Technical Support Document (TSD)

for the Transport Rule

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# Power Sector Variability

U.S. Environmental Protection Agency

Office of Air and Radiation

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This Technical Support Document (TSD) provides information in support of section IV.F, "Emission Reduction Requirements Including Variability", in the preamble to the proposed Transport Rule. This TSD is organized as follows:

1. Introduction
2. Estimating year-to-year variability in emissions
3. Estimating variability over a multi-year time period
4. Results of an analysis done using the air quality assessment tool

## 1. Introduction.

Section IV in the preamble of the proposed Transport Rule discusses EPA's approach to define "significant contribution" and "interference with maintenance" with respect to the 1997 8-hour ozone and annual fine particle ($PM_{2.5}$) National Ambient Air Quality Standards (NAAQS) and the 2006 24-hour $PM_{2.5}$ NAAQS. As discussed in preamble section IV, the EPA has identified the emissions that must be prohibited by each state to eliminate the state's significant contribution and interference with maintenance. To facilitate implementation of the requirement that these emissions be eliminated, the EPA also developed $SO_2$, annual $NO_X$, and ozone season $NO_X$ state emissions budgets based on its projections of state-by-state power sector emissions in an average year after the elimination of the prohibited emissions.[1]

However, because of the unavoidable variability in baseline emissions – resulting from the inherent variability in power system operations – state-level emissions may vary somewhat from year to year after all significant contribution and interference with maintenance that EPA has identified in the Transport Rule proposal are eliminated. This variability in emissions occurs even when the emission rates of the units within the state do not change. For this reason, as discussed in preamble section IV.F, the EPA has determined that it is appropriate to develop variability limits for each state budget. These

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[1] EPA developed annual $SO_2$ and $NO_X$ budgets for each state covered for the annual and/or 24-hour $PM_{2.5}$ NAAQS. Additionally, the EPA developed ozone season $NO_X$ budgets for each state covered for the ozone NAAQS. Table III.A-1 in preamble section III lists the states that would be covered for the $PM_{2.5}$ and/or ozone NAAQS.

limits are used to identify the range of emissions that EPA believes may occur in each state following the elimination of all significant contribution and interference with maintenance. This TSD describes the analyses that EPA performed to estimate the inherent variability in emissions from the power sector and to determine variability limits based on that inherent variability.

Preamble section IV.D discusses EPA's proposed approach to quantify for each upwind state the emissions that significantly contribute to nonattainment or interfere with maintenance downwind for the existing ozone and $PM_{2.5}$ NAAQS. Preamble section IV.E discusses the development of state emissions budgets for $SO_2$, annual $NO_X$, and ozone season $NO_X$. Preamble section IV.F discusses the inherent variability in electric power system operations and proposes variability limits on emissions for each state covered by the proposed Transport Rule. As explained in section IV.F, the EPA proposes to calculate variability limits for each state and to use those variability limits in conjunction with the state budgets (which are based on expected average conditions) to provide limited emissions flexibility. The Agency believes that because baseline emissions are variable, emissions after the elimination of all significant contribution and interference with maintenance are also variable and thus it is appropriate to take this variability into account.

As discussed in preamble section IV.F, the EPA proposes to use two variability limits: First, a "1-year" limit, based on the year-to-year variability in emissions relative to the proposed budgets. Second, a "3-year" limit, based on the variability in a three (consecutive) year average relative to the proposed budgets. The EPA determined 1-year variability limits that would apply to a state's emissions annually (or seasonally, for the ozone season) and 3-year variability limits that would apply to a state's annual (or ozone season) emissions on a 3-year rolling average basis.[2] Preamble section IV.F discusses EPA's rationale for implementing 1-year and 3-year variability limits. Section IV.F also describes EPA's proposed approach to calculating the proposed 1- and 3-year limits and an alternative calculation approach. This TSD describes these approaches in more detail.

Preamble section V.D describes the proposed remedy and two alternative remedies. In that section, EPA describes how the remedies would use variability limits in the

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[2] As discussed in the preamble, for purposes of emissions reductions requirements in the Transport Rule the EPA proposes to define the ozone season as May through September.

implementation of assurance provisions designed to ensure that the necessary emissions reductions occur within each covered state. As discussed in preamble section V.D, the EPA proposes to apply assurance provisions and variability limits starting in 2014 and, as further discussed in the preamble, is also taking comment on whether to apply them starting in 2012.

Preamble section IV.F presents proposed 1- and 3-year variability limits for each state and alternative 1- and 3-year limits calculated using the alternative approach. Table IV.F-1 in the preamble presents proposed and alternative 1- and 3-year variability limits on $SO_2$ emissions for each state. Table IV.F-2 presents proposed and alternative 1- and 3-year variability limits on annual $NO_X$ emissions. Table IV.F-3 presents proposed and alternative 1- and 3-year variability limits on ozone season emissions.

For the alternative where the limits would apply starting in 2012 instead of 2014, Table IV.F-4 in the preamble presents proposed and alternative 1- and 2-year variability limits. Preamble section IV.F explains that, for this alternative, EPA considered both 3-year average and 2-year average variability limits and determined the 2-year limits are preferable.

Preamble section IV.F describes EPA's proposed approach to determine 1-year variability limits. As discussed in the preamble, the approach would determine 1-year limits based on the expected annual (or ozone season) variation in power sector emissions derived from historical variation in annual (or ozone season) power sector heat input in combination with projected controlled emissions rates. The preamble discusses two approaches to determine 1-year limits based on expected variation in power sector emissions. Section 2 in this TSD, titled "Estimating year-to-year variability in annual emissions", describes in greater detail the method EPA used to estimate expected variation in year-to-year power sector emissions and the proposed and alternative approaches to determine 1-year limits based on that expected variation.

As discussed in preamble section IV.F, after determining 1-year variability limits, EPA used statistical methods to estimate multi-year (3-year and 2-year) average variability limits for covered states based on each state's 1-year variability. Section 3 in this TSD, titled "Estimating variability over a multi-year time period", describes the approach in greater detail than that provided in the preamble. As discussed in the preamble and in section 3 in this TSD, the average variability of a multi-year-average is the average variability of a single year divided by the square root of the number of years in the multi-year average. Thus, the variability of a 3-year average is equal to the annual variability divided by the square root of three.

As discussed above and in preamble section IV.F, for the alternative where the limits would apply starting in 2012 instead of 2014, the EPA determined 1- and 2-year variability limits. For this alternative EPA also considered 3-year variability limits instead of 2-year limits. Section 3 in this TSD compares the 3- and 2-year limits and discusses why EPA determined that the 2-year limits are preferable. Like the 3-year average variability discussed above, the variability of a 2-year average is equal to the annual variability divided by the square root of two (see section 3, below).

Section 4 in this TSD presents the results of an analysis using the air quality assessment tool (AQAT).

## 2. Estimating year-to-year variability in emissions.

This section describes the method that the Agency used to estimate the year-to-year ("1-year") variability in annual $SO_2$, annual $NO_X$ and ozone season $NO_X$ emissions. The method uses variation in heat input as a proxy for emissions. For an electric generating unit (EGU) fleet equipped with a constant set of control technologies and consistently using specific fuel types, the variability in heat input would be directly related to variability in emissions. This section in the TSD provides information on:

- The historical data set EPA established on a state-by-state basis of yearly heat input values applicable to each of the pollutants regulated in the Transport Rule (annual $SO_2$, annual $NO_x$, and ozone season $NO_x$). These historical heat input values are used to estimate the inherent variability in emissions due to power system operation.
- The method EPA developed (as well as an alternative method) to estimate the year-to-year variability in the heat input values. The year-to-year variability in heat input is estimated on a state-by-state basis.
- The approach EPA used to link heat input variability with projected pollutant emission rates to estimate the inherent variation in pollutant emissions.

- The method EPA developed to identify a single set of variability parameters that could be applied to all states in the program.

### (a) Establishing a historical data set for use in estimating inherent variability in emissions.

The objective of this section is to describe the inherent year-to-year (1-year) variability in emissions by characterizing the year-to-year variance in total annual heat input for each state in the Transport Rule. EPA is concerned with variation in total emissions from year-to-year (or the variation in total emissions from one ozone season to the next), not variation from day to day or month to month within a given year (or ozone season). Thus, EPA used total yearly heat input values equaling the sum of heat input from all units operating in each state during a particular year.

EPA estimated the expected variation in power sector emissions for a yearly time period based on the "standard deviation" of yearly power sector heat input (HI) assessed over a 7-year time frame (2002 through 2008). As described in section IV.F.1.a of the preamble, EPA chose to examine historical variability in heat input rather than emissions because emissions have changed over time due to controllable factors such as fuel switching and installing new emissions controls. EPA is interested in describing inherent variation in emissions due to factors such as variation in power demand, timing of maintenance activities, and unexpected shutdown of units. These factors are strongly correlated with heat input and variation in electric generation.

EPA chose the time period 2002 through 2008 for the analysis of variation in heat input because it represents a time period where there was substantial reporting of heat input and emissions data across many states and EGU source types for units in the Acid Rain Program (ARP). When the analysis began in 2009, the last complete year of data available was for 2008. A starting year of 2002 was selected for this analysis because in prior years (2000 and 2001) there had been large, uneven changes in annual heat input from fossil units for some states due, in part, to increased electricity demand and changes in composition of the power sector fleet. (Note, for instance, that all EGUs in the US affected by the ARP came under Phase 2 of the program starting in 2000). Consequently, incorporating data from years prior to 2002 in the analysis would lead to the inclusion of a single year where there is large change in heat input that is not representative of typical year-to-year variability, thereby leading to overestimates of variability. Since the objective is to estimate the inherent variability in heat input during time-periods of relative constancy in the fleet composition, including time-periods where there is uneven growth in electrical demand in the analysis would skew the variability estimates. Consequently, EPA chose 2002 for the start of the analysis to minimize that effect while still balancing the need to estimate the variance in heat input over as long a time period as possible.

For each year of the 7-year time period, EPA estimated total power sector heat input on a state-by-state basis using the sum of historical heat input for all units within each of three general categories of EGUs: (1) coal-fired units; (2) combined cycle turbines; and (3) a combination of oil- and gas-fired boilers and simple-cycle combustion turbines. Total annual heat input values (in million mmbtu) for the coal-fired EGU source category and for the total of all EGU source categories can be found in Table 1 and Table 2, respectively. Ozone-season heat input values for the total of all three EGU categories can be found in Table 3. For each state, EPA assessed the inherent year-to-year variability in annual and ozone season $NO_x$ emissions using the total yearly heat inputs summed across all three general EGU source types (Tables 2 and 3, respectively), while the Agency assessed year-to-year variability in annual $SO_2$ emissions using the yearly heat inputs from just the coal-fired EGUs (Table 1).

EGUs built prior to 2002 that reported heat input and emissions data between 2002 and 2008 and new EGUs were included for this analysis. EGUs that were built prior to 2002 but that did not start reporting until after 2002 were excluded from the assessment.

Table 1: Heat Input* (million mmbtu) from Coal-Fired Units for Each Year.

| State | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | Average HI | Max. Difference from Average |
|---|---|---|---|---|---|---|---|---|---|
| AL | 779.0 | 822.6 | 784.5 | 828.3 | 813.0 | 818.8 | 768.9 | 802.1 | 26.1 |
| CT | 18.1 | 28.3 | 30.9 | 30.2 | 31.5 | 26.1 | 30.5 | 27.9 | 3.5 |
| DE | 42.6 | 45.4 | 50.8 | 52.1 | 50.1 | 58.3 | 53.7 | 50.4 | 7.8 |
| FL | 700.6 | 735.9 | 659.3 | 697.0 | 711.4 | 707.3 | 660.8 | 696.0 | 39.9 |
| GA | 781.2 | 787.4 | 808.8 | 871.6 | 872.5 | 910.6 | 861.1 | 841.9 | 68.7 |
| IA | 393.1 | 389.6 | 386.7 | 384.5 | 378.9 | 415.9 | 431.2 | 397.1 | 34.1 |
| IL | 930.9 | 961.9 | 1,027.1 | 1,002.1 | 1,002.1 | 1,030.5 | 1,032.9 | 998.2 | 34.7 |
| IN | 1,231.4 | 1,236.3 | 1,266.0 | 1,281.2 | 1,269.9 | 1,256.9 | 1,243.6 | 1,255.0 | 26.1 |
| KS | 427.5 | 427.5 | 411.9 | 405.2 | 377.6 | 405.4 | 373.5 | 404.1 | 23.4 |
| KY | 946.5 | 931.1 | 938.1 | 970.3 | 987.0 | 977.9 | 978.5 | 961.3 | 25.7 |
| LA | 120.9 | 122.1 | 128.1 | 134.6 | 128.7 | 116.1 | 118.5 | 124.1 | 10.4 |
| MA | 108.9 | 103.9 | 101.7 | 115.2 | 107.2 | 114.8 | 101.7 | 107.6 | 7.5 |
| MD | 276.9 | 278.0 | 269.9 | 273.7 | 274.7 | 277.1 | 256.0 | 272.3 | 5.7 |
| MI | 700.1 | 706.9 | 709.7 | 721.1 | 699.7 | 736.0 | 714.4 | 712.5 | 23.4 |
| MN | 389.2 | 411.0 | 386.7 | 380.1 | 370.3 | 362.9 | 349.8 | 378.6 | 32.5 |
| MO | 724.5 | 769.6 | 770.8 | 783.6 | 783.5 | 762.0 | 732.8 | 761.0 | 22.6 |
| NC | 693.3 | 689.1 | 696.5 | 719.7 | 699.1 | 726.4 | 713.2 | 705.3 | 21.1 |
| NE | 227.0 | 238.3 | 231.2 | 238.3 | 234.0 | 222.4 | 233.8 | 232.1 | 6.2 |
| NJ | 80.0 | 75.3 | 79.6 | 92.2 | 81.9 | 77.8 | 62.8 | 78.5 | 13.7 |
| NY | 234.1 | 235.9 | 226.7 | 213.4 | 211.2 | 211.0 | 181.0 | 216.2 | 19.8 |
| OH | 1,290.2 | 1,316.3 | 1,247.3 | 1,315.1 | 1,294.0 | 1,319.7 | 1,290.0 | 1,296.1 | 23.6 |
| PA | 1,026.9 | 1,050.1 | 1,078.6 | 1,090.2 | 1,090.5 | 1,105.2 | 1,065.1 | 1,072.4 | 32.8 |
| SC | 381.5 | 384.7 | 401.4 | 407.7 | 410.4 | 422.6 | 417.1 | 403.7 | 19.0 |
| TN | 624.7 | 574.9 | 589.4 | 586.3 | 606.9 | 617.2 | 578.0 | 596.8 | 27.9 |
| VA | 340.5 | 312.5 | 296.7 | 298.4 | 288.0 | 298.9 | 264.2 | 299.9 | 40.6 |
| WI | 457.1 | 475.9 | 482.9 | 473.2 | 451.2 | 447.5 | 450.8 | 462.6 | 20.3 |
| WV | 898.8 | 898.5 | 851.0 | 861.2 | 852.4 | 883.3 | 851.6 | 871.0 | 27.8 |

*Source: EPA, March 2010. All relevant ARP units in the Transport Rule region. These data are available at http://www.epa.gov/airmarkets/ through Data and Maps.

Table 2: Total Heat Input* (million mmbtu) from All Three EGU Categories for Units Greater Than or Equal to 25 MW for Each Year.

| State | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | Average HI | Max. Difference from Average |
|---|---|---|---|---|---|---|---|---|---|
| AL | 901.0 | 916.0 | 904.6 | 936.6 | 964.1 | 1,000.0 | 938.9 | 937.3 | 62.7 |
| CT | 69.9 | 67.5 | 87.5 | 91.2 | 101.1 | 93.9 | 84.9 | 85.2 | 16.0 |
| DE | 52.6 | 53.3 | 59.1 | 60.9 | 55.6 | 66.4 | 60.5 | 58.3 | 8.0 |
| FL | 1,134.5 | 1,197.8 | 1,198.8 | 1,283.1 | 1,361.0 | 1,398.3 | 1,360.2 | 1,276.2 | 122.0 |
| GA | 841.9 | 822.4 | 853.4 | 948.0 | 968.5 | 1,033.0 | 958.2 | 917.9 | 115.1 |
| IA | 393.2 | 390.3 | 391.2 | 401.3 | 396.3 | 438.0 | 446.5 | 408.1 | 38.4 |
| IL | 976.1 | 982.7 | 1,046.2 | 1,053.8 | 1,038.2 | 1,086.2 | 1,059.9 | 1,034.7 | 51.5 |
| IN | 1,256.8 | 1,257.5 | 1,283.6 | 1,315.1 | 1,300.4 | 1,301.2 | 1,282.2 | 1,285.3 | 29.8 |
| KS | 429.2 | 429.4 | 412.5 | 406.8 | 381.2 | 410.0 | 378.6 | 406.8 | 22.6 |
| KY | 962.4 | 935.1 | 942.4 | 988.3 | 999.0 | 997.2 | 987.8 | 973.2 | 25.8 |
| LA | 193.6 | 266.6 | 312.7 | 332.2 | 336.2 | 322.5 | 326.2 | 298.6 | 37.6 |
| MA | 159.8 | 221.4 | 221.5 | 244.4 | 262.4 | 276.4 | 242.9 | 232.7 | 43.7 |
| MD | 288.2 | 290.6 | 280.8 | 287.8 | 282.6 | 286.0 | 263.7 | 282.8 | 7.8 |
| MI | 726.9 | 725.1 | 727.3 | 760.5 | 730.7 | 776.5 | 743.8 | 741.5 | 34.9 |
| MN | 399.0 | 423.1 | 396.4 | 401.8 | 391.7 | 394.6 | 371.6 | 396.9 | 26.2 |
| MO | 752.1 | 788.7 | 792.2 | 813.6 | 812.5 | 800.6 | 770.3 | 790.0 | 23.6 |
| NC | 718.8 | 706.3 | 718.4 | 747.2 | 727.1 | 767.7 | 749.7 | 733.6 | 34.1 |
| NE | 228.4 | 240.5 | 233.5 | 245.3 | 240.7 | 231.9 | 240.3 | 237.2 | 8.1 |
| NJ | 139.3 | 132.9 | 151.5 | 154.9 | 158.8 | 172.7 | 172.8 | 154.7 | 18.1 |
| NY | 288.3 | 297.3 | 309.9 | 322.9 | 380.6 | 393.1 | 366.6 | 337.0 | 56.1 |
| OH | 1,309.6 | 1,330.3 | 1,258.3 | 1,340.0 | 1,313.6 | 1,354.5 | 1,310.4 | 1,316.7 | 37.9 |
| PA | 1,060.2 | 1,090.0 | 1,155.1 | 1,172.4 | 1,185.4 | 1,240.9 | 1,200.0 | 1,157.7 | 83.2 |
| SC | 418.2 | 402.7 | 442.1 | 454.9 | 461.5 | 474.0 | 464.4 | 445.4 | 28.7 |
| TN | 635.7 | 580.5 | 592.1 | 592.6 | 613.2 | 623.8 | 582.3 | 602.9 | 32.8 |
| VA | 356.6 | 333.6 | 329.5 | 339.5 | 324.0 | 354.8 | 312.3 | 335.7 | 20.8 |
| WI | 475.3 | 494.1 | 498.4 | 528.5 | 492.3 | 497.4 | 490.0 | 496.6 | 31.9 |
| WV | 900.5 | 899.9 | 852.0 | 863.3 | 855.8 | 887.1 | 853.3 | 873.1 | 27.3 |

*Source: EPA, March 2010. All relevant ARP units in the Transport Rule region. These data are available at http://www.epa.gov/airmarkets/ through Data and Maps.

Table 3: Total Heat Input* (million mmbtu) from All Three EGU Categories for Units Greater Than or Equal to 25 MW for Ozone Season.

| State | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | Average HI | Max. Difference from Average |
|---|---|---|---|---|---|---|---|---|---|
| AL | 427.4 | 428.8 | 423.6 | 427.2 | 456.9 | 469.9 | 432.5 | 438.1 | 31.9 |
| AR | 124.0 | 152.5 | 149.2 | 142.0 | 173.6 | 170.4 | 150.5 | 151.7 | 21.8 |
| CT | 33.3 | 28.7 | 43.5 | 42.8 | 46.3 | 44.4 | 38.4 | 39.6 | 6.7 |
| DE | 27.9 | 24.2 | 25.4 | 29.0 | 23.6 | 30.3 | 24.9 | 26.5 | 3.8 |
| FL | 548.6 | 554.9 | 563.3 | 615.1 | 639.0 | 656.3 | 646.0 | 603.3 | 53.0 |
| GA | 403.8 | 382.9 | 407.1 | 461.8 | 469.5 | 489.6 | 449.9 | 437.8 | 51.8 |
| IL | 454.9 | 430.2 | 449.6 | 478.0 | 460.8 | 474.6 | 452.6 | 457.2 | 20.8 |
| IN | 557.2 | 545.4 | 540.7 | 578.4 | 566.4 | 559.8 | 550.5 | 556.9 | 21.5 |
| KS | 183.2 | 180.9 | 176.8 | 180.6 | 172.2 | 177.1 | 160.7 | 175.9 | 7.3 |
| KY | 433.3 | 400.1 | 401.0 | 434.4 | 435.3 | 436.1 | 417.8 | 422.6 | 13.6 |
| LA | 94.7 | 121.7 | 144.9 | 149.9 | 161.8 | 150.7 | 152.2 | 139.4 | 22.3 |
| MD | 134.8 | 118.8 | 121.8 | 131.5 | 123.3 | 126.8 | 117.1 | 124.9 | 9.9 |
| MI | 331.0 | 312.1 | 304.6 | 339.9 | 328.5 | 344.5 | 321.1 | 326.0 | 18.6 |
| MS | 117.8 | 116.2 | 129.5 | 137.3 | 147.7 | 155.9 | 143.2 | 135.4 | 20.6 |
| NC | 332.9 | 308.5 | 314.0 | 341.5 | 340.4 | 351.5 | 344.8 | 333.4 | 18.1 |
| NJ | 68.7 | 59.9 | 73.9 | 76.1 | 79.9 | 86.1 | 86.6 | 75.9 | 10.8 |
| NY | 126.1 | 121.4 | 136.3 | 152.5 | 174.7 | 170.5 | 158.9 | 148.6 | 26.1 |
| OH | 583.7 | 562.8 | 538.4 | 574.4 | 562.0 | 596.7 | 553.3 | 567.3 | 29.3 |
| OK | 204.5 | 223.4 | 220.0 | 248.4 | 244.6 | 241.1 | 247.9 | 232.8 | 15.6 |
| PA | 465.4 | 468.7 | 494.6 | 529.3 | 530.6 | 550.8 | 515.5 | 507.8 | 42.9 |
| SC | 203.1 | 178.4 | 204.8 | 214.1 | 215.8 | 222.7 | 222.0 | 208.7 | 14.0 |
| TN | 291.2 | 244.3 | 256.2 | 270.1 | 273.2 | 278.9 | 261.2 | 267.9 | 23.3 |
| TX | 1,031.9 | 1,089.9 | 1,170.0 | 1,229.1 | 1,255.4 | 1,262.8 | 1,252.7 | 1,184.6 | 78.2 |
| VA | 160.0 | 146.9 | 150.9 | 154.3 | 151.5 | 167.9 | 144.5 | 153.7 | 14.2 |
| WV | 379.5 | 384.5 | 361.0 | 375.4 | 373.1 | 390.3 | 366.9 | 375.8 | 14.5 |

*Source: EPA, March 2010; All relevant ARP units in the Transport Rule region. These data are available at http://www.epa.gov/airmarkets/ through Data and Maps.

### (b) Estimating the state-by-state variability in heat input using historical heat input data sets.

This subsection describes the method used by EPA to estimate the variability in heat input for each state in the Transport Rule region. EPA assessed the year-to-year variability over the 7-year time period of the yearly total heat input values (or ozone season heat input values) using the "standard deviation" while accounting for overall growth or decline in heat input over that time period. This method is described in detail in this and the following subsections and was selected for three reasons: First, it accounted for growth or decline in heat input over time. Second, a statistical approach (i.e., using the standard deviation) is less sensitive to data anomalies present in finite data sets. Third, a statistical approach also provides options for different levels of variability (i.e., different confidence levels). An alternative method was also examined, where the variability was defined as the difference between the maximum yearly value and the average heat input values over the time period.

Both the preferred and alternative methods were applied on a state-by-state basis. The majority of this section focuses on the analysis for the preferred method using the standard deviation, while accounting for growth. Where appropriate, differences between the preferred and alternative method are described.

In the preferred method, for each state, it was important to account for trends (growth or decline) in heat input over the 7-year time period. After accounting for growth in heat input over time, the year-to-year variation in heat input was assessed, as the differences between the actual yearly heat input values and the "yearly" average heat input values estimated according to the trend. For each state, to account for trends, a simple least-squares linear regression equation was fit to the heat input data as a function of time. This process fits a straight line to the data points using an equation of the form ($y = mx+b$). In this equation, "y" is the estimated heat input (million mmbtu) for a particular year "x", m is the slope of the line (with units of million mmbtu/year), and b is the "y-intercept" (the heat input value when the line is extrapolated to $x = 0$). The value of $r^2$ describes how well the data fit that line. Large $r^2$ values are important for states where there was substantial growth or decline in heat input over the time period (i.e., for states that have slopes for the regression line that are substantially different than zero). For states with relatively constant heat input values, low $r^2$ values are strongly correlated with small values for the slope of the regression line. For these states, low $r^2$ values are indicators of large year-to-year variability (relative to small amounts of growth over time). For example, for Delaware (Table 6), the slope of the linear regression is small, and the $r^2$ value is also very small. The conclusion is that for Delaware and other states with similar slopes and $r^2$ values, the year-to-year variation could likely have been adequately characterized without using the regression equation (which would account for growth in heat input over time).

For each state, the slopes of the regression equations, y-intercepts, and $r^2$ values, as well as the heat input estimated using the regression equations, can be found in Tables 4, 5, and 6. Using the regression equation for each state, yearly heat input values were estimated for each state for each year (between 2002 and 2008) in Tables 4, 5, and 6. Year-to-year variation was assessed for each year or for each ozone season as the difference between the actual heat input (from Tables 1-3) and the heat input estimated using the regression equation (Tables 4-6).

Table 4: Heat Input (million mmbtu) from Coal-Fired Units for Each Year Estimated Using the Regression Equation.

| State | Slope of Linear Regression (million mmbtu/year) | Intercept | $r^2$ Value | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| AL | -0.34 | 1,492 | 0.00 | 803.2 | 802.8 | 802.5 | 802.1 | 801.8 | 801.5 | 801.1 |
| CT | 1.19 | -2,365 | 0.30 | 24.4 | 25.6 | 26.7 | 27.9 | 29.1 | 30.3 | 31.5 |
| DE | 2.08 | -4,126 | 0.75 | 44.2 | 46.3 | 48.3 | 50.4 | 52.5 | 54.6 | 56.7 |
| FL | -4.44 | 9,600 | 0.12 | 709.4 | 704.9 | 700.5 | 696.0 | 691.6 | 687.2 | 682.7 |
| GA | 19.64 | -38,527 | 0.74 | 783.0 | 802.6 | 822.3 | 841.9 | 861.5 | 881.2 | 900.8 |
| IA | 5.69 | -11,002 | 0.41 | 380.1 | 385.8 | 391.4 | 397.1 | 402.8 | 408.5 | 414.2 |
| IL | 14.94 | -28,960 | 0.70 | 953.4 | 968.3 | 983.3 | 998.2 | 1,013.2 | 1,028.1 | 1,043.0 |
| IN | 2.92 | -4,592 | 0.12 | 1,246.3 | 1,249.2 | 1,252.1 | 1,255.0 | 1,257.9 | 1,260.9 | 1,263.8 |
| KS | -8.59 | 17,633 | 0.74 | 429.9 | 421.3 | 412.7 | 404.1 | 395.5 | 386.9 | 378.3 |
| KY | 8.52 | -16,113 | 0.68 | 935.8 | 944.3 | 952.8 | 961.3 | 969.9 | 978.4 | 986.9 |
| LA | -0.67 | 1,468 | 0.05 | 126.2 | 125.5 | 124.8 | 124.1 | 123.5 | 122.8 | 122.1 |
| MA | 0.20 | -290 | 0.01 | 107.0 | 107.2 | 107.4 | 107.6 | 107.8 | 108.0 | 108.2 |
| MD | -2.13 | 4,545 | 0.36 | 278.7 | 276.6 | 274.5 | 272.3 | 270.2 | 268.1 | 265.9 |
| MI | 3.26 | -5,825 | 0.30 | 702.8 | 706.0 | 709.3 | 712.5 | 715.8 | 719.1 | 722.3 |
| MN | -8.25 | 16,915 | 0.80 | 403.3 | 395.1 | 386.8 | 378.6 | 370.3 | 362.1 | 353.8 |
| MO | 0.80 | -836 | 0.01 | 758.6 | 759.4 | 760.2 | 761.0 | 761.8 | 762.6 | 763.4 |
| NC | 4.90 | -9,111 | 0.54 | 690.6 | 695.5 | 700.4 | 705.3 | 710.2 | 715.1 | 720.0 |
| NE | -0.32 | 869 | 0.01 | 233.1 | 232.8 | 232.5 | 232.1 | 231.8 | 231.5 | 231.2 |
| NJ | -1.58 | 3,241 | 0.15 | 83.2 | 81.7 | 80.1 | 78.5 | 76.9 | 75.4 | 73.8 |
| NY | -8.01 | 16,282 | 0.85 | 240.2 | 232.2 | 224.2 | 216.2 | 208.2 | 200.2 | 192.2 |
| OH | 1.88 | -2,480 | 0.03 | 1,290.4 | 1,292.3 | 1,294.2 | 1,296.1 | 1,298.0 | 1,299.8 | 1,301.7 |
| PA | 8.46 | -15,880 | 0.46 | 1,047.0 | 1,055.5 | 1,063.9 | 1,072.4 | 1,080.8 | 1,089.3 | 1,097.7 |
| SC | 6.84 | -13,312 | 0.90 | 383.1 | 390.0 | 396.8 | 403.7 | 410.5 | 417.3 | 424.2 |
| TN | -1.36 | 3,314 | 0.02 | 600.8 | 599.5 | 598.1 | 596.8 | 595.4 | 594.1 | 592.7 |
| VA | -9.45 | 19,252 | 0.77 | 328.2 | 318.8 | 309.3 | 299.9 | 290.4 | 281.0 | 271.5 |
| WI | -3.84 | 8,161 | 0.34 | 474.2 | 470.3 | 466.5 | 462.6 | 458.8 | 455.0 | 451.1 |
| WV | -6.09 | 13,082 | 0.36 | 889.2 | 883.2 | 877.1 | 871.0 | 864.9 | 858.8 | 852.7 |

Table 5: Total Heat Input (million mmbtu) from All Three EGU Categories for Each Year Estimated Using the Regression Equation.

| State | Slope of Linear Regression (million mmbtu/year) | Intercept | $r^2$ Value | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| AL | 12.18 | -23,490 | 0.55 | 900.8 | 913.0 | 925.1 | 937.3 | 949.5 | 961.7 | 973.9 |
| CT | 3.98 | -7,895 | 0.48 | 73.2 | 77.2 | 81.2 | 85.2 | 89.1 | 93.1 | 97.1 |
| DE | 1.65 | -3,256 | 0.54 | 53.4 | 55.0 | 56.7 | 58.3 | 60.0 | 61.6 | 63.3 |
| FL | 44.30 | -87,543 | 0.89 | 1,143.3 | 1,187.6 | 1,231.9 | 1,276.2 | 1,320.5 | 1,364.8 | 1,409.1 |
| GA | 31.61 | -62,466 | 0.75 | 823.1 | 854.7 | 886.3 | 917.9 | 949.5 | 981.1 | 1,012.8 |
| IA | 9.30 | -18,233 | 0.72 | 380.2 | 389.5 | 398.8 | 408.1 | 417.4 | 426.7 | 436.0 |
| IL | 16.09 | -31,231 | 0.73 | 986.5 | 1,002.5 | 1,018.6 | 1,034.7 | 1,050.8 | 1,066.9 | 1,083.0 |
| IN | 6.44 | -11,635 | 0.39 | 1,265.9 | 1,272.4 | 1,278.8 | 1,285.3 | 1,291.7 | 1,298.2 | 1,304.6 |
| KS | -7.92 | 16,295 | 0.70 | 430.6 | 422.7 | 414.8 | 406.8 | 398.9 | 391.0 | 383.1 |
| KY | 9.17 | -17,418 | 0.56 | 945.7 | 954.8 | 964.0 | 973.2 | 982.3 | 991.5 | 1,000.7 |
| LA | 19.04 | -37,877 | 0.63 | 241.4 | 260.5 | 279.5 | 298.6 | 317.6 | 336.6 | 355.7 |
| MA | 14.29 | -28,415 | 0.67 | 189.8 | 204.1 | 218.4 | 232.7 | 247.0 | 261.3 | 275.6 |
| MD | -2.89 | 6,080 | 0.47 | 291.5 | 288.6 | 285.7 | 282.8 | 279.9 | 277.0 | 274.1 |
| MI | 5.60 | -10,480 | 0.37 | 724.7 | 730.3 | 735.9 | 741.5 | 747.1 | 752.7 | 758.3 |
| MN | -5.14 | 10,702 | 0.53 | 412.3 | 407.2 | 402.0 | 396.9 | 391.7 | 386.6 | 381.5 |
| MO | 3.53 | -6,280 | 0.12 | 779.4 | 782.9 | 786.5 | 790.0 | 793.5 | 797.0 | 800.6 |
| NC | 8.00 | -15,302 | 0.63 | 709.6 | 717.6 | 725.6 | 733.6 | 741.6 | 749.6 | 757.6 |
| NE | 0.92 | -1,612 | 0.11 | 234.4 | 235.4 | 236.3 | 237.2 | 238.1 | 239.1 | 240.0 |
| NJ | 6.69 | -13,250 | 0.90 | 134.6 | 141.3 | 148.0 | 154.7 | 161.4 | 168.1 | 174.8 |
| NY | 17.76 | -35,264 | 0.82 | 283.7 | 301.4 | 319.2 | 337.0 | 354.7 | 372.5 | 390.2 |
| OH | 3.79 | -6,281 | 0.07 | 1,305.3 | 1,309.1 | 1,312.9 | 1,316.7 | 1,320.5 | 1,324.3 | 1,328.1 |
| PA | 26.84 | -52,648 | 0.85 | 1,077.2 | 1,104.0 | 1,130.9 | 1,157.7 | 1,184.5 | 1,211.4 | 1,238.2 |
| SC | 10.75 | -21,104 | 0.79 | 413.2 | 423.9 | 434.6 | 445.4 | 456.1 | 466.9 | 477.6 |
| TN | -1.88 | 4,376 | 0.04 | 608.5 | 606.6 | 604.8 | 602.9 | 601.0 | 599.1 | 597.2 |
| VA | -3.42 | 7,203 | 0.21 | 346.0 | 342.6 | 339.2 | 335.7 | 332.3 | 328.9 | 325.5 |
| WI | 1.60 | -2,711 | 0.05 | 491.8 | 493.4 | 495.0 | 496.6 | 498.2 | 499.8 | 501.4 |
| WV | -5.83 | 12,568 | 0.33 | 890.6 | 884.8 | 879.0 | 873.1 | 867.3 | 861.5 | 855.6 |

Table 6: Heat Input (million mmbtu) from All Three EGU Categories for Ozone Season Estimated Using the Regression Equation.

| State | Slope of Linear Regression (million mmbtu/year) | Intercept | $r^2$ Value | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|
| AL | 4.68 | -8,936 | 0.32 | 424.0 | 428.7 | 433.4 | 438.1 | 442.7 | 447.4 | 452.1 |
| AR | 4.99 | -9,850 | 0.41 | 136.8 | 141.8 | 146.8 | 151.7 | 156.7 | 161.7 | 166.7 |
| CT | 1.77 | -3,507 | 0.35 | 34.3 | 36.1 | 37.8 | 39.6 | 41.4 | 43.2 | 44.9 |
| DE | 0.04 | -54 | 0.00 | 26.4 | 26.4 | 26.4 | 26.5 | 26.5 | 26.6 | 26.6 |
| FL | 20.38 | -40,256 | 0.90 | 542.2 | 562.5 | 582.9 | 603.3 | 623.7 | 644.1 | 664.4 |
| GA | 14.80 | -29,231 | 0.64 | 393.4 | 408.2 | 423.0 | 437.8 | 452.6 | 467.4 | 482.2 |
| IL | 3.33 | -6,214 | 0.20 | 447.3 | 450.6 | 453.9 | 457.2 | 460.6 | 463.9 | 467.2 |
| IN | 1.23 | -1,911 | 0.04 | 553.2 | 554.4 | 555.7 | 556.9 | 558.1 | 559.4 | 560.6 |
| KS | -2.84 | 5,880 | 0.65 | 184.5 | 181.6 | 178.8 | 175.9 | 173.1 | 170.3 | 167.4 |
| KY | 2.15 | -3,883 | 0.08 | 416.1 | 418.3 | 420.4 | 422.6 | 424.7 | 426.9 | 429.0 |
| LA | 8.84 | -17,590 | 0.67 | 112.9 | 121.7 | 130.6 | 139.4 | 148.3 | 157.1 | 166.0 |
| MD | -1.27 | 2,671 | 0.18 | 128.7 | 127.4 | 126.1 | 124.9 | 123.6 | 122.3 | 121.1 |
| MI | 2.10 | -3,891 | 0.10 | 319.7 | 321.8 | 323.9 | 326.0 | 328.1 | 330.2 | 332.3 |
| MS | 6.21 | -12,325 | 0.80 | 116.7 | 122.9 | 129.1 | 135.4 | 141.6 | 147.8 | 154.0 |
| NC | 5.29 | -10,265 | 0.50 | 317.5 | 322.8 | 328.1 | 333.4 | 338.7 | 343.9 | 349.2 |
| NJ | 4.01 | -7,956 | 0.82 | 63.9 | 67.9 | 71.9 | 75.9 | 79.9 | 83.9 | 87.9 |
| NY | 8.39 | -16,679 | 0.74 | 123.4 | 131.8 | 140.2 | 148.6 | 157.0 | 165.4 | 173.8 |
| OH | 0.01 | 552 | 0.00 | 567.3 | 567.3 | 567.3 | 567.3 | 567.3 | 567.3 | 567.3 |
| OK | 6.80 | -13,402 | 0.75 | 212.4 | 219.2 | 226.0 | 232.8 | 239.6 | 246.4 | 253.2 |
| PA | 12.52 | -24,588 | 0.69 | 470.3 | 482.8 | 495.3 | 507.8 | 520.4 | 532.9 | 545.4 |
| SC | 5.58 | -10,974 | 0.62 | 192.0 | 197.5 | 203.1 | 208.7 | 214.3 | 219.8 | 225.4 |
| TN | -0.12 | 517 | 0.00 | 268.2 | 268.1 | 268.0 | 267.9 | 267.7 | 267.6 | 267.5 |
| TX | 39.05 | -77,113 | 0.85 | 1,067.4 | 1,106.5 | 1,145.5 | 1,184.6 | 1,223.6 | 1,262.7 | 1,301.7 |
| VA | -0.14 | 434 | 0.00 | 154.1 | 154.0 | 153.9 | 153.7 | 153.6 | 153.4 | 153.3 |
| WV | -0.50 | 1,387 | 0.01 | 377.3 | 376.8 | 376.3 | 375.8 | 375.3 | 374.8 | 374.3 |

On a state-by-state basis, the difference between the actual heat input and the estimated heat input using the regression equation was calculated for each year. The differences for $SO_2$, annual $NO_x$, and ozone season $NO_x$ can be found in Tables 7, 8, and 9, respectively. Some of these yearly differences are positive, while others are negative. Assessing the differences between actual and estimated heat input across all years for each state (and pollutant), a representative difference was estimated using the "standard deviation".

The standard deviation is defined as the square root of the variance (the sum of the square of the differences[3] divided by the number of samples minus one). The state- and pollutant-specific representative differences defined using the standard deviation were used for the remaining steps in the variability analyses for the preferred method. In using the standard deviation as a representative difference, we assume that: (1) differences between the actual and modeled heat inputs are "normally" distributed; (2) yearly mean values are independent; and, (3) distribution of hourly values is the same (i.e., the "within-year" variance is the same for each year).

For each state, the standard deviation of the differences is a measure of the year-to-year (1-year) variance in heat input. In essence, it suggests that, on average, 68% of all the year-specific heat input values could be expected to be within one standard deviation from the expected value (either higher or lower). The standard deviation in the heat input in million mmbtu rounded to three significant digits (as well as a percentage of the average heat input value) can be found in Tables 7, 8, and 9.

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[3] On a state-by-state basis, the standard deviation was calculated from the set of yearly difference values. As described, the yearly values were the difference between the actual heat input and the estimated heat input (using the regression equation) for each year.

Table 7: Difference Between Heat Input (million mmbtu) Measured and Estimated for Coal-Fired Units for Each Year Using the Regression Equation.

| State | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | Standard Deviation of Heat Input (million mmbtu) | Average Heat Input (2002-2008 (from Table 1) | Standard Deviation as a Fraction of Average HI | 95% Confidence Level Variability in HI (million mmbtu) | 95% Confidence Level Variability in HI (as a Fraction of Avg. HI) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AL | -24.1 | 19.7 | -18.0 | 26.1 | 11.2 | 17.3 | -32.2 | 24.0 | 802.1 | 0.03 | 47.0 | 0.059 |
| CT | -6.2 | 2.7 | 4.1 | 2.3 | 2.3 | -4.2 | -1.0 | 3.9 | 27.9 | 0.141 | 7.7 | 0.276 |
| DE | -1.6 | -0.8 | 2.5 | 1.6 | -2.4 | 3.7 | -2.9 | 2.6 | 50.4 | 0.051 | 5.1 | 0.100 |
| FL | -8.8 | 31.0 | -41.2 | 1.0 | 19.8 | 20.1 | -21.9 | 25.9 | 696.0 | 0.037 | 50.7 | 0.073 |
| GA | -1.8 | -15.2 | -13.5 | 29.7 | 11.0 | 29.4 | -39.7 | 25.4 | 841.9 | 0.03 | 49.7 | 0.059 |
| IA | 13.0 | 3.9 | -4.8 | -12.7 | -23.9 | 7.4 | 17.0 | 14.6 | 397.1 | 0.037 | 28.7 | 0.073 |
| IL | -22.5 | -6.4 | 43.8 | 3.8 | -11.0 | 2.4 | -10.1 | 21.3 | 998.2 | 0.021 | 41.7 | 0.041 |
| IN | -14.9 | -12.9 | 13.9 | 26.1 | 11.9 | -4.0 | -20.2 | 17.5 | 1,255.0 | 0.014 | 34.3 | 0.027 |
| KS | -2.4 | 6.3 | -0.8 | 1.1 | -17.9 | 18.4 | -4.8 | 11.0 | 404.1 | 0.027 | 21.6 | 0.053 |
| KY | 10.7 | -13.2 | -14.8 | 9.0 | 17.2 | -0.5 | -8.4 | 12.6 | 961.3 | 0.013 | 24.7 | 0.025 |
| LA | -5.2 | -3.4 | 3.3 | 10.4 | 5.2 | -6.7 | -3.6 | 6.4 | 124.1 | 0.051 | 12.5 | 0.100 |
| MA | 1.9 | -3.3 | -5.7 | 7.5 | -0.6 | 6.7 | -6.5 | 5.7 | 107.6 | 0.053 | 11.1 | 0.104 |
| MD | -1.8 | 1.4 | -4.6 | 1.4 | 4.5 | 9.0 | -10.0 | 6.2 | 272.3 | 0.023 | 12.1 | 0.045 |
| MI | -2.7 | 0.8 | 0.5 | 8.5 | -16.1 | 16.9 | -7.9 | 10.7 | 712.5 | 0.015 | 21.0 | 0.029 |
| MN | -14.1 | 16.0 | -0.2 | 1.6 | 0.0 | 0.8 | -4.0 | 8.9 | 378.6 | 0.023 | 17.4 | 0.045 |
| MO | -34.0 | 10.2 | 10.7 | 22.6 | 21.7 | -0.6 | -30.6 | 23.4 | 761.0 | 0.031 | 45.9 | 0.061 |
| NC | 2.7 | -6.5 | -4.0 | 14.3 | -11.1 | 11.3 | -6.8 | 9.7 | 705.3 | 0.014 | 19.1 | 0.027 |
| NE | -6.1 | 5.6 | -1.3 | 6.2 | 2.2 | -9.1 | 2.6 | 5.8 | 232.1 | 0.025 | 11.4 | 0.049 |
| NJ | -3.3 | -6.4 | -0.5 | 13.7 | 5.0 | 2.4 | -11.0 | 8.1 | 78.5 | 0.103 | 15.8 | 0.202 |
| NY | -6.2 | 3.7 | 2.5 | -2.8 | 3.1 | 10.8 | -11.1 | 7.3 | 216.2 | 0.034 | 14.2 | 0.067 |
| OH | -0.2 | 24.0 | -46.9 | 19.0 | -4.0 | 19.8 | -11.8 | 24.8 | 1,296.1 | 0.019 | 48.5 | 0.037 |
| PA | -20.1 | -5.4 | 14.7 | 17.8 | 9.7 | 15.9 | -32.7 | 19.9 | 1,072.4 | 0.019 | 39.1 | 0.037 |
| SC | -1.6 | -5.3 | 4.6 | 4.1 | -0.1 | 5.3 | -7.1 | 4.9 | 403.7 | 0.012 | 9.7 | 0.024 |
| TN | 23.8 | -24.6 | -8.7 | -10.4 | 11.5 | 23.1 | -14.7 | 19.3 | 596.8 | 0.032 | 37.8 | 0.063 |
| VA | 12.3 | -6.3 | -12.7 | -1.5 | -2.4 | 17.9 | -7.3 | 11.1 | 299.9 | 0.037 | 21.7 | 0.073 |
| WI | -17.1 | 5.6 | 16.4 | 10.5 | -7.7 | -7.5 | -0.3 | 11.7 | 462.6 | 0.025 | 22.9 | 0.049 |
| WV | 9.5 | 15.4 | -26.1 | -9.7 | -12.5 | 24.5 | -1.1 | 17.6 | 871.0 | 0.02 | 34.5 | 0.039 |

Table 8: Difference Between Total Heat Input (million mmbtu) Measured and Estimated from All Three EGU Categories for Each Year Using the Regression Equation.

| State | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | Standard Deviation of Heat Input (million mmbtu) | Average Heat Input (2002-2008 (from Table 2) | Standard Deviation as a Fraction of Average HI | 95% Confidence Level Variability in HI (million mmbtu) | 95% Confidence Level Variability in HI (as a Fraction of Avg. HI) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AL | 0.2 | 3.0 | -20.5 | -0.7 | 14.6 | 38.3 | -35.0 | 23.6 | 937.3 | 0.025 | 46.2 | 0.049 |
| CT | -3.3 | -9.7 | 6.3 | 6.1 | 12.0 | 0.8 | -12.2 | 8.9 | 85.2 | 0.105 | 17.5 | 0.206 |
| DE | -0.7 | -1.8 | 2.4 | 2.6 | -4.4 | 4.7 | -2.8 | 3.3 | 58.3 | 0.056 | 6.5 | 0.110 |
| FL | -8.8 | 10.1 | -33.1 | 6.9 | 40.5 | 33.4 | -48.9 | 32.8 | 1,276.2 | 0.026 | 64.4 | 0.051 |
| GA | 18.8 | -32.3 | -32.9 | 30.1 | 18.9 | 51.8 | -54.5 | 39.6 | 917.9 | 0.043 | 77.6 | 0.084 |
| IA | 13.0 | 0.8 | -7.7 | -6.8 | -21.2 | 11.3 | 10.5 | 12.6 | 408.1 | 0.031 | 24.8 | 0.061 |
| IL | -10.4 | -19.8 | 27.5 | 19.1 | -12.6 | 19.3 | -23.1 | 21.2 | 1,034.7 | 0.020 | 41.5 | 0.039 |
| IN | -9.2 | -14.8 | 4.8 | 29.8 | 8.7 | 3.0 | -22.3 | 17.3 | 1,285.3 | 0.013 | 33.9 | 0.025 |
| KS | -1.4 | 6.7 | -2.3 | -0.1 | -17.7 | 19.1 | -4.4 | 11.2 | 406.8 | 0.027 | 21.9 | 0.053 |
| KY | 16.8 | -19.7 | -21.6 | 15.1 | 16.6 | 5.7 | -12.9 | 17.5 | 973.2 | 0.018 | 34.3 | 0.035 |
| LA | -47.8 | 6.1 | 33.2 | 33.6 | 18.6 | -14.1 | -29.5 | 31.5 | 298.6 | 0.106 | 61.8 | 0.208 |
| MA | -30.0 | 17.3 | 3.1 | 11.7 | 15.5 | 15.1 | -32.7 | 21.9 | 232.7 | 0.094 | 42.9 | 0.184 |
| MD | -3.3 | 2.0 | -4.9 | 5.0 | 2.7 | 8.9 | -10.4 | 6.6 | 282.8 | 0.023 | 12.9 | 0.045 |
| MI | 2.2 | -5.3 | -8.7 | 19.0 | -16.5 | 23.7 | -14.5 | 15.9 | 741.5 | 0.021 | 31.1 | 0.041 |
| MN | -13.3 | 15.9 | -5.6 | 4.9 | -0.1 | 8.0 | -9.8 | 10.4 | 396.9 | 0.026 | 20.4 | 0.051 |
| MO | -27.3 | 5.7 | 5.8 | 23.6 | 19.0 | 3.6 | -30.3 | 21.1 | 790.0 | 0.027 | 41.3 | 0.053 |
| NC | 9.2 | -11.3 | -7.2 | 13.6 | -14.5 | 18.1 | -7.9 | 13.2 | 733.6 | 0.018 | 25.9 | 0.035 |
| NE | -6.1 | 5.1 | -2.7 | 8.1 | 2.5 | -7.2 | 0.3 | 5.7 | 237.2 | 0.024 | 11.2 | 0.047 |
| NJ | 4.7 | -8.4 | 3.5 | 0.2 | -2.6 | 4.6 | -1.9 | 4.8 | 154.7 | 0.031 | 9.4 | 0.061 |
| NY | 4.6 | -4.1 | -9.3 | -14.1 | 25.9 | 20.6 | -23.6 | 18.1 | 337.0 | 0.054 | 35.5 | 0.106 |
| OH | 4.3 | 21.2 | -54.6 | 23.3 | -6.9 | 30.3 | -17.6 | 29.6 | 1,316.7 | 0.023 | 58.1 | 0.045 |
| PA | -17.0 | -14.0 | 24.2 | 14.7 | 0.8 | 29.5 | -38.3 | 24.6 | 1,157.7 | 0.021 | 48.2 | 0.041 |
| SC | 5.0 | -21.2 | 7.4 | 9.5 | 5.3 | 7.2 | -13.2 | 12.1 | 445.4 | 0.027 | 23.7 | 0.053 |
| TN | 27.2 | -26.1 | -12.7 | -10.3 | 12.2 | 24.7 | -15.0 | 21.1 | 602.9 | 0.035 | 41.3 | 0.069 |
| VA | 10.5 | -9.0 | -9.7 | 3.8 | -8.3 | 25.9 | -13.2 | 14.2 | 335.7 | 0.042 | 27.9 | 0.082 |
| WI | -16.5 | 0.7 | 3.4 | 31.9 | -5.9 | -2.3 | -11.3 | 15.7 | 496.6 | 0.032 | 30.7 | 0.063 |
| WV | 9.8 | 15.1 | -26.9 | -9.8 | -11.5 | 25.7 | -2.4 | 18.0 | 873.1 | 0.021 | 35.2 | 0.041 |

Table 9: Difference Between Total Heat Input Measured and Estimated (million mmbtu) from All Three EGU Categories for Ozone Season Using the Regression Equation.

| State | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | Standard Deviation of Heat Input (million mmbtu) | Average Heat Input (2002-2008 (from Table 3) | Standard Deviation as a Fraction of Average HI | 95% Confidence Level Variability in HI (million mmbtu) | 95% Confidence Level Variability in HI (as a Fraction of Avg. HI) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AL | 3.4 | 0.1 | -9.8 | -10.8 | 14.1 | 22.5 | -19.5 | 14.8 | 438.1 | 0.034 | 29.0 | 0.067 |
| AR | -12.7 | 10.7 | 2.5 | -9.7 | 16.8 | 8.6 | -16.2 | 12.9 | 151.7 | 0.085 | 25.3 | 0.167 |
| CT | -1.0 | -7.4 | 5.6 | 3.2 | 4.9 | 1.2 | -6.6 | 5.3 | 39.6 | 0.133 | 10.3 | 0.261 |
| DE | 1.6 | -2.2 | -1.0 | 2.5 | -3.0 | 3.7 | -1.7 | 2.6 | 26.5 | 0.097 | 5.0 | 0.190 |
| FL | 6.4 | -7.6 | -19.6 | 11.8 | 15.3 | 12.2 | -18.5 | 15.0 | 603.3 | 0.025 | 29.4 | 0.049 |
| GA | 10.4 | -25.3 | -15.9 | 24.0 | 16.9 | 22.2 | -32.3 | 23.8 | 437.8 | 0.054 | 46.7 | 0.106 |
| IL | 7.6 | -20.4 | -4.3 | 20.8 | 0.3 | 10.7 | -14.6 | 14.5 | 457.2 | 0.032 | 28.3 | 0.063 |
| IN | 4.0 | -9.1 | -15.0 | 21.5 | 8.3 | 0.5 | -10.1 | 12.6 | 556.9 | 0.023 | 24.7 | 0.045 |
| KS | -1.3 | -0.7 | -2.0 | 4.7 | -0.9 | 6.9 | -6.7 | 4.5 | 175.9 | 0.026 | 8.8 | 0.051 |
| KY | 17.1 | -18.2 | -19.4 | 11.8 | 10.5 | 9.3 | -11.2 | 15.6 | 422.6 | 0.037 | 30.6 | 0.073 |
| LA | -18.2 | -0.1 | 14.4 | 10.5 | 13.5 | -6.4 | -13.7 | 13.3 | 139.4 | 0.095 | 26.1 | 0.186 |
| MD | 6.1 | -8.6 | -4.4 | 6.6 | -0.3 | 4.5 | -4.0 | 5.9 | 124.9 | 0.047 | 11.6 | 0.092 |
| MI | 11.4 | -9.7 | -19.2 | 13.9 | 0.4 | 14.4 | -11.2 | 13.7 | 326.0 | 0.042 | 26.8 | 0.082 |
| MS | 1.1 | -6.8 | 0.3 | 1.9 | 6.1 | 8.1 | -10.8 | 6.7 | 135.4 | 0.050 | 13.2 | 0.098 |
| NC | 15.3 | -14.3 | -14.0 | 8.2 | 1.7 | 7.5 | -4.4 | 11.4 | 333.4 | 0.034 | 22.4 | 0.067 |
| NJ | 4.8 | -7.9 | 2.1 | 0.2 | 0.0 | 2.2 | -1.3 | 4.0 | 75.9 | 0.053 | 7.9 | 0.104 |
| NY | 2.6 | -10.5 | -3.9 | 3.9 | 17.7 | 5.1 | -14.9 | 10.8 | 148.6 | 0.073 | 21.3 | 0.143 |
| OH | 16.4 | -4.5 | -28.9 | 7.1 | -5.4 | 29.3 | -14.0 | 19.4 | 567.3 | 0.034 | 38.0 | 0.067 |
| OK | -8.0 | 4.1 | -6.0 | 15.6 | 4.9 | -5.3 | -5.3 | 8.6 | 232.8 | 0.037 | 16.8 | 0.073 |
| PA | -4.9 | -14.1 | -0.8 | 21.5 | 10.2 | 17.9 | -29.9 | 18.3 | 507.8 | 0.036 | 35.8 | 0.071 |
| SC | 11.1 | -19.1 | 1.7 | 5.5 | 1.5 | 2.8 | -3.4 | 9.5 | 208.7 | 0.046 | 18.6 | 0.090 |
| TN | 22.9 | -23.9 | -11.8 | 2.2 | 5.5 | 11.3 | -6.3 | 15.5 | 267.9 | 0.058 | 30.3 | 0.114 |
| TX | -35.5 | -16.5 | 24.5 | 44.5 | 31.8 | 0.1 | -49.0 | 35.4 | 1,184.6 | 0.030 | 69.4 | 0.059 |
| VA | 5.8 | -7.1 | -3.0 | 0.6 | -2.1 | 14.5 | -8.8 | 8.0 | 153.7 | 0.052 | 15.7 | 0.102 |
| WV | 2.2 | 7.6 | -15.3 | -0.4 | -2.2 | 15.5 | -7.4 | 10.0 | 375.8 | 0.027 | 19.5 | 0.053 |

The standard deviation can also be used to estimate, on average, the probability of larger variations in heat input (for example a difference that we would expect less than 1% of the time). Using the standard deviation, "confidence levels" representing the variability difference in heat input that could be expected at different probabilities were found for each state (for each pollutant). Several different levels were examined (notably the 95th and 99th percent confidence levels). As an illustrative example, the two-tailed 95th percent confidence level indicates that we could expect, on average, that the total heat input for a particular year for a particular state will be within 1.960 standard deviations of the variation from its mean value 95 percent of the time. For this analysis, we focus on results for the two-tailed 95th percent confidence level for each state. EPA made the policy decision that, assessed across the large number of states included in the program, the 95th percent two-tailed confidence level[4] was the appropriate confidence level. EPA believes that using the 95th percent confidence level provides a high degree of confidence that sources subject to the rule will be able to operate within the constraints of the variability limits and without electric reliability problems arising.

When the alternative method for calculating variability (the maximum difference over the time period) was applied, the results for many states were comparable to the results using the 95th confidence level, showing that the proposed variation was similar to the maximum measured historical values. The major differences were for states that had growth (or decline) in heat input over the time period. The 95% upper confidence level heat inputs and percentages (the 95% heat input difference divided by the average heat input over the 2002-2008 time period) can be found in Tables 7, 8, and 9. The results from the alternative method using the maximum difference in heat input from the 7-year average heat input can be found in Tables 1, 2, and 3.

For states where there were differences between the proposed and alternative approaches, the difference was often a result of substantial growth in heat input over the 7-year time period. For example, as seen in Table 1, for Virginia, the heat input in 2002 is 340.5 million mmbtu. By 2008, the heat input had decreased to 264.2 million mmbtu. The average heat input over this time period was 299.9 million mmbtu. Consequently, the

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[4] The two-tailed 95th percent confidence level is the equivalent of the 97.5th upper (single-tailed) confidence level. Hereafter in this TSD, the "95th" percent confidence level refers to the two-tailed 95th percent confidence level.

maximum difference from the average was 40.6 million mmbtu (Table 1). Using the proposed approach (the 95% confidence level) and accounting for decline in heat input over time using the regression equation, the estimated variability in heat input is substantially reduced (21.7 million mmbtu, as seen in Table 7).

### (c) Estimation of the emission rates projected in 2014 used to estimate variability in emissions from the year-to-year variability in historical heat input.

The final step in estimating state-by-state year-to-year (1-year) variability in emissions is to convert the year-to-year variability in heat input into variability in pollutant emissions. This was done by multiplying the estimated variability in heat input by a representative pollutant emission rate. For each state, the state-specific 95th percent confidence level heat input variability value (converted to mmbtu) was multiplied by a state-specific emission rate (tons of pollutant per mmbtu). The resulting value is the 95th percent confidence level variability emission value (in tons of pollutant).

State-specific modeled emission rates were used in the calculation. The rates were based on IPM emissions and heat inputs projected to occur in 2014 when levels of controls similar to that for the proposed remedy are applied to each state. Modeled emission rates were used, rather than historical emission rates, because EPA wanted to estimate year-to-year variability in emissions within the same time and conditions as those of the proposed transport rule when new emissions controls could potentially be in operation.

Using IPM estimates for 2014, the emission rates for annual $SO_2$ were calculated using modeled estimates of total heat input and total emissions from coal-fired units, while annual and ozone season $NO_x$ were calculated using modeled estimates of total heat input and total emissions from all three EGU categories. EPA derived the state-specific emission rates from IPM projections parsed for 2014; the state-specific emission rates for annual $SO_2$, annual $NO_x$ and ozone season $NO_x$ are from IPM runs that required controls at \$1,600/ton for $SO_2$, \$500/ton for annual $NO_X$, and \$500/ton for ozone season $NO_X$, respectively.[5] Tables 10 through 14 list, for each state and the three EGU sectors defined

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[5] EPA developed the proposed variability limits in parallel with developing the overall control requirements. As such, while these IPM runs used to develop the variability limits assumed reasonable levels of emissions

above, the modeled emissions, the modeled fuel usage (the sum of the heat input), and the emission rates. For each state, the state-specific 95th percent confidence level heat input variability value was multiplied by the state-specific emission rate. The resulting 95% confidence level emission variability value, in units of tons of emissions, can be found in Tables 10, 12, and 14 for annual $SO_2$, annual $NO_x$, and ozone season $NO_x$, respectively (see the columns labeled "95% confidence level variability value").[6] The 95% confidence level emission variability value was normalized by dividing by each state's emissions, resulting in a "coefficient of variation" value. In this TSD, the value is referred to as the "percentage" variability value.

The 95% confidence level emission variability value can be compared to the difference between the emissions for a particular year and the emissions budget. We expect the difference to be less than the 95% emissions variability value, on average, 95 percent of the time. Consequently, the 95% emissions variability value represents a year-to-year variability that is sufficient, most of the time, to encompass the inherent variability in power sector generation. That is, sources within a state should not exceed the state's budget if variability is the only reason for emissions increases above the budget.

Subsequent sections in this TSD discuss how the 95% confidence level variability values were used to construct the variability limits applied in the proposed Transport Rule assurance provisions.

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control, they are not identical to the final control strategy chosen for the proposed rule. Whereas IPM output files report aggregated results for "model" plants (i.e., aggregates of generating units with similar operating characteristics), parsed files show IPM results at the generating unit level. The IPM runs that are the bases for the 2014 parsed files used to derive the state-specific rates are designated "TR_$SO_2$_1600", "TR_$NO_X$_500", and "TR_$NO_X$_OS_500" for $SO_2$, annual $NO_X$, and ozone season $NO_X$ rates, respectively. The IPM runs and parsed files can be found in the docket; Docket ID No. EPA-HQ-OAR-2009-0491.

[6] Tables 10, 12, and 14 also show resulting estimated emission variability values based on the alternative approach (see columns labeled "Alternative approach value").

Table 10. State-by-State $SO_2$ Emissions (thousand short tons), Fuel Use (million mmbtu), and Emission Rate Estimated in IPM for Units Greater Than or Equal to 25 MW. Also Shown are the Estimated 95th Percent Confidence $SO_2$ Tonnage and Percentage Values as well as the Alternative Approach $SO_2$ Tonnage and Percentage Values.

| State | Annual $SO_2$ Emissions From Coal-Fired Boilers (thousand tons) | Annual fuel use from coal-fired boilers (million mmbtu) | $SO_2$ Emission Rate (lbs/mmbtu) | 95% Confidence Level Variability Value (tons) | 95% Confidence Level Variability Value (percentage) | Alternative Approach Value (tons) | Alternative Approach Value (percentage) |
|---|---|---|---|---|---|---|---|
| AL | 103.38 | 852.69 | 0.242 | 5,693 | 5.9% | 3,170 | 3.3% |
| CT | 2.72 | 42.05 | 0.129 | 498 | 27.6% | 228 | 12.6% |
| DE | 7.38 | 62.66 | 0.236 | 595 | 10.0% | 923 | 15.6% |
| FL | 80.73 | 1,084.86 | 0.149 | 3,775 | 7.3% | 2,968 | 5.7% |
| GA | 94.39 | 977.67 | 0.193 | 4,801 | 5.9% | 6,631 | 8.2% |
| IL | 159.15 | 1,140.91 | 0.279 | 5,816 | 4.1% | 4,840 | 3.5% |
| IN | 231.11 | 1,380.68 | 0.335 | 5,733 | 2.7% | 4,375 | 2.1% |
| IA | 87.27 | 466.65 | 0.374 | 5,363 | 7.3% | 6,378 | 8.6% |
| KS | 44.99 | 380.57 | 0.236 | 2,555 | 5.3% | 2,771 | 5.8% |
| KY | 158.93 | 1,083.19 | 0.293 | 3,628 | 2.5% | 3,767 | 2.7% |
| LA | 92.78 | 387.40 | 0.479 | 2,992 | 10.0% | 2,500 | 8.4% |
| MD | 42.67 | 436.37 | 0.196 | 1,186 | 4.5% | 557 | 2.1% |
| MA | 8.44 | 111.12 | 0.152 | 844 | 10.4% | 572 | 7.0% |
| MI | 196.34 | 770.31 | 0.510 | 5,359 | 2.9% | 5,975 | 3.3% |
| MN | 40.10 | 386.00 | 0.208 | 1,807 | 4.5% | 3,371 | 8.6% |
| MO | 185.27 | 823.10 | 0.450 | 10,337 | 6.1% | 5,087 | 3.0% |
| NE | 68.91 | 287.50 | 0.479 | 2,730 | 4.9% | 1,489 | 2.7% |
| NJ | 14.23 | 155.23 | 0.183 | 1,449 | 20.2% | 1,255 | 17.4% |
| NY | 45.11 | 261.98 | 0.344 | 2,450 | 6.7% | 3,401 | 9.1% |
| NC | 88.43 | 931.48 | 0.190 | 1,809 | 2.7% | 2,001 | 3.0% |
| OH | 200.28 | 1,433.48 | 0.279 | 6,781 | 3.7% | 3,299 | 1.8% |
| PA | 150.88 | 1,362.73 | 0.221 | 4,325 | 3.7% | 3,636 | 3.1% |
| SC | 73.44 | 487.02 | 0.302 | 1,457 | 2.4% | 2,858 | 4.7% |
| TN | 109.09 | 617.16 | 0.354 | 6,688 | 6.3% | 4,927 | 4.7% |
| VA | 60.60 | 407.67 | 0.297 | 3,222 | 7.3% | 6,039 | 13.5% |
| WV | 138.89 | 1,029.88 | 0.270 | 4,652 | 3.9% | 3,748 | 3.2% |
| WI | 78.48 | 495.03 | 0.317 | 3,630 | 4.9% | 3,215 | 4.4% |

## Table 11. Annual $NO_x$ Emissions (thousand short tons) and Fuel Use (million mmbtu) Estimated in IPM, for Units Greater Than or Equal to 25 MW.

| | Annual $NO_x$ Emissions | | | | | Annual Fuel Usage | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| State | Coal-Fired Boilers (thousand tons) | Combined Cycle Turbines (thousand tons) | Simple Cycle CT (thousand tons) | Oil & Gas Boilers (thousand tons) | All Units (thousand tons) | Coal-Fired Boilers (million mmbtu) | Combined Cycle Turbines (million mmbtu) | Simple Cycle CT (million mmbtu) | Oil & Gas Boilers (million mmbtu) | All Units (million mmbtu) |
| AL | 60.805 | 0.888 | 0.030 | | 61.724 | 856.091 | 122.084 | 1.449 | | 979.624 |
| CT | 2.051 | 0.716 | 0.043 | 0.000 | 2.809 | 42.050 | 103.449 | 1.986 | 0.000 | 147.485 |
| DE | 3.725 | 0.584 | 0.017 | 0.000 | 4.327 | 60.215 | 26.258 | 0.685 | 0.000 | 87.158 |
| FL | 98.493 | 7.814 | 2.839 | 12.350 | 121.496 | 1,057.478 | 645.095 | 56.530 | 107.598 | 1,866.701 |
| GA | 44.781 | 0.437 | 0.128 | 0.000 | 45.346 | 984.344 | 57.183 | 6.240 | 0.000 | 1,047.766 |
| IL | 55.470 | 0.123 | 0.203 | 0.000 | 55.796 | 1,134.540 | 9.555 | 7.355 | 0.000 | 1,151.449 |
| IN | 111.365 | 0.058 | 0.047 | 0.000 | 111.470 | 1,392.974 | 7.880 | 1.393 | 0.000 | 1,402.248 |
| IA | 50.717 | 0.034 | 0.140 | | 50.891 | 480.860 | 3.991 | 1.687 | | 486.539 |
| KS | 37.399 | | 0.000 | 0.000 | 37.399 | 377.821 | | 0.000 | 0.000 | 377.821 |
| KY | 72.244 | | 0.011 | | 72.256 | 1,085.560 | | 0.289 | | 1,085.849 |
| LA | 34.268 | 0.754 | 0.090 | 1.197 | 36.310 | 384.835 | 75.389 | 3.188 | 11.737 | 475.149 |
| MD | 19.643 | 0.026 | 0.105 | 0.000 | 19.774 | 428.182 | 2.058 | 5.361 | 0.000 | 435.601 |
| MA | 5.584 | 1.171 | 0.019 | 0.000 | 6.774 | 111.117 | 204.806 | 0.742 | 0.000 | 316.666 |
| MI | 63.816 | 0.575 | 0.171 | 0.000 | 64.562 | 812.765 | 23.096 | 5.095 | 0.000 | 840.956 |
| MN | 32.037 | 0.069 | 0.075 | 0.000 | 32.181 | 373.950 | 10.424 | 3.089 | 0.000 | 387.463 |
| MO | 78.419 | 0.018 | 0.000 | | 78.437 | 843.016 | 2.056 | 0.000 | | 845.071 |
| NE | 32.967 | 0.010 | 0.151 | 0.000 | 33.128 | 298.044 | 1.494 | 1.887 | 0.000 | 301.425 |
| NJ | 10.622 | 0.952 | 0.517 | 0.000 | 12.091 | 155.481 | 112.882 | 7.173 | 0.000 | 275.536 |
| NY | 13.240 | 2.356 | 0.651 | 7.561 | 23.808 | 261.921 | 239.245 | 9.342 | 202.341 | 712.849 |
| NC | 59.417 | 0.112 | 0.145 | | 59.674 | 914.612 | 3.404 | 6.215 | | 924.231 |
| OH | 99.323 | 0.159 | 0.145 | | 99.627 | 1,450.382 | 18.752 | 4.609 | | 1,473.743 |
| PA | 112.489 | 0.657 | 0.074 | 0.000 | 113.220 | 1,353.586 | 105.537 | 2.365 | 0.000 | 1,461.488 |
| SC | 34.301 | 0.201 | 0.030 | 0.000 | 34.532 | 491.149 | 18.015 | 1.338 | 0.000 | 510.501 |
| TN | 28.272 | | 0.403 | | 28.675 | 616.230 | | 6.243 | | 622.473 |
| VA | 27.524 | 0.491 | 0.189 | 0.000 | 28.204 | 399.917 | 46.858 | 5.747 | 0.000 | 452.522 |
| WV | 54.084 | | 0.000 | | 54.084 | 1,010.968 | | 0.000 | | 1,010.968 |
| WI | 39.771 | 0.031 | 0.152 | 0.000 | 39.953 | 521.020 | 4.279 | 0.608 | 0.000 | 525.908 |

Table 12. State-by-State Annual $NO_x$ Emission Rate Calculated Using the IPM Estimates Presented in Table 11. Also Shown Are the Estimated 95th Percent Confidence $NO_x$ Tonnage and Percentage Values as well as the Alternative Approach $NO_x$ Tonnage and Percentage Values.

| State | Annual $NO_x$ Emission Rate (lb/mmbtu) | 95% Confidence Level Variability Value (tons) | 95% Confidence Level Variability Value (percentage) | Alternative Approach Value (tons) | Alternative Approach Value (percentage) |
|---|---|---|---|---|---|
| AL | 0.126 | 2,912 | 4.9% | 3,951 | 6.7% |
| CT | 0.038 | 333 | 20.6% | 305 | 18.8% |
| DE | 0.099 | 321 | 11.0% | 398 | 13.7% |
| FL | 0.130 | 4,190 | 5.1% | 7,941 | 9.6% |
| GA | 0.087 | 3,359 | 8.4% | 4,980 | 12.5% |
| IL | 0.097 | 2,010 | 3.9% | 2,496 | 5.0% |
| IN | 0.159 | 2,699 | 2.5% | 2,369 | 2.3% |
| IA | 0.209 | 2,591 | 6.1% | 4,015 | 9.4% |
| KS | 0.198 | 2,166 | 5.3% | 2,237 | 5.6% |
| KY | 0.133 | 2,283 | 3.5% | 1,716 | 2.6% |
| LA | 0.153 | 4,723 | 20.8% | 2,873 | 12.6% |
| MD | 0.091 | 586 | 4.5% | 353 | 2.8% |
| MA | 0.043 | 918 | 18.4% | 934 | 18.8% |
| MI | 0.154 | 2,390 | 4.1% | 2,682 | 4.7% |
| MN | 0.166 | 1,691 | 5.1% | 2,178 | 6.6% |
| MO | 0.186 | 3,832 | 5.3% | 2,191 | 3.0% |
| NE | 0.220 | 1,226 | 4.7% | 889 | 3.4% |
| NJ | 0.088 | 412 | 6.1% | 795 | 11.7% |
| NY | 0.067 | 1,187 | 10.6% | 1,874 | 16.7% |
| NC | 0.129 | 1,673 | 3.5% | 2,199 | 4.6% |
| OH | 0.135 | 3,928 | 4.5% | 2,559 | 2.9% |
| PA | 0.155 | 3,732 | 4.1% | 6,447 | 7.2% |
| SC | 0.135 | 1,603 | 5.3% | 1,938 | 6.4% |
| TN | 0.092 | 1,904 | 6.9% | 1,512 | 5.4% |
| VA | 0.125 | 1,738 | 8.2% | 1,297 | 6.2% |
| WV | 0.107 | 1,886 | 4.1% | 1,463 | 3.1% |
| WI | 0.152 | 2,333 | 6.3% | 2,426 | 6.4% |

## Table 13. Ozone Season $NO_x$ Emissions (thousand short tons) and Fuel Use (million mmbtu) Estimated in IPM for Units Greater Than or Equal to 25 MW.

| | Ozone Season $NO_x$ Emissions | | | | | Ozone Season Fuel Usage | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| State | Coal-Fired Boilers (thousand tons) | Combined Cycle Turbines (thousand tons) | Simple Cycle CT (thousand tons) | Oil & Gas Boilers (thousand tons) | All Units (thousand tons) | Coal-Fired Boilers (million mmbtu) | Combined Cycle Turbines (million mmbtu) | Simple Cycle CT (million mmbtu) | Oil & Gas Boilers (million mmbtu) | All Units (million mmbtu) |
| AL | 26.193 | 0.615 | 0.030 | | 26.838 | 370.7 | 85.0 | 1.4 | | 457.1 |
| AR | 10.730 | 1.021 | 0.036 | 0.000 | 11.787 | 169.1 | 60.5 | 1.0 | 0.0 | 230.6 |
| CT | 0.894 | 0.292 | 0.017 | 0.000 | 1.203 | 18.3 | 42.4 | 0.6 | 0.0 | 61.3 |
| DE | 1.564 | 0.255 | 0.016 | 0.000 | 1.835 | 25.3 | 11.4 | 0.6 | 0.0 | 37.3 |
| FL | 46.385 | 3.962 | 1.367 | 12.580 | 64.294 | 465.6 | 321.2 | 30.4 | 110.1 | 927.3 |
| GA | 19.583 | 0.344 | 0.128 | 0.000 | 20.055 | 431.9 | 43.0 | 6.2 | 0.0 | 481.2 |
| IL | 23.649 | 0.106 | 0.203 | 0.000 | 23.958 | 485.2 | 8.1 | 7.3 | 0.0 | 500.6 |
| IN | 47.093 | 0.049 | 0.047 | 0.000 | 47.188 | 589.4 | 6.2 | 1.4 | 0.0 | 597.1 |
| KS | 16.200 | | 0.000 | 0.000 | 16.200 | 163.5 | | 0.0 | 0.0 | 163.5 |
| KY | 29.843 | | 0.011 | | 29.855 | 450.2 | | 0.3 | | 450.5 |
| LA | 14.992 | 0.638 | 0.090 | 1.197 | 16.918 | 168.3 | 55.2 | 3.2 | 11.7 | 238.5 |
| MD | 8.217 | 0.016 | 0.095 | 0.000 | 8.328 | 178.3 | 1.1 | 4.0 | 0.0 | 183.4 |
| MI | 27.539 | 0.498 | 0.175 | 0.000 | 28.212 | 352.6 | 16.6 | 5.2 | 0.0 | 374.4 |
| MS | 7.651 | 0.167 | 0.049 | 0.000 | 7.866 | 67.5 | 26.4 | 2.5 | 0.0 | 96.4 |
| NJ | 4.522 | 0.537 | 0.446 | 0.000 | 5.506 | 65.2 | 56.3 | 5.4 | 0.0 | 126.9 |
| NY | 5.759 | 1.168 | 0.641 | 3.946 | 11.514 | 114.1 | 113.2 | 7.4 | 95.6 | 330.3 |
| NC | 25.468 | 0.084 | 0.132 | | 25.684 | 390.7 | 2.4 | 5.3 | | 398.4 |
| OH | 42.052 | 0.110 | 0.145 | | 42.308 | 608.8 | 13.0 | 4.6 | | 626.4 |
| OK | 19.566 | 1.895 | 0.165 | 2.378 | 24.003 | 257.2 | 75.4 | 2.0 | 16.0 | 350.7 |
| PA | 48.089 | 0.310 | 0.074 | 0.000 | 48.474 | 579.1 | 50.5 | 2.4 | 0.0 | 631.9 |
| SC | 14.729 | 0.164 | 0.030 | 0.000 | 14.922 | 211.6 | 14.8 | 1.3 | 0.0 | 227.8 |
| TN | 11.542 | | 0.423 | | 11.965 | 251.4 | | 6.4 | | 257.8 |
| TX | 56.728 | 6.237 | 0.645 | 4.824 | 68.434 | 1,022.3 | 375.3 | 14.2 | 118.7 | 1,530.5 |
| VA | 11.927 | 0.308 | 0.125 | 0.000 | 12.360 | 172.2 | 26.3 | 3.6 | 0.0 | 202.0 |
| WV | 24.235 | | 0.000 | | 24.235 | 429.9 | | 0.0 | | 429.9 |
| WI | 17.104 | 0.027 | 0.152 | 0.000 | 17.283 | 223.8 | 3.7 | 0.6 | 0.0 | 228.1 |

Table 14. State-by-State Ozone Season $NO_x$ Emission Rates Calculated Using the IPM Estimates Presented in Table 13. Also Shown Are the Estimated 95th Percent Confidence $NO_x$ Tonnage and Percentage Values as well as the Alternative Approach $NO_x$ Tonnage and Percentage Values for Ozone Season.

| State | Ozone Season $NO_x$ Emission Rate (lb/mmbtu) | 95% Confidence Level Variability Value (tons) | 95% Confidence Level Variability Value (percentage) | Alternative Approach Value (tons) | Alternative Approach Value (percentage) |
|---|---|---|---|---|---|
| AL | 0.117 | 1,702 | 6.7% | 1,871 | 7.3% |
| AR | 0.102 | 1,292 | 16.7% | 1,116 | 14.4% |
| CT | 0.039 | 203 | 26.1% | 131 | 16.9% |
| DE | 0.098 | 248 | 19.0% | 187 | 14.3% |
| FL | 0.139 | 2,037 | 4.9% | 3,674 | 8.8% |
| GA | 0.083 | 1,945 | 10.6% | 2,159 | 11.8% |
| IL | 0.096 | 1,355 | 6.3% | 994 | 4.5% |
| IN | 0.158 | 1,952 | 4.5% | 1,697 | 3.9% |
| KS | 0.198 | 873 | 5.1% | 721 | 4.1% |
| KY | 0.133 | 2,028 | 7.3% | 900 | 3.2% |
| LA | 0.142 | 1,849 | 18.6% | 1,585 | 16.0% |
| MD | 0.091 | 527 | 9.2% | 451 | 8.0% |
| MI | 0.151 | 2,016 | 8.2% | 1,400 | 5.7% |
| MS | 0.163 | 1,073 | 9.8% | 1,679 | 15.2% |
| NJ | 0.087 | 341 | 10.4% | 466 | 14.2% |
| NY | 0.070 | 741 | 14.3% | 909 | 17.5% |
| NC | 0.129 | 1,443 | 6.7% | 1,166 | 5.4% |
| OH | 0.135 | 2,569 | 6.7% | 1,982 | 5.2% |
| OK | 0.137 | 1,150 | 7.3% | 1,068 | 6.7% |
| PA | 0.153 | 2,747 | 7.1% | 3,293 | 8.5% |
| SC | 0.131 | 1,221 | 9.0% | 915 | 6.7% |
| TN | 0.093 | 1,408 | 11.4% | 1,082 | 8.7% |
| TX | 0.089 | 3,104 | 5.9% | 3,498 | 6.6% |
| VA | 0.122 | 960 | 10.2% | 868 | 9.2% |
| WV | 0.113 | 1,102 | 5.3% | 816 | 3.8% |

**(d) Procedure for identifying a single set of variability parameters (a tonnage and a percentage limit) to uniformly apply to all states in the program.**

From the state-by-state 1-year 95th confidence level tonnage and percentage emission variability values in Tables 10, 12, and 14, EPA identified a single set of variability limits (i.e., a tonnage and a percentage) for each pollutant (i.e., $SO_2$, annual $NO_X$, and ozone season $NO_X$) to apply to all covered states. For this analysis, EPA assumes that, on average, each state is meeting its proposed budget, but is also subject to inherent year-to-year variability in electric power system operations that could lead to short-term increases (or decreases) in emissions up to the variability limits. In identifying a single set of percentage and tonnage variability limits to apply across all states, EPA assumes that for some future year, each state would experience conditions such that it would need to utilize (but not exceed) its 1-year 95% confidence level emissions variability tonnage value . Thus, EPA has identified a set of minimum variability limits (a tonnage and a percentage) that when compared against the 95% confidence level tonnage and percentage values for each state, all states could (and would be required to) meet at least one of the two limits (the tonnage or the percentage).

Preamble section IV.F provides EPA's rationale for identifying a single tonnage and percentage combination to apply to all covered states. Preamble section IV.F also provides EPA's rationale for identifying both a tonnage limit and a percentage limit. As explained in section IV.F, the effect of identifying both a tonnage and percentage is to ensure that each state is allowed adequate inherent variability while minimizing the total amount of emissions allowed; this approach addresses the difficulty that smaller states with fewer units could face if only percentages were used to set the limits (or that larger states with many units could face if only tonnages were used). Most of the details of EPA's approach to determine the 1-year variability limits are provided in section IV.F in the preamble. This TSD presents some additional information.

To identify the 1-year tonnage and percentage limits, EPA looked at a wide range of percentage and tonnage combinations, and chose for further investigation combinations that provided states sufficient variability (based on historic variability) while minimizing the total allowed emissions. For annual $SO_2$ and ozone season $NO_x$, the tonnage limit criteria were examined in 300 ton increments, while the percentage criteria were applied in

2% increments. For annual $NO_X$, the tonnage limit criteria were applied in 500 ton increments, while the percentage criteria were applied in 5% increments. All combinations of these criteria were considered. For each pairing of percentage and tonnage limits, the first step is to determine, based on the estimates of each state's historical variability values, whether any of the states would exceed both of the limits (i.e., both the tonnage and the percentage). If more than four states were not able to meet one of the limits, this number of states was recorded (this can be seen in grayed squares in Tables 15, 16, and 17 for annual $SO_2$, annual $NO_x$ and ozone season $NO_x$, respectively). If four or fewer states were not able to meet one of the limits, the state abbreviations are listed in Tables 15, 16, and 17 (the cells are also grayed). If one of the percentage and tonnage limits could be met by each state (and thereby the combination of limits would be applicable to all states), both limits were applied to the state, and the larger of the two limits was chosen. This would then be the emission variability limit used for that state. The combinations of limits that were applicable (i.e., where the 95% confidence level variability values for all states was below at least one of the two limits) are shown in Tables 15, 16, and 17 by the white shading of cells, while combinations of limits where the 95% confidence level variability value for at least one state exceeds both limits are shown by the gray shading of cells.

The difference between the emission variability limit and the state-specific 95% confidence level emissions variability value (from Tables 10, 12, and 14) for each state was calculated, and, for each percentage and tonnage pairing, the total difference for all states was summed. The total differences for all states for each combination of tonnage and percentage limits can be seen in white cells in Tables 15, 16, and 17 for annual $SO_2$, annual $NO_x$ and ozone season $NO_x$, respectively.[7] In these tables, white cells represent possible combinations of percentage and tonnage limits that could successfully be met by all states included in the proposed rule. The optimal solution (marked in yellow in the table) was one where: (a) all states included in the proposed rule are able to meet at least one of the criteria, and (b) the sum of the total emissions was minimized.

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[7] Similar tables based on the alternative approach (where the max. heat input over the time period was found relative to the average value over the period) are in Appendix A.

Table 15. The Effects of Various Combinations of the Proposed Upper 95% Confidence Level Tonnage and Percentage Variability Limits on Annual EGU $SO_2$ Emissions (See Notes Below).

| | Percentage Limit | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Tonnage Limit** | **2** | **4** | **6** | **8** | **10** | **12** | **14** | **16** | **18** | **20** |
| **1,000** | 24 | 16 | 8 | LA, NJ, | NJ, | NJ, | NJ, | NJ, | NJ, | NJ, |
| **1,300** | 23 | 15 | 8 | LA, NJ, | NJ, | NJ, | NJ, | NJ, | NJ, | NJ, |
| **1,600** | 21 | 14 | 7 | LA, | 121,876 | 165,006 | 208,135 | 251,265 | 294,395 | 337,549 |
| **1,900** | 19 | 13 | 7 | LA, | 123,076 | 166,206 | 209,335 | 252,465 | 295,595 | 338,725 |
| **2,200** | 19 | 13 | 7 | LA, | 124,276 | 167,406 | 210,535 | 253,665 | 296,795 | 339,925 |
| **2,500** | 18 | 12 | 6 | LA, | 125,476 | 168,606 | 211,735 | 254,865 | 297,995 | 341,125 |
| **2,800** | 16 | 10 | 6 | LA, | 126,845 | 169,806 | 212,935 | 256,065 | 299,195 | 342,325 |
| **3,100** | 15 | 9 | 5 | **86,605** | 128,452 | 171,006 | 214,135 | 257,265 | 300,395 | 343,525 |
| **3,400** | 14 | 8 | FL, IA, MO, TN, | 88,897 | 130,252 | 172,449 | 215,335 | 258,465 | 301,595 | 344,725 |
| **3,700** | 12 | 7 | FL, IA, MO, TN, | 91,444 | 132,074 | 174,056 | 216,552 | 259,665 | 302,795 | 345,925 |
| **4,000** | 11 | 6 | IA, MO, TN, | 94,281 | 134,174 | 175,856 | 218,052 | 260,865 | 303,995 | 347,125 |
| **4,300** | 11 | 6 | IA, MO, TN, | 97,417 | 136,565 | 177,656 | 219,661 | 262,156 | 305,195 | 348,325 |
| **4,600** | 10 | 6 | IA, MO, TN, | 100,861 | 139,123 | 179,644 | 221,461 | 263,656 | 306,395 | 349,525 |
| **4,900** | 8 | 5 | IA, MO, TN, | 104,461 | 141,895 | 181,833 | 223,261 | 265,266 | 307,760 | 350,725 |
| **5,200** | 8 | 5 | IA, MO, TN, | 108,304 | 144,895 | 184,233 | 225,113 | 267,066 | 309,260 | 351,925 |
| **5,500** | 6 | AL, IL, MO, TN, | MO, TN, | 112,429 | 148,190 | 186,802 | 227,213 | 268,866 | 310,871 | 353,363 |
| **5,800** | IL, MO, OH, TN, | IL, MO, TN, | MO, TN, | 116,629 | 151,719 | 189,509 | 229,500 | 270,666 | 312,671 | 354,863 |
| **6,100** | MO, OH, TN, | MO, TN, | MO, TN, | 121,187 | 155,319 | 192,509 | 231,900 | 272,683 | 314,471 | 356,476 |
| **6,400** | MO, OH, TN, | MO, TN, | MO, TN, | 125,987 | 159,123 | 195,662 | 234,481 | 274,783 | 316,271 | 358,276 |
| **6,700** | MO, OH, | MO, | MO, | 130,956 | 163,129 | 198,977 | 237,181 | 277,168 | 318,152 | 360,076 |
| **7,000** | MO, | MO, | MO, | 136,056 | 167,329 | 202,577 | 240,122 | 279,568 | 320,252 | 361,876 |
| **7,300** | MO, | MO, | MO, | 141,156 | 171,529 | 206,177 | 243,135 | 282,160 | 322,435 | 363,676 |
| **7,600** | MO, | MO, | MO, | 146,256 | 176,127 | 209,942 | 246,435 | 284,860 | 324,835 | 365,722 |
| **7,900** | MO, | MO, | MO, | 151,511 | 180,927 | 213,842 | 249,836 | 287,736 | 327,235 | 367,822 |
| **8,200** | MO, | MO, | MO, | 156,911 | 185,763 | 218,029 | 253,436 | 290,736 | 329,839 | 370,103 |
| **8,500** | MO, | MO, | MO, | 162,311 | 190,863 | 222,229 | 257,036 | 293,907 | 332,539 | 372,503 |
| **8,800** | MO, | MO, | MO, | 167,980 | 195,963 | 226,429 | 260,762 | 297,207 | 335,349 | 374,903 |
| **9,100** | MO, | MO, | MO, | 173,680 | 201,063 | 231,067 | 264,662 | 300,694 | 338,349 | 377,518 |
| **9,400** | MO, | MO, | MO, | 179,489 | 206,163 | 235,867 | 268,730 | 304,294 | 341,380 | 380,218 |
| **9,700** | MO, | MO, | MO, | 185,696 | 211,282 | 240,667 | 272,930 | 307,894 | 344,680 | 382,963 |
| **10,000** | MO, | MO, | MO, | 191,996 | 216,682 | 245,670 | 277,130 | 311,581 | 347,980 | 385,963 |
| **10,300** | MO, | MO, | MO, | 198,296 | 222,082 | 250,770 | 281,330 | 315,481 | 351,553 | 388,963 |
| **10,600** | 186,027 | 186,027 | 188,625 | 204,596 | 227,482 | 255,870 | 286,007 | 319,430 | 355,153 | 392,152 |
| **10,900** | 194,127 | 194,127 | 195,825 | 210,896 | 233,118 | 260,970 | 290,807 | 323,630 | 358,753 | 395,452 |
| **11,200** | 202,227 | 202,227 | 203,564 | 217,196 | 238,818 | 266,070 | 295,607 | 327,830 | 362,400 | 398,811 |
| **11,500** | 210,327 | 210,327 | 211,364 | 223,801 | 244,518 | 271,170 | 300,477 | 332,030 | 366,300 | 402,411 |
| **11,800** | 218,427 | 218,427 | 219,164 | 230,701 | 250,404 | 276,452 | 305,577 | 336,230 | 370,200 | 406,011 |
| **12,100** | 226,527 | 226,527 | 226,964 | 237,601 | 256,638 | 281,852 | 310,677 | 340,947 | 374,330 | 409,611 |
| **12,400** | 234,627 | 234,627 | 234,764 | 244,501 | 262,938 | 287,252 | 315,777 | 345,747 | 378,530 | 413,219 |
| **12,700** | 242,727 | 242,727 | 242,727 | 251,401 | 269,238 | 292,652 | 320,877 | 350,547 | 382,730 | 417,119 |
| **13,000** | 250,827 | 250,827 | 250,827 | 258,301 | 275,538 | 298,256 | 325,977 | 355,347 | 386,930 | 421,019 |
| **13,300** | 258,927 | 258,927 | 258,927 | 265,201 | 281,838 | 303,956 | 331,077 | 360,384 | 391,130 | 425,031 |
| **13,600** | 267,027 | 267,027 | 267,027 | 272,101 | 288,138 | 309,656 | 336,223 | 365,484 | 395,887 | 429,231 |

*Numbers in white cells represent the sum (across all states) of the differences in emissions between the state-specific 95% confidence level variability values and the state-specific variability limit (in tons); the variability limit selected for each state is the larger of either the percentage limit or the tonnage limit.

** If the cell is grey, it means that there is a state or several states whose state-specific 95% confidence level variability values exceed both the tonnage and percentage limits. The cell either lists the states that could exceed the limits, or lists the number of states.

*** If the cell is yellow, this is the combination tonnage and percentage limits that minimize the sum of the differences between the state-specific 95% confidence level variability values and the state-specific variability limit (in tons).

Table 16. The Effects of Various Combinations of the Proposed Upper 95% Confidence Level Tonnage and Percentage Variability Limits on Annual EGU $NO_x$ Emissions (See Notes Below).

| | Percentage Limit | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Tonnage Limit** | **5** | **10** | **15** | **20** | **25** | **30** | **35** | **40** | **45** | **50** |
| **1,000** | 12 | LA, NY, | LA, | LA, | 224,069 | 280,207 | 336,368 | 392,653 | 448,937 | 505,222 |
| **1,500** | 11 | LA, | LA, | LA, | 225,323 | 281,212 | 337,346 | 393,484 | 449,622 | 505,761 |
| **2,000** | 7 | LA, | LA, | LA, | 227,129 | 282,712 | 338,601 | 394,490 | 450,622 | 506,761 |
| **2,500** | 5 | LA, | LA, | LA, | 229,129 | 284,680 | 340,230 | 395,990 | 451,879 | 507,768 |
| **3,000** | FL, GA, LA, MO, | LA, | LA, | LA, | 231,326 | 286,680 | 342,230 | 397,781 | 453,379 | 509,268 |
| **3,500** | FL, LA, MO, | LA, | LA, | LA, | 234,079 | 288,816 | 344,230 | 399,781 | 455,331 | 510,881 |
| **4,000** | FL, LA, | LA, | LA, | LA, | 237,079 | 291,420 | 346,306 | 401,781 | 457,331 | 512,881 |
| **4,500** | LA, | LA, | LA, | LA, | 240,079 | 294,420 | 348,806 | 403,796 | 459,331 | 514,881 |
| **5,000** | 76,672 | 98,561 | 140,230 | 189,970 | 243,079 | 297,420 | 351,760 | 406,296 | 461,331 | 516,881 |
| **5,500** | 89,877 | 107,933 | 146,230 | 194,258 | 246,302 | 300,420 | 354,760 | 409,101 | 463,786 | 518,881 |
| **6,000** | 103,377 | 117,683 | 152,673 | 199,208 | 250,118 | 303,420 | 357,760 | 412,101 | 466,441 | 521,276 |
| **6,500** | 116,877 | 128,211 | 160,138 | 204,649 | 254,118 | 306,587 | 360,760 | 415,101 | 469,441 | 523,781 |
| **7,000** | 130,377 | 139,211 | 168,266 | 210,514 | 258,666 | 310,267 | 363,760 | 418,101 | 472,441 | 526,781 |
| **7,500** | 143,877 | 150,471 | 177,153 | 216,576 | 263,666 | 314,267 | 366,872 | 421,101 | 475,441 | 529,781 |
| **8,000** | 157,377 | 161,971 | 186,461 | 223,105 | 269,092 | 318,448 | 370,415 | 424,101 | 478,441 | 532,781 |
| **8,500** | 170,877 | 173,748 | 195,961 | 230,420 | 274,798 | 323,123 | 374,415 | 427,157 | 481,441 | 535,781 |
| **9,000** | 184,377 | 186,036 | 205,836 | 238,391 | 280,798 | 328,123 | 378,415 | 430,657 | 484,441 | 538,781 |
| **9,500** | 197,877 | 198,968 | 216,336 | 246,745 | 287,001 | 333,535 | 382,793 | 434,563 | 487,442 | 541,781 |
| **10,000** | 211,377 | 211,968 | 227,128 | 255,745 | 293,537 | 339,083 | 387,581 | 438,563 | 490,942 | 544,781 |
| **10,500** | 224,877 | 224,968 | 238,128 | 264,989 | 300,806 | 345,083 | 392,581 | 442,638 | 494,712 | 547,781 |
| **11,000** | 238,377 | 238,377 | 249,267 | 274,489 | 308,645 | 351,083 | 397,978 | 447,138 | 498,712 | 551,228 |
| **11,500** | 251,877 | 251,877 | 260,767 | 283,989 | 316,692 | 357,426 | 403,478 | 452,039 | 502,712 | 554,860 |
| **12,000** | 265,377 | 265,377 | 272,267 | 293,989 | 325,337 | 363,969 | 409,367 | 457,039 | 506,983 | 558,860 |
| **12,500** | 278,877 | 278,877 | 283,934 | 304,489 | 334,337 | 371,192 | 415,367 | 462,421 | 511,496 | 562,860 |
| **13,000** | 292,377 | 292,377 | 295,934 | 315,045 | 343,517 | 378,898 | 421,367 | 467,921 | 516,496 | 566,860 |
| **13,500** | 305,877 | 305,877 | 308,365 | 326,045 | 353,017 | 386,898 | 427,851 | 473,651 | 521,496 | 571,328 |
| **14,000** | 319,377 | 319,377 | 321,263 | 337,045 | 362,517 | 395,155 | 434,401 | 479,651 | 526,864 | 575,954 |
| **14,500** | 332,877 | 332,877 | 334,263 | 348,064 | 372,017 | 403,929 | 441,578 | 485,651 | 532,364 | 580,954 |
| **15,000** | 346,377 | 346,377 | 347,263 | 359,564 | 382,142 | 412,929 | 449,152 | 491,776 | 537,936 | 585,954 |
| **15,500** | 359,877 | 359,877 | 360,263 | 371,064 | 392,642 | 422,045 | 457,152 | 498,276 | 543,936 | 591,307 |
| **16,000** | 373,377 | 373,377 | 373,377 | 382,564 | 403,142 | 431,545 | 465,152 | 504,833 | 549,936 | 596,807 |
| **16,500** | 386,877 | 386,877 | 386,877 | 394,120 | 413,961 | 441,045 | 473,618 | 511,964 | 555,936 | 602,307 |
| **17,000** | 400,377 | 400,377 | 400,377 | 406,120 | 424,961 | 450,545 | 482,521 | 519,464 | 562,200 | 608,220 |
| **17,500** | 413,877 | 413,877 | 413,877 | 418,194 | 435,961 | 460,127 | 491,521 | 527,405 | 568,700 | 614,220 |
| **18,000** | 427,377 | 427,377 | 427,377 | 430,694 | 446,961 | 470,296 | 500,574 | 535,405 | 575,265 | 620,220 |
| **18,500** | 440,877 | 440,877 | 440,877 | 443,558 | 458,361 | 480,796 | 510,074 | 543,581 | 582,349 | 626,220 |
| **19,000** | 454,377 | 454,377 | 454,377 | 456,558 | 469,861 | 491,296 | 519,574 | 552,113 | 589,849 | 632,625 |
| **19,500** | 467,877 | 467,877 | 467,877 | 469,558 | 481,361 | 501,878 | 529,074 | 561,113 | 597,659 | 639,125 |
| **20,000** | 481,377 | 481,377 | 481,377 | 482,558 | 492,861 | 512,878 | 538,574 | 570,113 | 605,659 | 645,697 |
| **20,500** | 494,877 | 494,877 | 494,877 | 495,558 | 504,361 | 523,878 | 548,252 | 579,113 | 613,659 | 652,735 |
| **21,000** | 508,377 | 508,377 | 508,377 | 508,558 | 516,305 | 534,878 | 558,449 | 588,602 | 622,044 | 660,235 |
| **21,500** | 521,877 | 521,877 | 521,877 | 521,877 | 528,305 | 545,878 | 568,949 | 598,102 | 630,706 | 667,912 |
| **22,000** | 535,377 | 535,377 | 535,377 | 535,377 | 540,523 | 557,158 | 579,449 | 607,602 | 639,706 | 675,912 |

*Numbers in white cells represent the sum (across all states) of the differences in emissions between the state-specific 95% confidence level variability values and the state-specific variability limit (in tons); the variability limit selected for each state is the larger of either the percentage limit or the tonnage limit.

** If the cell is grey, it means that there is a state or several states whose state-specific 95% confidence level variability values exceed both the tonnage and percentage limits. The cell either lists the states that could exceed the limits, or lists the number of states.

*** If the cell is yellow, this is the combination tonnage and percentage limits that minimize the sum of the differences between the state-specific 95% confidence level variability values and the state-specific variability limit (in tons).

Table 17. The Effects of Various Combinations of the Proposed Upper 95% Confidence Level Tonnage and Percentage Variability Limits on Ozone Season EGU $NO_x$ Emissions (See Notes Below).

| | Percentage Limit | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Tonnage Limit** | **0** | **2** | **4** | **6** | **8** | **10** | **12** | **14** | **16** | **18** |
| **800** | 20 | 20 | 20 | 15 | 8 | 5 | AR, LA, | AR, LA, | AR, LA, | LA, |
| **1,100** | 17 | 17 | 17 | 13 | 6 | AR, GA, LA, TN, | AR, LA, | AR, LA, | AR, LA, | LA, |
| **1,400** | 12 | 12 | 12 | 9 | GA, LA, MI, TN, | GA, LA, TN, | LA, | LA, | LA, | LA, |
| **1,700** | 10 | 10 | 10 | 7 | GA, LA, MI, | GA, LA, | LA, | LA, | LA, | LA, |
| **2,000** | 6 | 6 | 6 | KY, MI, OH, PA, | MI, | 27,836 | 35,240 | 43,315 | 51,653 | 60,326 |
| **2,300** | OH, PA, TX, | OH, PA, TX, | OH, PA, TX, | OH, PA, | **27,326** | 32,529 | 39,180 | 46,694 | 54,787 | 63,096 |
| **2,600** | PA, TX, | PA, TX, | PA, TX, | PA, | 33,326 | 37,824 | 43,491 | 50,524 | 58,149 | 66,258 |
| **2,900** | TX, | TX, | TX, | 36,882 | 39,326 | 43,628 | 48,591 | 54,724 | 61,909 | 69,603 |
| **3,200** | 44,115 | 44,115 | 44,115 | 44,115 | 45,528 | 49,628 | 54,086 | 59,554 | 66,069 | 73,320 |
| **3,500** | 51,615 | 51,615 | 51,615 | 51,615 | 52,338 | 55,628 | 59,931 | 64,725 | 70,517 | 77,413 |
| **3,800** | 59,115 | 59,115 | 59,115 | 59,115 | 59,538 | 61,628 | 65,931 | 70,348 | 75,617 | 81,666 |
| **4,100** | 66,615 | 66,615 | 66,615 | 66,615 | 66,738 | 68,081 | 71,931 | 76,234 | 80,910 | 86,580 |
| **4,400** | 74,115 | 74,115 | 74,115 | 74,115 | 74,115 | 74,993 | 77,931 | 82,234 | 86,610 | 91,680 |
| **4,700** | 81,615 | 81,615 | 81,615 | 81,615 | 81,615 | 82,193 | 84,034 | 88,234 | 92,536 | 97,172 |
| **5,000** | 89,115 | 89,115 | 89,115 | 89,115 | 89,115 | 89,393 | 90,645 | 94,234 | 98,536 | 102,872 |
| **5,300** | 96,615 | 96,615 | 96,615 | 96,615 | 96,615 | 96,615 | 97,649 | 100,234 | 104,536 | 108,839 |
| **5,600** | 104,115 | 104,115 | 104,115 | 104,115 | 104,115 | 104,115 | 104,849 | 106,588 | 110,536 | 114,839 |
| **5,900** | 111,615 | 111,615 | 111,615 | 111,615 | 111,615 | 111,615 | 112,049 | 113,267 | 116,536 | 120,839 |
| **6,200** | 119,115 | 119,115 | 119,115 | 119,115 | 119,115 | 119,115 | 119,249 | 120,305 | 122,569 | 126,839 |
| **6,500** | 126,615 | 126,615 | 126,615 | 126,615 | 126,615 | 126,615 | 126,615 | 127,505 | 129,141 | 132,839 |
| **6,800** | 134,115 | 134,115 | 134,115 | 134,115 | 134,115 | 134,115 | 134,115 | 134,705 | 135,889 | 138,839 |
| **7,100** | 141,615 | 141,615 | 141,615 | 141,615 | 141,615 | 141,615 | 141,615 | 141,905 | 142,960 | 145,094 |
| **7,400** | 149,115 | 149,115 | 149,115 | 149,115 | 149,115 | 149,115 | 149,115 | 149,115 | 150,160 | 151,694 |
| **7,700** | 156,615 | 156,615 | 156,615 | 156,615 | 156,615 | 156,615 | 156,615 | 156,615 | 157,360 | 158,510 |
| **8,000** | 164,115 | 164,115 | 164,115 | 164,115 | 164,115 | 164,115 | 164,115 | 164,115 | 164,560 | 165,616 |
| **8,300** | 171,615 | 171,615 | 171,615 | 171,615 | 171,615 | 171,615 | 171,615 | 171,615 | 171,760 | 172,816 |
| **8,600** | 179,115 | 179,115 | 179,115 | 179,115 | 179,115 | 179,115 | 179,115 | 179,115 | 179,115 | 180,016 |
| **8,900** | 186,615 | 186,615 | 186,615 | 186,615 | 186,615 | 186,615 | 186,615 | 186,615 | 186,615 | 187,216 |
| **9,200** | 194,115 | 194,115 | 194,115 | 194,115 | 194,115 | 194,115 | 194,115 | 194,115 | 194,115 | 194,416 |
| **9,500** | 201,615 | 201,615 | 201,615 | 201,615 | 201,615 | 201,615 | 201,615 | 201,615 | 201,615 | 201,616 |
| **9,800** | 209,115 | 209,115 | 209,115 | 209,115 | 209,115 | 209,115 | 209,115 | 209,115 | 209,115 | 209,115 |
| **10,100** | 216,615 | 216,615 | 216,615 | 216,615 | 216,615 | 216,615 | 216,615 | 216,615 | 216,615 | 216,615 |
| **10,400** | 224,115 | 224,115 | 224,115 | 224,115 | 224,115 | 224,115 | 224,115 | 224,115 | 224,115 | 224,115 |
| **10,700** | 231,615 | 231,615 | 231,615 | 231,615 | 231,615 | 231,615 | 231,615 | 231,615 | 231,615 | 231,615 |
| **11,000** | 239,115 | 239,115 | 239,115 | 239,115 | 239,115 | 239,115 | 239,115 | 239,115 | 239,115 | 239,115 |
| **11,300** | 246,615 | 246,615 | 246,615 | 246,615 | 246,615 | 246,615 | 246,615 | 246,615 | 246,615 | 246,615 |
| **11,600** | 254,115 | 254,115 | 254,115 | 254,115 | 254,115 | 254,115 | 254,115 | 254,115 | 254,115 | 254,115 |
| **11,900** | 261,615 | 261,615 | 261,615 | 261,615 | 261,615 | 261,615 | 261,615 | 261,615 | 261,615 | 261,615 |
| **12,200** | 269,115 | 269,115 | 269,115 | 269,115 | 269,115 | 269,115 | 269,115 | 269,115 | 269,115 | 269,115 |
| **12,500** | 276,615 | 276,615 | 276,615 | 276,615 | 276,615 | 276,615 | 276,615 | 276,615 | 276,615 | 276,615 |
| **12,800** | 284,115 | 284,115 | 284,115 | 284,115 | 284,115 | 284,115 | 284,115 | 284,115 | 284,115 | 284,115 |
| **13,100** | 291,615 | 291,615 | 291,615 | 291,615 | 291,615 | 291,615 | 291,615 | 291,615 | 291,615 | 291,615 |
| **13,400** | 299,115 | 299,115 | 299,115 | 299,115 | 299,115 | 299,115 | 299,115 | 299,115 | 299,115 | 299,115 |

*Numbers in white cells represent the sum (across all states) of the differences in emissions between the state-specific 95% confidence level variability values and the state-specific variability limit (in tons); the variability limit selected for each state is the larger of either the percentage limit or the tonnage limit.

** If the cell is grey, it means that there is a state or several states whose state-specific 95% confidence level variability values exceed both the tonnage and percentage limits. The cell either lists the states that could exceed the limits, or lists the number of states.

*** If the cell is yellow, this is the combination tonnage and percentage limits that minimize the sum of the differences between the state-specific 95% confidence level variability values and the state-specific variability limit (in tons).

From the tables above, EPA determined that a number of tonnage and percentage combinations resulted in fairly similar total emissions. For each pollutant, a percentage limit of 10 percent coupled with a tonnage limit specific to the pollutant was a combination amongst those that would result in the lowest total emissions, so EPA chose 10 percent. The tonnage limits for each pollutant, as shown below, were established[8]. The procedure used to identify these tonnage and percentage limits ensures that every state is able to meet at least one of the limits, while minimizing total EGU emissions. The resulting 1-year tonnage and percentage limits (which are also presented in the preamble) are as follows:

- $SO_2$ – 1,700 tons or 10 percent of state's budget
- Annual $NO_X$ – 5,000 tons or 10 percent of state's budget
- Ozone season $NO_X$ – 2,100 tons or 10 percent of state's budget

As described in the preamble, after determining for each pollutant a 1-year tonnage and 1-year percentage limit, EPA assigned each state one of these values – either the tonnage limit or the percentage limit, whichever was greater for that state. In other words, for $SO_2$, every state has a 1-year variability limit of 1,700 tons or 10 percent of the state's $SO_2$ budget, whichever is greater. For annual $NO_X$, every state has 1-year variability limit of 5,000 tons or 10 percent of the state's annual $NO_X$ budget, whichever is greater. And, for ozone season $NO_X$, every state has a 1-year variability limit of 2,100 tons or 10 percent of the state's ozone season $NO_X$ budget, whichever is greater.

For example, Connecticut's annual $SO_2$ budget is 3,059 tons, and 10 percent (the percentage limit for $SO_2$) of 3,059 tons is 306 tons. Because 1,700 tons (the tonnage limit for $SO_2$) is greater than 306 tons, Connecticut's 1-year $SO_2$ variability limit is 1,700 tons. The 1-year variability limits for $SO_2$, annual $NO_X$, and ozone season $NO_X$ emissions for each covered state that result from this approach are presented in section IV.F in the preamble.

As discussed in preamble section IV.F, the EPA also requests comment on an alternative calculation method for determining 1-year variability limits. The alternative

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[8] EPA developed the proposed variability limits in parallel with developing the overall control requirements. As such, while the particular "optimal" 1-year tonnage and percentage limits presented here are close to the optimal values (presented in Tables 15, 16, and 17), they are not exact because during the development of the limits, changes were made in the states covered by the proposed rule. The IPM modeling and CAMx air quality modeling for the proposed rule used these values. As discussed in the preamble, EPA requests comment on the variability limits.

method would use the results of the proposed method but add a "ceiling percentage" equal to the maximum 95% confidence level percentage of variability among all covered states as observed in the historic heat input data described previously. The percentage variability limits for all states are shown in Tables 10, 12, and 14 for annual $SO_2$, annual $NO_x$ and ozone season $NO_x$, respectively. The alternative 1-year variability limits resulting from this calculation method are presented in preamble section IV.F. EPA explained in the preamble its rationale for considering this alternative calculation method.

The ceiling percentages for each pollutant, based on the historic data, are as follows:

- $SO_2$ – 28 percent of state's budget (equal to the value for Connecticut)
- Annual $NO_X$ – 21 percent of state's budget (equal to the value for Louisiana)
- Ozone season $NO_X$ – 27 percent of state's budget (equal to the value for Connecticut)

Under this alternative calculation method, for $SO_2$ emissions, a state's 1-year variability limit would be 1,700 tons as long as 1,700 tons is between 10 and 28 percent of the state's $SO_2$ emissions budget. If 1,700 tons is greater than 28 percent of the state's $SO_2$ budget, then the state's 1-year variability limit is set at 28 percent of the state's $SO_2$ budget. If 1,700 tons is less than 10 percent of the state's $SO_2$ budget, then the state's 1-year variability limit is set at 10 percent of the state's $SO_2$ budget. The alternative calculation method would be applied to determine annual and ozone season $NO_X$ 1-year variability limits in the same manner as for the $SO_2$ limits.

Tables 18, 19, and 20 demonstrate application of this alternative method to determining 1-year variability limits for $SO_2$ emissions, annual $NO_X$ emissions, and ozone season $NO_X$ emissions, respectively. In Table 18, the first column lists the state and the second column lists the state's 2014 $SO_2$ emissions budget. The third column lists, for each state, 10 percent (the percentage limit for $SO_2$) of the state's $SO_2$ budget. The fourth column lists the tonnage limit for $SO_2$ emissions, which is 1,700 tons for all states, as discussed above. The fifth column lists, for each state, 28 percent (the percentage ceiling for $SO_2$) of the state's $SO_2$ budget. And finally, the sixth column lists the state's alternative 1-year variability limit. The columns in Tables 19 and 20 follow the same pattern but for annual $NO_X$ and ozone season $NO_X$ emissions, respectively.

Again, using Connecticut's 1-year $SO_2$ variability limit as an example, Connecticut's annual $SO_2$ budget is 3,059 tons. Ten percent (the percentage limit for $SO_2$) of 3,059 tons is 306 tons. Twenty-eight percent (the percentage ceiling for $SO_2$) of 3,059 tons is 857 tons. Because 1,700 tons (the tonnage limit for $SO_2$) is greater than 857 tons, Connecticut's 1-year $SO_2$ variability limit is set at 857 tons, as shown in Table 18. In contrast, using the proposed approach would result in a 1-year $SO_2$ variability limit of 1,700 tons for Connecticut, as discussed above and in preamble section V.F.

Table 18. Application of Alternative Calculation Method for Determining 1-Year Variability Limits on $SO_2$ Emissions for 2014 and Later.

| State | 2014 $SO_2$ Annual Emissions Budget (tons) | 10 Percent of $SO_2$ Budget (tons) | $SO_2$ Tonnage Limit (tons) | 28 Percent of $SO_2$ Budget (tons) | Alternative 1-Year Limit (tons) |
|---|---|---|---|---|---|
| Alabama | 161,871 | 16,187 | 1,700 | 45,324 | 16,187 |
| Connecticut | 3,059 | 306 | 1,700 | 857 | 857 |
| Delaware | 7,784 | 778 | 1,700 | 2,180 | 1,700 |
| District of Columbia | 337 | 34 | 1,700 | 94 | 94 |
| Florida | 161,739 | 16,174 | 1,700 | 45,287 | 16,174 |
| Georgia | 85,717 | 8,572 | 1,700 | 24,001 | 8,572 |
| Illinois | 151,530 | 15,153 | 1,700 | 42,428 | 15,153 |
| Indiana | 201,412 | 20,141 | 1,700 | 56,395 | 20,141 |
| Iowa | 86,088 | 8,609 | 1,700 | 24,105 | 8,609 |
| Kansas | 57,275 | 5,728 | 1,700 | 16,037 | 5,728 |
| Kentucky | 113,844 | 11,384 | 1,700 | 31,876 | 11,384 |
| Louisiana | 90,477 | 9,048 | 1,700 | 25,334 | 9,048 |
| Maryland | 39,665 | 3,967 | 1,700 | 11,106 | 3,967 |
| Massachusetts | 7,902 | 790 | 1,700 | 2,213 | 1,700 |
| Michigan | 155,675 | 15,568 | 1,700 | 43,589 | 15,568 |
| Minnesota | 47,101 | 4,710 | 1,700 | 13,188 | 4,710 |
| Missouri | 158,764 | 15,876 | 1,700 | 44,454 | 15,876 |
| Nebraska | 71,598 | 7,160 | 1,700 | 20,047 | 7,160 |
| New Jersey | 11,291 | 1,129 | 1,700 | 3,161 | 1,700 |
| New York | 42,041 | 4,204 | 1,700 | 11,771 | 4,204 |
| North Carolina | 81,859 | 8,186 | 1,700 | 22,921 | 8,186 |
| Ohio | 178,307 | 17,831 | 1,700 | 49,926 | 17,831 |
| Pennsylvania | 141,693 | 14,169 | 1,700 | 39,674 | 14,169 |
| South Carolina | 116,483 | 11,648 | 1,700 | 32,615 | 11,648 |
| Tennessee | 100,007 | 10,001 | 1,700 | 28,002 | 10,001 |
| Virginia | 40,785 | 4,079 | 1,700 | 11,420 | 4,079 |
| West Virginia | 119,016 | 11,902 | 1,700 | 33,324 | 11,902 |
| Wisconsin | 66,683 | 6,668 | 1,700 | 18,671 | 6,668 |

Table 19. Application of Alternative Calculation Method for Determining 1-Year Variability Limits on $NO_X$ Annual Emissions for 2014 and Later.

| State | 2014 $NO_X$ Annual Emissions Budget (tons) | 10 Percent of $NO_X$ Annual Budget (tons) | $NO_X$ Annual Tonnage Limit (tons) | 21 Percent of $NO_X$ Annual Budget (tons) | Alternative 1-Year Limit (tons) |
|---|---|---|---|---|---|
| Alabama | 69,169 | 6,917 | 5,000 | 14,525 | 6,917 |
| Connecticut | 2,775 | 278 | 5,000 | 583 | 583 |
| Delaware | 6,206 | 621 | 5,000 | 1,303 | 1,303 |
| District of Columbia | 170 | 17 | 5,000 | 36 | 36 |
| Florida | 120,001 | 12,000 | 5,000 | 25,200 | 12,000 |
| Georgia | 73,801 | 7,380 | 5,000 | 15,498 | 7,380 |
| Illinois | 56,040 | 5,604 | 5,000 | 11,768 | 5,604 |
| Indiana | 115,687 | 11,569 | 5,000 | 24,294 | 11,569 |
| Iowa | 46,068 | 4,607 | 5,000 | 9,674 | 5,000 |
| Kansas | 51,321 | 5,132 | 5,000 | 10,777 | 5,132 |
| Kentucky | 74,117 | 7,412 | 5,000 | 15,565 | 7,412 |
| Louisiana | 43,946 | 4,395 | 5,000 | 9,229 | 5,000 |
| Maryland | 17,044 | 1,704 | 5,000 | 3,579 | 3,579 |
| Massachusetts | 5,960 | 596 | 5,000 | 1,252 | 1,252 |
| Michigan | 64,932 | 6,493 | 5,000 | 13,636 | 6,493 |
| Minnesota | 41,322 | 4,132 | 5,000 | 8,678 | 5,000 |
| Missouri | 57,681 | 5,768 | 5,000 | 12,113 | 5,768 |
| Nebraska | 43,228 | 4,323 | 5,000 | 9,078 | 5,000 |
| New Jersey | 11,826 | 1,183 | 5,000 | 2,483 | 2,483 |
| New York | 23,341 | 2,334 | 5,000 | 4,902 | 4,902 |
| North Carolina | 51,800 | 5,180 | 5,000 | 10,878 | 5,180 |
| Ohio | 97,313 | 9,731 | 5,000 | 20,436 | 9,731 |
| Pennsylvania | 113,903 | 11,390 | 5,000 | 23,920 | 11,390 |
| South Carolina | 33,882 | 3,388 | 5,000 | 7,115 | 5,000 |
| Tennessee | 28,362 | 2,836 | 5,000 | 5,956 | 5,000 |
| Virginia | 29,581 | 2,958 | 5,000 | 6,212 | 5,000 |
| West Virginia | 51,990 | 5,199 | 5,000 | 10,918 | 5,199 |
| Wisconsin | 44,846 | 4,485 | 5,000 | 9,418 | 5,000 |

Table 20. Application of Alternative Calculation Method for Determining 1-Year Variability Limits on $NO_X$ Ozone Season Emissions for 2014 and Later.

| State | 2014 $NO_X$ Ozone Season Emissions Budget (tons) | 10 Percent of $NO_X$ Ozone Season Budget (tons) | $NO_X$ Ozone Season Tonnage Limit (tons) | 27 Percent of $NO_X$ Ozone Season Budget (tons) | Alternative 1-Year Limit (tons) |
|---|---|---|---|---|---|
| Alabama | 29,738 | 2,974 | 2,100 | 8,029 | 2,974 |
| Arkansas | 16,660 | 1,666 | 2,100 | 4,498 | 2,100 |
| Connecticut | 1,315 | 132 | 2,100 | 355 | 355 |
| Delaware | 2,450 | 245 | 2,100 | 662 | 662 |
| District of Columbia | 105 | 11 | 2,100 | 28 | 28 |
| Florida | 56,939 | 5,694 | 2,100 | 15,374 | 5,694 |
| Georgia | 32,144 | 3,214 | 2,100 | 8,679 | 3,214 |
| Illinois | 23,570 | 2,357 | 2,100 | 6,364 | 2,357 |
| Indiana | 49,987 | 4,999 | 2,100 | 13,496 | 4,999 |
| Kansas | 21,433 | 2,143 | 2,100 | 5,787 | 2,143 |
| Kentucky | 30,908 | 3,091 | 2,100 | 8,345 | 3,091 |
| Louisiana | 21,220 | 2,122 | 2,100 | 5,729 | 2,122 |
| Maryland | 7,232 | 723 | 2,100 | 1,953 | 1,953 |
| Michigan | 28,253 | 2,825 | 2,100 | 7,628 | 2,825 |
| Mississippi | 16,530 | 1,653 | 2,100 | 4,463 | 2,100 |
| New Jersey | 5,269 | 527 | 2,100 | 1,423 | 1,423 |
| New York | 11,090 | 1,109 | 2,100 | 2,994 | 2,100 |
| North Carolina | 23,539 | 2,354 | 2,100 | 6,356 | 2,354 |
| Ohio | 40,661 | 4,066 | 2,100 | 10,978 | 4,066 |
| Oklahoma | 37,087 | 3,709 | 2,100 | 10,013 | 3,709 |
| Pennsylvania | 48,271 | 4,827 | 2,100 | 13,033 | 4,827 |
| South Carolina | 15,222 | 1,522 | 2,100 | 4,110 | 2,100 |
| Tennessee | 11,575 | 1,158 | 2,100 | 3,125 | 2,100 |
| Texas | 75,574 | 7,557 | 2,100 | 20,405 | 7,557 |
| Virginia | 12,608 | 1,261 | 2,100 | 3,404 | 2,100 |
| West Virginia | 22,234 | 2,223 | 2,100 | 6,003 | 2,223 |

### 3. Estimating variability over a multi-year time period.

As described in section 2, for each state, EPA estimated the inherent year-to-year (1-year) variability in emissions at the 95% confidence level using the historical year-to-year standard deviation in heat input along with a modeled emission rate. From these values EPA identified a set of variability limits (a percentage and tonnage) and assigned a particular proposed “1-year” variability tonnage limit to each state for each year under the proposed Transport Rule. As described in section IV.F.1 of the preamble, for each state, EPA proposes to also assess the difference between each state’s emissions budget and a 3-year rolling average of its emissions, comparing it against a “3-year” variability limit. This section of the TSD describes the method EPA used to determine each state's 3-year variability limit.

EPA used a standard statistical method to estimate the variability that could be expected (on average) in a 3-year average of a state's yearly emissions, assuming that the emissions for each year are independent of the following year. For this analysis, we assume that, for each state, the year-to-year variability in emissions is described using the 1-year values in section 2 of this TSD.

What is our expectation for how a 3-year average of emissions would compare to the emissions for a single year? We would expect that the emissions for a single year could be higher or lower than the budget. What happens if we begin to average the emissions from multiple years? We would expect that we would average some years that are higher than the budget with some years that are lower than budget. The resulting average would be relatively close to the budget. Some variation from the budget value is expected, though, when multiple 3-year time periods are examined. How variable could we expect the 3-year average to be relative to the variability for a single year? The answer to these questions can be estimated with the standard deviation of the annual emissions (i.e., the year-to-year variability) and the number of years that are being averaged together (using some standard statistics equations along with some basic assumptions about normality and independence of the yearly emission values).

The average variability of a multi-year-average is the average variability of a single year divided by the square root of the number of years in the multi-year average.[9] Thus, the variability of a 3-year average is equal to the annual variability divided by the square root of three. EPA used this approach to determine 3-year variability limits based on the 1-year limits.

Most general introductory statistics textbooks state the general equation, and some describe a basic derivation. Derivation of the equation is found in those textbooks and the statistics literature. However, a rudimentary outline of some of the principles is described here. Usually, the problem is cast as combining the variances for either three different random samples of a variable, or alternatively, averaging three independent "variables"

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[9] Moore, David S. and George P. McCabe. Introduction to the Practice of Statistics. 2nd ed. New York: W.H. Freeman and Company, 1993. p.395.

(where each year in the three sequential years that are going to be averaged together would be a different "variable"). For this example, we will describe three independent yearly "variables" of the emissions. These yearly variables are called $Y_1$, $Y_2$, and $Y_3$. Each of these yearly variables could assume a particular emissions value for a particular year. It is assumed that the individual realized yearly values are uncorrelated and independent from each other, that their average and variability can be described with a normal distribution classified by a mean value (i.e., the budget value) and a standard deviation (i.e., the year-to-year standard deviation). For explanatory purposes, it will first be assumed without loss of generality that the distributions of hourly emissions values from year-to-year is identical (i.e., the "within-year" variation is the same) and that all three years have the same mean value and expected variation.

The expected variance of the average of the three years of emissions can be estimated. If the years are assumed to be uncorrelated, and random samples are drawn independently from each of the year-specific distributions, the variance in the resulting estimate of the sample mean can be written as follows[10]:

$$Var(\overline{X}) = \frac{1}{3^2}(\sigma_{Y_1}^2 + \sigma_{Y_2}^2 + \sigma_{Y_3}^2)$$

where,

Var ( $\overline{X}$ ) = the variance of the mean of yearly emission values from each of three independent years, $Y_i$, where i =1 to 3;

$\overline{X} = (1/3) * (X_1 + X_2 + X_3)$

$\sigma_{Y_i}^2$ = the year-specific variance of three independent years, $Y_i$, where i = 1 to 3

If the variance from each of the three years is equal (as would be the case if the state budget is not changing over the three-year time period), the variance in the sample mean can be reduced to the following equation, $\sigma^2/n$ (where n, is the number of years in the average and is equal to 3). This form of the equation is used by EPA in the proposed approach to calculate the 3-year variance in the sample mean from the year-to-year variance.

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[10] http://en.wikipedia.org/wiki/Variance

Applying these equations on a state-by-state basis using the state-specific 1-year emission variability limits and the mean values (the state emissions budgets), EPA calculated the 3-year variability limits that are presented in section IV.F in the preamble. These limits are the 1-year limits divided by the square root of three. The 3-year limits can be derived from the state-specific standard deviations and 95% confidence level variability values. The method for identifying a set of limits is identical (where all the values have been divided by the square root of 3). The results are identical (except all values are divided by the square root of three). Consequently, EPA elected to simply divide the proposed 1-year limits by the square root of three.

Similarly, EPA applied the equations above to define variability for the 2-year variability limits presented as an alternative in preamble section IV.F. These limits are the 1-year limits divided by the square root of two (since we are interested in the variance of just two years, rather than three). As discussed in the preamble, the 2-year variability limits would be applied for the 15 $SO_2$ group 1 states, i.e., the more stringent $SO_2$ tier, if EPA were to finalize an alternative remedy that uses variability limits for the years 2012 and 2013 (the Transport Rule's first phase).

As discussed in the preamble, EPA also considered, instead of 2-year average limits for the 15 $SO_2$ group 1 states in 2012 and 2013, 3-year average limits for these states starting in 2014 (for Phase 1). EPA considered the alternative of 3-year average limits starting in 2014 for these states because this is the approach EPA would apply to $SO_2$ group 2 states (and all states for $NO_X$ emissions) in the event EPA were to finalize a remedy that uses variability limits in the first phase. The group 1 states have different $SO_2$ budgets in 2012 and 2013 than in 2014 and beyond.

The equations described above can be applied to determine 3-year average limits for the case of the group 1 states whose $SO_2$ emission budgets change in 2014, in other words the situation where the mean value and the standard deviation changes in the third year. As an illustrative example, consider a state with emission budgets of 1000, 1000, and 700 thousand tons of $SO_2$ in 2012, 2013, and 2014, respectively. The 1-year 95th percent upper confidence variability limit for this state is 10% of its yearly budgets (or, 100, 100, and 70 for each of the three years). The 1-year standard deviation variability for each year is the 95th percent upper confidence variability limit divided by 1.960. The values are 51, 51, and 35.7 thousand tons for each of the three years, respectively. For a 3-year limit in 2014, the situation is a little complicated because the expected mean value for the three years is changing (because the base budgets are not constant for the three-year time period). First, the calculation of the 3-year variance uses the equation described above (for Var ( $\overline{X}$ )). In this case, the year-specific variances, $\sigma_{Y_i}^2$ , are not identical. Putting the values into the equation, the expected variance of the 3-year average is

$$\text{Var}\,(\overline{X}) = (1/3)^2*(51^2+51^2+35.7^2) = 6481.7/3^2 = 720.2.$$

Thus, the standard deviation is the square root of the variance, or 26.8 thousand tons. The 95% confidence level is 1.960 multiplied by the standard deviation (26.8) which equals 52.6 thousand tons of $SO_2$. Thus, this is the variability that we would expect from the "average" value for the three years (2012, 2013, and 2014). An estimate of the mean value for the three years, $\overline{X}$ , is simply the mean of the budgets for the three years, which is calculated as: $\overline{X}$=(1/3)*(1000+1000+700)=2700/3=900 thousand tons of $SO_2$.

EPA calculated the 3-year average of the 95th percent confidence level limits for 2014 for the group 1 states using these equations and compared these to the 2-year average of the 95th percent confidence level limits that are presented in the preamble. These 3-year and 2-year limits are shown in Table 21. As discussed in the preamble, EPA believes that the 2-year average limit approach is reasonable (and preferable if the alternative approach is chosen where variability limits are applied during the first phase). EPA's proposed remedy does not use variability limits during the first phase (2012 and 2013), however, as explained in the preamble, EPA is also taking comment on an alternative approach that would use variability limits in Phase 1. The 2-year average limits presented in the preamble and shown in Table 21 are calculated based on the Phase 1 $SO_2$ emissions budgets and are intended for use in 2013. In contrast, the alternative 3-year average limits shown in Table 21, while intended to limit $SO_2$ emissions in Phase 1, are impacted (reduced) by the tighter Phase 2 $SO_2$ budgets that apply to these states starting in 2014. If it is ultimately decided to use variability limits in Phase 1, EPA believes it is more appropriate to base the multi-year average limits for Phase 1 on the stringency of the Phase

1 emissions budgets, not the stringency of the Phase 2 budgets, thus it is preferable to use the 2-year limits.

Table 21. Phase 1 Variability Limits for $SO_2$ Group 1 States: Comparison of 2-Year Average to Alternative 3-Year Average Limits of the 95th Percent Confidence Level.

| **$SO_2$ Group 1 State** | **$SO_2$ Annual Emissions Budgets (tons)** | | **Phase 1 Multi-Year Variability Limits (tons)** | |
|---|---|---|---|---|
| | **2012** | **2014** | **2-Year Limits*** | **3-Year Limits**** |
| Georgia | 233,260 | 85,717 | 16,494 | 11,361 |
| Illinois | 208,957 | 151,530 | 14,775 | 11,070 |
| Indiana | 400,378 | 201,412 | 28,311 | 20,033 |
| Iowa | 94,052 | 86,088 | 6,651 | 5,281 |
| Kentucky | 219,549 | 113,844 | 15,524 | 11,023 |
| Michigan | 251,337 | 155,675 | 17,772 | 12,935 |
| Missouri | 203,689 | 158,764 | 14,403 | 10,964 |
| New York | 66,542 | 42,041 | 4,705 | 3,436 |
| North Carolina | 111,485 | 81,859 | 7,883 | 5,922 |
| Ohio | 464,964 | 178,307 | 32,878 | 22,710 |
| Pennsylvania | 388,612 | 141,693 | 27,479 | 18,918 |
| Tennessee | 100,007 | 100,007 | 7,072 | 5,774 |
| Virginia | 72,595 | 40,785 | 5,133 | 3,682 |
| West Virginia | 205,422 | 119,016 | 14,526 | 10,465 |
| Wisconsin | 96,439 | 66,683 | 6,819 | 5,060 |

* 2-year average limits on 2012-2013 emissions for $SO_2$ group 1 states for the alternative where variability limits would be used in the first phase (as presented in preamble section IV.F).

** Alternative approach of 3-year average limits on 2012-2014 emissions for $SO_2$ group 1 states for the alternative where variability limits would be used in the first phase.

### 4. Results of an analysis done using the air quality assessment tool

The objective of this section is to estimate the possible effects on air quality of the variability in emissions. This analysis was done using the air quality assessment tool, or AQAT, and uses state-by-state emissions to estimate downwind state-by-state air quality contributions at various nonattainment and maintenance monitors (See the Analysis for Significant Contribution TSD for details on the construction and use of the AQAT as well as the estimated downwind air quality concentrations resulting from the proposed remedy). See preamble section IV.C and the Air Quality Modeling TSD for a list of the nonattainment and maintenance monitors.

For this analysis, EPA varied the $SO_2$ emissions of each upwind state included in the proposed Transport Rule[11] around the proposed budgets, simulating the effects of variation in emissions resulting from the proposed allowed variability under the variability limits, and estimated the resulting variability in air quality (daily $PM_{2.5}$ concentrations). This analysis focused on variability in emissions related to the daily $PM_{2.5}$ concentrations for several reasons. First, the number of monitors classified as nonattainment and/or maintenance was larger than for the other standards. Second, generally, sites required larger emissions reductions and larger relative air quality improvements (under the daily $PM_{2.5}$ NAAQS, compared with the annual $PM_{2.5}$ NAAQS). Lastly, the $SO_2$ emissions reductions from EGUs relative to total $SO_2$ emissions for daily $PM_{2.5}$ standard is proportionally larger than $NO_x$ emissions reductions from EGUs relative to total $NO_x$ emissions. Consequently, the variability in estimated daily $PM_{2.5}$ concentrations relative to variation in $SO_2$ emissions is larger than variability in estimated ozone concentrations relative to variation in $NO_x$ emissions.

Two approaches were taken to estimate the variation in downwind air quality at each monitor for daily $PM_{2.5}$ allowed under the Transport Rule in 2014 due to the inherent variability in $SO_2$ emissions. Each of these approaches will be described, in turn, in the following paragraphs. To summarize the two approaches: The first approach examined the 1-year variability effects on daily $PM_{2.5}$ concentration when variations in emissions

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[11] The states included in this analysis were Alabama, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia, and Wisconsin.

from different states are independent from each other. This is intended to represent "typical" random variations in emissions and the resulting typical variations in air quality that might be seen under the Transport Rule. The second approach examined the "worst" case 1-year scenario for each monitor, when the upwind states with the largest impacts per ton emit at the upper end of the variability limit, while upwind states with the lowest impacts per ton emit below their budgets. This is intended to estimate an upper bound for the effects of emissions variability on air quality. For both approaches, the effects of the inherent variation in emissions on daily $PM_{2.5}$ concentrations were estimated to be small.

For the first approach, the $SO_2$ emissions for each state included in the proposed control region were allowed to randomly vary around the level of the budgets. That is, by chance, one state may increase its emissions, while another state may decrease its emissions. This random variation is intended to represent the inherent "random" variations in heat input (and emissions) that were characterized in section 2. As with the analysis in section 2, variations were assumed to be "normally" distributed and characterized by a standard deviation equal to 5.1% of the state's budget. This standard deviation is derived from the two-tailed 95% confidence level 1-year variability limit (equal to 10% of a state's budget for many states). (Note that this process did not account for the fact that the proposed 1-year variability limits for some of the smaller states are larger than 10% of the budgets.) This process also did not account for banking due to early reductions. The reader should keep in mind that for this approach, when the state-by-state variations in emissions are assessed across all states included in the proposed Transport Rule region, the emissions from states that emit over their budgets largely cancel out with emissions from states that emit below their budgets, with the result that total region-wide emissions are relatively constant.

As described in section 2b of this TSD when determining the state-by-state year-to-year variability in emissions, we assume, on a state-by-state basis that: (1) from year-to-year, the differences between the budget and modeled emissions are "normally" distributed; (2) the yearly emissions are independent from each other and are independent from the emissions of any other state; and, (3) the distribution of hourly emissions values is the same from year to year (i.e., the "within-year" variance is the same each year).

Consequently, for a particular downwind monitor, it is possible to estimate the 1-year variance in air quality concentration as a function of the variance in emissions for each of the upwind states. Specifically, the variance in air quality concentration at the downwind monitor due to a particular upwind state would equal the square of the product of the air quality impact per ton of emissions multiplied by the standard deviation of the variation in emissions. The total variance in air quality impact at the downwind monitor is the sum of the variances resulting from each individual upwind state. The square root of this value is the estimated variability in air quality impact (in $\mu g/m^3$).

For an individual monitor, the air quality impact per ton of emissions can be estimated using the daily $PM_{2.5}$ 2012 base case air quality sulfate contributions from the CAMx source-apportionment modeling results and the 2012 base case emissions inventory also used in the modeling (see the Air Quality Modeling TSD and section IV.C of the preamble for details on both of these data sets). For each individual upwind state contributing to a particular monitor, the estimated impact per ton of sulfate is the air quality contribution of sulfate from that state to the particular monitor, divided by the state's total 2012 base case emission inventory of $SO_2$. The standard deviation in emissions (in tons) for each state can be found by multiplying the proposed 2014 state budget by 0.1 (10%) and dividing by 1.960 (to convert the variability limit in emissions at the 95% confidence level back to the standard deviation level). The state-by-state $SO_2$ budgets in 2014 (and the budgets multiplied by 0.1) can be found in Table 18.

For each combination of upwind state and downwind monitor, the impact per ton is then multiplied by the standard deviation of emissions (in tons). This product is then squared, becoming the variance. The variances from states that were modeled in IPM as well as in the CAMx source-apportionment air quality modeling, but were not included in the proposed remedy, were assumed to be equal to zero (i.e., they were assumed to have no variability in their emissions).

For a downwind monitor, the total 1-year variance in air quality contribution was found by adding the variances from all states together. This was done for all states (including the state containing the monitor) as well as, separately, for just upwind states (where the state containing the monitor was excluded). Following this, the square root of the total variance was taken, resulting in the standard deviation of the variability in air quality. The standard deviation of the total variance from all states as well as just from upwind states can be found in Table 22. These standard deviation values represent the year-to-year (1-year) variability in air quality impact ($\mu g/m^3$) that we would expect to see, on average, at each monitor location due to the year-to-year variability in emissions (Table 22). The estimated variations in air quality are quite small (a fraction of a percent) relative to the 2012 base case design values. The locations in Table 22 are in order of decreasing 2012 base case average design value.

To assess more unusual variations in air quality air quality (i.e., those that, on average, will occur with a lower probability), we calculated the two-tailed 95% confidence level 1-year variability in air quality ($\mu g/m^3$) by multiplying the standard deviations in air quality by 1.960. The resulting 95% confidence variability values can be found in Table 22. Assessed across all monitoring locations, the average and maximum estimated 95% confidence level variability values are 0.14 $\mu g/m^3$ and 0.26 $\mu g/m^3$, respectively. When just variability due to the upwind states is examined, the average and maximum 95% confidence level variability values are 0.10 $\mu g/m^3$ and 0.22 $\mu g/m^3$, respectively. All of the values (the standard deviation values and the 95% confidence level values in Table 22) are usually substantially smaller than the differences between the average and maximum design values (with the maximum still less than 1% of the level of the NAAQS standard). Assessed across all the daily $PM_{2.5}$ monitors shown in Table 22, the average difference between the 2012 base case average and maximum design values is 1.4 $\mu g/m^3$. Recall that, from section 3 of this TSD, that a 3-year variability is less than the 1-year variability. Since the design values are found on a 3-year rolling basis, we expect that the variability in the 1-year values used to create the 3-year design values would be substantially larger than is seen based on the difference between the maximum and average design values. Consequently, we expect the year-to-year differences between the average design value and a yearly value to be substantially larger than 1.4 $\mu g/m^3$.

In conclusion, we found that, even while allowing each state's emissions to randomly vary up to 10% of its budget (the 2-tailed 95% confidence variability level prescribed for many states in the Transport Rule), the combined downwind air quality impacts were essentially negligible.

In the second approach, EPA examined the "worst" case scenario for each monitor location. This approach is intended to simulate a situation where all of the states in the region surrounding a monitor increase their $SO_2$ emissions to the maximum amount possible (the 1-year variability limit for each state), while states far away make all of the emissions reductions to compensate. In this scenario, the covered upwind states with the largest air quality impacts per ton of emissions were modeled to <u>increase</u> their $SO_2$ emissions up to their proposed 2014 $SO_2$ budget variability limit (Table 18). The upwind states with the lowest air quality impacts per ton of emissions were modeled to <u>reduce</u> their emissions by the number of tons equal to the variability limit (Table 18). This was done such that the total emissions (i.e., the sum of the budgets with variability changes) remained exactly at the total emissions level for the proposed region (i.e., the sum of all the state budgets). In other words, for this approach, on a monitor-by-monitor basis, emissions increases in the upwind states that have the largest air quality impacts per ton are paired with equivalent emissions decreases in states that are having the lowest air quality impacts per ton. A result of this approach is that overall regional emissions do not change at all from the sum of the budgets.

The state containing the monitor was included in this analysis (unless the state was not included in the proposed Transport Rule region). For the "middle" state (i.e., the state whose impact per ton value was such that the total emissions from states with higher impacts per ton equaled the total emissions from states with lower impacts per ton), the emissions were set at an intermediate level. States that were not included in the proposed Transport Rule region had their variability in emissions set to zero. The results of this analysis, seen in Table 22 in the "worst" case columns, show the cumulative air quality impact from all states and from just the upwind states. The average values were 0.30 $\mu g/m^3$ for all states, and 0.20 $\mu g/m^3$ for just the upwind states, while the maximum values were 0.66 $\mu g/m^3$ and 0.35 $\mu g/m^3$, respectively. Again, the air quality impacts, while larger than for the random variability approaches, are still substantially less than the difference between the average and maximum design values. These results suggest that even under a "worst case" scenario, where nearby states minimize reductions in emissions, while states far away maximize reduction, the resulting increases in air quality are small relative to other factors (i.e., weather).

Collectively, by assessing these two approaches, it appears that the magnitude of the variability in air quality resulting from the proposed levels of variability in emissions is likely to be smaller than other factors impacting air quality. These results suggest that the estimated variations in air quality resulting from the small variations in emissions (even under "worst-case" scenarios) are not substantial. The variations are much smaller than documented year-to-year variability in air quality (as measured at the monitors and expressed as the difference between the average and maximum design values). Consequently, allowing variation in emissions under the proposed variability limits in the Transport Rule, while allowing flexibility for the power sector to address inherent fluctuations in electric generation, does not overly affect air quality.

Table 22. Using AQAT, the Estimates of the Effects of Variability in Emissions of $SO_2$ (Using the Proposed Budgets) on Downwind Sulfate Concentrations ($\mu g/m^3$) in 2014 are Shown for Each Downwind Monitor for Daily PM2.5. The 2012 Base Case Average and Maximum Design Values as well as the Estimated Standard Deviation, the 95% Confidence Level, and the Worst Case Variability Estimates Are Shown.

| **Monitor Identification Number** | **Receptor State** | **Receptor County** | **2012 Base Case Average DV** ($\mu g/m^3$) | **2012 Base Case Maximum DV** ($\mu g/m^3$) | **Difference Between Average and Maximum 2012 Base DVs** ($\mu g/m^3$) | **Standard Deviation (All States)** | **Standard Deviation (Upwind States)** | **95% Confidence Level (All States)** | **95% Confidence Level (Upwind States)** | **Worst Case (All States)** | **Worst Case (Upwind States)** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 420030064 | Pennsylvania | Allegheny | 58.8 | 62.3 | 3.5 | 0.047 | 0.038 | 0.092 | 0.074 | 0.195 | 0.141 |
| 261630033 | Michigan | Wayne | 42.1 | 42.6 | 0.5 | 0.104 | 0.043 | 0.205 | 0.085 | 0.345 | 0.159 |
| 390350038 | Ohio | Cuyahoga | 41.2 | 44.0 | 2.8 | 0.086 | 0.048 | 0.168 | 0.094 | 0.342 | 0.202 |
| 420030093 | Pennsylvania | Allegheny | 41.1 | 46.2 | 5.1 | 0.060 | 0.052 | 0.117 | 0.102 | 0.253 | 0.196 |
| 170311016 | Illinois | Cook | 41.0 | 44.1 | 3.1 | 0.050 | 0.039 | 0.098 | 0.076 | 0.218 | 0.156 |
| 261630016 | Michigan | Wayne | 40.6 | 43.0 | 2.4 | 0.093 | 0.033 | 0.182 | 0.065 | 0.307 | 0.138 |
| 180970043 | Indiana | Marion | 40.5 | 42.0 | 1.5 | 0.126 | 0.057 | 0.248 | 0.112 | 0.458 | 0.237 |
| 390170003 | Ohio | Butler | 40.3 | 42.3 | 2.0 | 0.109 | 0.089 | 0.214 | 0.174 | 0.472 | 0.348 |
| 180970066 | Indiana | Marion | 40.3 | 41.8 | 1.5 | 0.132 | 0.058 | 0.258 | 0.113 | 0.480 | 0.247 |
| 420210011 | Pennsylvania | Cambria | 40.3 | 40.7 | 0.4 | 0.102 | 0.055 | 0.200 | 0.107 | 0.389 | 0.220 |
| 180970081 | Indiana | Marion | 40.1 | 41.1 | 1.0 | 0.117 | 0.054 | 0.228 | 0.106 | 0.425 | 0.223 |
| 010730023 | Alabama | Jefferson | 40.0 | 40.7 | 0.7 | 0.132 | 0.020 | 0.259 | 0.040 | 0.324 | 0.068 |
| 171191007 | Illinois | Madison | 40.0 | 40.6 | 0.6 | 0.067 | 0.055 | 0.132 | 0.108 | 0.282 | 0.208 |
| 540090011 | West Virginia | Brooke | 39.9 | 40.8 | 0.9 | 0.050 | 0.047 | 0.097 | 0.091 | 0.219 | 0.187 |
| 390618001 | Ohio | Hamilton | 39.6 | 40.3 | 0.7 | 0.071 | 0.051 | 0.140 | 0.100 | 0.286 | 0.188 |
| 390350060 | Ohio | Cuyahoga | 39.4 | 42.8 | 3.4 | 0.072 | 0.034 | 0.142 | 0.066 | 0.266 | 0.140 |
| 171190023 | Illinois | Madison | 39.4 | 40.2 | 0.8 | 0.105 | 0.084 | 0.206 | 0.164 | 0.422 | 0.298 |
| 180970083 | Indiana | Marion | 39.0 | 39.3 | 0.3 | 0.132 | 0.059 | 0.259 | 0.115 | 0.485 | 0.253 |
| 550790043 | Wisconsin | Milwaukee | 38.8 | 39.7 | 0.9 | 0.070 | 0.060 | 0.137 | 0.117 | 0.318 | 0.248 |
| 180970078 | Indiana | Marion | 38.7 | 39.7 | 1.0 | 0.126 | 0.057 | 0.246 | 0.111 | 0.455 | 0.236 |
| 261630019 | Michigan | Wayne | 38.6 | 39.1 | 0.5 | 0.063 | 0.032 | 0.124 | 0.062 | 0.235 | 0.128 |
| 170310052 | Illinois | Cook | 38.5 | 39.7 | 1.2 | 0.049 | 0.033 | 0.096 | 0.064 | 0.196 | 0.125 |
| 261630015 | Michigan | Wayne | 38.5 | 39.1 | 0.6 | 0.105 | 0.050 | 0.206 | 0.098 | 0.365 | 0.184 |
| 390170017 | Ohio | Butler | 38.5 | 38.5 | 0.0 | 0.090 | 0.073 | 0.176 | 0.144 | 0.390 | 0.287 |
| 261470005 | Michigan | St. Clair | 38.4 | 39.4 | 1.0 | 0.059 | 0.035 | 0.115 | 0.068 | 0.233 | 0.141 |
| 170313301 | Illinois | Cook | 38.2 | 41.0 | 2.8 | 0.059 | 0.043 | 0.115 | 0.084 | 0.252 | 0.173 |
| 340172002 | New Jersey | Hudson | 38.2 | 38.2 | 0.0 | 0.035 | 0.030 | 0.069 | 0.059 | 0.186 | 0.132 |
| 180190006 | Indiana | Clark | 38.1 | 40.2 | 2.1 | 0.081 | 0.055 | 0.159 | 0.107 | 0.341 | 0.223 |
| 261610008 | Michigan | Washtenaw | 38.1 | 39.8 | 1.7 | 0.067 | 0.046 | 0.130 | 0.090 | 0.261 | 0.166 |
| 010732003 | Alabama | Jefferson | 38.1 | 38.9 | 0.8 | 0.083 | 0.017 | 0.163 | 0.034 | 0.226 | 0.066 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 170313103 | Illinois | Cook | 38.1 | 38.7 | 0.6 | 0.046 | 0.028 | 0.090 | 0.055 | 0.189 | 0.118 |
| 420031008 | Pennsylvania | Allegheny | 38.0 | 39.3 | 1.3 | 0.070 | 0.058 | 0.137 | 0.114 | 0.291 | 0.215 |
| 390610006 | Ohio | Hamilton | 38.0 | 38.0 | 0.0 | 0.091 | 0.074 | 0.179 | 0.146 | 0.385 | 0.281 |
| 261250001 | Michigan | Oakland | 37.9 | 38.4 | 0.5 | 0.082 | 0.052 | 0.160 | 0.102 | 0.325 | 0.201 |
| 390171004 | Ohio | Butler | 37.8 | 38.6 | 0.8 | 0.089 | 0.071 | 0.175 | 0.139 | 0.381 | 0.274 |
| 420710007 | Pennsylvania | Lancaster | 37.7 | 40.1 | 2.4 | 0.033 | 0.012 | 0.066 | 0.024 | 0.135 | 0.074 |
| 420070014 | Pennsylvania | Beaver | 37.7 | 39.1 | 1.4 | 0.057 | 0.051 | 0.111 | 0.100 | 0.242 | 0.195 |
| 550790010 | Wisconsin | Milwaukee | 37.7 | 39.0 | 1.3 | 0.049 | 0.037 | 0.095 | 0.072 | 0.241 | 0.178 |
| 390617001 | Ohio | Hamilton | 37.7 | 38.1 | 0.4 | 0.085 | 0.064 | 0.166 | 0.126 | 0.367 | 0.259 |
| 390610014 | Ohio | Hamilton | 37.5 | 38.5 | 1.0 | 0.081 | 0.059 | 0.159 | 0.116 | 0.330 | 0.221 |
| 390170016 | Ohio | Butler | 37.5 | 37.8 | 0.3 | 0.086 | 0.075 | 0.169 | 0.146 | 0.378 | 0.293 |
| 170316005 | Illinois | Cook | 37.4 | 39.8 | 2.4 | 0.048 | 0.031 | 0.094 | 0.060 | 0.193 | 0.121 |
| 180890022 | Indiana | Lake | 37.3 | 42.1 | 4.8 | 0.058 | 0.028 | 0.114 | 0.054 | 0.218 | 0.117 |
| 180970079 | Indiana | Marion | 37.2 | 38.3 | 1.1 | 0.119 | 0.061 | 0.234 | 0.119 | 0.456 | 0.255 |
| 171192009 | Illinois | Madison | 37.2 | 38.2 | 1.0 | 0.095 | 0.076 | 0.186 | 0.149 | 0.388 | 0.278 |
| 390610042 | Ohio | Hamilton | 37.2 | 38.0 | 0.8 | 0.083 | 0.058 | 0.163 | 0.113 | 0.342 | 0.225 |
| 360610056 | New York | New York | 37.1 | 38.0 | 0.9 | 0.040 | 0.016 | 0.078 | 0.032 | 0.167 | 0.096 |
| 420030116 | Pennsylvania | Allegheny | 37.1 | 37.1 | 0.0 | 0.060 | 0.051 | 0.117 | 0.100 | 0.259 | 0.198 |
| 261150005 | Michigan | Monroe | 37.0 | 38.0 | 1.0 | 0.074 | 0.063 | 0.145 | 0.123 | 0.321 | 0.243 |
| 210590005 | Kentucky | Daviess | 37.0 | 37.0 | 0.0 | 0.133 | 0.110 | 0.260 | 0.215 | 0.494 | 0.347 |
| 550790099 | Wisconsin | Milwaukee | 36.8 | 37.7 | 0.9 | 0.053 | 0.044 | 0.104 | 0.086 | 0.260 | 0.201 |
| 191630019 | Iowa | Scott | 36.8 | 36.8 | 0.0 | 0.083 | 0.073 | 0.162 | 0.143 | 0.407 | 0.330 |
| 340390004 | New Jersey | Union | 36.7 | 37.2 | 0.5 | 0.030 | 0.026 | 0.059 | 0.050 | 0.173 | 0.127 |
| 420031301 | Pennsylvania | Allegheny | 36.6 | 38.6 | 2.0 | 0.062 | 0.052 | 0.121 | 0.101 | 0.266 | 0.199 |
| 471251009 | Tennessee | Montgomery | 36.6 | 37.9 | 1.3 | 0.068 | 0.058 | 0.133 | 0.113 | 0.320 | 0.249 |
| 390490024 | Ohio | Franklin | 36.6 | 37.6 | 1.0 | 0.064 | 0.040 | 0.126 | 0.078 | 0.267 | 0.168 |
| 390811001 | Ohio | Jefferson | 36.5 | 39.9 | 3.4 | 0.065 | 0.043 | 0.126 | 0.084 | 0.261 | 0.166 |
| 390350065 | Ohio | Cuyahoga | 36.5 | 38.9 | 2.4 | 0.072 | 0.035 | 0.142 | 0.070 | 0.274 | 0.151 |
| 180372001 | Indiana | Dubois | 36.5 | 38.0 | 1.5 | 0.102 | 0.055 | 0.200 | 0.109 | 0.380 | 0.212 |
| 171193007 | Illinois | Madison | 36.5 | 37.3 | 0.8 | 0.103 | 0.083 | 0.202 | 0.163 | 0.420 | 0.300 |
| 295100087 | Missouri | St. Louis City | 36.4 | 36.9 | 0.5 | 0.097 | 0.071 | 0.191 | 0.139 | 0.395 | 0.264 |
| 550790026 | Wisconsin | Milwaukee | 36.3 | 40.1 | 3.8 | 0.046 | 0.036 | 0.091 | 0.071 | 0.226 | 0.170 |
| 180890026 | Indiana | Lake | 36.3 | 39.3 | 3.0 | 0.051 | 0.036 | 0.101 | 0.070 | 0.218 | 0.145 |
| 391130032 | Ohio | Montgomery | 36.3 | 38.5 | 2.2 | 0.090 | 0.068 | 0.177 | 0.134 | 0.393 | 0.277 |
| 245100040 | Maryland | Baltimore (City) | 36.3 | 38.3 | 2.0 | 0.068 | 0.013 | 0.133 | 0.026 | 0.187 | 0.057 |
| 170310076 | Illinois | Cook | 36.3 | 37.3 | 1.0 | 0.066 | 0.051 | 0.130 | 0.099 | 0.278 | 0.195 |
| 180970042 | Indiana | Marion | 36.3 | 37.2 | 0.9 | 0.129 | 0.060 | 0.252 | 0.118 | 0.480 | 0.257 |
| 261630036 | Michigan | Wayne | 36.3 | 36.9 | 0.6 | 0.069 | 0.042 | 0.136 | 0.083 | 0.256 | 0.149 |
| 360610128 | New York | New York | 36.2 | 38.0 | 1.8 | 0.042 | 0.032 | 0.083 | 0.062 | 0.221 | 0.167 |
| 390490025 | Ohio | Franklin | 36.1 | 36.4 | 0.3 | 0.062 | 0.039 | 0.122 | 0.077 | 0.253 | 0.157 |
| 390350045 | Ohio | Cuyahoga | 36.0 | 39.0 | 3.0 | 0.078 | 0.040 | 0.153 | 0.078 | 0.302 | 0.170 |
| 211110044 | Kentucky | Jefferson | 36.0 | 36.5 | 0.5 | 0.094 | 0.076 | 0.184 | 0.149 | 0.359 | 0.252 |
| 390610043 | Ohio | Hamilton | 36.0 | 36.4 | 0.4 | 0.091 | 0.078 | 0.179 | 0.154 | 0.395 | 0.304 |
| 295100007 | Missouri | St. Louis City | 36.0 | 36.3 | 0.3 | 0.133 | 0.075 | 0.261 | 0.147 | 0.497 | 0.282 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 421330008 | Pennsylvania | York | 35.9 | 38.8 | 2.9 | 0.058 | 0.025 | 0.113 | 0.049 | 0.215 | 0.113 |
| 181570008 | Indiana | Tippecanoe | 35.9 | 36.9 | 1.0 | 0.080 | 0.050 | 0.156 | 0.099 | 0.345 | 0.225 |
| 180830004 | Indiana | Knox | 35.9 | 36.5 | 0.6 | 0.093 | 0.049 | 0.182 | 0.096 | 0.355 | 0.200 |
| 420030008 | Pennsylvania | Allegheny | 35.9 | 36.3 | 0.4 | 0.052 | 0.042 | 0.102 | 0.081 | 0.217 | 0.155 |
| 360050080 | New York | Bronx | 35.9 | 36.2 | 0.3 | 0.041 | 0.023 | 0.081 | 0.045 | 0.201 | 0.133 |
| 390610040 | Ohio | Hamilton | 35.8 | 36.8 | 1.0 | 0.084 | 0.065 | 0.166 | 0.128 | 0.377 | 0.272 |
| 211110043 | Kentucky | Jefferson | 35.8 | 36.4 | 0.6 | 0.101 | 0.087 | 0.197 | 0.170 | 0.382 | 0.282 |
| 420430401 | Pennsylvania | Dauphin | 35.7 | 37.1 | 1.4 | 0.038 | 0.017 | 0.074 | 0.034 | 0.160 | 0.095 |
| 170310057 | Illinois | Cook | 35.7 | 37.0 | 1.3 | 0.050 | 0.032 | 0.097 | 0.063 | 0.210 | 0.136 |
| 090091123 | Connecticut | New Haven | 35.7 | 36.6 | 0.9 | 0.031 | 0.030 | 0.060 | 0.059 | 0.223 | 0.162 |
| 290990012 | Missouri | Jefferson | 35.7 | 36.5 | 0.8 | 0.122 | 0.074 | 0.239 | 0.144 | 0.474 | 0.284 |
| 340171003 | New Jersey | Hudson | 35.7 | 36.1 | 0.4 | 0.038 | 0.029 | 0.075 | 0.057 | 0.217 | 0.143 |
| 170312001 | Illinois | Cook | 35.6 | 38.2 | 2.6 | 0.064 | 0.059 | 0.125 | 0.116 | 0.258 | 0.211 |
| 391530017 | Ohio | Summit | 35.6 | 37.2 | 1.6 | 0.069 | 0.040 | 0.135 | 0.078 | 0.274 | 0.164 |
| 211110048 | Kentucky | Jefferson | 35.6 | 36.4 | 0.8 | 0.084 | 0.068 | 0.165 | 0.134 | 0.331 | 0.234 |
| 291831002 | Missouri | Saint Charles | 35.5 | 37.1 | 1.6 | 0.107 | 0.072 | 0.209 | 0.141 | 0.435 | 0.281 |
| 245100049 | Maryland | Baltimore (City) | 35.5 | 35.5 | 0.0 | 0.066 | 0.013 | 0.130 | 0.025 | 0.180 | 0.052 |
| 261630001 | Michigan | Wayne | 35.4 | 37.8 | 2.4 | 0.085 | 0.056 | 0.166 | 0.111 | 0.345 | 0.221 |
| 360610062 | New York | New York | 35.3 | 37.0 | 1.7 | 0.033 | 0.025 | 0.064 | 0.050 | 0.180 | 0.140 |
| 420410101 | Pennsylvania | Cumberland | 35.3 | 37.0 | 1.7 | 0.033 | 0.018 | 0.065 | 0.035 | 0.142 | 0.087 |
| 390810017 | Ohio | Jefferson | 35.3 | 36.8 | 1.5 | 0.062 | 0.042 | 0.121 | 0.082 | 0.256 | 0.167 |
| 171630010 | Illinois | Saint Clair | 35.3 | 35.9 | 0.6 | 0.099 | 0.080 | 0.195 | 0.157 | 0.402 | 0.288 |
| 295100085 | Missouri | St. Louis City | 35.3 | 35.7 | 0.4 | 0.128 | 0.073 | 0.251 | 0.143 | 0.484 | 0.278 |
| 181670023 | Indiana | Vigo | 35.1 | 36.5 | 1.4 | 0.099 | 0.048 | 0.195 | 0.093 | 0.384 | 0.212 |
| 550250047 | Wisconsin | Dane | 35.1 | 36.1 | 1.0 | 0.056 | 0.040 | 0.109 | 0.078 | 0.254 | 0.179 |
| 471650007 | Tennessee | Sumner | 35.1 | 36.0 | 0.9 | 0.081 | 0.067 | 0.159 | 0.131 | 0.376 | 0.285 |
| 171971002 | Illinois | Will | 35.1 | 35.8 | 0.7 | 0.052 | 0.040 | 0.101 | 0.079 | 0.222 | 0.158 |
| 210290006 | Kentucky | Bullitt | 35.0 | 36.3 | 1.3 | 0.090 | 0.073 | 0.176 | 0.143 | 0.377 | 0.273 |
| 170310022 | Illinois | Cook | 34.9 | 36.6 | 1.7 | 0.070 | 0.069 | 0.138 | 0.134 | 0.214 | 0.184 |
| 551330027 | Wisconsin | Waukesha | 34.9 | 35.6 | 0.7 | 0.048 | 0.042 | 0.094 | 0.081 | 0.225 | 0.178 |
| 550790059 | Wisconsin | Milwaukee | 34.8 | 36.3 | 1.5 | 0.056 | 0.047 | 0.111 | 0.093 | 0.261 | 0.202 |
| 245100035 | Maryland | Baltimore (City) | 34.7 | 35.5 | 0.8 | 0.065 | 0.012 | 0.127 | 0.023 | 0.171 | 0.046 |
| 390350027 | Ohio | Cuyahoga | 34.5 | 36.6 | 2.1 | 0.065 | 0.027 | 0.128 | 0.053 | 0.231 | 0.115 |
| 191390015 | Iowa | Muscatine | 34.5 | 36.0 | 1.5 | 0.038 | 0.026 | 0.074 | 0.050 | 0.158 | 0.104 |
| 211451004 | Kentucky | McCracken | 34.4 | 36.8 | 2.4 | 0.087 | 0.079 | 0.171 | 0.155 | 0.362 | 0.289 |
| 420030095 | Pennsylvania | Allegheny | 34.3 | 36.6 | 2.3 | 0.052 | 0.043 | 0.102 | 0.083 | 0.223 | 0.165 |
| 180431004 | Indiana | Floyd | 34.3 | 35.7 | 1.4 | 0.097 | 0.062 | 0.191 | 0.121 | 0.388 | 0.240 |
| 391130031 | Ohio | Montgomery | 34.3 | 35.6 | 1.3 | 0.065 | 0.048 | 0.127 | 0.094 | 0.275 | 0.189 |
| 391351001 | Ohio | Preble | 34.3 | 35.5 | 1.2 | 0.087 | 0.073 | 0.170 | 0.143 | 0.376 | 0.284 |
| 390950024 | Ohio | Lucas | 34.2 | 36.5 | 2.3 | 0.058 | 0.047 | 0.113 | 0.093 | 0.240 | 0.176 |
| 360610079 | New York | New York | 34.2 | 36.4 | 2.2 | 0.050 | 0.027 | 0.099 | 0.054 | 0.244 | 0.161 |
| 390990014 | Ohio | Mahoning | 34.2 | 35.8 | 1.6 | 0.053 | 0.030 | 0.103 | 0.059 | 0.211 | 0.127 |
| 170310050 | Illinois | Cook | 34.1 | 35.8 | 1.7 | 0.063 | 0.055 | 0.123 | 0.108 | 0.273 | 0.214 |

|  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 110010041 | District Of Columbia | District Of Columbia | 34.0 | 35.6 | 1.6 | 0.043 | 0.043 | 0.085 | 0.085 | 0.655 | 0.193 |
| 540090005 | West Virginia | Brooke | 33.9 | 36.1 | 2.2 | 0.055 | 0.049 | 0.107 | 0.096 | 0.226 | 0.178 |
| 391550007 | Ohio | Trumbull | 33.9 | 35.6 | 1.7 | 0.051 | 0.033 | 0.100 | 0.064 | 0.217 | 0.141 |
| 421255001 | Pennsylvania | Washington | 33.9 | 35.5 | 1.6 | 0.071 | 0.068 | 0.139 | 0.132 | 0.288 | 0.245 |
| 420033007 | Pennsylvania | Allegheny | 33.8 | 38.5 | 4.7 | 0.066 | 0.056 | 0.130 | 0.109 | 0.281 | 0.210 |
| 240031003 | Maryland | Anne Arundel | 33.8 | 36.7 | 2.9 | 0.057 | 0.027 | 0.112 | 0.053 | 0.225 | 0.126 |
| 180390003 | Indiana | Elkhart | 33.8 | 35.6 | 1.8 | 0.056 | 0.030 | 0.110 | 0.059 | 0.197 | 0.104 |
| 212270007 | Kentucky | Warren | 33.7 | 36.3 | 2.6 | 0.086 | 0.079 | 0.169 | 0.154 | 0.385 | 0.315 |
| 390350034 | Ohio | Cuyahoga | 33.7 | 35.7 | 2.0 | 0.061 | 0.036 | 0.120 | 0.070 | 0.246 | 0.149 |
| 170314007 | Illinois | Cook | 33.6 | 35.7 | 2.1 | 0.065 | 0.047 | 0.128 | 0.093 | 0.268 | 0.180 |
| 390950026 | Ohio | Lucas | 33.6 | 35.6 | 2.0 | 0.068 | 0.050 | 0.134 | 0.098 | 0.299 | 0.208 |
| 110010042 | District Of Columbia | District Of Columbia | 33.0 | 35.6 | 2.6 | 0.034 | 0.034 | 0.067 | 0.067 | 0.606 | 0.159 |

# Appendix A:

# Alternative Method for Identifying 1-Year Tonnage and Percentage Limits

## Table A-1. The Effects of Various Combinations of the Alternative Method Tonnage and Percentage Variability Limits on Annual EGU $SO_2$ Emissions (See Notes Below).

| | Percentage Limit | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Tonnage Limit** | **2** | **4** | **6** | **8** | **10** | **12** | **14** | **16** | **18** | **20** |
| **1,000** | 22 | 12 | 7 | 7 | NJ, VA, | NJ, VA, | NJ, | NJ, | 302,343 | 345,824 |
| **1,300** | 21 | 11 | 6 | 6 | VA, | VA, | 216,599 | 259,662 | 302,879 | 346,236 |
| **1,600** | 20 | 11 | 6 | 6 | VA, | VA, | 217,799 | 260,853 | 303,907 | 346,997 |
| **1,900** | 20 | 11 | 6 | 6 | VA, | VA, | 218,999 | 262,053 | 305,107 | 348,162 |
| **2,200** | 19 | 11 | 6 | 6 | VA, | VA, | 220,199 | 263,253 | 306,307 | 349,362 |
| **2,500** | 18 | 10 | 5 | 5 | VA, | VA, | 221,399 | 264,453 | 307,507 | 350,562 |
| **2,800** | 17 | 9 | 5 | 5 | VA, | VA, | 222,599 | 265,653 | 308,707 | 351,762 |
| **3,100** | 15 | 7 | 5 | 5 | VA, | VA, | 223,799 | 266,853 | 309,907 | 352,962 |
| **3,400** | 12 | 5 | GA, IA, NY, VA, | GA, IA, NY, VA, | VA, | VA, | 224,999 | 268,053 | 311,107 | 354,162 |
| **3,700** | 10 | GA, IA, TN, VA, | GA, IA, VA, | GA, IA, VA, | VA, | VA, | 226,199 | 269,253 | 312,307 | 355,362 |
| **4,000** | 8 | GA, IA, TN, VA, | GA, IA, VA, | GA, IA, VA, | VA, | VA, | 227,671 | 270,453 | 313,507 | 356,562 |
| **4,300** | 8 | GA, IA, TN, VA, | GA, IA, VA, | GA, IA, VA, | VA, | VA, | 229,308 | 271,692 | 314,707 | 357,762 |
| **4,600** | 7 | GA, IA, TN, VA, | GA, IA, VA, | GA, IA, VA, | VA, | VA, | 231,108 | 273,192 | 315,907 | 358,962 |
| **4,900** | 6 | GA, IA, TN, VA, | GA, IA, VA, | GA, IA, VA, | VA, | VA, | 232,908 | 274,835 | 317,214 | 360,162 |
| **5,200** | GA, IA, MI, VA, | GA, IA, VA, | GA, IA, VA, | GA, IA, VA, | VA, | VA, | 234,708 | 276,635 | 318,714 | 361,362 |
| **5,500** | GA, IA, MI, VA, | GA, IA, VA, | GA, IA, VA, | GA, IA, VA, | VA, | VA, | 236,797 | 278,435 | 320,362 | 362,736 |
| **5,800** | GA, IA, MI, VA, | GA, IA, VA, | GA, IA, VA, | GA, IA, VA, | VA, | VA, | 239,191 | 280,235 | 322,162 | 364,236 |
| **6,100** | GA, IA, | GA, IA, | GA, IA, | GA, IA, | 165,234 | 202,313 | 241,591 | 282,179 | 323,962 | 365,889 |
| **6,400** | GA, | GA, | GA, | GA, | 169,134 | 205,498 | 244,151 | 284,387 | 325,762 | 367,689 |
| **6,700** | 90,919 | 93,882 | 112,952 | 140,982 | 173,038 | 208,821 | 246,862 | 286,787 | 327,562 | 369,489 |
| **7,000** | 99,019 | 100,931 | 118,652 | 146,082 | 177,238 | 212,421 | 249,862 | 289,187 | 329,662 | 371,289 |
| **7,300** | 107,119 | 108,222 | 124,781 | 151,182 | 181,438 | 216,021 | 252,911 | 291,755 | 331,983 | 373,089 |
| **7,600** | 115,219 | 116,022 | 131,081 | 156,282 | 186,077 | 219,916 | 256,211 | 294,455 | 334,383 | 375,044 |
| **7,900** | 123,319 | 123,822 | 137,381 | 161,502 | 190,877 | 223,816 | 259,621 | 297,411 | 336,783 | 377,179 |
| **8,200** | 131,419 | 131,622 | 143,681 | 166,902 | 195,748 | 227,881 | 263,221 | 300,411 | 339,360 | 379,579 |
| **8,500** | 139,519 | 139,519 | 150,163 | 172,363 | 200,848 | 232,081 | 266,821 | 303,624 | 342,060 | 381,979 |
| **8,800** | 147,619 | 147,619 | 157,063 | 178,063 | 205,948 | 236,281 | 270,699 | 306,924 | 344,960 | 384,379 |
| **9,100** | 155,719 | 155,719 | 163,963 | 183,763 | 211,048 | 240,968 | 274,599 | 310,421 | 347,960 | 386,964 |
| **9,400** | 163,819 | 163,819 | 170,863 | 189,466 | 216,148 | 245,768 | 278,525 | 314,021 | 351,037 | 389,664 |
| **9,700** | 171,919 | 171,919 | 177,763 | 195,668 | 221,248 | 250,568 | 282,725 | 317,621 | 354,337 | 392,509 |
| **10,000** | 180,019 | 180,019 | 184,663 | 201,968 | 226,623 | 255,614 | 286,925 | 321,482 | 357,637 | 395,509 |
| **10,300** | 188,119 | 188,119 | 191,586 | 208,268 | 232,023 | 260,714 | 291,157 | 325,382 | 361,221 | 398,509 |
| **10,600** | 196,219 | 196,219 | 198,786 | 214,568 | 237,474 | 265,814 | 295,859 | 329,282 | 364,821 | 401,750 |
| **10,900** | 204,319 | 204,319 | 206,024 | 220,868 | 243,174 | 270,914 | 300,659 | 333,369 | 368,421 | 405,050 |
| **11,200** | 212,419 | 212,419 | 213,824 | 227,228 | 248,874 | 276,014 | 305,459 | 337,569 | 372,265 | 408,422 |
| **11,500** | 220,519 | 220,519 | 221,624 | 234,045 | 254,574 | 281,114 | 310,380 | 341,769 | 376,165 | 412,022 |
| **11,800** | 228,619 | 228,619 | 229,424 | 240,945 | 260,328 | 286,343 | 315,480 | 346,034 | 380,065 | 415,622 |
| **12,100** | 236,719 | 236,719 | 237,224 | 247,845 | 266,555 | 291,743 | 320,580 | 350,751 | 384,012 | 419,222 |
| **12,400** | 244,819 | 244,819 | 245,024 | 254,745 | 272,855 | 297,143 | 325,680 | 355,551 | 388,212 | 423,048 |
| **12,700** | 252,919 | 252,919 | 252,919 | 261,645 | 279,155 | 302,585 | 330,780 | 360,351 | 392,412 | 426,948 |
| **13,000** | 261,019 | 261,019 | 261,019 | 268,545 | 285,455 | 308,285 | 335,880 | 365,151 | 396,612 | 430,848 |
| **13,300** | 269,119 | 269,119 | 269,119 | 275,445 | 291,755 | 313,985 | 340,980 | 370,245 | 400,911 | 434,748 |
| **13,600** | 277,219 | 277,219 | 277,219 | 282,345 | 298,055 | 319,685 | 346,080 | 375,345 | 405,642 | 438,856 |

*Numbers in white cells represent the sum (across all states) of the differences in emissions between the state-specific “alternative approach” variability values and the state-specific variability limit (in tons); the variability limit selected for each state is the larger of either the percentage limit or the tonnage limit.

** If the cell is grey, it means that there is a state or there are several states whose “alternative approach” level variability values exceed both the tonnage and percentage limits. The cell either lists the states that could exceed the limits, or lists the number of states.

*** If the cell is yellow, this is the combination tonnage and percentage limits that minimizes the sum of the differences between the state-specific “alternative approach” variability values and the state-specific variability limit (in tons).

## Table A-2. The Effects of Various Combinations of the Alternative Method Tonnage and Percentage Variability Limits on Annual EGU $NO_x$ Emissions (See Notes Below).

| | **Percentage Limit** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Tonnage Limit** | **5** | **10** | **15** | **20** | **25** | **30** | **35** | **40** | **45** | **50** |
| **1,000** | 13 | GA, LA, NY, | NY, | 160,818 | 216,772 | 272,730 | 328,701 | 384,804 | 440,907 | 497,010 |
| **1,500** | 12 | GA, LA, NY, | NY, | 162,461 | 218,027 | 273,737 | 329,688 | 385,646 | 441,604 | 497,562 |
| **2,000** | 9 | GA, LA, | 109,477 | 164,461 | 219,830 | 275,237 | 330,946 | 386,655 | 442,604 | 498,562 |
| **2,500** | 6 | GA, LA, | 112,477 | 166,710 | 221,830 | 277,200 | 332,570 | 388,155 | 443,864 | 499,573 |
| **3,000** | 5 | GA, | 115,477 | 169,642 | 224,017 | 279,200 | 334,570 | 389,939 | 445,364 | 501,073 |
| **3,500** | 5 | GA, | 118,916 | 172,642 | 226,807 | 281,324 | 336,570 | 391,939 | 447,309 | 502,678 |
| **4,000** | FL, GA, IA, PA, | GA, | 123,005 | 175,642 | 229,807 | 283,972 | 338,631 | 393,939 | 449,309 | 504,678 |
| **4,500** | FL, GA, PA, | GA, | 127,840 | 178,957 | 232,807 | 286,972 | 341,137 | 395,939 | 451,309 | 506,678 |
| **5,000** | FL, PA, | 91,796 | 133,376 | 182,894 | 235,807 | 289,972 | 344,137 | 398,438 | 453,309 | 508,678 |
| **5,500** | FL, PA, | 101,282 | 139,376 | 187,180 | 239,076 | 292,972 | 347,137 | 401,303 | 455,745 | 510,678 |
| **6,000** | FL, PA, | 111,184 | 145,758 | 192,125 | 242,872 | 295,972 | 350,137 | 404,303 | 458,468 | 513,052 |
| **6,500** | FL, | 121,708 | 153,315 | 197,600 | 246,872 | 299,195 | 353,137 | 407,303 | 461,468 | 515,633 |
| **7,000** | FL, | 132,708 | 161,315 | 203,507 | 251,411 | 302,850 | 356,137 | 410,303 | 464,468 | 518,633 |
| **7,500** | FL, | 143,875 | 170,203 | 209,507 | 256,411 | 306,850 | 359,313 | 413,303 | 467,468 | 521,633 |
| **8,000** | 150,982 | 155,375 | 179,682 | 216,017 | 261,879 | 311,029 | 362,828 | 416,303 | 470,468 | 524,633 |
| **8,500** | 164,482 | 167,069 | 189,182 | 223,463 | 267,639 | 315,697 | 366,828 | 419,432 | 473,468 | 527,633 |
| **9,000** | 177,982 | 179,199 | 199,284 | 231,426 | 273,639 | 320,697 | 370,828 | 422,932 | 476,468 | 530,633 |
| **9,500** | 191,482 | 192,199 | 209,784 | 239,610 | 279,708 | 326,159 | 375,203 | 426,806 | 479,551 | 533,633 |
| **10,000** | 204,982 | 205,199 | 220,571 | 248,610 | 286,276 | 331,770 | 379,983 | 430,806 | 483,051 | 536,633 |
| **10,500** | 218,482 | 218,482 | 231,571 | 258,082 | 293,708 | 337,770 | 384,983 | 434,878 | 486,784 | 539,670 |
| **11,000** | 231,982 | 231,982 | 242,572 | 267,582 | 301,536 | 343,770 | 390,438 | 439,378 | 490,784 | 543,170 |
| **11,500** | 245,482 | 245,482 | 254,072 | 277,197 | 309,536 | 349,953 | 395,938 | 444,269 | 494,784 | 546,762 |
| **12,000** | 258,982 | 258,982 | 265,572 | 287,385 | 318,018 | 356,535 | 401,901 | 449,269 | 499,052 | 550,762 |
| **12,500** | 272,482 | 272,482 | 277,112 | 297,885 | 327,018 | 363,954 | 407,901 | 454,718 | 503,555 | 554,762 |
| **13,000** | 285,982 | 285,982 | 289,112 | 308,433 | 336,482 | 371,647 | 413,901 | 460,218 | 508,555 | 558,762 |
| **13,500** | 299,482 | 299,482 | 301,308 | 319,433 | 345,982 | 379,647 | 420,198 | 466,033 | 513,555 | 563,227 |
| **14,000** | 312,982 | 312,982 | 314,308 | 330,433 | 355,482 | 387,647 | 426,794 | 472,033 | 518,997 | 567,841 |
| **14,500** | 326,482 | 326,482 | 327,308 | 341,433 | 365,250 | 396,425 | 434,199 | 478,033 | 524,497 | 572,841 |
| **15,000** | 339,982 | 339,982 | 340,308 | 352,769 | 375,486 | 405,425 | 441,758 | 484,033 | 530,164 | 577,841 |
| **15,500** | 353,482 | 353,482 | 353,482 | 364,269 | 385,986 | 414,883 | 449,758 | 490,443 | 536,164 | 583,277 |
| **16,000** | 366,982 | 366,982 | 366,982 | 375,769 | 396,486 | 424,383 | 457,758 | 497,052 | 542,164 | 588,777 |
| **16,500** | 380,482 | 380,482 | 380,482 | 387,269 | 407,296 | 433,883 | 465,910 | 504,444 | 548,164 | 594,295 |
| **17,000** | 393,982 | 393,982 | 393,982 | 399,156 | 418,296 | 443,383 | 474,832 | 511,944 | 554,188 | 600,295 |
| **17,500** | 407,482 | 407,482 | 407,482 | 411,156 | 429,296 | 453,304 | 483,832 | 519,869 | 560,688 | 606,295 |
| **18,000** | 420,982 | 420,982 | 420,982 | 423,416 | 440,296 | 463,586 | 493,283 | 527,869 | 567,311 | 612,295 |
| **18,500** | 434,482 | 434,482 | 434,482 | 436,416 | 451,465 | 474,086 | 502,783 | 535,869 | 574,689 | 618,295 |
| **19,000** | 447,982 | 447,982 | 447,982 | 449,416 | 462,965 | 484,586 | 512,283 | 544,239 | 582,189 | 624,433 |
| **19,500** | 461,482 | 461,482 | 461,482 | 462,416 | 474,465 | 495,159 | 521,783 | 553,239 | 589,980 | 630,933 |
| **20,000** | 474,982 | 474,982 | 474,982 | 475,416 | 485,965 | 506,159 | 531,358 | 562,239 | 597,980 | 637,570 |
| **20,500** | 488,482 | 488,482 | 488,482 | 488,482 | 497,465 | 517,159 | 541,358 | 571,683 | 605,980 | 644,935 |
| **21,000** | 501,982 | 501,982 | 501,982 | 501,982 | 509,199 | 528,159 | 551,687 | 581,183 | 613,980 | 652,435 |
| **21,500** | 515,482 | 515,482 | 515,482 | 515,482 | 521,199 | 539,159 | 562,187 | 590,683 | 622,646 | 660,091 |
| **22,000** | 528,982 | 528,982 | 528,982 | 528,982 | 533,199 | 550,162 | 572,687 | 600,183 | 631,646 | 668,091 |

*Numbers in white cells represent the sum (across all states) of the differences in emissions between the state-specific “alternative approach” variability values and the state-specific variability limit (in tons); the variability limit selected for each state is the larger of either the percentage limit or the tonnage limit.

** If the cell is grey, it means that there is a state or there are several states whose “alternative approach” level variability values exceed both the tonnage and percentage limits. The cell either lists the states that could exceed the limits, or lists the number of states.

*** If the cell is yellow, this is the combination tonnage and percentage limits that minimizes the sum of the differences between the state-specific “alternative approach” variability values and the state-specific variability limit (in tons).

Table A-3. The Effects of Various Combinations of the Alternative Method Tonnage and Percentage Variability Limits on Ozone Season EGU $NO_x$ Emissions (See Notes Below).

| | Percentage Limit | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Tonnage Limit** | **0** | **2** | **4** | **6** | **8** | **10** | **12** | **14** | **16** | **18** |
| **800** | 20 | 20 | 17 | 13 | 9 | 5 | AR, LA, MS, NY, | AR, LA, MS, NY, | LA, NY, | 55,182 |
| **1,100** | 12 | 12 | 11 | 8 | 6 | AR, GA, LA, MS, | AR, LA, MS, | AR, LA, MS, | LA, | 56,328 |
| **1,400** | 9 | 9 | 8 | 7 | 5 | GA, LA, MS, | LA, MS, | LA, MS, | LA, | 57,832 |
| **1,700** | 6 | 6 | 6 | 5 | FL, GA, PA, | GA, | 33,340 | 41,805 | 50,605 | 59,639 |
| **2,000** | FL, GA, PA, TX, | FL, GA, PA, TX, | FL, GA, PA, TX, | FL, GA, PA, TX, | FL, GA, PA, | GA, | 36,727 | 44,851 | 53,249 | 61,971 |
| **2,300** | FL, PA, TX, | FL, PA, TX, | FL, PA, TX, | FL, PA, TX, | FL, PA, | 33,911 | 40,645 | 48,219 | 56,362 | 64,733 |
| **2,600** | FL, PA, TX, | FL, PA, TX, | FL, PA, TX, | FL, PA, TX, | FL, PA, | 39,183 | 44,923 | 52,023 | 59,711 | 67,872 |
| **2,900** | FL, PA, TX, | FL, PA, TX, | FL, PA, TX, | FL, PA, TX, | FL, PA, | 44,982 | 49,998 | 56,223 | 63,421 | 71,203 |
| **3,200** | FL, PA, TX, | FL, PA, TX, | FL, PA, TX, | FL, PA, TX, | FL, PA, | 50,982 | 55,464 | 60,985 | 67,602 | 74,865 |
| **3,500** | FL, | FL, | FL, | FL, | FL, | 56,982 | 61,304 | 66,146 | 71,973 | 78,980 |
| **3,800** | 60,374 | 60,374 | 60,374 | 60,374 | 60,812 | 62,982 | 67,304 | 71,746 | 77,072 | 83,180 |
| **4,100** | 67,874 | 67,874 | 67,874 | 67,874 | 68,012 | 69,455 | 73,304 | 77,625 | 82,342 | 88,059 |
| **4,400** | 75,374 | 75,374 | 75,374 | 75,374 | 75,374 | 76,272 | 79,304 | 83,625 | 88,027 | 93,159 |
| **4,700** | 82,874 | 82,874 | 82,874 | 82,874 | 82,874 | 83,471 | 85,431 | 89,625 | 93,947 | 98,609 |
| **5,000** | 90,374 | 90,374 | 90,374 | 90,374 | 90,374 | 90,671 | 92,031 | 95,625 | 99,947 | 104,309 |
| **5,300** | 97,874 | 97,874 | 97,874 | 97,874 | 97,874 | 97,874 | 98,930 | 101,625 | 105,947 | 110,269 |
| **5,600** | 105,374 | 105,374 | 105,374 | 105,374 | 105,374 | 105,374 | 106,130 | 108,007 | 111,947 | 116,269 |
| **5,900** | 112,874 | 112,874 | 112,874 | 112,874 | 112,874 | 112,874 | 113,330 | 114,651 | 117,947 | 122,269 |
| **6,200** | 120,374 | 120,374 | 120,374 | 120,374 | 120,374 | 120,374 | 120,530 | 121,589 | 124,016 | 128,269 |
| **6,500** | 127,874 | 127,874 | 127,874 | 127,874 | 127,874 | 127,874 | 127,874 | 128,789 | 130,583 | 134,269 |
| **6,800** | 135,374 | 135,374 | 135,374 | 135,374 | 135,374 | 135,374 | 135,374 | 135,989 | 137,291 | 140,269 |
| **7,100** | 142,874 | 142,874 | 142,874 | 142,874 | 142,874 | 142,874 | 142,874 | 143,189 | 144,249 | 146,560 |
| **7,400** | 150,374 | 150,374 | 150,374 | 150,374 | 150,374 | 150,374 | 150,374 | 150,389 | 151,449 | 153,160 |
| **7,700** | 157,874 | 157,874 | 157,874 | 157,874 | 157,874 | 157,874 | 157,874 | 157,874 | 158,649 | 159,931 |
| **8,000** | 165,374 | 165,374 | 165,374 | 165,374 | 165,374 | 165,374 | 165,374 | 165,374 | 165,849 | 166,908 |
| **8,300** | 172,874 | 172,874 | 172,874 | 172,874 | 172,874 | 172,874 | 172,874 | 172,874 | 173,049 | 174,108 |
| **8,600** | 180,374 | 180,374 | 180,374 | 180,374 | 180,374 | 180,374 | 180,374 | 180,374 | 180,374 | 181,308 |
| **8,900** | 187,874 | 187,874 | 187,874 | 187,874 | 187,874 | 187,874 | 187,874 | 187,874 | 187,874 | 188,508 |
| **9,200** | 195,374 | 195,374 | 195,374 | 195,374 | 195,374 | 195,374 | 195,374 | 195,374 | 195,374 | 195,708 |
| **9,500** | 202,874 | 202,874 | 202,874 | 202,874 | 202,874 | 202,874 | 202,874 | 202,874 | 202,874 | 202,908 |
| **9,800** | 210,374 | 210,374 | 210,374 | 210,374 | 210,374 | 210,374 | 210,374 | 210,374 | 210,374 | 210,374 |
| **10,100** | 217,874 | 217,874 | 217,874 | 217,874 | 217,874 | 217,874 | 217,874 | 217,874 | 217,874 | 217,874 |
| **10,400** | 225,374 | 225,374 | 225,374 | 225,374 | 225,374 | 225,374 | 225,374 | 225,374 | 225,374 | 225,374 |
| **10,700** | 232,874 | 232,874 | 232,874 | 232,874 | 232,874 | 232,874 | 232,874 | 232,874 | 232,874 | 232,874 |
| **11,000** | 240,374 | 240,374 | 240,374 | 240,374 | 240,374 | 240,374 | 240,374 | 240,374 | 240,374 | 240,374 |
| **11,300** | 247,874 | 247,874 | 247,874 | 247,874 | 247,874 | 247,874 | 247,874 | 247,874 | 247,874 | 247,874 |
| **11,600** | 255,374 | 255,374 | 255,374 | 255,374 | 255,374 | 255,374 | 255,374 | 255,374 | 255,374 | 255,374 |
| **11,900** | 262,874 | 262,874 | 262,874 | 262,874 | 262,874 | 262,874 | 262,874 | 262,874 | 262,874 | 262,874 |
| **12,200** | 270,374 | 270,374 | 270,374 | 270,374 | 270,374 | 270,374 | 270,374 | 270,374 | 270,374 | 270,374 |
| **12,500** | 277,874 | 277,874 | 277,874 | 277,874 | 277,874 | 277,874 | 277,874 | 277,874 | 277,874 | 277,874 |
| **12,800** | 285,374 | 285,374 | 285,374 | 285,374 | 285,374 | 285,374 | 285,374 | 285,374 | 285,374 | 285,374 |
| **13,100** | 292,874 | 292,874 | 292,874 | 292,874 | 292,874 | 292,874 | 292,874 | 292,874 | 292,874 | 292,874 |
| **13,400** | 300,374 | 300,374 | 300,374 | 300,374 | 300,374 | 300,374 | 300,374 | 300,374 | 300,374 | 300,374 |

*Numbers in white cells represent the sum (across all states) of the differences in emissions between the state-specific "alternative approach" variability values and the state-specific variability limit (in tons); the variability limit selected for each state is the larger of either the percentage limit or the tonnage limit.

** If the cell is grey, it means that there is a state or there are several states whose "alternative approach" level variability values exceed both the tonnage and percentage limits. The cell either lists the states that could exceed the limits, or lists the number of states.

*** If the cell is yellow, this is the combination tonnage and percentage limits that minimizes the sum of the differences between the state-specific "alternative approach" variability values and the state-specific variability limit (in tons).