Technical Support Document (TSD)

for the final Transport Rule

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Power Sector Variability
Final Rule TSD

U.S. Environmental Protection Agency

Office of Air and Radiation

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Power Sector Variability

This Technical Support Document (TSD) provides information in support of section VI.E, "Approach to Power Sector Emissions Variability," of the preamble to the final Transport Rule. This TSD is organized as follows:

1. Introduction
2. Estimating variability in power system operations and emissions
3. Numerical simulation of 1 and 3-year variability
4. Results of an analysis using the air quality assessment tool
5. Variation in electric generation from fossil units relative to total generation.

1. Introduction.

Section VI of the preamble to the final 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 VI, EPA has identified the emissions that must be reduced by each state to address the state's significant contribution and interference with maintenance. To facilitate implementation of the requirement that these emissions be eliminated, EPA also developed SO_2, annual NO_X, and ozone-season NO_X state budgets based on its projections of state-by-state power sector emissions in an average year reflecting these emission reductions.[1]

However, because of inherent variability in year-to-year baseline emissions – resulting from the inherent variability in power system operations – state-level emissions may vary somewhat from year to year even after all the significant contribution and interference with maintenance that EPA has identified in the Transport Rule has been eliminated. Therefore, and for the reasons discussed in preamble sections VI.E and VI.F, EPA has determined that it is appropriate to develop variability limits for each state

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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 and ozone-season NO_X budgets for each state covered for the ozone NAAQS, as discussed in section VI.D of the final Transport Rule's preamble. Table III-1 in preamble section III lists the 27 states that are covered by the Transport Rule. As discussed in preamble section III, EPA will issue a supplemental proposal to require ozone-season NO_X reductions in 6 additional states.

budget. These limits are used to identify the range of emissions that EPA believes may occur in each state following the elimination of all emissions identified by EPA as significantly contributing to nonattainment or interfering with maintenance in one or more other states.

Preamble sections VI.A through VI.D discuss EPA's 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 and to determine state emissions budgets for SO_2, annual NO_X, and ozone season NO_X. Preamble sections VI.E and VI.F discuss the inherent variability in electric power system operations and EPA's approach to determine appropriate variability limits on emissions for each state covered by the final Transport Rule to account for this variability. As explained in preamble section VI.E, EPA calculated variability limits for each state emissions budget. The final Transport Rule applies those variability limits in addition to the state budgets (which are based on expected average conditions) to determine the "assurance level" for each state in each compliance period. The Agency believes that because baseline power system operations (and therefore emissions) are variable at the state level, 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 while assuring that each state makes necessary reductions.

In the final Transport Rule, EPA derived "1-year" variability limits from an assessment of historical year-to-year variability in heat input, which was originally described in the "Power Sector Variability" TSD from the proposed Transport Rule and is re-analyzed in this TSD for all states included in the final Transport Rule, as well as for the additional states EPA is proposing, through a supplemental proposal, to include in the Transport Rule ozone program. For the reasons discussed in section VI.E of the preamble, although EPA proposed to implement both 1-year variability limits and 3-year average variability limits, the final Transport Rule decided to finalize only the 1-year limits. Section 3 of this TSD presents an analysis of 1 and 3-year variability that supports EPA's decision to finalize only the 1-year variability limits in the final rule.

Section 4 of this TSD describes an analysis using the air quality assessment tool (AQAT) to estimate the resulting air quality effects in a given year assuming several potential degrees of variability in year-to-year annual emissions from the power sector.

Section 5 of this TSD describes an assessment of electric generation from the fossil sector (i.e., coal, petroleum, and gas) compared with the total electric generation of all sectors (e.g., hydroelectric, nuclear, coal). The results of this analysis are used to put the variability in generation from the units in the Transport Rule in the broader context of total electric generation. This reinforces the conclusion that all states have the potential to experience the same degree of variability observed in the states with the highest historic variability.

2. Estimating variability in power system operations and emissions.

This section describes the method that the Agency used to estimate the year-to-year ("1-year") variability in power system operations and thereby annual SO_2, annual NO_X and ozone season NO_X emissions. As discussed above, the goal of this assessment is to determine the amount of variability in state-level emissions that is due to inherent variability in power system operations. To quantify this expected variability, EPA used variation in historic heat input. EPA considered the use of variation in historic emissions but determined this to be inappropriate because it reflected factors such as the installation of new emission controls and changes in the operation of existing controls. These factors are not directly related to variability in power system operations. In fact, these factors are activities that EPA is attempting to regulate with the implementation of the state budgets themselves. EPA believes that all controls (existing or newly installed) should be operated with consistency under the rule's programs. As such, EPA is assuming a constant relationship between heat input variability and emission variability for the purposes of this historic variability analysis (i.e., variation in heat input is a proxy for variation in emissions holding the effectiveness of emission control in that state constant). 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 final Transport Rule (SO_2, annual NO_x, and ozone season NO_x). EPA used these historical heat input values to estimate the inherent variability in emissions due to power system operation.

- The method EPA utilized to estimate the year-to-year variability in the heat input values. The year-to-year variability in heat input was estimated on a state-by-state basis.
- The approach EPA used to link inherent heat input variability with projected pollutant emission levels to estimate the resulting variation expected in future pollutant emissions on a year-to-year basis.

(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), as compliance with the Transport Rule programs must be demonstrated for total tonnage emitted during a single year or ozone season. For this assessment, 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 an 11-year time frame (2000 through 2010). EPA believes such data would capture inherent variation in year-to-year 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 2000 through 2010 for the analysis of variation in heat input because it features nearly comprehensive reporting of heat input across many states and EGUs for the longest available time period. This is responsive to commenters who said that the variability analysis should begin in 2000 (i.e., utilizing all available data since EPA began collecting such data from a substantial majority of the fleet starting in that year), and that any uneven increases or decreases in heat input due to changes in fleet composition and utilization are representative of long-run year-to-year variability in power system operation. Fitting a regression line to this historic data accounts for a systematic trend in heat input over time, thereby holding that longer-run trend constant while allowing for an assessment of year-to-year variability around that trend. Similarly, the use of all available data since 2000, including annual heat input data now available from 2009 and 2010, is responsive to comments suggesting that the analysis include all available data (i.e., including heat input from 2009 and 2010) to improve the long-run approximation of year-to-year variability impacting the power sector at the state level.

For each year of the 11-year time period, EPA estimated total power sector heat input on a state-by-state basis using the sum of reported heat input[2] for all units expected to be covered by the Transport Rule. Total annual heat input values (in million MMBtu) for these units for each state can be found in Table 1. Ozone-season heat input values for all units can be found in Table 2. EPA assessed the inherent year-to-year variability in annual annual NO_x, annual SO_2, and ozone season NO_x emissions using the total yearly and ozone season heat inputs summed across all EGUs (Tables 1 and 2, respectively).

In the proposed Transport Rule, the Agency assessed year-to-year variability in annual SO_2 emissions using as a proxy the yearly heat inputs from coal-fired EGUs. However, for the final rule EPA has determined that annual historic heat inputs across all covered units offer a straightforward and sufficient basis for anticipating potential year-to-year variability in SO_2 emissions at the state level, considering that all such units will be regulated for SO_2 control under the Transport Rule. Consequently, EPA analyzed annual variation in historic heat input for all units to inform the determination of variability limits for both annual NO_x and SO_2 in the final Transport Rule.

The development of the final Transport Rule included identification of the units expected to be subject to the Transport Rule programs. Consequently, EPA updated its variability analysis to include historic heat input at these relevant units. For the final variability assessment, EPA also removed the limitation which excluded units that had not operated continuously throughout the time-period to give a more complete representation of the year-to-year variation in total heat input in each state. EPA notes that the regression

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[2] As reported to the US EPA Clean Air Markets Division.

line accounts for longer-run trends in heat input resulting from the addition of new generation capacity or increased utilization of existing units.

Table 1: Total Annual Heat Input* (million MMBtu) from All Units Expected to be in the Final Transport Rule.

State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average HI
AL	883.7	845.9	901.2	916.4	904.9	937.0	964.2	1,000.2	939.2	814.6	945.9	913.9
GA	843.1	777.8	842.4	823.9	854.1	949.4	968.9	1,033.6	958.7	860.4	928.2	894.6
IA	392.4	388.8	393.2	390.4	391.2	401.3	396.3	438.1	447.1	398.9	440.0	407.1
IL	887.6	892.3	965.5	974.3	1,040.5	1,051.2	1,036.6	1,083.4	1,063.7	989.5	1,039.8	1,002.2
IN	1,313.3	1,239.7	1,217.3	1,219.1	1,243.8	1,277.2	1,267.6	1,268.2	1,249.0	1,110.7	1,185.3	1,235.6
KS	416.2	398.0	449.7	448.7	429.4	427.0	397.0	429.3	398.6	384.2	391.2	415.4
KY	1,006.9	1,000.1	961.2	934.3	943.4	987.5	1,002.0	1,000.2	990.8	904.2	994.8	975.0
MD	339.5	326.4	338.6	343.6	331.8	346.0	308.3	318.8	288.9	254.8	283.7	316.4
MI	758.4	746.5	751.5	776.7	781.2	811.3	779.5	825.5	813.2	779.2	806.7	784.5
MN	333.6	325.3	355.3	379.5	354.0	360.1	366.2	374.0	372.4	354.0	339.7	355.8
MO	713.2	739.0	752.1	788.7	792.2	813.7	812.5	800.6	770.9	762.2	797.8	776.6
NC	727.0	695.8	723.1	726.2	745.4	773.6	752.8	795.2	791.2	688.2	785.0	745.8
NE	212.0	235.7	230.3	241.6	234.0	245.8	241.2	233.3	240.6	263.2	253.3	239.2
NJ	242.1	228.3	260.7	246.4	256.1	265.3	251.0	272.1	273.8	227.2	274.1	254.3
NY	697.6	698.0	667.8	650.5	652.6	689.1	627.4	658.8	600.9	532.0	590.4	642.3
OH	1,311.4	1,236.0	1,304.7	1,327.4	1,261.7	1,351.0	1,327.9	1,367.1	1,324.9	1,169.8	1,228.0	1,291.8
PA	1,111.1	1,082.9	1,181.5	1,232.3	1,305.1	1,329.4	1,302.4	1,364.4	1,340.3	1,316.6	1,406.3	1,270.2
SC	396.2	377.3	418.6	412.0	451.3	464.7	471.3	483.1	472.9	435.1	480.7	442.1
TN	633.3	610.5	635.7	581.4	592.0	593.0	613.7	624.5	582.6	411.8	452.8	575.6
TX	2,581.8	2,550.6	2,778.0	2,866.6	2,897.2	3,034.3	3,050.9	3,100.2	3,103.7	2,978.1	3,074.1	2,910.5
VA	395.5	411.7	401.2	447.2	452.2	463.4	404.4	460.0	429.4	383.5	437.3	426.0
WI	490.8	479.4	467.5	487.4	491.8	528.8	494.9	499.7	487.4	451.2	491.1	488.2
WV	893.9	788.9	900.5	908.9	859.0	870.2	871.5	902.8	869.4	689.6	769.3	847.6

*Source: EPA, June 2011. All relevant 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 Units Expected to be in the Final Transport Rule for Ozone Season.

State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average HI
AL	398.0	391.2	427.5	429.0	423.8	427.5	457.0	470.1	432.8	374.2	450.3	425.6
AR	162.5	146.3	136.9	157.6	154.1	146.6	175.9	173.2	153.9	170.9	189.4	160.7
FL	622.2	623.3	701.6	731.3	750.0	788.9	801.5	807.8	797.6	785.0	858.1	751.6
GA	410.7	372.1	404.1	383.6	407.4	462.5	469.7	490.1	450.1	414.9	457.3	429.3
IA	164.5	169.5	170.8	161.8	161.8	183.5	168.9	189.9	182.4	165.5	191.4	173.6
IL	404.8	410.2	449.9	427.1	449.7	479.1	458.9	473.4	453.7	420.4	449.9	443.4
IN	543.7	547.1	539.0	530.2	524.5	563.1	551.8	545.3	536.9	461.4	528.4	533.8
KS	188.4	183.2	196.0	192.5	186.1	193.1	184.1	190.9	172.8	167.7	180.8	185.1
KY	438.1	442.1	432.1	400.1	401.1	434.4	436.5	437.3	419.1	390.2	431.6	423.9
LA	308.4	281.6	296.5	273.9	303.4	305.9	296.2	304.4	300.2	287.0	330.1	298.9
MD	148.8	153.6	163.2	140.1	148.2	164.1	140.3	143.8	130.2	107.2	141.1	143.7
MI	344.1	336.2	346.5	351.0	355.5	387.0	378.2	379.7	354.3	335.8	374.4	358.4
MO	312.7	323.9	337.7	347.6	348.0	354.3	362.8	357.7	342.0	333.2	358.5	343.5
MS	122.5	145.6	164.2	138.3	155.2	165.2	173.9	190.4	171.9	168.7	205.3	163.7
NC	312.3	319.9	334.8	324.6	332.0	359.0	359.6	371.4	363.4	304.8	367.0	340.8
NJ	110.8	112.5	131.1	112.8	128.8	135.1	128.6	136.6	135.8	104.4	139.6	125.1
NY	314.7	330.9	319.0	290.4	288.7	336.2	307.6	302.7	282.7	232.1	304.6	300.9
OH	560.5	531.7	580.2	560.4	542.8	580.0	567.8	602.5	559.1	479.1	559.2	556.7
OK	258.7	254.7	267.0	277.9	262.8	307.9	305.5	297.7	303.3	302.6	306.3	285.9
PA	470.8	463.6	530.5	529.1	558.2	606.2	591.9	610.1	576.8	565.5	631.4	557.6
SC	176.4	176.1	203.4	187.6	213.8	223.8	225.2	231.7	230.3	200.8	237.6	209.7
TN	277.8	270.8	291.2	245.2	256.2	270.6	273.8	279.7	261.3	176.2	210.0	255.7
TX	1,240.2	1,234.2	1,323.6	1,361.9	1,361.8	1,465.3	1,493.8	1,445.4	1,486.2	1,464.3	1,515.5	1,399.3
VA	171.8	178.4	183.1	209.9	223.9	227.6	206.9	231.5	200.2	167.0	217.3	201.6
WI	213.1	211.7	214.7	207.2	202.6	240.0	224.6	221.0	205.4	181.1	222.9	213.1
WV	372.8	352.3	379.5	390.9	368.0	382.3	379.5	396.6	373.4	275.8	333.4	364.1

*Source: EPA, June 2011; All relevant 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 EPA used to estimate the variability in heat input for each state covered by the final Transport Rule. It repeats some of the relevant data and calculations presented in the proposed Transport Rule TSD "Power Sector Variability" with updates reflecting the states covered by the final Transport Rule and updates to the heat input estimates.

In the final Transport Rule, EPA used the method presented in the proposed Transport Rule and assessed the year-to-year variability over the 11-year time period of the yearly total heat input values or ozone season heat input values by deriving a standard deviation for each state while "screening out" 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 two reasons: First, it held constant any longer trend in growth or decline in a state's heat input over the baseline period analyzed; second, a statistical approach (i.e., using the standard deviation) is less sensitive to data anomalies present in finite data sets - in other words, it effectively screens out extraneous information to characterize long-run variability.

For each state, it was important to first adjust the data set to screen out trends (growth or decline) in heat input over the 11-year time period, so that the data would then reflect year-to-year variability independent of trends in electricity demand. After controlling 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. To account for trends, a simple least-squares linear regression equation was fit to the heat input data as a function of time. In other words, this step of the analysis attempts to define the amount of variability in the data set for each state that can be attributed to a trend over time, which EPA is attempting to hold constant in this analysis to determine year-to-year variability independent of longer-run trends in heat input (e.g., rising electricity demand).

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, the square of the Pearson product moment correlation coefficient, describes the proportion of variance in “y” that is accounted for by knowing “x”. It indicates how significant a trend (growth or decline) is present in the data. Large r^2 values (r^2 values are maximized at 1) indicate that the least squares fit picks up a strong trend (upward or downward) in the data which should be removed by the procedure described below. This is 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). Small r^2 values, on the other hand, indicate that the least squares fit did not detect a strong trend (upward or downward) in the heat input data. Consequently, the procedure described below has less of a corrective role to play, since there is no strong trend that needs to be controlled for (held constant) when characterizing the data set’s year-to-year variability.

For each state, the slopes of the regression equations, y-intercepts, and r^2 values can be found in Tables 3 and 4. Using the slope and y-intercept from the regression equation for each state, yearly heat input values were estimated for each state for each year from 2000 through 2010 (Tables 3 and 4). 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 and 2) and the heat input estimated using the regression equation (Tables 3 and 4).

Table 3: Total Annual Heat Input (million MMBtu) from All Units Expected to be in the Final Transport Rule for Each Year Estimated Using the Regression Equation.

State	Slope of Linear Regression (million MMBtu/year)	Intercept	r^2 Value	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AL	4.79	-8,689	0.09	890.0	894.8	899.6	904.4	909.1	913.9	918.7	923.5	928.3	933.1	937.9
GA	14.90	-28,986	0.41	820.1	835.0	849.9	864.8	879.7	894.6	909.5	924.4	939.3	954.2	969.1
IA	4.91	-9,445	0.52	382.5	387.4	392.3	397.2	402.1	407.1	412.0	416.9	421.8	426.7	431.6
IL	15.08	-29,242	0.56	926.8	941.9	957.0	972.1	987.1	1,002.2	1,017.3	1,032.4	1,047.5	1,062.6	1,077.6
IN	-8.53	18,339	0.28	1,278.2	1,269.7	1,261.2	1,252.6	1,244.1	1,235.6	1,227.0	1,218.5	1,210.0	1,201.4	1,192.9
KS	-3.67	7,781	0.28	433.8	430.1	426.4	422.7	419.1	415.4	411.7	408.0	404.4	400.7	397.0
KY	-1.50	3,986	0.02	982.5	981.0	979.5	978.0	976.5	975.0	973.5	972.0	970.5	969.0	967.5
MD	-7.15	14,659	0.65	352.2	345.0	337.9	330.7	323.5	316.4	309.2	302.1	294.9	287.8	280.6
MI	5.94	-11,123	0.55	754.8	760.8	766.7	772.6	778.6	784.5	790.5	796.4	802.3	808.3	814.2
MN	1.79	-3,241	0.12	346.9	348.7	350.5	352.3	354.0	355.8	357.6	359.4	361.2	363.0	364.8
MO	5.60	-10,461	0.33	748.6	754.2	759.8	765.4	771.0	776.6	782.2	787.8	793.4	799.0	804.6
NC	5.54	-10,368	0.24	718.1	723.6	729.2	734.7	740.2	745.8	751.3	756.9	762.4	768.0	773.5
NE	3.07	-5,923	0.60	223.8	226.9	230.0	233.0	236.1	239.2	242.3	245.3	248.4	251.5	254.5
NJ	2.19	-4,139	0.18	243.3	245.5	247.7	249.9	252.1	254.3	256.5	258.7	260.9	263.1	265.2
NY	-12.81	26,330	0.69	706.3	693.5	680.7	667.9	655.1	642.3	629.5	616.7	603.8	591.0	578.2
OH	-4.33	9,976	0.06	1,313.5	1,309.1	1,304.8	1,300.5	1,296.1	1,291.8	1,287.5	1,283.1	1,278.8	1,274.5	1,270.2
PA	28.62	-56,114	0.82	1,127.1	1,155.7	1,184.3	1,213.0	1,241.6	1,270.2	1,298.8	1,327.4	1,356.1	1,384.7	1,413.3
SC	8.90	-17,393	0.65	397.6	406.5	415.4	424.3	433.2	442.1	451.0	459.9	468.8	477.7	486.6
TN	-15.90	32,450	0.51	655.1	639.2	623.3	607.4	591.5	575.6	559.7	543.8	527.9	512.0	496.1
TX	52.45	-102,244	0.76	2,648.3	2,700.7	2,753.2	2,805.6	2,858.1	2,910.5	2,962.9	3,015.4	3,067.8	3,120.3	3,172.7
VA	1.44	-2,456	0.03	418.8	420.2	421.7	423.1	424.6	426.0	427.4	428.9	430.3	431.7	433.2
WI	-0.22	926	0.00	489.3	489.0	488.8	488.6	488.4	488.2	488.0	487.7	487.5	487.3	487.1
WV	-10.12	21,141	0.23	898.2	888.1	878.0	867.9	857.8	847.6	837.5	827.4	817.3	807.1	797.0

Table 4: Heat Input (million MMBtu) from All Units Expected to be in the Final Transport Rule for Ozone Season Estimated Using the Regression Equation.

State	Slope of Linear Regression (million MMBtu/year)	Intercept	r^2 Value	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AL	2.95	-5,493	0.12	410.8	413.8	416.7	419.7	422.6	425.6	428.5	431.5	434.4	437.4	440.3
AR	3.06	-5,978	0.43	145.4	148.4	151.5	154.5	157.6	160.7	163.7	166.8	169.9	172.9	176.0
FL	21.08	-41,516	0.85	646.2	667.2	688.3	709.4	730.5	751.6	772.6	793.7	814.8	835.9	857.0
GA	7.44	-14,481	0.41	392.1	399.6	407.0	414.4	421.9	429.3	436.8	444.2	451.6	459.1	466.5
IA	1.97	-3,768	0.35	163.8	165.8	167.7	169.7	171.7	173.6	175.6	177.6	179.5	181.5	183.5
IL	3.45	-6,479	0.22	426.1	429.6	433.0	436.5	439.9	443.4	446.8	450.3	453.7	457.2	460.6
IN	-3.34	7,235	0.18	550.5	547.1	543.8	540.5	537.1	533.8	530.4	527.1	523.8	520.4	517.1
KS	-1.59	3,372	0.37	193.0	191.4	189.8	188.2	186.6	185.1	183.5	181.9	180.3	178.7	177.1
KY	-1.54	3,507	0.08	431.6	430.0	428.5	426.9	425.4	423.9	422.3	420.8	419.3	417.7	416.2
LA	1.77	-3,260	0.15	290.0	291.8	293.6	295.4	297.1	298.9	300.7	302.5	304.2	306.0	307.8
MD	-2.94	6,037	0.38	158.4	155.4	152.5	149.6	146.6	143.7	140.7	137.8	134.9	131.9	129.0
MI	2.30	-4,256	0.17	346.9	349.2	351.5	353.8	356.1	358.4	360.7	363.0	365.3	367.6	369.9
MO	2.86	-5,386	0.37	329.2	332.0	334.9	337.8	340.6	343.5	346.3	349.2	352.1	354.9	357.8
MS	5.93	-11,731	0.72	134.1	140.0	145.9	151.9	157.8	163.7	169.7	175.6	181.5	187.5	193.4
NC	3.82	-7,324	0.28	321.7	325.5	329.3	333.2	337.0	340.8	344.6	348.5	352.3	356.1	359.9
NJ	1.57	-3,025	0.17	117.2	118.8	120.4	121.9	123.5	125.1	126.7	128.2	129.8	131.4	132.9
NY	-4.65	9,621	0.30	324.1	319.5	314.8	310.2	305.5	300.9	296.2	291.6	286.9	282.3	277.6
OH	-1.55	3,672	0.03	564.4	562.9	561.3	559.8	558.2	556.7	555.1	553.6	552.0	550.4	548.9
OK	5.65	-11,035	0.75	257.6	263.3	268.9	274.6	280.2	285.9	291.5	297.1	302.8	308.4	314.1
PA	14.05	-27,608	0.72	487.4	501.5	515.5	529.5	543.6	557.6	571.7	585.7	599.8	613.8	627.9
SC	5.32	-10,456	0.62	183.1	188.4	193.7	199.1	204.4	209.7	215.0	220.3	225.7	231.0	236.3
TN	-6.55	13,385	0.41	288.5	281.9	275.4	268.8	262.3	255.7	249.2	242.6	236.1	229.5	223.0
TX	28.04	-54,811	0.85	1,259.1	1,287.1	1,315.2	1,343.2	1,371.2	1,399.3	1,427.3	1,455.3	1,483.4	1,511.4	1,539.5
VA	2.37	-4,541	0.11	189.8	192.1	194.5	196.9	199.2	201.6	204.0	206.3	208.7	211.1	213.4
WI	-0.47	1,164	0.01	215.5	215.0	214.5	214.1	213.6	213.1	212.6	212.2	211.7	211.2	210.7
WV	-4.53	9,443	0.19	386.7	382.2	377.6	373.1	368.6	364.1	359.5	355.0	350.5	345.9	341.4

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On a state-by-state basis, EPA calculated the difference between the actual heat input and the estimated heat input using the regression equation for each year (2000 through 2010). The differences for annual and ozone season heat input can be found in Tables 5 and 6, respectively. Some of these differences are positive, while others are negative; the size of the variation on either side of the regression line is meaningful for this analysis. EPA assessed the differences between actual and estimated heat input across all years for each state by calculating 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. In using the standard deviation as a representative difference, we assume that: (1) differences between the actual and modeled heat inputs are "normally" distributed; and (2) yearly mean values are independent.

For each state, the standard deviation of the differences is a conventional statistical measure of the year-to-year (1-year) variation in heat input. The statistical definition of a standard deviation in this context conveys that, on average, 68 percent of all the year-specific heat input values over the long run would be no farther from the average annual heat input (either higher or lower) than by the amount measured as the standard deviation.

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 percent 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. Following the analysis from the proposed Transport Rule and after reviewing all relevant public comment, the two-tailed 95th percent confidence level was selected as the appropriate level of variation. The two-tailed 95th percent confidence level indicates that we could expect that, on average, the total heat

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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.

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. This statistical confidence interval is very commonly used to make future projections from data sets similar to EPA's purpose in this analysis. As described in the proposal, 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 while still meeting their obligations to provide a reliable electricity supply across the states affected.

The 95th percent upper confidence level heat inputs, fractions (the 95th percent heat input difference divided by the average heat input over the 2000-2010 time period), and percentages can be found in Tables 5 and 6 for annual and ozone season heat input, respectively.

The standard deviation in the heat input in million MMBtu can be found in Tables 5 and 6. The standard deviation of the heat input was divided by the average heat input value, resulting in a fraction (when the fraction is multiplied by one hundred, the result is the standard deviation percent variation).

Table 5: Difference between Total Annual Heat Input (million MMBtu) Measured and Estimated from All Units Expected to be in the Final Transport Rule for Each Year Using the Regression Equation.

State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Standard Deviation of Heat Input (million MMBtu)	Average Heat Input (2000-2010, 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)	95% Confidence Level Variability in HI (as a Percentage of Avg. HI)
AL	-6.3	-48.8	1.7	12.0	-4.2	23.0	45.5	76.7	10.9	-118.5	8.0	50.3	913.9	0.055	98.6	0.108	11%
GA	23.0	-57.2	-7.4	-40.9	-25.6	54.9	59.4	109.2	19.4	-93.8	-40.9	59.6	894.6	0.067	116.8	0.131	13%
IA	9.9	1.4	0.9	-6.9	-11.0	-5.7	-15.7	21.2	25.3	-27.8	8.4	15.8	407.1	0.039	30.9	0.076	8%
IL	-39.2	-49.6	8.6	2.2	53.3	49.0	19.3	51.0	16.2	-73.0	-37.8	44.0	1,002.2	0.044	86.2	0.086	9%
IN	35.1	-30.0	-43.9	-33.5	-0.3	41.6	40.6	49.7	39.0	-90.7	-7.6	45.6	1,235.6	0.037	89.5	0.072	7%
KS	-17.6	-32.1	23.2	25.9	10.3	11.6	-14.7	21.3	-5.8	-16.5	-5.8	19.5	415.4	0.047	38.2	0.092	9%
KY	24.4	19.1	-18.3	-43.8	-33.1	12.5	28.4	28.2	20.3	-64.9	27.3	33.8	975.0	0.035	66.3	0.068	7%
MD	-12.7	-18.6	0.7	12.9	8.3	29.6	-1.0	16.7	-6.0	-32.9	3.1	17.4	316.4	0.055	34.1	0.108	11%
MI	3.6	-14.3	-15.2	4.1	2.6	26.8	-11.0	29.1	10.9	-29.1	-7.6	17.8	784.5	0.023	34.9	0.045	4%
MN	-13.2	-23.4	4.9	27.3	0.0	4.2	8.6	14.6	11.2	-9.0	-25.2	16.2	355.8	0.046	31.8	0.089	9%
MO	-35.4	-15.2	-7.7	23.2	21.2	37.1	30.2	12.8	-22.6	-36.8	-6.8	26.3	776.6	0.034	51.5	0.066	7%
NC	8.9	-27.8	-6.0	-8.5	5.2	27.9	1.5	38.3	28.8	-79.7	11.6	32.5	745.8	0.044	63.7	0.085	9%
NE	-11.8	8.8	0.3	8.6	-2.1	6.6	-1.1	-12.0	-7.8	11.7	-1.3	8.3	239.2	0.035	16.2	0.068	7%
NJ	-1.2	-17.2	13.0	-3.5	4.0	11.1	-5.5	13.4	12.9	-35.8	8.8	15.3	254.3	0.060	30.1	0.118	12%
NY	-8.7	4.5	-12.9	-17.5	-2.5	46.8	-2.1	42.2	-2.9	-59.1	12.2	28.6	642.3	0.045	56.1	0.087	9%
OH	-2.1	-73.1	-0.1	27.0	-34.5	59.2	40.4	83.9	46.1	-104.7	-42.2	58.6	1,291.8	0.045	114.8	0.089	9%
PA	-16.0	-72.8	-2.8	19.3	63.5	59.2	3.5	37.0	-15.8	-68.1	-7.0	44.5	1,270.2	0.035	87.2	0.069	7%
SC	-1.4	-29.2	3.2	-12.3	18.1	22.6	20.3	23.2	4.1	-42.6	-5.9	21.6	442.1	0.049	42.4	0.096	10%
TN	-21.7	-28.7	12.4	-26.0	0.6	17.4	54.0	80.7	54.7	-100.2	-43.3	51.7	575.6	0.090	101.4	0.176	18%
TX	-66.4	-150.2	24.9	61.0	39.2	123.8	87.9	84.8	35.9	-142.2	-98.6	97.1	2,910.5	0.033	190.4	0.065	7%
VA	-23.3	-8.5	-20.4	24.1	27.7	37.4	-23.0	31.2	-0.9	-48.2	4.1	27.6	426.0	0.065	54.1	0.127	13%
WI	1.6	-9.7	-21.4	-1.3	3.4	40.7	7.0	11.9	-0.1	-36.1	4.0	19.3	488.2	0.040	37.8	0.078	8%
WV	-4.4	-99.2	22.5	41.0	1.3	22.6	34.0	75.4	52.1	-117.6	-27.7	60.6	847.6	0.071	118.8	0.140	14%

Table 6: Difference between Total Heat Input Measured and Estimated (million MMBtu) from All Units Expected to be in the Final Transport Rule for Ozone Season Using the Regression Equation.

State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Standard Deviation of Heat Input (million MMBtu)	Average Heat Input (2000-2010, 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)	95% Confidence Level Variability in HI (as a Percentage of Avg. HI)
AL	-12.8	-22.6	10.8	9.4	1.1	1.9	28.5	38.6	-1.7	-63.2	10.0	27.0	425.6	0.063	52.9	0.124	12%
AR	17.2	-2.1	-14.6	3.1	-3.5	-14.1	12.2	6.4	-16.0	-2.0	13.4	11.7	160.7	0.073	22.9	0.142	14%
FL	-24.0	-44.0	13.3	21.9	19.5	37.3	28.8	14.1	-17.2	-50.9	1.2	29.8	751.6	0.040	58.3	0.078	8%
GA	18.5	-27.5	-2.9	-30.8	-14.5	33.2	33.0	46.0	-1.6	-44.2	-9.2	29.3	429.3	0.068	57.5	0.134	13%
IA	0.7	3.7	3.1	-7.9	-9.9	9.9	-6.7	12.3	2.9	-16.0	7.9	9.0	173.6	0.052	17.6	0.101	10%
IL	-21.3	-19.3	16.9	-9.4	9.8	35.7	12.0	23.1	0.0	-36.8	-10.7	21.7	443.4	0.049	42.6	0.096	10%
IN	-6.8	-0.1	-4.8	-10.2	-12.6	29.3	21.4	18.2	13.2	-59.0	11.4	24.0	533.8	0.045	47.1	0.088	9%
KS	-4.6	-8.2	6.2	4.3	-0.5	8.0	0.6	9.1	-7.5	-11.0	3.7	6.9	185.1	0.038	13.6	0.074	7%
KY	6.5	12.1	3.6	-26.9	-24.3	10.5	14.2	16.5	-0.1	-27.5	15.4	17.6	423.9	0.041	34.5	0.081	8%
LA	18.4	-10.2	3.0	-21.4	6.3	7.0	-4.5	2.0	-4.0	-19.0	22.4	13.8	298.9	0.046	27.0	0.090	9%
MD	-9.6	-1.8	10.7	-9.5	1.5	20.5	-0.5	6.0	-4.6	-24.7	12.1	12.4	143.7	0.086	24.3	0.169	17%
MI	-2.8	-13.0	-5.0	-2.8	-0.6	28.5	17.5	16.7	-11.0	-31.9	4.5	16.6	358.4	0.046	32.6	0.091	9%
MO	-16.5	-8.2	2.8	9.8	7.3	10.8	16.5	8.5	-10.1	-21.7	0.8	12.4	343.5	0.036	24.2	0.071	7%
MS	-11.6	5.5	18.3	-13.6	-2.6	1.5	4.2	14.8	-9.7	-18.8	11.9	12.3	163.7	0.075	24.2	0.148	15%
NC	-9.4	-5.6	5.5	-8.5	-5.0	18.2	15.0	23.0	11.1	-51.3	7.1	20.3	340.8	0.060	39.8	0.117	12%
NJ	-6.4	-6.3	10.7	-9.2	5.3	10.0	1.9	8.3	6.0	-27.0	6.7	11.4	125.1	0.091	22.3	0.178	18%
NY	-9.4	11.4	4.1	-19.7	-16.8	35.3	11.4	11.1	-4.2	-50.2	26.9	23.8	300.9	0.079	46.7	0.155	16%
OH	-3.9	-31.2	18.9	0.6	-15.4	23.4	12.7	48.9	7.1	-71.4	10.3	31.5	556.7	0.057	61.8	0.111	11%
OK	1.0	-8.6	-1.9	3.3	-17.5	22.1	14.0	0.5	0.5	-5.8	-7.7	10.8	285.9	0.038	21.2	0.074	7%
PA	-16.6	-37.9	15.0	-0.4	14.6	48.6	20.2	24.3	-23.0	-48.3	3.5	29.0	557.6	0.052	56.8	0.102	10%
SC	-6.7	-12.4	9.7	-11.5	9.4	14.1	10.2	11.3	4.7	-30.2	1.3	13.7	209.7	0.065	26.9	0.128	13%
TN	-10.6	-11.1	15.8	-23.6	-6.1	14.9	24.6	37.1	25.3	-53.3	-12.9	26.3	255.7	0.103	51.6	0.202	20%
TX	-18.9	-52.9	8.4	18.7	-9.5	66.0	66.4	-10.0	2.8	-47.2	-23.9	39.2	1,399.3	0.028	76.8	0.055	5%
VA	-18.0	-13.7	-11.4	13.0	24.6	26.0	3.0	25.1	-8.4	-44.0	3.9	21.8	201.6	0.108	42.8	0.212	21%
WI	-2.4	-3.3	0.2	-6.9	-11.0	26.9	12.0	8.8	-6.3	-30.1	12.1	14.9	213.1	0.070	29.2	0.137	14%
WV	-13.9	-29.9	1.9	17.8	-0.6	18.3	20.0	41.6	22.9	-70.2	-8.0	30.6	364.1	0.084	60.1	0.165	16%

(c) Estimation of variability in emissions using the year-to-year variability in historical heat input.

The analysis described in the sections above results in estimated 95th percent confidence level historic variabilities in heat input for each state and pollutant (Tables 5 and 6). As described in the preamble in section VI.E.2, from these variability values, for both annual and ozone season, EPA identified a specific variability percentage level for each state defined as the maximum value assessed across all states. This was 18 percent, for annual NO_x and SO_2 and 21 percent for ozone season NO_x. The 95th percent confidence level percentage variability in each state as well as the final variability percentage can be found in Table 7.

EPA believes that it is reasonable to treat the maximum state variability percentage figures for the Transport Rule states for 2000-2010 as representative of the level of variability that may occur in any of these states in the future. Although Tennessee and Virginia have the highest variability percentages for 2000 through 2010 among the Transport Rule states, a multiplicity of factors (such as, for example, level of economic activity, weather, percentage of generation comprising fossil-fuel fired generation, and length and number of unplanned outages) affects a state's total heat input for a given year and thus the variability in a state's heat input over a period of years. Neither Tennessee nor Virginia seems to be unusual --- with to regard to these types of factors --- among the Transport Rule states. For example, based on total heat input, total EGU emissions of SO_2 or NO_x, geographic area, or population, neither of these states could be described as comparable in size to the states EPA classified as “small” in the proposed Transport Rule (e.g., Connecticut and Delaware). By further example, with the central location of these states within the Transport Rule domain, and moderate latitude and longitudes, EPA expects other more-northerly, more-southerly, or more-westerly states could experience larger climatological extremes. Consequently, EPA maintains that the percentage variability experienced in Tennessee and Virginia can reasonably be regarded as a level that is representative of what percentage level may occur in any other Transport Rule state in the future. Moreover, because the percentage variability level is then applied to the individual state-specific budgets, the resulting variability limit, expressed in tons for each state, is a state-specific value. For these reasons, and for the reasons described in preamble section VI.E, EPA is taking the straight forward approach of applying to all Transport Rule states the highest historical percentage variability for the Transport Rule states for 2000 through 2010.

As described in section VI.E.2 of the preamble, the final step in estimating state-by-state year-to-year (1-year) variability in emissions is to convert the variability percentage level in each state into variability in pollutant emissions (i.e., a “variability limit”). EPA did this by multiplying the variability percentage level for each pollutant by the state emissions budgets for each pollutant (section VI.D of the preamble discusses EPA’s approach to determine the final Transport Rule budgets, and lists the budgets in Tables VI.D-3 and VI.D-4). For each state, Tables VI.F-1, VI.F-2, and VI.F-3 list the resulting variability limits for each state for SO_2, annual NO_X and ozone-season NO_X, respectively.

Table 7. Relationship between 95% Confidence Level Historic Variability in Heat Input Percentage and Variability Limit Percentage Used in the Transport Rule*.

	SO_2 and Annual NO_X		Ozone-Season NO_X	
State	Historic Variability	Transport Rule Variability Limit	Historic Variability	Transport Rule Variability Limit
AL	11%	18%	12%	21%
AR			14%	21%
FL			8%	21%
GA	13%	18%	13%	21%
IL	9%	18%	10%	21%
IN	7%	18%	9%	21%
IA*	8%	18%	10%	21%
KS*	9%	18%	7%	21%
KY	7%	18%	8%	21%
LA			9%	21%
MD	11%	18%	17%	21%
MI*	4%	18%	9%	21%
MN	9%	18%		
MS			15%	21%
MO*	7%	18%	7%	21%
NE	7%	18%		
NJ	12%	18%	18%	21%
NY	9%	18%	16%	21%
NC	9%	18%	12%	21%
OH	9%	18%	11%	21%
OK*			7%	21%
PA	7%	18%	10%	21%
SC	10%	18%	13%	21%
TN	18%	18%	20%	21%
TX	7%	18%	5%	21%
VA	13%	18%	21%	21%
WV	14%	18%	16%	21%
WI*	8%	18%	14%	21%

*Indicates a state (IA, KS, MI, OK, WI, and MO) that is included in the supplemental notice of proposed rulemaking for ozone-season NO_x emission reductions. See the preamble for details.

3. Numerical simulation of 1- and 3-year variability

For the reasons discussed in section VI.E of the preamble, although EPA proposed to implement both 1-year variability limits and 3-year average variability limits, the final Transport Rule includes only the 1-year limits. In the proposal, EPA first established 1-year variability limits (following the procedure outlined above) and then established corresponding 3-year variability limits to be statistically indistinguishable from the 1-year variability limits. In other words, the proposal's 3-year variability limits were calculated on a statistical basis to offer states the same degree of future variability (based on historic variability) as the 1-year variability limits. For the final rule, EPA analyzed the relationship between the 1-year and 3-year variability limits, performing a numerical verification of equal likelihood of potential violations of a state's assurance level when evaluating random variation (10 percent at the 95th percent two-tailed confidence level) around a constant budget.

As discussed in section VI.E of the final Transport Rule preamble, the state-by-state emissions budgets are based on the availability of emission reductions at an equal cost threshold (within each of the programs). As such, EPA expects the sources in each covered state to make these cost-effective reductions and to meet the emission budgets each year. On average EPA does not expect any systematic bias in emissions (against the established state budgets) to occur. Thus, a non-biased assessment of variability is appropriate. EPA simulated 1- and 3-year variation around a constant budget for a hypothetical state, and found, as described below, comparable results affirming that on a statistical basis, the 3-year variability limits are no more likely to be exceeded than the 1-year variability limits.

Using a random-number generator within Microsoft Excel, EPA numerically simulated random variation using the 95th percent two-tailed confidence level 1-year variability of 10 percent. The 1-year variability standard deviation is 10 percent divided by 1.960, or 5.1 percent. Using the formula, =NORMINV(RAND(),100,(10/1.960)), EPA simulated yearly emissions for a "state" with a budget of 100, with random variation of 5.1 percent. EPA simulated five consecutive "years" of emissions, then calculated three 3-year consecutive averages ("years" 1, 2, and 3; 2, 3, and 4; and 3, 4, and 5) . EPA, then, assessed the average number of "exceedances" of the 1-year and 3-year "budgets plus variability limits". The 1-year budget plus variability limit is 110, while the 3-year budget plus variability limit (as defined in the proposal) is 105.77. EPA simulated 10,000 5-year time-periods, and averaged the number of exceedances of the 1-year (50,000 data points) and 3-year limits (30,000 data points). For both the 1-year and 3-year cases, the average number of exceedances was 2.5 percent, conforming to the expected 95th percent two-tailed confidence exceedance value of 2.5 percent.

This finding confirms that the proposed 3-year variability limits are statistically indistinguishable from the 1-year variability limits for each state; therefore, EPA has determined that the 3-year variability limits are redundant with the 1-year variability limits and are thus unnecessary.

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

The objective of this section is to estimate the possible effects of the variability limits on air quality in 2014. This analysis used the air quality assessment tool, or AQAT, and state-by-state emissions to estimate downwind state-by-state air quality contributions at receptors with nonattainment and maintenance problems in the CAMx air quality modeling of the 2012 base case (section VI.C of the final Transport Rule preamble discusses AQAT; section V of the final Transport Rule preamble discusses air quality modeling). This analysis is similar to the analyses performed for the proposed Transport Rule (and reported in the proposed Transport Rule "Power Sector Variability" TSD). It concludes that, as estimated using AQAT, while variability in power system operation (and thereby SO_2 emissions from EGUs under the Transport Rule) does have perceptible downwind air quality effects on $PM_{2.5}$ concentrations, these effects are minimal. EPA believes that variation in other factors such as SO_2 and NO_x emission patterns from non-EGU sources, contributions from other pollutants (i.e., ammonia, elemental and organic carbon for $PM_{2.5}$ and volatile organic carbon for ozone), and meteorological factors play important roles in downwind air quality.

For this analysis, EPA varied the EGU SO_2 emissions of upwind states included in the final Transport Rule that are "linked" to downwind receptors (as described in section V of the preamble). The variation in emissions was designed to reflect the allowance of inherent year-to-year (1-year) variability in power system operations above average state-level emissions equal to the $2,300/ton and $500/ton SO_2 cost thresholds for group 1 and group 2 states respectively ("$2,300/ton" for the purposes of this discussion). Details on this scenario (TR_SO2_2300_Final) can be found in appendix A of the Significant Contribution and State

Emissions Budgets Final Rule TSD. EPA estimated the air quality impacts using the change in the maximum daily $PM_{2.5}$ design value. This analysis focused on variability limits related to annual SO_2 emissions and the 24-hour $PM_{2.5}$ concentrations for the same reasons listed in the proposed Transport Rule "Power Sector Variability" TSD, with the addition that the improved "calibrated" AQAT used in the final Transport Rule only allows SO_2 emissions to be varied for estimating downwind ammonium sulfate concentrations (which is discussed further in section VI.C in the final rule's preamble).

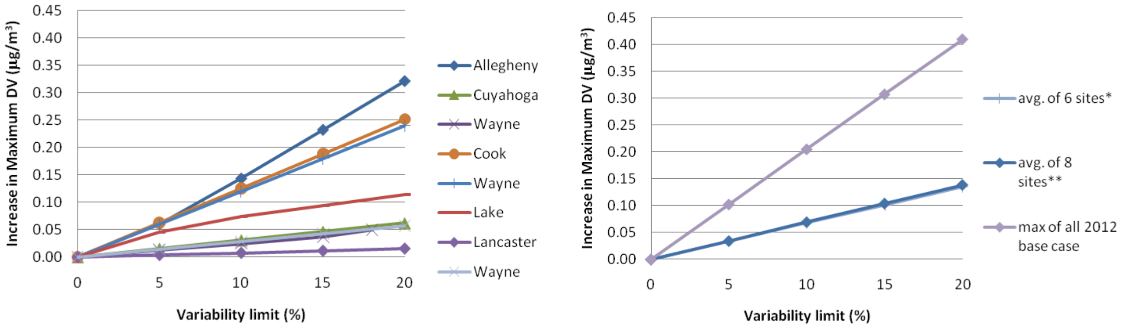
In contrast to the analyses in the proposed Transport Rule, this analysis focuses on the "worst-case" emissions variability in 2014. This is intended to estimate upper bounds for the effects of year-to-year variability in power system operations on air quality. For this analysis, the "worst case" situation is defined as the hypothetical scenario in which all upwind states that are linked to a particular receptor increase their SO_2 emissions to a "variability maximum" equal to the 2014 emissions equal to the final Transport Rule cost thresholds plus a fixed percentage (variability level) of the state budget. States that were not linked to the receptor were held at base case SO_2 emission levels. This analysis focused exclusively on the downwind air quality effects of variation in emissions from "linked" upwind states, since it is variation in these emissions that are relevant to Clean Air Act (CAA) section 110(a)(2)(D)(i)(I). Thus, the emissions from the state containing the receptor (i.e., the "home" state) were maintained at a constant level, equal to its final Transport Rule cost threshold. In this assessment, four variability levels were examined (5, 10, 15, and 20 percent). The 20 percent level analysis increases emissions from linked upwind states further than the allowed variability in the final Transport Rule programs, which is limited to 18 percent. Therefore, estimated air quality impacts from the 20 percent level analysis would exceed the expected air quality impacts from a scenario in which all of the upwind linked states emitted at their variability limits in a given year

This variability analysis does not balance emission increases in some states with emission decreases in other states (as was done in the analysis for the proposed Transport Rule). Specifically, this analysis does not account for corresponding decreases from other states included in the final Transport Rule that are not contributing above the 1 percent threshold to a particular receptor.

EPA specifically notes that this analysis is intended to demonstrate the potential air quality impacts from year-to-year variability under "extreme" worst-case scenarios, where states linked to a downwind receptor simultaneously need to utilize the maximum power sector variability; it is distinct from the “typical” operating conditions represented in an “average” year under which significant contribution and interference with maintenance are examined to inform EPA’s determination of emission reductions available at various cost thresholds. In other words, the Transport Rule state budgets are established on the basis of conditions in an average year, while the variability provisions address the inherent year-to-year fluctuations of power sector operations around those average conditions. This analysis examines the fluctuations in downwind air quality that may be attributable to various potential degrees of year-to-year power sector emission variability around upwind state budgets. Such an analysis is fundamentally different from the Transport Rule’s analysis to determine significant contribution and interference with maintenance, which includes an examination of downwind air quality impacts not on a fluctuating year-to-year basis, but on the basis of the degree of stringency of upwind emissions control under expected (i.e., average) operating conditions as represented by EPA’s power sector modeling projections. Therefore, the results of this TSD’s analysis are not pertinent to the Agency’s consideration of downwind air quality impacts as one factor in its multifactor analysis of significant contribution and interference with maintenance.

The results of the analysis can be found in Table 8 and in Figure 1, below. The estimated increases in maximum design value $PM_{2.5}$ concentrations across the range of variability levels examined are relatively small, with an average increase of 0.19 $\mu g/m^3$ and a maximum increase of 0.41 $\mu g/m^3$ for receptor number 420031008 in Allegheny, Pennsylvania at 20 percent variability. In particular, the differences in air quality increases between 15 percent and 20 percent variability levels are small, with no projected overall changes in receptor nonattainment status. Based on these results, EPA can determine that downwind air quality impacts of linked upwind states all using their full variability limits (of 18 percent or 21 percent) in a given year would have limited impacts on downwind air quality that would not undermine the upwind state’s elimination of significant contribution to nonattainment or interference with maintenance at the downwind receptors. These estimates were confirmed in two ways. First, using the same methodology used for 5, 10, 15, and 20 percent variability (Table 8), AQAT was used to estimate the effects on air quality for the 18 and 21 percent variability levels. The results can be seen in Table 9, again showing relatively small air quality impacts for both cases. Second, EPA used IPM to estimate emissions when an assurance level at 18 percent is implemented (i.e., a remedy sensitivity run). The resulting air quality estimates can be found in Table 1 of Appendix E of the "Significant Contribution and State Emissions Budget Final Rule" TSD. The air quality differences between this run and the final Transport Rule remedy (as modeled in AQAT) are small.

For most locations, the largest contributor to increased $PM_{2.5}$ concentration from a single upwind state will be from sources within the state containing the receptor itself (this conclusion is drawn from comparing the Worst Case (All States) and Worst Case (Upwind States) columns in Table 22 from the "Power Sector Variability" TSD from the proposed Transport Rule.



*The six sites are Allegheny, PA (64); Lancaster, PA (07); Wayne, MI (16 and 19); Cook, IL (16); and Lake, IN (22).
**The eight sites include the six sites listed above as well as Cuyahoga, OH (38) and Wayne, MI (33).

Figure 1. Increase in maximum $PM_{2.5}$ design value (µg/m^3) in 2014 at the $2300/ton cost threshold level as the variability level is increased from 0 to 20 percent, individually for the eight sites (left panel) as well as for various combinations of sites (right panel). The combinations of sites can be found in Table 8. The state containing the receptor is held constant with no variability at the 2014 $2300/ton cost emission level.

Table 8. Maximum $PM_{2.5}$ DVs ($\mu g/m^3$) in 2014 with Linked States at the Final Transport Rule Cost Threshold Level with Various Additional Amounts of Emissions Due to Variability with the Home State Held Constant with No Variability at the 2014 Final Transport Rule Cost Threshold.

Site ID	**State**	**County**	**Variability (%)**					**Difference in Air Quality Between the 0% Variability Level and Another Level.**				
			0	**5**	**10**	**15**	**20**	**0**	**5**	**10**	**15**	**20**
avg. of 6 sites*			38.39	38.42	38.46	38.49	38.52	0.00	0.03	0.07	0.10	0.13
avg. of 8 sites**			37.62	37.66	37.69	37.73	37.76	0.00	0.03	0.07	0.10	0.14
max of all 2012 base case			48.63	48.69	48.78	48.87	48.95	0.00	0.10	0.21	0.31	0.41
420030064	Pennsylvania	Allegheny	48.63	48.69	48.78	48.87	48.95	0.00	0.06	0.14	0.23	0.32
420030093	Pennsylvania	Allegheny	34.80	34.88	34.95	35.03	35.10	0.00	0.08	0.15	0.23	0.30
390350038	Ohio	Cuyahoga	35.41	35.42	35.44	35.46	35.47	0.00	0.02	0.03	0.05	0.06
261630016	Michigan	Wayne	35.65	35.67	35.68	35.69	35.70	0.00	0.01	0.02	0.04	0.05
390350060	Ohio	Cuyahoga	33.04	33.07	33.11	33.13	33.14	0.00	0.04	0.07	0.09	0.10
170311016	Illinois	Cook	36.54	36.60	36.67	36.73	36.79	0.00	0.06	0.13	0.19	0.25
261630033	Michigan	Wayne	35.23	35.29	35.35	35.41	35.47	0.00	0.06	0.12	0.18	0.24
180890022	Indiana	Lake	36.51	36.55	36.58	36.60	36.62	0.00	0.05	0.07	0.09	0.11
540090011	West Virginia	Brooke	30.02	30.12	30.21	30.31	30.41	0.00	0.10	0.19	0.29	0.39
420710007	Pennsylvania	Lancaster	37.18	37.18	37.18	37.19	37.19	0.00	0.00	0.01	0.01	0.02
390350045	Ohio	Cuyahoga	27.60	27.64	27.69	27.74	27.79	0.00	0.05	0.09	0.14	0.19
390811001	Ohio	Jefferson	28.03	28.11	28.19	28.27	28.35	0.00	0.08	0.16	0.25	0.33
261630019	Michigan	Wayne	35.83	35.84	35.86	35.87	35.88	0.00	0.01	0.03	0.04	0.06
390350065	Ohio	Cuyahoga	27.00	27.06	27.13	27.19	27.26	0.00	0.06	0.13	0.19	0.26
170313301	Illinois	Cook	32.84	32.88	32.93	32.97	33.01	0.00	0.04	0.08	0.13	0.17
420070014	Pennsylvania	Beaver	28.70	28.75	28.82	28.90	28.99	0.00	0.05	0.12	0.20	0.29
420033007	Pennsylvania	Allegheny	28.81	28.87	28.93	29.00	29.06	0.00	0.06	0.13	0.19	0.26
010730023	Alabama	Jefferson	32.12	32.15	32.19	32.22	32.26	0.00	0.03	0.07	0.10	0.14
550790026	Wisconsin	Milwaukee	33.21	33.25	33.30	33.34	33.38	0.00	0.04	0.09	0.13	0.18
180970043	Indiana	Marion	27.82	27.87	27.93	27.98	28.03	0.00	0.05	0.11	0.16	0.21
261470005	Michigan	St Clair	33.38	33.40	33.42	33.44	33.45	0.00	0.02	0.04	0.05	0.07
550790043	Wisconsin	Milwaukee	33.92	33.95	33.98	34.01	34.04	0.00	0.03	0.06	0.09	0.12
180890026	Indiana	Lake	33.37	33.39	33.42	33.44	33.46	0.00	0.02	0.05	0.07	0.10
180970081	Indiana	Marion	27.59	27.67	27.74	27.80	27.85	0.00	0.08	0.15	0.21	0.27
180970066	Indiana	Marion	29.13	29.22	29.30	29.37	29.43	0.00	0.09	0.17	0.24	0.30
171191007	Illinois	Madison	30.66	30.75	30.80	30.85	30.90	0.00	0.09	0.14	0.19	0.24
550790010	Wisconsin	Milwaukee	33.13	33.17	33.22	33.26	33.31	0.00	0.04	0.09	0.13	0.18
390170003	Ohio	Butler	27.33	27.39	27.48	27.56	27.65	0.00	0.06	0.15	0.24	0.32
170316005	Illinois	Cook	34.82	34.85	34.88	34.91	34.93	0.00	0.03	0.06	0.09	0.12
420031008	Pennsylvania	Allegheny	25.62	25.72	25.83	25.93	26.03	0.00	0.10	0.21	0.31	0.41
261610008	Michigan	Washtenaw	29.33	29.35	29.38	29.40	29.42	0.00	0.02	0.05	0.07	0.09
170312001	Illinois	Cook	32.33	32.38	32.42	32.46	32.50	0.00	0.04	0.08	0.12	0.16
170310052	Illinois	Cook	30.31	30.34	30.37	30.40	30.43	0.00	0.03	0.06	0.09	0.12
421330008	Pennsylvania	York	33.91	33.93	33.94	33.95	33.97	0.00	0.01	0.03	0.04	0.05
261630015	Michigan	Wayne	31.99	32.01	32.02	32.04	32.06	0.00	0.02	0.03	0.05	0.06
010732003	Alabama	Jefferson	31.91	31.94	31.97	32.00	32.03	0.00	0.03	0.06	0.09	0.12
390618001	Ohio	Hamilton	26.73	26.79	26.85	26.91	26.97	0.00	0.06	0.12	0.18	0.24
171190023	Illinois	Madison	29.50	29.56	29.62	29.68	29.73	0.00	0.06	0.12	0.17	0.23
420031301	Pennsylvania	Allegheny	26.15	26.21	26.27	26.32	26.38	0.00	0.06	0.11	0.17	0.23
391130032	Ohio	Montgomery	24.62	24.69	24.75	24.82	24.89	0.00	0.07	0.13	0.20	0.27
420030116	Pennsylvania	Allegheny	26.34	26.40	26.46	26.53	26.59	0.00	0.06	0.12	0.19	0.25

*The six sites are Allegheny, PA (64); Lancaster, PA (07); Wayne, MI (16 and 19); Cook, IL (16); and Lake, IN (22).

**The eight sites include the six sites listed above as well as Cuyahoga, OH (38) and Wayne, MI (33).

In conclusion, EPA found that year-to-year variability reflecting inherent fluctuations in reliable operation of the power sector yield small impacts to downwind air quality, even with variability of up to 21 percent. This analysis confirms that even under a program allowing up to 21% of year-to-year variability around a budget in any given state's power sector emissions, the downwind air quality goals of the program are very unlikely to be compromised.

- The 18 percent variability limits allowed under the Transport Rule annual programs to account for year-to-year variability baseline power sector operation, and the corresponding 21 percent variability limits accounting for ozone-season operations, are bounded by the variability levels examined in this analysis. At all levels examined, the resulting variation in air quality is small.
- Higher levels of emission variability (beyond what EPA has calculated here as year-to-year variability due to baseline operation of the power sector), such as could theoretically occur under an unlimited interstate cap-and-trade emission program, would not undermine the program's achievement of downwind air quality improvements. This is especially true if coupled with emission reductions in the state containing the receptor.
- The heterogeneity of where, when, and how emission reductions occur (processes not explicitly considered under the Transport Rule, such as intra-state shifting of emissions) will possibly have larger downwind air quality impacts at a given receptor than the minor variations in air quality attributable to the small shifts in state-level emissions due to inherent year-to-year variability.

As was described in the proposed Transport Rule "Power Sector Variability" TSD, the variations in downwind air quality found in this analysis of potential year-to-year variability in upwind EGU emissions are much smaller than documented year-to-year variability in air quality (as measured at the receptors and expressed as the differences between the average and maximum design values), indicating that other factors such as meteorology play a much larger role in the variability of downwind air quality outcomes (once emissions are broadly controlled at a given level of stringency). Consequently, EPA finds that allowing variation in emissions under the final variability limits in the Transport Rule allows the power sector to address inherent fluctuations in electric generation without negatively affecting downwind air quality.

Table 9. Maximum PM$_{2.5}$ DVs (μg/m^3) in 2014 with Linked States at the Final Transport Rule Cost Threshold Level with 18 percent and 21 percent Additional Amounts of Emissions Due to Variability with the Home State Held Constant with No Variability at the 2014 Final Transport Rule Cost Threshold.

Site ID	**State**	**County**	**Variability (%)**		**Difference in Air Quality Between the 0% Variability Level and the 18% Level.**	**Variability (%)**		**Difference in Air Quality Between the 0% Variability Level and the 21% Level.**
			0	**18**		**0**	**21**	
420030064	Pennsylvania	Allegheny	48.63	48.92	0.29	48.63	48.97	0.34
420030093	Pennsylvania	Allegheny	34.80	35.07	0.27	34.80	35.12	0.32
390350038	Ohio	Cuyahoga	35.41	35.46	0.06	35.41	35.47	0.07
261630016	Michigan	Wayne	35.65	35.70	0.04	35.65	35.71	0.05
390350060	Ohio	Cuyahoga	33.04	33.13	0.10	33.04	33.14	0.10
170311016	Illinois	Cook	36.54	36.77	0.23	36.54	36.80	0.26
261630033	Michigan	Wayne	35.23	35.45	0.22	35.23	35.48	0.25
180890022	Indiana	Lake	36.51	36.61	0.11	36.51	36.62	0.12
540090011	West Virginia	Brooke	30.02	30.37	0.35	30.02	30.43	0.41
420710007	Pennsylvania	Lancaster	37.18	37.19	0.01	37.18	37.19	0.02
390350045	Ohio	Cuyahoga	27.60	27.77	0.17	27.60	27.80	0.20
390811001	Ohio	Jefferson	28.03	28.32	0.29	28.03	28.37	0.34
261630019	Michigan	Wayne	35.83	35.88	0.05	35.83	35.89	0.06
390350065	Ohio	Cuyahoga	27.00	27.23	0.23	27.00	27.27	0.27
170313301	Illinois	Cook	32.84	32.99	0.15	32.84	33.02	0.18
420070014	Pennsylvania	Beaver	28.70	28.95	0.25	28.70	29.00	0.30
420033007	Pennsylvania	Allegheny	28.81	29.04	0.23	28.81	29.08	0.27
010730023	Alabama	Jefferson	32.12	32.24	0.13	32.12	32.26	0.15
550790026	Wisconsin	Milwaukee	33.21	33.37	0.16	33.21	33.39	0.19
180970043	Indiana	Marion	27.82	28.01	0.19	27.82	28.04	0.22
261470005	Michigan	St Clair	33.38	33.45	0.07	33.38	33.46	0.08
550790043	Wisconsin	Milwaukee	33.92	34.03	0.11	33.92	34.04	0.12
180890026	Indiana	Lake	33.37	33.46	0.09	33.37	33.47	0.10
180970081	Indiana	Marion	27.59	27.83	0.24	27.59	27.87	0.28
180970066	Indiana	Marion	29.13	29.40	0.27	29.13	29.44	0.31
171191007	Illinois	Madison	30.66	30.88	0.22	30.66	30.91	0.25
550790010	Wisconsin	Milwaukee	33.13	33.29	0.16	33.13	33.31	0.19
390170003	Ohio	Butler	27.33	27.62	0.29	27.33	27.67	0.34
170316005	Illinois	Cook	34.82	34.92	0.11	34.82	34.94	0.12
420031008	Pennsylvania	Allegheny	25.62	25.99	0.37	25.62	26.05	0.43
261610008	Michigan	Washtenaw	29.33	29.42	0.08	29.33	29.43	0.10
170312001	Illinois	Cook	32.33	32.48	0.15	32.33	32.51	0.17
170310052	Illinois	Cook	30.31	30.42	0.11	30.31	30.44	0.12
421330008	Pennsylvania	York	33.91	33.96	0.05	33.91	33.97	0.06
261630015	Michigan	Wayne	31.99	32.05	0.06	31.99	32.06	0.07
010732003	Alabama	Jefferson	31.91	32.02	0.10	31.91	32.03	0.12
390618001	Ohio	Hamilton	26.73	26.94	0.22	26.73	26.98	0.25
171190023	Illinois	Madison	29.50	29.71	0.21	29.50	29.75	0.24
420031301	Pennsylvania	Allegheny	26.15	26.36	0.21	26.15	26.39	0.24
391130032	Ohio	Montgomery	24.62	24.86	0.24	24.62	24.90	0.28
420030116	Pennsylvania	Allegheny	26.34	26.56	0.22	26.34	26.60	0.26

5. Variation in electric generation from fossil units relative to total generation.

Many individual units across many sectors (e.g., hydroelectric, fossil, nuclear, wind) provide generation to meet electric generation demands in the U.S. However, only a subset of these units is expected to be included in the final Transport Rule. As described in section VI.E of the preamble and in this TSD, there are many reasons why emissions within a state may vary from year to year (or, from ozone season to ozone season). One reason is the relative proportion of electric generation from fossil units relative to the total generation. For example, in some states, there are large capacity units that have only marginal, or even zero, SO_2 and NO_X emission rates. These could be, for example, nuclear units. As electric demand varies from one year to the next, it is possible that the proportion of that demand that is met by fossil units could vary. For example, for a state with substantial nuclear generation (typically operating as relatively constant baseload units), it is possible that fossil generation could experience larger year-to-year variation in proportion to its baseline generation share as compared to year-to-year variation in total electricity demand in that state.

Using electric generation data from the Energy Information Administration[4], EPA assessed the electric generation for the fossil generation sector and for the total generation from all sectors for each of the states expected to be in the Transport Rule program for the time period 2000 through 2009 (Tables 10 and 11). Data for the year 2010 was not included because it was not available at the time of this final rulemaking. As shown in Table 12, for each year, EPA calculated the percentage of total generation provided by fossil fuel-fired generators in each state. The results for Tables 10, 11, and 12 are summarized in Table 13.

The results show that there is considerable variation in fossil generation from year to year, variation in total generation from year to year, and that the proportion of total generation from fossil units also varies from year to year. Some states have high percentages of their generation from fossil (e.g., Indiana) while others (e.g., Illinois) have lower percentages (Table 12). For all states, the proportion of fossil generation varies from one year to the next (i.e., the standard deviation from Table 12), with little or no obvious trend across states with regard to total generation, total fossil generation, or general (in any given year) proportion of fossil

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[4] Source: State Electricity Profiles, 2009 Edition; EIA; April 2011 (http://www.eia.gov/cneaf/electricity/st_profiles/e_profiles_sum.html)

generation to total generation (Table 13). For example, a large proportion of Iowa's total generation is from fossil. However, it has a relatively high year-to-year variability in the fossil to total generation of 3.6% (Table 13). Kansas has a very similar proportion of fossil generation, a similar total generation, and yet has less than half (i.e., 1.7%) of the year-to-year variation experienced by Iowa (Table 13). However, as would be expected, states with almost complete fossil generation to total generation (i.e., 98%) appeared to have slightly less variable fossil generation to total generation percentages.

Since the proportion of fossil generation to total electric generation is one of the factors that could potentially affect the state-by-state assessment of heat input variability (see section 2 of this TSD for details of the heat input assessment), it is important to examine how Tennessee and Virginia compare with all of the other states expected to be in the Transport Rule. These states demonstrated the highest 95th percent confidence level variabilities in heat input over the time period from 2000 through 2010.

In examining electric generation of fossil relative to other generation, Tennessee and Virginia are representative of most other states expected to be in the Transport Rule (being within one standard deviation of average percent fossil generation relative to total generation for the time period 2000-2009 assessed across all states) and show similar patterns of year-to-year variability in the percent fossil relative to total compared with other states (i.e., the standard deviation for each of these states being within two standard deviations for percent of fossil variation compared with all other states). During the 2000-2009 timeframe, these states happened to establish the highest value observed for year-to-year variability in fossil generation. This is comparable to what EPA determined for the year-to-year variation in heat input over the 2000-2010 timeframe (as described above in section 2). In this generation share assessment, the year-to-year variability values in fossil generation share for both Tennessee and Virginia fall within the 95th percent confidence level of the distribution of all states' year-to-year variability levels calculated in this analysis. That is to say, neither Tennessee nor Virginia present an "outlier" finding for year-to-year variability among the Transport Rule states analyzed. Thus, EPA finds that their proportion of generation, and variation in fossil generation relative to total generation, are representative of all Transport Rule states. EPA interprets this finding as statistical evidence that the year-to-year variations exhibited by Tennessee and Virginia could be exhibited in the future by other states covered in the Transport Rule programs.

In conclusion, EPA finds that both Virginia and Tennessee have representative fossil to other generation mixes and demonstrate year-to-year fluctuations in that generation ratio that are representative of year-to-year variability in other states. Based in part on this case study of year-to-year variability in the fossil fuel-fired share of a state's generation (a relevant factor informing year-to-year variability in state EGU emissions), EPA believes it is reasonable to accommodate the statistical potential in all states to experience the maximum observed historic year-to-year variability among those states in the analysis presented above in section 2.

Table 10. Fossil Electric Industry Generation Sector by Year (Megawatthours) (Coal, Petroleum, and Gas Generation)

State*	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average (2000-2009)
South Carolina	40,587,323	38,183,421	41,746,692	39,551,749	43,591,379	45,730,318	45,777,840	47,764,530	47,449,150	44,781,189	43,516,359
New Jersey	28,269,374	27,772,751	29,495,528	26,362,066	27,748,311	27,996,979	26,910,083	29,576,322	30,264,384	26,172,779	28,056,858
Illinois	88,005,813	86,018,711	96,219,615	93,208,355	98,803,288	99,905,430	97,212,331	103,072,379	101,100,510	94,662,485	95,820,892
New York	79,769,670	78,755,767	73,224,414	71,029,014	71,351,947	76,483,124	69,879,757	75,234,282	66,755,913	57,186,776	71,967,066
Virginia	47,353,187	47,427,595	46,261,913	47,495,691	47,247,427	47,984,304	42,342,803	48,421,535	42,241,799	38,888,332	45,566,459
Pennsylvania	123,257,783	119,112,469	123,923,647	126,571,924	131,715,015	137,220,631	138,172,520	143,908,754	137,861,607	136,047,080	131,779,143
Arkansas	28,251,936	28,350,764	27,861,034	31,093,932	30,961,268	29,250,905	33,626,179	34,202,584	34,639,352	36,385,133	31,462,309
Tennessee	63,444,284	60,604,095	60,456,740	55,956,927	58,556,257	59,827,766	61,335,979	61,204,754	57,753,073	42,241,501	58,138,138
North Carolina	77,901,547	75,148,857	79,341,500	77,140,309	78,715,678	82,113,946	79,133,706	84,935,370	80,312,350	70,231,526	78,497,479
Maryland	34,767,108	33,601,840	33,713,429	35,032,267	34,087,166	35,337,813	32,091,398	33,302,504	29,810,049	26,529,272	32,827,285
Alabama	83,142,223	82,434,492	88,370,318	89,447,001	91,285,610	92,437,882	97,827,165	101,560,826	97,375,571	87,579,809	91,146,090
Nebraska	18,963,946	20,615,626	20,377,695	21,384,309	20,776,485	21,652,165	21,460,666	20,775,698	22,272,915	23,684,230	21,196,374
Minnesota	35,487,886	33,643,796	36,164,954	38,373,030	36,241,242	36,433,421	36,125,436	36,463,293	34,879,236	32,263,080	35,607,537
Georgia	85,972,180	79,597,593	86,921,839	84,109,539	87,019,143	97,986,385	100,298,809	107,164,700	99,661,230	90,633,619	91,936,504
Michigan	82,063,526	82,192,176	83,666,519	80,218,113	84,648,878	85,336,546	80,004,350	84,932,522	80,179,418	75,868,993	81,911,104
Mississippi	25,239,704	42,090,307	31,892,758	28,223,492	31,913,860	33,460,964	34,253,614	39,184,193	37,407,555	36,266,297	33,993,274
Wisconsin	44,987,855	43,935,204	42,306,475	44,668,394	45,349,157	48,862,617	46,352,158	47,530,414	47,880,609	43,476,586	45,534,947
Louisiana	73,293,099	66,231,383	73,313,913	73,948,305	76,263,521	72,693,078	69,795,311	71,027,828	72,850,498	70,155,103	71,957,204
Kansas	35,739,739	34,336,478	37,667,319	37,299,518	36,278,743	36,604,591	35,171,928	38,590,021	36,363,175	35,032,695	36,308,421
Florida	151,711,197	152,378,116	162,784,858	173,183,074	178,708,928	183,324,770	184,530,490	188,433,327	180,167,254	181,553,197	173,677,521
Iowa	35,602,734	35,360,575	35,990,642	36,234,176	36,205,522	36,882,772	37,013,529	41,388,360	42,734,425	38,620,904	37,603,364
Texas	336,018,948	329,588,630	342,954,605	340,415,604	343,571,908	350,877,744	349,849,160	351,720,285	344,812,945	333,226,991	342,303,682
Missouri	66,111,416	70,259,930	71,508,299	76,994,700	78,086,967	81,474,061	81,245,146	80,127,334	78,787,805	75,121,522	75,971,718
Ohio	131,048,463	125,856,299	135,315,403	137,185,397	131,238,121	141,209,958	137,493,780	138,542,595	134,877,563	119,711,673	133,247,925
Oklahoma	53,274,124	52,802,543	57,134,398	58,705,640	57,155,277	64,987,956	68,092,606	67,764,810	70,121,839	68,699,869	61,873,906
Kentucky	90,669,222	91,552,565	87,716,454	87,449,856	90,323,151	94,422,841	95,719,860	95,075,440	95,477,555	86,936,622	91,534,357
West Virginia	91,699,645	80,858,445	93,664,643	93,164,499	88,255,268	92,012,899	92,062,841	92,510,654	89,481,340	68,394,521	88,210,476
Indiana	127,101,358	121,868,463	125,065,281	123,853,265	126,670,732	129,431,154	129,345,084	129,576,104	128,206,437	114,118,178	125,523,606

*This table is sorted in order of increasing average fraction of fossil relative to the total electric industry for the state (seen in Tables 12 and 13).

Table 11. Total Electric Industry Generation for All Sectors by Year (Megawatthours).

State*	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Average (2000-2009)**
South Carolina	93,346,240	89,158,987	96,563,498	93,772,678	97,939,929	102,514,665	99,267,606	103,402,142	100,978,005	100,125,486	97,706,924
New Jersey	58,085,215	59,421,260	61,569,386	57,399,351	55,882,342	60,549,583	60,700,139	62,671,245	63,674,789	61,811,239	60,176,455
Illinois	178,496,081	179,249,285	188,054,449	189,055,260	191,957,778	194,120,146	192,426,958	200,260,681	199,475,178	193,864,357	190,696,017
New York	138,079,075	143,914,559	139,591,689	137,643,316	137,964,794	146,887,419	142,265,432	145,878,687	140,322,100	133,150,550	140,569,762
Virginia	77,189,370	74,104,750	75,005,652	75,309,420	78,900,040	78,943,045	73,069,537	78,360,507	72,678,531	70,082,066	75,364,292
Pennsylvania	201,687,980	196,576,591	204,322,878	206,349,514	214,658,501	218,091,125	218,811,595	226,088,340	222,350,925	219,496,144	212,843,359
Arkansas	43,875,766	47,192,035	47,611,645	50,401,102	51,927,632	47,794,509	52,168,703	54,596,236	55,050,528	57,457,739	50,807,590
Tennessee	95,838,584	96,221,976	96,114,262	92,221,790	97,594,542	97,117,165	93,911,102	95,113,409	90,663,312	79,716,889	93,451,303
North Carolina	122,274,356	117,495,850	124,468,029	127,582,320	126,329,957	129,748,578	125,214,784	130,115,301	125,239,063	118,407,403	124,687,564
Maryland	51,145,380	49,062,340	48,279,088	52,244,237	52,052,770	52,661,600	48,956,880	50,197,924	47,360,953	43,774,832	49,573,600
Alabama	124,405,340	125,345,113	132,920,670	137,487,222	137,354,771	137,948,581	140,895,441	143,826,271	145,869,895	143,255,556	136,930,886
Nebraska	29,109,863	30,485,212	31,618,494	30,455,984	32,008,709	31,464,734	31,669,969	32,442,699	32,373,522	34,001,892	31,563,108
Minnesota	51,423,339	48,523,226	52,777,967	55,050,996	52,364,127	53,018,995	53,237,789	54,477,646	54,763,360	52,491,849	52,812,929
Georgia	123,877,413	118,316,789	126,512,215	124,076,834	126,812,715	136,667,892	138,010,208	145,155,158	136,173,395	128,698,376	130,430,100
Michigan	104,209,594	111,845,610	117,889,087	111,347,060	118,487,269	121,619,771	112,556,739	119,309,936	114,989,806	101,202,605	113,345,748
Mississippi	37,614,563	53,446,452	42,888,812	40,148,278	43,662,613	45,067,453	46,228,847	50,043,686	48,205,711	48,701,484	45,600,790
Wisconsin	59,644,417	58,763,431	58,431,438	60,122,424	60,444,933	61,824,664	61,639,843	63,390,630	63,479,555	59,959,060	60,770,040
Louisiana	92,865,635	87,894,377	94,970,963	94,885,040	98,172,309	92,616,878	90,921,829	92,578,329	92,453,141	90,993,676	92,835,218
Kansas	44,815,905	44,748,523	47,188,446	46,567,561	46,782,659	45,862,696	45,523,736	50,122,196	46,630,321	46,677,308	46,491,935
Florida	191,815,840	190,945,344	203,352,774	212,610,012	218,117,928	220,256,412	223,751,621	225,416,060	219,636,818	217,952,308	212,385,512
Iowa	41,542,010	40,658,512	42,528,385	42,116,192	43,248,189	44,156,160	45,483,462	49,789,217	53,086,786	51,860,063	45,446,898
Texas	377,742,365	372,580,002	385,628,541	379,199,685	390,299,132	396,668,722	400,582,878	405,492,296	404,787,781	397,167,910	391,014,931
Missouri	76,593,939	79,544,873	81,162,197	87,225,087	87,632,910	90,828,230	91,686,343	91,153,081	91,028,795	88,354,272	86,520,973
Ohio	149,060,280	142,261,807	147,068,849	146,638,128	148,345,905	156,976,323	155,434,075	155,155,545	153,412,251	136,090,225	149,044,339
Oklahoma	55,571,957	55,249,450	59,183,419	60,626,856	60,729,560	68,607,827	70,614,880	72,819,095	76,328,908	75,066,809	65,479,876
Kentucky	93,006,083	95,417,626	92,106,668	91,718,820	94,529,947	97,822,419	98,792,014	97,225,319	97,863,340	90,630,427	94,911,266
West Virginia	92,865,176	81,836,725	94,761,753	94,711,554	89,749,562	93,626,285	93,815,804	93,933,109	91,123,097	70,782,514	89,720,558
Indiana	127,819,516	122,569,673	125,608,139	124,888,218	127,770,396	130,371,573	130,489,788	130,637,999	129,510,294	116,670,280	126,633,588

*This table is sorted in order of increasing average fraction of fossil relative to the total electric industry for the state (seen in Tables 12 and 13).

Table 12. Percent of Fossil Electric Industry Generation Relative to Total Electric Industry Generation by Year

State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average (2000-2009)	Standard Deviation (2000-2009)
South Carolina	43%	43%	43%	42%	45%	45%	46%	46%	47%	45%	44%	1.6%
New Jersey	49%	47%	48%	46%	50%	46%	44%	47%	48%	42%	47%	2.1%
Illinois	49%	48%	51%	49%	51%	51%	51%	51%	51%	49%	50%	1.3%
New York	58%	55%	52%	52%	52%	52%	49%	52%	48%	43%	51%	4.0%
Virginia	61%	64%	62%	63%	60%	61%	58%	62%	58%	55%	60%	2.6%
Pennsylvania	61%	61%	61%	61%	61%	63%	63%	64%	62%	62%	62%	1.1%
Arkansas	64%	60%	59%	62%	60%	61%	64%	63%	63%	63%	62%	2.0%
Tennessee	66%	63%	63%	61%	60%	62%	65%	64%	64%	53%	62%	3.7%
North Carolina	64%	64%	64%	60%	62%	63%	63%	65%	64%	59%	63%	1.8%
Maryland	68%	68%	70%	67%	65%	67%	66%	66%	63%	61%	66%	2.7%
Alabama	67%	66%	66%	65%	66%	67%	69%	71%	67%	61%	67%	2.5%
Nebraska	65%	68%	64%	70%	65%	69%	68%	64%	69%	70%	67%	2.3%
Minnesota	69%	69%	69%	70%	69%	69%	68%	67%	64%	61%	67%	2.7%
Georgia	69%	67%	69%	68%	69%	72%	73%	74%	73%	70%	70%	2.4%
Michigan	79%	73%	71%	72%	71%	70%	71%	71%	70%	75%	72%	2.7%
Mississippi	67%	79%	74%	70%	73%	74%	74%	78%	78%	74%	74%	3.6%
Wisconsin	75%	75%	72%	74%	75%	79%	75%	75%	75%	73%	75%	1.8%
Louisiana	79%	75%	77%	78%	78%	78%	77%	77%	79%	77%	77%	1.1%
Kansas	80%	77%	80%	80%	78%	80%	77%	77%	78%	75%	78%	1.7%
Florida	79%	80%	80%	81%	82%	83%	82%	84%	82%	83%	82%	1.6%
Iowa	86%	87%	85%	86%	84%	84%	81%	83%	80%	74%	83%	3.6%
Texas	89%	88%	89%	90%	88%	88%	87%	87%	85%	84%	88%	1.8%
Missouri	86%	88%	88%	88%	89%	90%	89%	88%	87%	85%	88%	1.4%
Ohio	88%	88%	92%	94%	88%	90%	88%	89%	88%	88%	89%	1.9%
Oklahoma	96%	96%	97%	97%	94%	95%	96%	93%	92%	92%	95%	1.9%
Kentucky	97%	96%	95%	95%	96%	97%	97%	98%	98%	96%	96%	1.0%
West Virginia	99%	99%	99%	98%	98%	98%	98%	98%	98%	97%	98%	0.6%
Indiana	99%	99%	100%	99%	99%	99%	99%	99%	99%	98%	99%	0.5%

Table 13. Average Fossil Generation, Average Total Generation, Ratio of Average Fossil Generation to Average Total Generation, and Standard Deviation of Year-to-Year Ratio of Fossil Generation to Total Generation for each State in the Transport Rule.

State	**Average Fossil Generation (2000-2009) (MWH) (See Table 10)**	**Average Total Generation (2000-2009) (MWH) (See Table 11)**	**Average Fossil to Total (See Table 12)**	**Standard Deviation (Fossil to Total) (See Table 12)**
South Carolina	43,516,359	97,706,924	44%	1.6%
New Jersey	28,056,858	60,176,455	47%	2.1%
Illinois	95,820,892	190,696,017	50%	1.3%
New York	71,967,066	140,569,762	51%	4.0%
Virginia	45,566,459	75,364,292	60%	2.6%
Pennsylvania	131,779,143	212,843,359	62%	1.1%
Arkansas	31,462,309	50,807,590	62%	2.0%
Tennessee	58,138,138	93,451,303	62%	3.7%
North Carolina	78,497,479	124,687,564	63%	1.8%
Maryland	32,827,285	49,573,600	66%	2.7%
Alabama	91,146,090	136,930,886	67%	2.5%
Nebraska	21,196,374	31,563,108	67%	2.3%
Minnesota	35,607,537	52,812,929	67%	2.7%
Georgia	91,936,504	130,430,100	70%	2.4%
Michigan	81,911,104	113,345,748	72%	2.7%
Mississippi	33,993,274	45,600,790	74%	3.6%
Wisconsin	45,534,947	60,770,040	75%	1.8%
Louisiana	71,957,204	92,835,218	77%	1.1%
Kansas	36,308,421	46,491,935	78%	1.7%
Florida	173,677,521	212,385,512	82%	1.6%
Iowa	37,603,364	45,446,898	83%	3.6%
Texas	342,303,682	391,014,931	88%	1.8%
Missouri	75,971,718	86,520,973	88%	1.4%
Ohio	133,247,925	149,044,339	89%	1.9%
Oklahoma	61,873,906	65,479,876	95%	1.9%
Kentucky	91,534,357	94,911,266	96%	1.0%
West Virginia	88,210,476	89,720,558	98%	0.6%
Indiana	125,523,606	126,633,588	99%	0.5%
		Median	71%	1.9%
		Average	73%	2.1%
		Standard Deviation	16%	0.9%
		One Standard Deviation. Below Average	57%	
		Upper 95% Confidence Variability Level		3.9%