57	-4.244,27	-3.205,60	-1.343,53	-1.633,87	-1.468,90	-3.458,10	-1.826,10	-1.349,40	-4.394,00	

The **emissions** from As, Cd, Cr, Hg and Ni were deleted. The VPI proofed that these emissions does not occur. For Pb the emissions 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, 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 2: Change of emissions between Submission 2020 and Submission 2021

	Schadstoff/Quellegruppe	Einheit	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	
Subm2020	As	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,02388268	0,02891513	0,04936401	0,04625886	0,05263967	0,08814149	0,09178277	0,0792148	0,03405425	0,05751492	0,06431253	0,03211897	0,04849419	0,04834776	0,06164164	0,0762	0,05945725	0,0562	0,05672676	0,0562	0,05672676	0,0562	0,05672676	0,0562	0,05672676	0,0562	0,05672676	0,05672676	
Subm2021	As	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Difference	As		t	-0,02388268	-0,02891513	-0,04936401	-0,04625886	-0,05263967	-0,08814149	-0,09178277	-0,0792148	-0,03405425	-0,05751492	-0,06431253	-0,03211897	-0,04849419	-0,04834776	-0,06164164	-0,0762	-0,05945725	-0,0562	-0,05672676	-0,0562	-0,05672676	-0,0562	-0,05672676	-0,0562	-0,05672676	-0,0562	-0,05672676	-0,05672676	
Subm2020	Cd	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,02057621	0,0217624	0,05493138	0,0547693	0,0587648	0,09882624	0,10213421	0,0881488	0,03789498	0,06400156	0,07156584	0,03574141	0,05396346	0,05380052	0,0689371	0,0562	0,044602	0,044602	0,044602	0,044602	0,044602	0,044602	0,044602	0,044602	0,044602	0,044602	0,044602	0,044602	
Subm2021	Cd	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference	Cd		t	-0,02057621	-0,0217624	-0,05493138	-0,0547693	-0,0587648	-0,09882624	-0,10213421	-0,0881488	-0,03789498	-0,06400156	-0,07156584	-0,03574141	-0,05396346	-0,05380052	-0,0689371	-0,0562	-0,044602	-0,044602	-0,044602	-0,044602	-0,044602	-0,044602	-0,044602	-0,044602	-0,044602	-0,044602	-0,044602	-0,044602	
Subm2020	CO	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	128.381835	155.446005	265.37797	248.684865	282.887705	473.84337	493.41864	425.854	183.073605	308.196745	345.740395	372.68664	260.70187	259.914655	331.381765	272.759133	316.933957	318.638605	301.931153	398.132187	304.959055	276.258363	306.425167	270.603905	322.923315	326.442455	323.239345	315.391505	332.201155
Subm2021	CO	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	99.66395	117.22997	175.57825	187.13194	194.14109	367.682295	388.050805	345.21058	172.88557	176.551375	187.923305	154.163295	185.85424	184.17971	209.397045	206.31283	218.01351	238.783545	246.39901	215.032675	224.792425	236.161345	228.284505	237.67029	250.240705	232.887655	242.640255	235.804855	249.89785
Difference	CO		t	29.530215	24.97781	82.204305	43.8867	48.60999	53.24748	56.34486	49.996375	37.32443	82.10022	77.975705	33.89958	44.50775	44.732545	61.09818	53.664325	76.90111	58.880965	57.831345	53.773005	57.24719	53.61765	58.181695	51.816765	60.52761	63.145225	67.83348	61.0896	64.9792
Subm2020	Cr	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,80223	13.28225	47.60184	17.66622	40.23625	52.933595	48.022975	30.647045	27.136395	50.54335	79.84333	13.393235	31.33988	31.0024	40.88654	12.772983	16.019387	21.974095	2.2902167	30.3405067	22.92004	9.6062633	11.6821467	10.502635	24.724515	13.056615	22.51821	11.66165	31.4171
Subm2021	Cr	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference	Cr		t	-0,80223	-13.28225	-47.60184	-17.66622	-40.23625	-52.933595	-48.022975	-30.647045	-27.136395	-50.54335	-79.84333	-13.393235	-31.33988	-31.0024	-40.88654	-12.772983	-16.019387	-21.974095	-2.2902167	-30.3405067	-22.92004	-9.6062633	-11.6821467	-10.502635	-24.724515	-13.056615	-22.51821	-11.66165	-31.4171
Subm2020	Cu	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,28012764	0,33913452	0,57900648	0,54258516	0,61742772	1,03384008	1,07654976	0,929136	0,9941332	0,87461108	0,75434268	0,71673376	0,56880408	0,56708852	0,72301476	0,59511088	0,67840136	0,69739332	0,65873888	0,65289588	0,66536852	0,60274552	0,668564	0,59040852	0,70455996	0,71223828	0,70512488	0,68812692	0,72480252
Subm2021	Cu	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference	Cu		t	-0,28012764	-0,33913452	-0,57900648	-0,54258516	-0,61742772	-1,03384008	-1,07654976	-0,929136	-0,9941332	-0,87461108	-0,75434268	-0,71673376	-0,56880408	-0,56708852	-0,72301476	-0,59511088	-0,67840136	-0,69739332	-0,65873888	-0,65289588	-0,66536852	-0,60274552	-0,668564	-0,59040852	-0,70455996	-0,71223828	-0,70512488	-0,68812692	-0,72480252
Subm2020	Cu	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	7,9728636	9,652878	16,4794152	15,4428084	17,5729428	29,4246792	30,6402524	26,44464	13,868488	19,204892	1,4897532	10,7224224	16,1890392	16,1401548	20,5781124	16,9377712	19,3083464	19,8488868	18,7492912	18,5787232	18,9373548	17,1550648	18,039348	20,0528604	20,2713972	20,0724852	19,5851508	20,6289948	
Subm2021	Cu	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	8,188916	7,779732	10,902462	11,620012	12,055744	22,810572	24,1592388	21,4368528	10,7358312	10,96347	1,6461688	9,5721272	11,5411584	11,4371736	13,0031272	12,8125328	13,5381816	14,8279372	15,3008616	13,353078	13,999138	12,2998	14,689962	12,9340308	14,7588264	15,594228	14,4618348	15,0674508	14,6429888
Difference	Cu		t	-1,833744	1,551096	2,6707988	2,752572	1,0185784	3,0685568	3,4988976	1,04667	2,717688	5,098832	4,8421308	2,1050928	2,70174	2,7777972	3,7940888	3,332442	4,7753976	3,6563844	3,5952052	3,3939308	3,5549304	3,29556	3,6129612	3,2177124	3,7586376	3,921186	4,212168	3,793536	4,035072
Subm2020	Hg	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,0486168	0,822066	2,955974	1,097032	2,49861	3,2870652	2,982126	1,9031172	1,6851132	1,138636	4,9581036	0,958876	1,9461408	1,925184	3,7809264	0,7931764	0,9947672	1,3645452	0,1427756	1,8844544	1,4273884	0,5965288	0,7254368	-0,6521916	1,5353964	0,8107884	1,3983336	0,724164	1,950936
Subm2021	Hg	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,00102354	0,0012822	0,0021156	0,00198252	0,00225399	0,00377748	0,00393355	0,00339492	0,0014947	0,00246493	0,00275623	0,00137653	0,00207832	0,00207205	0,00264178	0,00217444	0,00247877	0,00254817	0,002407	0,00238485	0,00243115	0,00220234	0,00244283	0,00215728	0,00237435	0,00260241	0,00257687	0,00251431	0,00264832
Difference	Hg		t	-0,0475933	-0,820784	-2,954759	-1,095050	-2,496844	-3,283298	-2,980204	-1,899726	-1,683622	-4,9567036	-0,9574935	-1,944724	-1,923392	-3,7730476	-0,7910024	-0,9922888	-1,3621275	-0,1403686	-1,8820718	-1,4250156	-0,5946332	-0,7230024	0,6507184	1,5332025	0,8083536	1,3962172	0,7216728	1,9485036	
Subm2020	SO2	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,00102354	0,0012822	0,0021156	0,00198252	0,00225399	0,00377748	0,00393355	0,00339492	0,0014947	0,00246493	0,00275623	0,00137653	0,00207832	0,00207205	0,00264178	0,00217444	0,00247877	0,00254817	0,002407	0,00238485	0,00243115	0,00220234	0,00244283	0,00215728	0,00237435	0,00260241	0,00257687	0,00251431	0,00264832
Subm2021	SO2	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,00102354	0,0012822	0,0021156	0,00198252	0,00225399	0,00377748	0,00393355	0,00339492	0,0014947	0,00246493	0,00275623	0,00137653	0,00207832	0,00207205	0,00264178	0,00217444	0,00247877	0,00254817	0,002407	0,00238485	0,00243115	0,00220234	0,00244283	0,00215728	0,00237435	0,00260241	0,00257687	0,00251431	0,00264832
Difference	SO2		t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subm2020	SO2	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,00102354	0,0012822	0,0021156	0,00198252	0,00225399	0,00377748	0,00393355	0,00339492	0,0014947	0,00246493	0,00275623	0,00137653	0,00207832	0,00207205	0,00264178	0,00217444	0,00247877	0,00254817	0,002407	0,00238485	0,00243115	0,00220234	0,00244283	0,00215728	0,00237435	0,00260241	0,00257687	0,00251431	0,00264832
Subm2021	SO2	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,00102354	0,0012822	0,0021156	0,00198252	0,00225399	0,00377748	0,00393355	0,00339492	0,0014947	0,00246493	0,00275623	0,00137653	0,00207832	0,00207205	0,00264178	0,00217444	0,00247877	0,00254817	0,002407	0,00238485	0,00243115	0,00220234	0,00244283	0,00215728	0,00237435	0,00260241	0,00257687	0,00251431	0,00264832
Difference	SO2		t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subm2020	SO2	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,00102354	0,0012822	0,0021156	0,00198252	0,00225399	0,00377748	0,00393355	0,00339492	0,0014947	0,00246493	0,00275623	0,00137653	0,00207832	0,00207205	0,00264178	0,00217444	0,00247877	0,00254817	0,002407	0,00238485	0,00243115	0,00220234	0,00244283	0,00215728	0,00237435	0,00260241	0,00257687	0,00251431	0,00264832
Subm2021	SO2	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,00102354	0,0012822	0,0021156	0,00198252	0,00225399	0,00377748	0,00393355	0,00339492	0,0014947	0,00246493	0,00275623	0,00137653	0,00207832	0,00207205	0,00264178	0,00217444	0,00247877	0,00254817	0,002407	0,00238485	0,00243115	0,00220234	0,00244283	0,00215728	0,00237435	0,00260241	0,00257687	0,00251431	0,00264832
Difference	SO2		t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subm2020	SO2	Feuerwerk, Silvester, Feuerwerk, unterjährig	t	0,00102354	0,0012822	0,0021156	0,00198252	0,00225399	0,00377748	0,00393355	0,00339492	0,0014947	0,00246493	0,00275623	0,00137653	0,00207832	0,00207205	0,00264178	0,00217444	0,00247877	0,00											

	Schadstoff	Qualifgruppe	Einheit	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						
Substanz	2021	NI	Feuerwerk, Silvester, unterjährig	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
Substanz	2020	NI	Feuerwerk, Silvester, unterjährig	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Difference	2021	NI		t	0.538707	0.652221	1.131474	2.043433	1.187761	1.988154	2.070288	1.7868	0.768141	1.297329	1.450659	0.724488	1.093854	1.090551	1.390413	1.144444	1.304618	1.341141	1.266844	1.255184	1.279551	1.159126	1.2857	1.135405	1.354923	1.369689	1.356249	1.323121	1.339851					
Substanz	2020	NI	Feuerwerk, Silvester, unterjährig	t	4.668794	5.652582	9.650108	9.043086	10.290462	17.330668	17.942496	5.4856	6.657222	11.243518	12.572378	6.278896	9.480068	9.451442	12.050246	9.91851467	11.3066893	11.623222	10.9793147	10.8782613	11.088442	10.0457587	11.1427333	9.840142	11.742666	11.870638	11.754158	11.468782	12.080042					
Substanz	2021	NI	Feuerwerk, Silvester, unterjährig	t	3.62414	4.262908	6.38443	6.804798	7.059676	13.389538	14.147302	12.553112	6.286748	6.42005	6.833502	5.605938	6.758336	6.697444	7.614438	7.502612	7.927764	8.683038	8.959964	7.81937	8.17427	7.7467	8.60223	7.573982	8.642556	9.099662	8.468642	8.823282	8.574722					
Substanz	2020	NI	Feuerwerk, Silvester, unterjährig	t	1.078826	0.908284	1.534702	1.59588	1.767636	1.936272	2.048904	1.81805	1.357252	2.985528	2.835482	1.232712	1.5821	1.266838	2.221752	1.95143	2.796404	2.141126	2.102958	1.955382	2.081716	1.94974	2.145688	1.884246	2.201004	2.296319	2.466672	2.22144	2.36288					
Difference	2021	NI		t	0.291572	0.481139	1.730976	0.642408	1.46315	1.624858	1.746209	1.114438	0.968778	1.837394	2.963394	0.559754	1.139632	1.127336	2.214056	0.46447267	0.58252133	0.799058	0.08360733	1.10350933	0.833456	0.34931867	0.42480533	0.381914	0.899108	0.817486	0.818844	0.62406	1.142444					
Substanz	2020	NI	Feuerwerk, Silvester, unterjährig	t	14.070296	17.044788	19.087872	17.246324	11.029708	11.957012	14.102264	16.09504	20.070848	13.903313	17.910522	18.932884	26.566032	16.4997338	16.3831264	19.5081385	14.0940171	15.0484848	13.1266905	10.3021410	11.4389328	10.2916261	11.5996167	19.0718128	15.4085044	15.7943392	15.4433072	14.3623788	14.4259758					
Substanz	2021	NI	Feuerwerk, Silvester, unterjährig	t	3.2379894	2.52814071	5.91576037	3.70168615	5.6907089	5.9298757	3.2074117	5.23020923	3.17409108	2.77005468	9.9739028	6.9718866	6.36997231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Difference	2021	NI		t	0.0876648	2.65104775	6.89328537	7.78278609	12.4020341	23.5535041	27.9062546	36.0844442	11.208854	25.1769358	26.6514449	38.4997326	38.3361264	29.9081345	34.0940171	35.0484848	33.1068545	32.8021410	33.4389328	30.2918261	33.5996267	19.0718128	15.4085044	15.7943392	15.4433072	14.3623788	14.4259758							
Substanz	2020	PM 10	Feuerwerk, Silvester, unterjährig	t						6.62188	6.89544	5.95124	2.56842	4.32097	6.83166	2.41303	3.64326	3.63226	4.63100	3.81176	4.34525	4.45689	4.21944	4.18040	4.26176	3.86066	4.28224	3.78164	4.51280	4.58198	4.51721	4.40754	4.64245					
Substanz	2021	PM 10	Feuerwerk, Silvester, unterjährig	t						2.67404	2.82960	2.51075	1.25741	1.28407	1.36677	1.12124	1.35173	1.33955	1.52296	1.37094	1.39630	1.50867	1.58169	1.37446	1.40933	1.31301	1.50758	1.34288	1.54972	1.66154	1.54792	1.62394	1.59193					
Substanz	2020	PM 10	Feuerwerk, Silvester, unterjährig	t						467.683873	494.888817	439.128731	327.820359	317.119398	884.87754	297.747177	382.137766	392.895399	536.638231	542.780771	774.245460	593.519172	578.081406	527.987599	554.482233	516.512612	569.56148	487.09494	572.944407	594.479838	627.050634	563.379267	577.265866					
Difference	2021	PM 10		t						-3480.1554	-3570.950599	-3001.36071	-973.181883	-2315.777797	-2780.01648	-894.038163	-1899.81185	-2571.40157	-1898.04731	-2174.69749	-2364.70831	-2057.66761	-2278.15684	-2297.94362	-2031.13487	-2205.09756	-1951.66815	-2390.13679	-2305.96094	-2342.24645	-2220.22203	-2473.25708						
Substanz	2020	PM 2.5	Feuerwerk, Silvester, unterjährig	t						3.44216	3.58436	3.09355	1.22991	2.24611	2.51157	1.25433	1.89383	1.88811	2.40727	1.98141	2.25873	2.32196	2.19333	2.17314	2.21533	2.00683	2.22598	1.96576	2.34582	2.37139	2.34812	2.29111	2.41322					
Substanz	2021	PM 2.5	Feuerwerk, Silvester, unterjährig	t						2.13208	2.25612	2.00189	1.00257	1.05383	0.88976	895.997322	2.07777	1.06806	1.21436	1.10028	1.12607	1.22283	2.28853	2.11673	1.14670	0.97625	1.24161	1.10775	1.28239	1.37839	1.28787	1.35430	1.36973					
Substanz	2020	PM 2.5	Feuerwerk, Silvester, unterjährig	t						369.710572	391.216456	347.137337	259.152853	370.05486	541.40517	235.373263	302.08519	810.589248	424.219945	429.071993	612.051751	469.185116	456.981349	417.381501	438.325876	408.310365	450.24623	385.055288	452.82048	469.944536	495.692201	445.3939104	456.336853					
Difference	2021	PM 2.5		t						-3480.262626	-3571.025511	-344.522135	-61.888939	-452.227449	-880.408122	-124.959688	-512.96669	-509.434865	-748.149023	-452.086073	-520.010767	-429.9448771	-447.821938	-439.820357	-452.304647	-522.771924	-514.117733	-472.351762	-469.974848	-515.057419	-544.536806	-481.404077	-647.158392					
Substanz	2019	S02	Feuerwerk, Silvester, unterjährig	t						44.229838	65.656914	112.089716	305.038922	119.527674	200.340838	206.468992	179.8712	17.236194	135.597186	146.03086	17.931792	131.114436	139.866242	115.307381	131.331545	135.008394	126.353189	128.883154	116.683531	129.427133	134.297534	136.303582	137.882028	138.229066	140.314334			
Substanz	2021	S02	Feuerwerk, Silvester, unterjährig	t						42.09578	49.515316	74.15761	79.040346	82.000852	155.282328	164.326354	145.809224	73.022996	14.57135	79.373754	65.11526	76.500672	77.793388	88.444626	87.145724	92.084028	100.856826	104.077428	90.82499	94.94729	89.9809	99.91821	87.974714	100.386612	98.366534	102.485814	99.588694	
Substanz	2020	S02	Feuerwerk, Silvester, unterjährig	t						12.472902	10.550068	17.826154	18.53676	20.531772	22.490544	23.798808	21.11735	15.765004	34.678056	32.932414	34.818424	18.3767	18.894026	25.800504	22.46661	32.483308	24.870002	24.426666	22.712514	24.179932	22.64698	24.574466	21.88042	25.565508	26.87113	26.651344	25.80288	27.44576
Difference	2021	S02		t						0.338844	5.591513	20.105952	7.461816	16.99505	22.357966	20.26383	12.944626	11.461806	11.344838	33.724038	6.501758	13.237264	13.09472	25.717112	1.59502867	4.76620933	9.281366	0.97113133	12.8176853	6.680912	4.05747087	4.93427733	4.436078	10.443462	5.514822	6.511188	4.92562	13.26988
Substanz	2020	TSP	Feuerwerk, Silvester, unterjährig	t						1.97221	2.38778	6.07643	3.82011	4.34693	7.27863	7.57932	6.54147	2.81216	4.74852	5.31086	2.85235	4.00460	3.99251	5.09030	4.18981	4.77621	4.90992	4.63792	4.59523	4.68444	6.24356	4.70695	4.15670	4.96037	6.01443	4.96523	4.84468	5.10289
Substanz	2021	TSP	Feuerwerk, Silvester, unterjährig	t						724.863616	852.623493	1.27695	1.36103	1.41200	2.67404	2.82960	2.51075	1.25741	1.28407	1.36677	1.12124	1.35173	1.33955	1.52296	1.37094	1.39630	1.50867	1.58169	1.37446	1.40933	1.31301	1.50758	1.34288	1.54972	1.66154	1.54792	1.62394	1.59193
Substanz	2020	TSP	Feuerwerk, Silvester, unterjährig	t						259.370121	219.383386	370.689333	385.466164	426.951818	467.683873	494.888817	439.128731	327.820359	317.119398	884.87754	297.747177	382.137766	392.895399	536.638231	542.780771	774.245460	593.519172	578.081406	527.987599	554.482233	516.512612	569.56148	487.09494	572.944407	594.479838	627.050634	563.379267	577.265866
Difference	2021	TSP		t						467.972759	1315.7722	2428.79024	2073.31558	507.757223	4136.90939	4254.83812	3991.60031	1226.93446	2744.22898	2359.2175	1233.3607	2270.72813	2260.05716	3039.70133	2276.09931	2605.6561	2807.771189	2476.14842	2692.78596	2726.62196	2414.03282	2629.80713	2326.72894	2837.71302	2758.41847	2790.2607	2657.35906	2933.89253
Substanz	2020	Zn	Feuerwerk, Silvester, unterjährig	t						4.668794	5.652582	9.650108	9.043086	10.290462	17.330668	17.942496	5.4856	6.657222	11.243518	12.572378	6.278896	9.480068	9.451442	12.050246	9.91851467	11.3066893	11.623222	10.9793147	10.8782613	11.088442	10.0457587	11.1427333	9.840142	11.742666	11.870638	11.754158	11.468782	12.080042
Substanz	2021	Zn	Feuerwerk, Silvester, unterjährig	t						3.62414	4.262908	6.38443	6.804798	7.059676	13.389538	14.147302	12.553112	6.286748	6.42005	6.833502	5.605938	6.758336	6.697444	7.614438	7.502612	7.927764	8.683038	8.959964	7.81937	8.17427	7.7467	8.60223	7.573982	8.642556	9.099662	8.468642	8.823282	8.574722
Substanz	2020	Zn	Feuerwerk, Silvester, unterjährig	t						1.078826	0.908284	1.534702	1.59588	1.767636	1.936272	2.048904	1.81805	1.357252	2.985528	2.835482	1.232712	1.5821	1.266838	2.221752	1.95143	2.796404	2.141126	2.102958	1.955382	2.081716	1.94974	2.145688	1.884246	2.201004	2.296319	2.466672	2.22144	2.36288
Difference	2021	Zn		t						0.291572	0.481139	1.730976	0.642408	1.46315	1.																							