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Subject: Air Quality Analysis Using Sulfur Dioxide (SO_2) Air Quality Data, Updated

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Introduction

The EPA is finalizing a revision to the secondary sulfur dioxide (SO_2) national ambient air quality standards (NAAQS) (see Table 1 for a summary of the current primary 1-hour SO_2 and secondary 3-hour SO_2 NAAQS, as well as the revised secondary annual SO_2 NAAQS). This memorandum presents an air quality analysis the EPA prepared using SO_2 air quality data from the Agency's air quality system (AQS); this analysis uses the same methodology as was used in the memorandum docketed at proposal. Based on the analysis, we estimate no additional emissions reductions would be needed, at any monitor sites, to meet the revised secondary annual SO_2 NAAQS after the sites record concentrations that meet the current primary 1-hour SO_2 NAAQS.

Table 1. Current Primary and Secondary SO_2 NAAQS, Revised Secondary SO_2 NAAQS

	Level	Averaging Time, Form
Current Primary SO_2	75 ppb	1 hour, annual 99th percentile of daily maximum 1-hour concentrations, averaged over 3 years
Current Secondary SO_2	0.5 ppm (500 ppb)	3 hours, not to be exceeded more than once per year
Revised Secondary SO_2	10 ppb	1 year, annual mean, averaged over 3 years

The remainder of this memorandum provides background information, a description of the analysis, and overall conclusions from the analysis.

Background

When the EPA reviews and revises a NAAQS, many areas are continuing to implement an existing, or current, NAAQS. In analyzing a revision, to avoid double counting potential emissions reductions, costs, and benefits associated with meeting a current NAAQS, we assume areas meet the current standards, even if areas have not fully implemented necessary programs and policies to meet those NAAQS. Then, for a revision we estimate whether any additional emissions reductions would be needed to meet a revised NAAQS beyond the *baseline* levels reflecting assumed compliance with current NAAQS.

To assess whether additional emissions reductions might be needed to meet the revised secondary annual SO_2 NAAQS of 10 ppb, we prepared an air quality analysis for all monitor sites with SO_2 data in AQS.[1] We used certified AQS data from 2017 through 2023, where available.

- **Monitors with 1-hour DVs at or below the current primary 1-hour SO_2 NAAQS** -- For monitors with 1-hour DVs at or below 75 ppb, the estimated 3-year annual average values for the most recent design value

[1] For this analysis, we did not include monitoring sites located in Hawaii because our focus was on anthropogenic emissions and potential costs or benefits associated with reductions in those emissions. Had we included those sites with the contribution of nonanthropogenic volcanic emissions, our results and overall conclusions would not have changed.

(DV) period for each monitor ranged from 0.02 ppb to 3.61 ppb, with 99 percent below 2.5 ppb.[2] For these monitors, no emissions reductions would be needed to meet the current primary 1-hour SO_2 standard or the revised secondary annual SO_2 standard.[3]

- **Monitors with 1-hour DVs above the current primary 1-hour SO_2 NAAQS** -- There are 17 monitor sites with DVs above 75 ppb for the average of the five most recent DV periods (2017-2019 to 2021-2023) or for the most recent DV period (2021-2023). We focused additional analysis on the monitors with DVs above 75 ppb and manually adjusted, or *rolled back*, the DVs at those monitors to reflect meeting the current primary 1-hour SO_2 NAAQS. This approach simulates how an annual average value might change in response to emissions reductions needed to meet the current primary 1-hour standard. To reflect the relationship between the air quality concentrations associated with the current primary and revised secondary standards, we calculated *peak-to-mean* ratios for each monitor site for each relevant DV period and then calculated an average of those ratios for each site. [4,5]

  We applied the *average* ratio for each site to the *rolled back*, current primary 1-hour SO_2 NAAQS of 75 ppb or to a mean 1-hour DV to estimate the site-specific 3-year annual average value associated with the revised secondary annual SO_2 NAAQS. For each site, we compared the estimated site-specific 3-year annual average value to the revised secondary annual SO_2 NAAQS of 10 ppb; the highest estimated 3-year annual average value at all monitor sites analyzed was 5.54 ppb, well below the revised secondary annual SO_2 NAAQS of 10 ppb. A more detailed description of the analysis is below.

Detailed Description of Air Quality Analysis and Results

We reviewed historical SO_2 concentrations in AQS to assess how the ratio of the 1-hour DV to the 3-year annual average value associated with the revised secondary annual SO_2 NAAQS changed over time. Because SO_2 concentrations have generally decreased over time and we want to reflect concentrations that are representative of recent years, we chose to focus this analysis on the last five DV periods when the ratios appear to stabilize. Specifically, for this analysis we examined data for the following DV periods: 2017-2019, 2018-2020, 2019-2021, 2020-2022, and 2021-2023.

For each monitor site with either (i) an average DV above 75 ppb for the five most recent DV periods (2017-2019 to 2021-2023)[6] or (ii) a DV above 75 ppb for the most recent DV period (i.e., 2021-2023)[7] (see Table 2), we calculated a *peak-to-mean* ratio for each DV period (1-hour DV/3-year annual average value based on the revised secondary annual SO_2 NAAQS) from 2017 to 2023 (by monitor, Table 3 shows the 3-year annual average values for each DV period that were used to calculate the *peak-to-mean* ratios, and Table 4 includes the *peak-to-mean* ratios for each DV period). We then calculated an average of those ratios for each monitor site (see Table 5). For 16 monitor sites with an average DV above 75 ppb for the five most recent DV periods, we applied the *average* ratio to a *rolled back* 1-hour DV of 75 ppb to estimate what the 3-year annual average value would be after *rolling back* the

[2] Where possible, this summary reflects the estimated 3-year annual average value for the most recent DV period (2021-2023). If there was incomplete data for a monitor, we included the estimated 3-year annual average value for the most recent DV period for which complete data was available.

[3] For these monitors, no emissions reductions would be needed to meet the existing secondary 3-hour SO_2 standard. Also, during this period, and excluding the monitoring sites in Hawaii, there were no monitors that had violations of the existing secondary 3-hour SO_2 standard.

[4] For monitors with DVs slightly under 75 ppb, we did not find any that have *peak-to-mean* ratios that would result in estimated 3-year annual average values above the revised secondary annual SO_2 NAAQS of 10 ppb.

[5] A *peak-to-mean* ratio describes the relationship between a "peak" statistic (or high value) versus a "mean" statistic (or average value). In the context of this analysis, the peak statistic is the 3-year average of the 99th percentile of daily maximum 1-hour values (the design value for the current primary 1-hour SO_2 NAAQS), and the mean statistic is the 3-year annual average value (which is associated with the revised secondary annual SO_2 NAAQS). The peak-to-mean ratio is simply the peak statistic divided by the mean statistic.

[6] We computed an average 1-hour DV across the five most recent DV periods for each monitor site to incorporate any additional monitors with relatively high DVs in more recent years that were not above 75 ppb in the most recent DV period.

[7] Several monitors have an average 1-hour DV above 75 ppb for the five most recent DV periods and a 1-hour DV above 75 ppb for the most recent DV period. One monitor (AQS ID 26-147-0005) does not have an average 1-hour DV above 75 ppb across the five most recent DV periods but does have a 1-hour DV above 75 ppb for the most recent DV period.

1-hour DV. Effectively, the calculation is 75 divided by the site-specific *average* ratio. For the monitor site with a 1-hour DV above 75 ppb for the most recent DV period (2021-2023), we applied the *average* ratio to the mean, or average, 1-hour DV over that period (see Table 5). In addition, for that monitor site we also applied the *average* ratio to the DVs for the most recent DV period; the estimated 3-year annual average values were 2.1714 ppb and 2.2642 ppb, respectively, both of which round to 2 ppb.

For all 17 monitors, see Table 5 for the estimated 3-year annual average values. Across all 17 monitor sites, the highest estimated 3-year annual average value was 5.54 ppb, which rounds to 6 ppb, well below the revised secondary annual SO_2 NAAQS of 10 ppb.

Conclusions

For monitors with 1-hour DVs at or below 75 ppb, the estimated 3-year annual average values for those sites ranged from 0.02 ppb to 3.61 ppb, with 99 percent below 2.5 ppb. For these monitors, no emissions reductions would be needed to meet either the current primary and secondary SO_2 standards, or the revised secondary annual SO_2 standard of 10 ppb.

For monitors with 1-hour DVs above 75 ppb, we prepared additional analysis. The additional air quality analysis demonstrates that monitor sites either with DVs above 75 ppb for the average of the five most recent DV periods or for the most recent DV period are estimated to meet a revised secondary annual SO_2 NAAQS of 10 ppb, after simulating emissions reductions needed to meet the current primary standard. As such, no additional emissions reductions beyond any needed to meet the current primary 1-hour SO_2 NAAQS would be expected to be necessary to meet the revised secondary annual SO_2 NAAQS of 10 ppb, resulting in no costs or monetized benefits associated with pollution controls for this NAAQS revision. Also, as shown in Table 3, only two of the monitor sites have estimated 3-year annual average values above the revised secondary annual SO_2 NAAQS of 10 ppb before simulating emissions reductions needed to meet the current primary standard.

Further, as no revisions are being finalized for the standards for nitrogen dioxide (NO_2) or particulate matter with mass median aerodynamic diameter less than 2.5 microns ($PM_{2.5}$), EPA did not prepare an analysis of the potential need for emissions reductions for those pollutants or a regulatory impact analysis.

Table 2. By Monitor Site, SO_2 1-hour DVs for DV Periods 2017-2019, 2018-2020, 2019-2021, 2020-2022, and 2021-2023 and Mean 1-hour DV

AQS ID	EPA Region	County	City	AQS CBSA Name/State	SO2 1 hr DV 2017-2019	SO2 1 hr DV 2018-2020	SO2 1 hr DV 2019-2021	SO2 1 hr DV 2020-2022	SO2 1 hr DV 2021-2023	Mean 1 hr DV, 2017-2023
Mean 1 hr DV, 2017-2023 > 75 ppb										
04-007-0011	09	Gila	Not in a City	Payson, AZ	172	105	90	63	62	98.40
04-007-1001	09	Gila	Hayden	Payson, AZ	226	134	65	3	2	86.00
21-101-1011	04	Henderson	Not in a City	Evansville, IN-KY	98	91	80	71	78	83.60
24-001-8881	03	Allegany	Westernport	Cumberland, MD-WV	89					89.00
24-001-8882	03	Allegany	Westernport	Cumberland, MD-WV	156					156.00
29-143-9001	07	New Madrid	Not in a City	MO	202	320	376	417	452	353.40
29-143-9002	07	New Madrid	Not in a City	MO	268	361	333	291	291	308.80
29-143-9003	07	New Madrid	Not in a City	MO	47	68	83	95	115	81.60
36-089-0004	02	St. Lawrence	Not in a City	Ogdensburg-Massena, NY	86	86	88	86	81	85.40
48-227-1072	06	Howard	Big Spring	Big Spring, TX	89	93			161	114.33
48-233-1073	06	Hutchinson	Borger	Borger, TX	209	185	183	163	140	176.00
48-349-1081	06	Navarro	Richland	Corsicana, TX	165	172	159	115	136	149.40
48-375-1077	06	Potter	Amarillo	Amarillo, TX	114	107	104	125	143	118.60
48-401-1082	06	Rusk	Tatum	Longview, TX		103	93	81		92.33
51-071-0007	03	Giles	Not in a City	Blacksburg-Christiansburg-Radford, VA	203	97	107	101	66	114.80
54-057-8883	03	Mineral	Keyser	Cumberland, MD-WV	175					175.00
Most recent DV (2021-2023) > 75 ppb										
26-147-0005	05	St. Clair	Port Huron	Detroit-Warren-Dearborn, MI	67	74	70	85	78	74.80

Table 3. By Monitor Site, SO_2 3-year Annual Average Values for DV Periods 2017-2019, 2018-2020, 2019-2021, 2020-2022, and 2021-2023

AQS ID	EPA Region	County	City	AQS CBSA Name/State	SO2 3-yr Annual Average Value 2017-2019	SO2 3-yr Annual Average Value 2018-2020	SO2 3-yr Annual Average Value 2019-2021	SO2 3-yr Annual Average Value 2020-2022	SO2 3-yr Annual Average Value 2021-2023
Mean 1 hr DV, 2017-2023 > 75 ppb									
04-007-0011	09	Gila	Not in a City	Payson, AZ	2.41	2.03	1.83	1.66	1.58
04-007-1001	09	Gila	Hayden	Payson, AZ	7.06	4.54	2.18	0.71	0.19
21-101-1011	04	Henderson	Not in a City	Evansville, IN-KY	2.20	1.93	1.50	1.36	1.67
24-001-8881	03	Allegany	Westernport	Cumberland, MD-WV	1.17	1.22	1.16		
24-001-8882	03	Allegany	Westernport	Cumberland, MD-WV	2.76	2.43	1.82		
29-143-9001	07	New Madrid	Not in a City	MO	12.14	19.72	30.11	35.35	43.05
29-143-9002	07	New Madrid	Not in a City	MO	11.10	16.12	17.31	15.68	16.08
29-143-9003	07	New Madrid	Not in a City	MO	1.52	2.15	2.40	2.30	2.39
36-089-0004	02	St. Lawrence	Not in a City	Ogdensburg-Massena, NY	4.39	3.92	3.80	3.51	3.59
48-227-1072	06	Howard	Big Spring	Big Spring, TX	3.83	3.82	3.96	6.46	8.47
48-233-1073	06	Hutchinson	Borger	Borger, TX	7.18	6.55	6.31	5.13	3.86
48-349-1081	06	Navarro	Richland	Corsicana, TX	2.09	2.04	2.11	2.16	2.32
48-375-1077	06	Potter	Amarillo	Amarillo, TX	2.52	2.36	2.29	2.56	2.72
48-401-1082	06	Rusk	Tatum	Longview, TX	2.35	2.13	2.07	1.78	1.83
51-071-0007	03	Giles	Not in a City	Blacksburg-Christiansburg-Radford, VA	2.60	3.27	3.42	3.25	2.45
54-057-8883	03	Mineral	Keyser	Cumberland, MD-WV	2.81	2.81	2.50		
Most recent DV (2021-2023) > 75 ppb									
26-147-0005	05	St. Clair	Port Huron	Detroit-Warren-Dearborn, MI	2.37	2.30	2.20	2.16	1.92

Table 4. By Monitor Site, Ratios of 1-hour DVs to 3-year Annual Average Values for DV Periods 2017-2019, 2018-2020, 2019-2021, 2020-2022, and 2021-2023

AQS ID	EPA Region	County	City	AQS CBSA Name/State	Ratio of 1 hr DV to 3-yr Annual Average Value, 2017-2019	Ratio of 1 hr DV to 3-yr Annual Average Value, 2018-2020	Ratio of 1 hr DV to 3-yr Annual Average Value, 2019-2021	Ratio of 1 hr DV to 3-yr Annual Average Value, 2020-2022	Ratio of 1 hr DV to 3-yr Annual Average Value, 2021-2023
Mean 1 hr DV, 2017-2023 > 75 ppb									
04-007-0011	09	Gila	Not in a City	Payson, AZ	71.37	51.72	49.18	37.95	39.24
04-007-1001	09	Gila	Hayden	Payson, AZ	32.01	29.52	29.82	4.23	10.53
21-101-1011	04	Henderson	Not in a City	Evansville, IN-KY	44.55	47.15	53.33	52.21	46.71
24-001-8881	03	Allegany	Westernport	Cumberland, MD-WV	76.07				
24-001-8882	03	Allegany	Westernport	Cumberland, MD-WV	56.52				
29-143-9001	07	New Madrid	Not in a City	MO	16.64	16.23	12.49	11.80	10.50
29-143-9002	07	New Madrid	Not in a City	MO	24.14	22.39	19.24	18.56	18.10
29-143-9003	07	New Madrid	Not in a City	MO	30.92	31.63	34.58	41.30	48.12
36-089-0004	02	St. Lawrence	Not in a City	Ogdensburg-Massena, NY	19.59	21.94	23.16	24.50	22.56
48-227-1072	06	Howard	Big Spring	Big Spring, TX	23.24	24.35			19.01
48-233-1073	06	Hutchinson	Borger	Borger, TX	29.11	28.24	29.00	31.77	36.27
48-349-1081	06	Navarro	Richland	Corsicana, TX	78.95	84.31	75.36	53.24	58.62
48-375-1077	06	Potter	Amarillo	Amarillo, TX	45.24	45.34	45.41	48.83	52.57
48-401-1082	06	Rusk	Tatum	Longview, TX		48.36	44.93	45.51	
51-071-0007	03	Giles	Not in a City	Blacksburg-Christiansburg-Radford, VA	78.08	29.66	31.29	31.08	26.94
54-057-8883	03	Mineral	Keyser	Cumberland, MD-WV	62.28				
Most recent DV (2021-2023) > 75 ppb									
26-147-0005	05	St. Clair	Port Huron	Detroit-Warren-Dearborn, MI	28.27	32.17	31.82	39.35	40.63

Table 5. By Monitor Site, Average Ratios of 1-hour DVs to 3-year Annual Average Values and Estimated 3-year Annual Average Values after Rollback

AQS ID	EPA Region	County	City	AQS CBSA Name/State	Average Ratio (1 hr DV/3-yr Annual Average Value), 2017-2023	Rollback of Mean 1 hr DV, 2017-2023 to 75 ppb	After Rollback of Mean 1 hr DV to 75 ppb, Estimated 3-yr Annual Average Value
Mean 1 hr DV, 2017-2023 > 75 ppb							
04-007-0011	09	Gila	Not in a City	Payson, AZ	49.8932	75	1.50
04-007-1001	09	Gila	Hayden	Payson, AZ	21.2190	75	3.53
21-101-1011	04	Henderson	Not in a City	Evansville, IN-KY	48.7883	75	1.54
24-001-8881	03	Allegany	Westernport	Cumberland, MD-WV	76.0684	75	0.99
24-001-8882	03	Allegany	Westernport	Cumberland, MD-WV	56.5217	75	1.33
29-143-9001	07	New Madrid	Not in a City	MO	13.5299	75	5.54
29-143-9002	07	New Madrid	Not in a City	MO	20.4864	75	3.66
29-143-9003	07	New Madrid	Not in a City	MO	37.3108	75	2.01
36-089-0004	02	St. Lawrence	Not in a City	Ogdensburg-Massena, NY	22.3501	75	3.36
48-227-1072	06	Howard	Big Spring	Big Spring, TX	22.1971	75	3.38
48-233-1073	06	Hutchinson	Borger	Borger, TX	30.8796	75	2.43
48-349-1081	06	Navarro	Richland	Corsicana, TX	70.0956	75	1.07
48-375-1077	06	Potter	Amarillo	Amarillo, TX	47.4787	75	1.58
48-401-1082	06	Rusk	Tatum	Longview, TX	46.2633	75	1.62
51-071-0007	03	Giles	Not in a City	Blacksburg-Christiansburg-Radford, VA	39.4086	75	1.90
54-057-8883	03	Mineral	Keyser	Cumberland, MD-WV	62.2776	75	1.20
Most recent DV (2021-2023) > 75 ppb							
26-147-0005	05	St. Clair	Port Huron	Detroit-Warren-Dearborn, MI	34.4478	74.80	2.17