Technical Support Document (TSD)

for the Cross-State Air Pollution Rule for the 2008 Ozone NAAQS

Docket ID No. EPA-HQ-OAR-2015-0500

Ozone Transport Policy Analysis

Proposed Rule TSD

U.S. Environmental Protection Agency

Office of Air and Radiation

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This Technical Support Document (TSD) provides information that supports EPA's proposal to update the Cross-State Air Pollution Rule (CSAPR) to address the 2008 ozone National Ambient Air Quality Standards (NAAQS). This TSD includes analysis to quantify upwind state emissions that significantly contribute to nonattainment or interfere with maintenance of the NAAQS in downwind states; quantification of emissions budgets (i.e., limits on emissions); and illustrative analysis to evaluate compliance with the regulatory control alternatives. The analysis is described in detail in the preamble to the proposed rule. This TSD is organized as follows:

A. Background on EPA's Analysis to Quantify Emissions that Significantly Contribute to Nonattainment or Interfere with Maintenance of the 2008 ozone NAAQS

In the preamble, we describe EPA's multi-step process to identify upwind states' emissions that significantly contribute to nonattainment or interfere with maintenance with respect to the 2008 ozone NAAQS. This approach is consistent with the approach used in CSAPR. See section III of the preamble for an overview of this approach.

The approach first uses air quality analysis to identify nonattainment and maintenance receptors with respect to interstate transport for the 2008 ozone NAAQS. The approach then uses further air quality analysis to identify upwind states whose ozone pollution contributions to these monitoring sites meet or exceed a specified threshold amount of 1% of the NAAQS. See section V of the preamble for details of applying these steps with respect to interstate emissions transport for the 2008 ozone NAAQS.

The next step in the process identifies the EGU NO_x reductions in each state in response to ascending uniform NO_X cost thresholds. See section B in this TSD for discussion of this analysis. Next, the process uses the ozone Air Quality Assessment Tool (AQAT) to estimate the impact of the upwind state EGU NO_x reductions on downwind ozone pollution levels for the assessed EGU NO_x cost-per-ton levels. See section C in this TSD for discussion of the development and use of the ozone AQAT.

As described in the preamble, the EPA uses this air quality information in a multi-factor test, along with EGU NO_x reductions and costs, to select a cost threshold to quantify each state's significant contribution to nonattainment and interference with maintenance. The cost threshold assessment evaluates EGU NO_x mitigation potential for all states in the contiguous U.S. However, the EPA only evaluates EGU NO_x reductions in the multi-factor test from states that were “linked” and which have EGU NO_x reduction potential in at least one of the evaluated EGU NO_x cost thresholds. These states are listed in Table A-1 below. As described in preamble section VII, Delaware is “linked” to downwind ozone problems but is not currently regulated under CSAPR and does not have any EGU NO_x reduction potential at any of the cost thresholds evaluated. Therefore, the EPA is not proposing to include Delaware in the proposal and the EPA did not include Delaware in applying the multi-factor test.

Table A-1. States Evaluated in the Multi-factor Test

Ozone Season NO_x	
Alabama	New Jersey
Arkansas	New York
Illinois	North Carolina
Indiana	Ohio
Iowa	Oklahoma
Kansas	Pennsylvania
Kentucky	Tennessee
Louisiana	Texas
Maryland	Virginia
Michigan	West Virginia
Mississippi	Wisconsin
Missouri	

A set of Excel spreadsheet files containing ozone AQAT data supporting the determination of emissions that constitute significant contribution to nonattainment and interference with maintenance of downwind air quality is available in the docket for this rulemaking. Appendix B in this TSD describes these files.

B. Electric Generating Unit Significant Contribution Cost Analysis

EPA used the Integrated Planning Model (IPM) to analyze the ozone-season NO_x emissions reductions available from electric generating units (EGUs) at various uniform cost levels in each upwind state. IPM was also used to evaluate illustrative compliance with the proposal’s regulatory control alternatives (i.e., compliance with the proposed emissions budgets, with a more stringent alternative, and with a less stringent alternative).

IPM is a multiregional, dynamic, deterministic linear programming model of the U.S. electric power sector that EPA uses to analyze cost and emissions impacts of environmental policies. See “Documentation for EPA Base Case v.5.13 Using the Integrated Planning Model”, “EPA Base Case v.5.14 Using IPM Incremental Documentation. March 25, 2015”, and “EPA

Base Case v.5.15 Using IPM Incremental Documentation. August, 2015" for further description of the IPM model.[1]

Using IPM, the EPA first modeled a base case EGU emissions scenario (i.e., a scenario absent any emission reduction requirements related to this rule). The base case modeling includes the Title IV SO_2 cap and trade program; NO_x SIP Call regional ozone season cap and trade program; the CSAPR regional cap and trade programs; settlements; and state and federal rules as listed in the IPM documentation referenced above.

The air quality modeling for this proposal, including identifying nonattainment and maintenance receptors, performing contribution analysis, and modeling an illustrative control case relied on IPM v5.14. After the modeling analyses were underway, the EPA released an updated IPM base case, version 5.15, and the final Clean Power Plan (CPP). In order to reflect all on-the-books policies as well as the most current power sector modeling data, the EPA performed an assessment (described in this TSD) to reflect inclusion of IPM 5.15 with the CPP for this proposal.[2]

EPA modeled the emissions reductions that would occur within each state first from moving from the IPM v5.14 base case to the IPM v5.15 base case, and then from applying ascending cost thresholds of emissions control based on IPM v5.15 cost threshold scenarios. EPA designed a series of IPM runs that imposed increasing cost thresholds for ozone-season NO_x emissions and tabulated those projected emissions for each state at each cost level. EPA has referred to these tabulations as "cost curves".[3] The cost curves report the remaining emissions at each cost threshold after the state has made emission reductions that are available up to the particular cost threshold analyzed.

This part of the analysis applied ozone-season cost thresholds to all fossil-fuel-fired EGUs with a capacity greater than 25 MW in each state. Because of the time required to build advanced pollution controls, the model was prevented from building any new post-combustion controls, such as SCR or SNCR in 2017 in response to the cost thresholds.[4] The modeling does allow the turning on of idled existing SCR and SNCR, the optimization of existing SCR and SNCR, shifting generation to lower-NO_X emitting EGUs, and addition or upgrading of NO_x combustion controls in 2017, such as low NO_x burners (LNB).

In these scenarios, EPA imposed cost thresholds ranging from $500 per ton to $10,000 per ton of ozone-season NO_x. The IPM-projected EGU emissions of ozone-season NO_x from the

[1] http://www.epa.gov/airmarkets/powersectormodeling

[2] Changes between IPM v5.14 and v5.15 are documented in "EPA Base Case v. 5.15 Using IPM Incremental Documentation. August, 2015" available in the docket for this rule.

[3] These projected state level emissions for each "cost threshold" run are presented in several formats. The IPM analysis outputs available in the docket contain a "state emissions" file for each analysis. The file contains two worksheets. The first is titled "all units" and shows aggregate emissions for all units in the state. The second is titled "all fossil > 25MW" and shows emissions for a subset of these units that have a capacity greater than 25 MW. The emissions in the "all fossil > 25 MW" worksheet are used to derive the budgets for each upwind state at the cost thresholds determined to eliminate significant contribution to nonattainment or interference with maintenance in linked downwind states, in an average year.

[4] IPM results do include newly built 2017 post-combustion pollution control retrofits in base case modeling, cost curve runs, and remedy runs. These 2017 retrofits do not reflect any controls installed in response to the rule, but instead represent those that are already announced and/or under construction and expected to be online by 2017, or controls that were projected to be built in the base case in response to existing consent decree or state rule requirements.

"Fossil > 25 MW" units and "All Units" are shown at each cost threshold for 2017[5] in Tables B-1 and B-2.[6] For more information about EPA's adjustment of IPM outputs to reflect 2017, please see Appendix C.

As described in Preamble section VI, the EPA limited generation shifting potential to units within each state in IPM as an analytic proxy designed to respect the feasibility of near-term generation shifting in light of these potential near-term out-of-merit order dispatch constraints. The EPA conducted a separate analysis similar to the $1,300 per ton cost threshold scenario, except without limiting IPM's ability to shift generation between states. That analysis, described in detail Appendix F, showed a minimal impact on the overall tons of reductions available at the $1,300 per ton cost threshold (1,686 tons in the proposed Transport Rule states) and a minimal impact on state budgets (the largest percent change was a less than 3% decrease).

As explained in preamble section VI, EPA determined that $500/ton was the appropriate lowest cost threshold for ozone-season NO_x control for all potentially covered states in this rulemaking. EPA then used the ozone AQAT to identify improvements in downwind air quality at $500 per ton and, then, for the higher cost thresholds when that level did not completely resolve all nonattainment and maintenance to which each state was "linked". EPA examined cost levels of $500/ton, $1,300/ton, $3,400/ton, $5,000/ton, $6,400/ton, and $10,000/ton as a representative sampling of points along the NO_x cost curve. EPA selected these particular cost levels because analysis suggested they were associated either with costs when particular emission controls were widely available, reflected the costs examined for other EPA rules (e.g., $6,400/ton), or served as an upper-bound of the cost curve analysis (e.g., $10,000/ton).
At each cost threshold examined with the IPM model, the model outputs include state emission totals from "All Units" as well as from "All fossil > 25 MW". The "All Fossil > 25 MW" totals represent an approximation of emissions from EGUs subject to this rule. The resulting state ozone season NO_x emissions levels from "All Units" at each cost threshold analyzed were examined in the ozone AQAT to determine the impact on downwind air quality. The preamble explains how EPA considered the results of the cost and air quality analyses described in this TSD to determine the appropriate set of cost thresholds for reducing significant contribution to nonattainment and interference with maintenance. Because there are slight differences in the units labeled as "EGUs" in the air quality modeling and the "All Units" from IPM, in the ozone AQAT EPA used the difference in emissions between the base case emissions and the other cost

[5] See section 2.3.3 "Documentation for EPA Base Case v.5.13 Using the Integrated Planning Model" for a description about IPM model run years. Each year in the future is mapped to one of seven modeled years. While 2017 is mapped to the "2016" run year, for this analysis, EPA started with the 2018 run year and made small modifications to emissions to simulate 2017. Specifically, individual units that may be retiring, converting to gas, or retrofitting NO_x controls in 2018 were adjusted to match their expected operation in 2017. This approach provided a better estimate than using the "2016" run year because that run year would not capture similar fleet changes expected to occur before 2017. Additionally, it provides a better projection of allowance banking behavior, as the model would have two years to bank ozone-season NO_x allowances in the CSAPR ozone-season NO_x Phase 1 period, which matches the real world timeline.

[6] EPA notes that, while ozone-season emissions generally decline as the cost threshold increases, there are instances where a state may see a small increase in emissions at a higher cost threshold compared to a lower cost threshold analyzed. This is related to the interconnected, interstate nature of the grid, and the ability of generation to shift from a less efficient/higher emitting source in one state to a more efficient/lower emitting source in another state at higher cost levels. In other words, as multiple states experience the higher cost threshold on ozone-season NO_x, a region may minimize cost by dispatching more generation from lower-emitting-rate units in a particular state that counterintuitively raise that state's total ozone-season NO_x emissions, even as the regional ozone-season NO_x emissions decline as a result.

thresholds from “All Units”. The emission differences are shown in Table B-3. To construct total emissions for use in ozone AQAT, these differences were added to the total base case ozone season anthropogenic NO_x emissions used in the air quality modeling.

As described in the preamble, EPA developed state EGU NO_x emissions budgets for each of the three regulatory control alternatives. First, EPA calculated each covered state’s IPM ozone-season NO_x emission rate (i.e. lbs NO_x /MMBtu) from the $500, $1,300, and $3,400 per ton uniform cost threshold assessment. The state-level rate was calculated as the total emissions from affected sources within the state, divided by the total heat input from these sources.

Second, the EPA multiplied this modeled state-level emissions rate by 2014 reported historical state-level heat input. Multiplying the projected state-level emissions rate by historical heat input yielded state-specific ozone season EGU NO_X emissions. While the Energy Information Administration’s Annual Energy Outlook projects a slight increase in national generation from 2014 to 2017, it projects generation from fossil sources to decrease slightly (-0.4%). As electricity generation from fossil sources is projected to be almost unchanged from 2014 to 2017, the EPA did not adjust the 2014 heat input to calculate state-specific ozone season EGU NO_X emissions.

Third, the EPA added an adjustment to account for differences in unit and SCR availability and operation between the IPM run year of 2018 and the expected conditions applicable to calendar year 2017[7]. Appendix C explains the 2017 adjustments and shows the adjustments made by model plant.

Fourth, the EPA selected EGU emissions budgets as the lower of this calculated 2017 emission level and the 2014 historic monitored emissions. EPA conducted this analysis, and estimated a resulting “budget” of emissions, for 37 states and the District of Columbia in the Eastern U.S., whether or not this proposal would subject a given state to its emission budget estimated here. The state-level emission rate from IPM, the 2014 historic heat input, and the resulting ozone-season NO_x EGU emissions budgets are shown in Table B-4.
Finally, the EPA calculated the variability limits and assurance levels for each state based on the calculated emissions budgets. Each state’s variability limit is 21% of its budget, and its assurance level is the sum of its budget and variability limit, shown in Table B-5. Under the methodology established in the final Transport Rule, the state-specific portion of the NUSA (including the Indian Country NUSA) is calculated as the percentage equal to the projected emissions from “planned units” divided by the state budget plus a base two percent. The calculated existing unit allocation and new unit set aside (NUSA), including the Indian Country NUSA, for the proposed budgets is shown in table B-6.[8]

As explained in the preamble, EPA proposes to promulgate EGU NO_x ozone-season emissions budgets reflecting the uniform cost threshold of $1,300/ton to reduce significant contribution to nonattainment and interference with maintenance.

The IPM runs performed for the cost analyses are listed in Table Appendix A-1 in of this TSD. Table Appendix A-1 lists the name of each IPM run next to a description of the run. The output files of these model runs can be found in the rulemaking docket. In Tables B-1 through

[7] In modeling the three regulatory control alternatives in IPM, EPA did not include the 2017 budget adjustments. This allowed EPA to accurately understand the policy impacts of the regulatory alternatives for two reasons. First, the 2017 adjustments account for emissions that IPM does not have included in the 2018 run year. Including the adjustments would artificially inflate the 2018 cap since it would be adding in allowances that the model did not need. Second, using the 2018 model run year for analysis allowed units two years to use and bank allowances, matching the time that these units will have to use and bank allowances under CSAPR Phase 1.
[8] See ‘O3 NAAQS CSAPR Update -- NUSA Calculations’ (Excel spreadsheet) in the docket for this proposal.

B-4, the emissions are presented rounded to the nearest ton. A summary of the budgets and assurance levels can be found in Appendix D and detailed calculations can be found in Appendix E.

As noted above, EPA used the emissions shown in Table B-3 as inputs to the air quality assessment tool to estimate the impact that the combined reductions available from states covered under the proposal to update CSAPR, at different cost-per-ton levels, would have on air quality at downwind monitors that were identified as nonattainment and/or maintenance receptors for this proposal. Section C in this TSD describes EPA's development and use of the assessment tool and the results from our analysis.

Table B-1. 2017 Ozone Season NO_x EGU Emissions* for Each State at Various Pollution Control Cost Thresholds (CT) per Ton of Reduction (Tons) "Fossil >25 MW".

	5.14 Base Case	5.15 Base Case	$500/ton CT	$1300/ton CT	$3400/ton CT	$5000/ton CT	$6400/ton CT	$10000/ton CT	Less Stringent Control Alternative	Proposed Emissions Budgets	More Stringent Control Alternative
Alabama	11,821	13,289	11,560	9,708	9,620	8,509	7,871	7,450	11,792	10,182	10,221
Arizona	20,695	16,823	16,823	10,758	11,012	10,895	10,875	10,787	16,838	16,837	16,838
Arkansas	11,767	6,224	6,211	6,120	5,365	5,076	4,982	4,289	6,239	6,239	6,361
California	1,799	1,723	1,722	1,721	1,715	1,718	1,718	1,603	1,723	1,723	1,723
Colorado	14,369	13,000	12,999	12,964	12,316	12,051	11,619	10,888	13,000	13,000	13,000
Connecticut	382	409	408	408	381	362	362	336	408	408	408
Delaware	285	477	477	477	477	477	477	473	477	477	477
District of Columbia	0	0	0	0	0	0	0	0	0	0	0
Florida	28,786	25,345	24,138	18,812	18,200	18,052	17,626	17,410	25,584	25,733	25,769
Georgia	9,432	7,394	7,275	7,157	7,055	6,968	6,937	6,968	7,397	7,406	7,412
Idaho	0	42	36	36	35	35	35	35	43	39	41
Illinois	15,323	10,021	9,626	9,549	9,475	9,399	9,381	9,260	9,772	9,760	9,749
Indiana	43,122	41,748	35,137	29,575	28,759	27,978	28,310	24,639	35,095	30,285	30,270
Iowa	8,629	7,911	7,725	7,488	7,194	7,194	7,194	6,594	7,757	7,539	7,539
Kansas	11,434	11,332	10,904	10,894	10,867	10,654	10,494	10,182	10,904	10,904	10,904
Kentucky	38,933	27,141	23,533	15,245	14,759	14,668	13,685	12,638	24,143	15,916	15,966
Louisiana	13,662	10,897	10,833	10,780	10,497	10,436	10,430	10,191	10,900	10,812	10,807
Maine	222	261	261	261	261	253	249	248	261	261	261
Maryland	4,317	6,470	5,442	5,444	5,307	5,294	5,102	5,102	5,279	5,285	5,156
Massachusetts	652	863	912	874	860	825	754	699	866	866	863
Michigan	29,743	20,049	19,646	17,016	16,520	16,293	16,160	15,638	19,875	18,437	18,437
Minnesota	9,579	9,275	9,196	8,999	8,779	8,729	8,672	7,597	9,278	9,278	9,278
Mississippi	8,549	7,871	7,789	7,574	6,978	6,706	6,392	5,663	7,360	7,151	6,639
Missouri	18,495	17,050	16,116	16,054	15,897	15,752	15,120	14,275	16,144	16,180	16,218
Montana	8,498	7,756	7,743	7,743	7,743	7,719	7,719	7,719	7,756	7,756	7,756
Nebraska	14,164	14,173	14,173	13,770	10,921	10,742	10,284	9,248	14,173	14,173	14,173
Nevada	4,055	4,410	4,395	4,393	3,186	3,021	2,447	1,690	4,409	4,409	4,409
New Hampshire	140	140	140	140	140	139	139	138	140	140	140
New Jersey	3,980	3,302	2,932	2,931	2,924	2,921	2,918	2,837	2,439	2,438	2,433
New Mexico	17,248	17,356	17,356	16,848	16,850	16,721	16,272	15,989	17,356	17,356	17,356
New York	6,419	4,948	4,833	4,664	4,589	4,578	4,287	4,042	4,908	4,712	4,714
North Carolina	19,753	14,435	12,513	12,513	10,909	10,809	10,020	9,792	12,468	12,468	11,342
North Dakota	23,037	16,423	16,423	13,078	13,054	12,743	12,480	12,430	16,246	16,246	16,246
Ohio	27,785	27,795	22,049	18,149	18,129	18,022	17,718	17,564	22,050	18,369	18,369
Oklahoma	24,327	19,593	18,891	17,423	16,425	15,772	13,891	12,984	19,587	18,076	18,087
Oregon	212	0	0	0	0	0	0	0	0	0	0
Pennsylvania	50,517	41,661	39,451	14,902	14,870	14,748	14,729	14,657	40,466	15,152	15,150
Rhode Island	150	199	199	202	199	199	199	199	196	197	198
South Carolina	5,998	5,678	4,622	4,542	4,505	4,497	4,494	4,447	5,815	5,845	5,847
South Dakota	653	297	297	297	297	297	297	297	297	297	297
Tennessee	6,369	5,554	5,480	5,441	5,408	5,329	5,312	5,269	5,480	5,480	5,481
Texas	64,959	58,199	57,513	54,589	52,389	51,259	50,427	49,819	58,227	56,145	56,188
Utah	25,153	24,482	24,482	21,011	21,011	20,071	19,839	18,984	24,482	24,482	24,482
Vermont	3	3	3	3	3	3	3	3	3	3	3
Virginia	8,130	7,196	6,773	6,656	5,609	4,092	3,636	3,586	7,247	6,877	6,906
Washington	146	136	136	136	136	136	136	70	136	136	136
West Virginia	25,326	25,384	24,792	14,475	13,369	13,173	13,141	13,141	24,792	14,475	13,369
Wisconsin	8,214	5,257	5,252	5,221	5,150	5,126	4,981	4,639	5,251	5,251	5,251
Wyoming	14,281	10,796	10,724	10,167	9,258	9,244	8,810	8,334	10,796	10,796	10,796
Nationwide	**661,514**	**570,787**	**539,942**	**457,206**	**439,404**	**397,120**	**386,293**	**367,409**	**511,907**	**486,000**	**451,848**

*Source: Integrated Planning Model run by EPA, 2015. See Appendix A for list and description of these IPM runs. Emissions have been rounded to the nearest ton. Emissions shown for all fossil-fired units greater than 25 MW when only an ozone season cost constraint is applied. Costs are in 2011$.

Table B-2. 2017 Ozone Season NO_x EGU Emissions* for Each State at Various Pollution Control Cost Thresholds (CT) per Ton of Reduction (Tons) "All Units".

	5.14 Base Case	5.15 Base Case	$500/ton CT	$1300/ton CT	$3400/ton CT	$5000/ton CT	$6400/ton CT	$10000/ton CT	Less Stringent Control Alternative	Proposed Emissions Budgets	More Stringent Control Alternative
Alabama	12,151	13,592	11,863	10,015	9,944	8,846	8,219	7,797	12,095	10,486	10,531
Arizona	20,835	16,960	16,961	10,895	11,150	11,032	11,012	10,924	16,975	16,975	16,975
Arkansas	11,890	6,399	6,386	6,295	5,624	5,335	5,254	4,560	6,414	6,414	6,536
California	4,122	3,789	3,789	3,788	3,781	3,786	3,785	3,670	3,789	3,789	3,789
Colorado	14,897	13,467	13,467	13,444	12,835	12,584	12,176	11,541	13,467	13,467	13,467
Connecticut	1,587	1,607	1,607	1,610	1,589	1,570	1,570	1,544	1,607	1,607	1,607
Delaware	388	580	580	580	580	580	580	576	580	580	580
District of Columbia	0	0	0	0	0	0	0	0	0	0	0
Florida	33,539	30,046	28,840	23,522	22,968	22,820	22,397	22,190	30,284	30,433	30,469
Georgia	9,535	7,498	7,378	7,260	7,159	7,072	7,041	7,072	7,501	7,510	7,516
Idaho	206	251	244	245	245	246	246	246	252	248	249
Illinois	15,810	11,002	10,627	10,564	10,493	10,427	10,415	10,295	10,773	10,761	10,750
Indiana	43,910	42,496	35,885	30,374	29,590	28,811	29,143	25,797	35,843	31,033	31,018
Iowa	9,364	8,307	8,190	7,951	7,913	7,913	7,940	7,342	8,153	7,935	7,935
Kansas	11,694	11,820	11,393	11,424	11,602	11,426	11,393	11,766	11,393	11,393	11,393
Kentucky	38,993	27,201	23,593	15,306	14,848	14,756	13,774	12,726	24,203	15,976	16,027
Louisiana	13,925	11,162	11,127	11,074	10,791	10,739	10,741	10,535	11,166	11,077	11,083
Maine	1,609	1,565	1,565	1,565	1,565	1,557	1,552	1,552	1,565	1,565	1,565
Maryland	5,107	7,324	6,295	6,297	6,160	6,147	5,955	5,955	6,132	6,138	6,009
Massachusetts	1,956	2,219	2,268	2,229	2,221	2,186	2,115	2,069	2,222	2,222	2,219
Michigan	32,421	22,233	21,858	19,340	18,862	18,713	18,717	18,677	22,073	20,635	20,635
Minnesota	11,501	11,223	11,145	10,947	10,743	10,691	10,650	9,576	11,226	11,226	11,226
Mississippi	8,951	8,299	8,217	8,002	7,416	7,208	6,895	6,258	7,788	7,579	7,067
Missouri	20,632	18,663	17,732	17,705	17,767	17,881	17,322	17,113	17,757	17,793	17,831
Montana	8,502	7,759	7,746	7,746	7,746	7,722	7,722	7,722	7,759	7,759	7,759
Nebraska	14,548	14,613	14,613	14,237	11,388	11,209	10,752	9,786	14,579	14,577	14,578
Nevada	4,192	4,547	4,532	4,530	3,323	3,158	2,584	1,840	4,546	4,546	4,546
New Hampshire	301	289	289	289	294	296	295	299	289	289	289
New Jersey	4,617	3,950	3,581	3,580	3,576	3,573	3,570	3,489	3,091	3,090	3,085
New Mexico	17,266	17,372	17,372	16,940	16,942	16,813	16,364	16,238	17,372	17,372	17,372
New York	9,123	7,911	7,807	7,638	7,578	7,579	7,305	7,072	7,870	7,675	7,676
North Carolina	22,048	17,307	15,385	15,389	13,784	13,685	12,895	12,774	15,341	15,341	14,215
North Dakota	23,037	16,423	16,423	13,078	13,054	12,743	12,480	12,430	16,246	16,246	16,246
Ohio	29,693	29,249	23,503	19,603	19,583	19,785	19,545	19,473	23,504	19,823	19,823
Oklahoma	24,335	19,620	18,918	17,450	16,452	15,799	13,930	13,023	19,614	18,103	18,114
Oregon	1,038	800	800	800	800	800	800	800	800	800	800
Pennsylvania	52,173	43,599	41,389	16,834	16,826	16,704	16,686	16,613	42,421	17,094	17,087
Rhode Island	208	257	257	260	257	257	257	257	254	255	256
South Carolina	6,183	5,875	4,819	4,739	4,701	4,693	4,690	4,721	6,016	6,046	6,047
South Dakota	653	297	297	297	297	297	297	297	297	297	297
Tennessee	6,382	5,566	5,492	5,454	5,446	5,367	5,350	5,307	5,493	5,493	5,494
Texas	66,651	59,199	58,570	56,391	54,406	53,283	52,529	52,707	59,228	57,146	57,223
Utah	25,160	24,489	24,489	21,018	21,018	20,078	19,846	19,209	24,489	24,489	24,489
Vermont	198	163	163	163	163	163	163	163	163	163	163
Virginia	11,254	9,201	8,778	8,662	7,809	6,292	6,182	6,339	9,252	8,882	8,911
Washington	1,002	747	747	747	747	747	747	926	747	747	747
West Virginia	25,606	25,664	25,071	14,755	13,649	13,453	13,421	13,421	25,071	14,755	13,649
Wisconsin	8,801	5,923	5,920	5,906	5,845	5,825	5,674	5,331	5,917	5,917	5,917
Wyoming	14,281	10,796	10,724	10,167	9,258	9,245	8,812	8,345	10,796	10,796	10,796
Nationwide	**702,278**	**609,317**	**578,695**	**497,105**	**480,788**	**397,120**	**386,293**	**367,409**	**511,907**	**524,543**	**451,848**

*Source: Integrated Planning Model run by EPA, 2015. See Appendix A for list and description of these IPM runs. Emissions have been rounded to the nearest ton. Emissions shown for all fossil-fired units greater than 25 MW when only an ozone season cost constraint is applied. Costs are in 2011$.

Table B-3. Emission Differences between the 5.14 Base Case and the Other Pollution Control Cost Thresholds (Tons) from "All Units".

	5.14 Base Case	5.15 Base Case	$500/ton CT	$1300/ton CT	$3400/ton CT	$5000/ton CT	$6400/ton CT	$10000/ton CT	Less Stringent Control Alternative	Proposed Emissions Budgets	More Stringent Control Alternative
Alabama	0	1,441	-288	-2,136	-2,207	-3,305	-3,932	-4,354	-56	-1,665	-1,620
Arizona	0	-3,874	-3,874	-9,940	-9,685	-9,802	-9,822	-9,911	-3,860	-3,860	-3,860
Arkansas	0	-5,492	-5,505	-5,595	-6,267	-6,555	-6,637	-7,330	-5,476	-5,476	-5,355
California	0	-333	-333	-334	-341	-336	-337	-452	-333	-333	-333
Colorado	0	-1,430	-1,430	-1,453	-2,062	-2,313	-2,721	-3,356	-1,430	-1,430	-1,430
Connecticut	0	20	19	22	2	-17	-17	-44	20	20	20
Delaware	0	192	192	192	192	192	192	188	192	192	192
District of Columbia	0	0	0	0	0	0	0	0	0	0	0
Florida	0	-3,493	-4,700	-10,017	-10,571	-10,719	-11,142	-11,350	-3,255	-3,106	-3,070
Georgia	0	-2,038	-2,157	-2,275	-2,376	-2,464	-2,494	-2,463	-2,035	-2,025	-2,019
Idaho	0	44	38	38	39	39	39	39	45	42	43
Illinois	0	-4,808	-5,183	-5,245	-5,317	-5,383	-5,394	-5,515	-5,037	-5,049	-5,060
Indiana	0	-1,414	-8,025	-13,536	-14,320	-15,099	-14,767	-18,113	-8,067	-12,877	-12,892
Iowa	0	-1,057	-1,174	-1,413	-1,452	-1,452	-1,424	-2,023	-1,211	-1,429	-1,429
Kansas	0	126	-301	-271	-93	-269	-301	71	-301	-301	-301
Kentucky	0	-11,792	-15,400	-23,687	-24,146	-24,237	-25,220	-26,267	-14,790	-23,017	-22,967
Louisiana	0	-2,764	-2,798	-2,851	-3,134	-3,187	-3,185	-3,391	-2,760	-2,849	-2,843
Maine	0	-44	-44	-44	-44	-52	-57	-57	-44	-44	-44
Maryland	0	2,217	1,189	1,191	1,053	1,041	848	848	1,026	1,032	903
Massachusetts	0	262	312	273	264	230	158	113	265	265	262
Michigan	0	-10,188	-10,563	-13,081	-13,559	-13,708	-13,704	-13,744	-10,348	-11,786	-11,786
Minnesota	0	-278	-356	-553	-758	-810	-851	-1,925	-275	-275	-275
Mississippi	0	-653	-734	-949	-1,536	-1,743	-2,056	-2,693	-1,163	-1,372	-1,884
Missouri	0	-1,969	-2,900	-2,927	-2,865	-2,751	-3,310	-3,519	-2,875	-2,839	-2,801
Montana	0	-743	-756	-756	-756	-780	-780	-780	-743	-743	-743
Nebraska	0	65	65	-311	-3,160	-3,339	-3,796	-4,762	31	29	30
Nevada	0	355	340	338	-868	-1,034	-1,608	-2,352	355	354	354
New Hampshire	0	-12	-12	-12	-7	-5	-6	-2	-12	-12	-12
New Jersey	0	-667	-1,036	-1,037	-1,041	-1,044	-1,047	-1,128	-1,526	-1,528	-1,532
New Mexico	0	106	106	-326	-324	-452	-902	-1,027	106	106	106
New York	0	-1,213	-1,317	-1,486	-1,545	-1,545	-1,818	-2,051	-1,253	-1,448	-1,447
North Carolina	0	-4,741	-6,663	-6,659	-8,263	-8,363	-9,153	-9,274	-6,707	-6,707	-7,833
North Dakota	0	-6,614	-6,614	-9,959	-9,983	-10,295	-10,557	-10,607	-6,791	-6,791	-6,791
Ohio	0	-444	-6,190	-10,090	-10,110	-9,908	-10,147	-10,220	-6,189	-9,870	-9,870
Oklahoma	0	-4,714	-5,417	-6,884	-7,883	-8,535	-10,404	-11,311	-4,720	-6,232	-6,220
Oregon	0	-238	-238	-238	-238	-238	-238	-238	-238	-238	-238
Pennsylvania	0	-8,575	-10,785	-35,339	-35,347	-35,469	-35,488	-35,560	-9,752	-35,079	-35,086
Rhode Island	0	49	49	52	49	49	49	49	47	48	48
South Carolina	0	-308	-1,365	-1,444	-1,482	-1,491	-1,493	-1,462	-167	-137	-136
South Dakota	0	-356	-356	-356	-356	-356	-356	-356	-356	-356	-356
Tennessee	0	-816	-890	-928	-937	-1,015	-1,032	-1,075	-890	-889	-888
Texas	0	-7,452	-8,081	-10,260	-12,245	-13,369	-14,123	-13,944	-7,423	-9,506	-9,428
Utah	0	-671	-671	-4,142	-4,142	-5,082	-5,314	-5,951	-671	-671	-671
Vermont	0	-36	-36	-36	-36	-36	-36	-36	-36	-36	-36
Virginia	0	-2,054	-2,476	-2,593	-3,445	-4,962	-5,072	-4,915	-2,002	-2,372	-2,343
Washington	0	-256	-256	-256	-256	-256	-256	-76	-256	-256	-256
West Virginia	0	57	-535	-10,851	-11,957	-12,153	-12,185	-12,185	-535	-10,851	-11,957
Wisconsin	0	-2,878	-2,881	-2,894	-2,955	-2,976	-3,127	-3,469	-2,884	-2,884	-2,884
Wyoming	0	-3,486	-3,558	-4,115	-5,023	-5,037	-5,470	-5,937	-3,486	-3,486	-3,486
Nationwide	**0**	**-92,961**	**-123,583**	**-205,173**	**-221,490**	**-230,390**	**-240,492**	**-253,916**	**-117,865**	**-177,736**	**-180,222**

*Source: Integrated Planning Model run by EPA, 2015. See Appendix A for list and description of these IPM runs. Emissions have been rounded to the nearest ton. Emissions shown for all fossil-fired units greater than 25 MW when only an ozone season cost constraint is applied. Costs are in 2011$.

Table B-4. 2014 Heat Input, Emission Rates, and State Budgets

		Less Stringent Control Alternative			Proposed Alternative			More Stringent Control Alternative		
State	**2014 Heat Input (MMBtu)**	**2018 IPM Emission Rate**	**2018 IPM Emission Rate * 2014 Heat Input**	**2017 Budget (w/2017 Adjustment and 2014 Historic Emission Limiter)**	**2018 IPM Emission Rate**	**2018 IPM Emission Rate * 2014 Heat Input (Historic * IPM Rate)**	**2017 Budget (w/2017 Adjustment and 2014 Historic Emission Limiter) (w/ 2017 Adjustment)**	**2018 IPM Emission Rate**	**2018 IPM Emission Rate * 2014 Heat Input (Historic * IPM Rate)**	**2017 Budget (w/2017 Adjustment and 2014 Historic Emission Limiter) (w/ 2017 Adjustment)**
Alabama	410,477,094	0.058	11,886	11,886	0.049	9,979	9,979	0.048	9,931	9,931
Arkansas	185,511,093	0.076	6,987	7,038	0.075	6,898	6,949	0.066	6,051	6,101
Illinois	388,382,456	0.063	12,121	12,144	0.062	12,069	12,078	0.062	11,992	11,992
Indiana	447,417,615	0.150	33,483	33,483	0.126	28,284	28,284	0.123	27,585	27,585
Iowa	151,989,571	0.113	8,614	8,614	0.110	8,351	8,351	0.107	8,118	8,118
Kansas	154,921,650	0.120	9,278	9,278	0.120	9,272	9,272	0.120	9,259	9,259
Kentucky	380,694,315	0.184	28,320	32,783	0.119	19,350	21,519	0.116	18,776	20,945
Louisiana	326,662,000	0.097	15,844	15,861	0.097	15,790	15,807	0.094	15,360	15,378
Maryland	86,239,563	0.098	2,155	4,026	0.098	2,160	4,026	0.096	2,160	4,026
Michigan	307,723,171	0.145	20,186	22,022	0.126	17,279	19,115	0.123	16,646	18,624
Mississippi	172,406,970	0.071	6,083	6,083	0.069	5,910	5,910	0.064	5,487	5,487
Missouri	330,006,788	0.093	14,257	15,380	0.093	14,113	15,323	0.092	13,740	15,240
New Jersey	112,887,439	0.036	2,016	2,016	0.036	2,015	2,015	0.036	2,011	2,011
New York	235,619,397	0.039	4,607	4,607	0.038	4,450	4,450	0.037	4,391	4,391
North Carolina	315,255,877	0.078	12,278	12,278	0.078	12,275	12,275	0.068	10,705	10,705
Ohio	457,251,027	0.088	20,194	20,194	0.073	16,660	16,660	0.073	16,637	16,637
Oklahoma	236,715,186	0.158	16,215	16,215	0.145	16,215	16,215	0.138	16,215	16,215
Pennsylvania	508,608,673	0.151	38,270	38,270	0.057	14,387	14,387	0.056	14,358	14,358
Tennessee	196,132,311	0.056	5,520	5,520	0.056	5,481	5,481	0.056	5,449	5,449
Texas	1,474,773,212	0.083	58,492	58,492	0.079	57,970	58,002	0.076	55,764	55,864
Virginia	179,324,728	0.078	6,955	6,955	0.076	6,818	6,818	0.065	5,834	5,834
West Virginia	317,087,558	0.145	22,932	22,932	0.084	13,390	13,390	0.078	12,367	12,367
Wisconsin	205,305,933	0.054	5,588	5,588	0.054	5,561	5,561	0.054	5,511	5,511

Table B-5. 2017 State Budgets, Variability Limits, and Assurance Levels

	Less Stringent Alternative			Proposed Budgets and Assurance Levels			More Stringent Alternative		
State	**2017 Budgets**	**2017 Variability Limit**	**2017 Assurance Level**	**2017 Budgets**	**2017 Variability Limit**	**2017 Assurance Level**	**2017 Budgets**	**2017 Variability Limit**	**2017 Assurance Level**
Alabama	11,886	2,496	14,382	9,979	2,096	12,075	9,931	2,086	12,017
Arkansas	7,038	1,478	8,516	6,949	1,459	8,408	6,101	1,281	7,382
Illinois	12,144	2,550	14,694	12,078	2,536	14,614	11,992	2,518	14,510
Indiana	33,483	7,031	40,514	28,284	5,940	34,224	27,585	5,793	33,378
Iowa	8,614	1,809	10,423	8,351	1,754	10,105	8,118	1,705	9,823
Kansas	9,278	1,948	11,226	9,272	1,947	11,219	9,259	1,944	11,203
Kentucky	32,783	6,884	39,667	21,519	4,519	26,038	20,945	4,398	25,343
Louisiana	15,861	3,331	19,192	15,807	3,319	19,126	15,378	3,229	18,607
Maryland	4,026	845	4,871	4,026	845	4,871	4,026	845	4,871
Michigan	22,022	4,625	26,647	19,115	4,014	23,129	18,624	3,911	22,535
Mississippi	6,083	1,277	7,360	5,910	1,241	7,151	5,487	1,152	6,639
Missouri	15,380	3,230	18,610	15,323	3,218	18,541	15,240	3,200	18,440
New Jersey	2,016	423	2,439	2,015	423	2,438	2,011	422	2,433
New York	4,607	967	5,574	4,450	935	5,385	4,391	922	5,313
North Carolina	12,278	2,578	14,856	12,275	2,578	14,853	10,705	2,248	12,953
Ohio	20,194	4,241	24,435	16,660	3,499	20,159	16,637	3,494	20,131
Oklahoma	16,215	3,405	19,620	16,215	3,405	19,620	16,215	3,405	19,620
Pennsylvania	38,270	8,037	46,307	14,387	3,021	17,408	14,358	3,015	17,373
Tennessee	5,520	1,159	6,679	5,481	1,151	6,632	5,449	1,144	6,593
Texas	58,492	12,283	70,775	58,002	12,180	70,182	55,864	11,731	67,595
Virginia	6,955	1,461	8,416	6,818	1,432	8,250	5,834	1,225	7,059
West Virginia	22,932	4,816	27,748	13,390	2,812	16,202	12,367	2,597	14,964
Wisconsin	5,588	1,173	6,761	5,561	1,168	6,729	5,511	1,157	6,668

Table B-6. Existing Unit Allocation and NUSA Calculations for Proposed Budgets.

	Proposed 2017 Budgets	Existing Unit Allocation	NUSA	Non Indian Country NUSA (tons)	Indian Country NUSA (tons)
Alabama	9,979	9,774	205	205	
Arkansas	6,949	6,808	141	141	
Illinois	12,078	11,487	591	591	
Indiana	28,284	27,719	565	565	
Iowa	8,351	7,932	419	411	8
Kansas	9,272	8,991	281	272	9
Kentucky	21,519	20,872	647	647	
Louisiana	15,807	15,179	628	612	16
Maryland	4,026	3,541	485	485	
Michigan	19,115	18,733	382	363	19
Mississippi	5,910	5,320	590	584	6
Missouri	15,323	15,009	314	314	
New Jersey	2,015	864	1,151	1,151	
New York	4,450	4,357	93	89	4
North Carolina	12,275	12,027	248	236	12
Ohio	16,660	16,323	337	337	
Oklahoma	16,215	15,890	325	309	16
Pennsylvania	14,387	13,370	1,017	1,017	
Tennessee	5,481	5,372	109	109	
Texas	58,002	55,092	2,910	2,852	58
Virginia	6,818	4,974	1,844	1,844	
West Virginia	13,390	13,122	268	268	
Wisconsin	5,561	5,440	121	115	6

C. Analysis of Significant Contribution Using an Ozone Air Quality Assessment Tool

EPA has defined significant contribution to nonattainment and interference with maintenance of downwind air quality using a multi-factor test (described in the preamble) which is based on cost, emissions, and air quality factors. A key quantitative input for determining the amount of significant contribution is the predicted downwind ambient air quality impacts of upwind EGU emission reductions under the various NO_x cost thresholds described in section B of this TSD. Time and resource limitations (in particular the amount of time needed to set up, run the CAMx model,[9] and analyze the results for a single model run precluded the use of full air quality modeling for all but a few emissions scenarios. Because EPA needed to evaluate emission reductions under several different NO_x cost thresholds, it was not possible to use CAMx air quality modeling to evaluate all cases.

Consequently, EPA used a simplified assessment tool to estimate the downwind air quality impacts from the NO_x cost thresholds. For the NO_x cost thresholds, the state-by-state EGU emissions are projected using EPA's IPM model under a given cost threshold of emission reductions (see section B of this TSD for details about the IPM model runs and for the emission projections). The air quality impacts of these cost thresholds are then estimated using the ozone AQAT. The inputs and outputs of the tool can be found in the "ozone_AQAT.xlsx" excel workbook. The simplified tool allows the Agency to analyze many more NO_x cost thresholds than would otherwise be possible. The remainder of section C of this document will:

- Present an introduction and overview of the ozone AQAT;
- Describe the construction of the ozone AQAT;
- Provide the results of the NO_x cost threshold analyses;

1. Introduction: Development of the ozone AQAT

The ozone AQAT was developed specifically for use in the rule's significant contribution analysis. EPA described and used a similar tool in CSAPR to evaluate fine particulate matter (PM2.5) significant contribution. For this rule, EPA refined both the construction and application of the assessment tool for use in estimating change in ozone concentrations in response to changes in NO_x emissions. One important change between CSAPR and this effort is to use the ozone AQAT to examine changes in ozone. We follow the methodology developed in the final CSAPR where we calibrate the response of a pollutant[10] using two CAMx simulations at different emission levels. In this rule, we used CAMx to calibrate the assessment tool's predicted change in ozone concentrations to changes in NO_x emissions. This calibration is

[9] See the Air Quality Modeling TSD, or "Updated Air Quality Modeling Technical Support Document for the 2008 Ozone NAAQS Transport Assessment" for additional details. www.epa.gov/airtransport/pdfs/Updated_2008_Ozone_NAAQS_Transport_AQModeling_TSD.pdf and the Emission inventory information relevant to the 2011 and 2018 simulations , available at www.epa.gov/ttn/chief/emch/index.html

[10] In CSAPR, we estimated changes in sulfate using changes in SO_2 emissions.

receptor-specific and is based on the changes in NO_x emissions and resulting ozone concentrations between the 2017 base case and the modeled illustrative control case[11] in 2017.

A critical factor in the assessment tool is the establishment of a relationship between ozone-season NO_x emission reductions and reductions in ozone. For the purposes of developing and using an assessment tool to compare the air quality impacts of NO_x emission reductions under various cost thresholds, we determine the relationship between changes in emissions and changes in ozone contributions on a receptor-by-receptor basis. Specifically, EPA assumed that, within the range of total NO_x emissions being considered (as defined by the NO_x cost thresholds), a change in ozone-season NO_x emissions leads to a proportional change in downwind ozone contributions[12]. This proportional relationship was then modified using calibration factors based on air quality modeling, as described below.

Within the assessment tool, the relationships between upwind emissions and downwind air quality are defined using the 2017 base case contribution air quality modeling and a 2017 illustrative control case. As described in the Air Quality Modeling TSD, CAMx state-by-state source-apportionment modeling was used to quantify the contributions to ozone at monitoring sites due to NO_x emissions from each upwind state for the 2017 base case emission scenario. For example, from the output of the CAMx source apportionment modeling, we know the ozone contribution at a downwind monitor resulting from the specific NO_x emissions in the 2017 base case from a particular upwind state. In the ozone AQAT, we associate a change in emissions from that upwind state with a particular change in its downwind contribution. In the "uncalibrated" ozone AQAT, for example, we assume that a 20% decrease in the upwind state's emissions leads to a 20% decrease in its downwind ozone contribution. This relationship is calibrated using emission reductions from the 2017 base case to the 2017 illustrative control case[13] by calculating the relationship between the relative change in ozone at each receptor using CAMx air quality modeling and the relative change in ozone at each receptor using the ozone AQAT. Using this relationship, it was possible to calibrate the ozone AQAT's ozone response for use in assessing ozone under various NO_x cost thresholds. This is described further in section C.2 of this document. For the example above, where a 20% reduction in emissions resulted in a 20% decrease in contribution, using "calibrated" ozone AQAT may yield, for example, a 10% reduction in concentration from the 20% reduction in emissions (as derived directly from the emission reduction and concentration change from the 2017 base case to the 2017 illustrative control case).

In the application of the uncalibrated ozone AQAT, we assume that the reduction of a ton of emissions of NO_x from the upwind state has an equivalent air quality effect downwind (on an

[11] An integral input to the creation and use of the assessment tool was CAMx air quality modeling of the control scenario used in calibration. This "illustrative control case" was created during the development of the assessment tool for the proposed rule and its EGU emissions modeling reflects the geography and cost threshold from the control scenario at $1,300/ton for ozone-season NO_x using IPM v. 5.14. Note that the emission reductions for this scenario differ from the final values used in the proposed rule.

[12] The relationship between NO_x emissions and ozone concentrations is known to be non-linear when examined over large ranges of NO_x emissions (e.g., Seinfeld and Pandis, pp 236-236). However, for some ranges of NO_x, VOC, and meteorological conditions, the relationship may be reasonably linear. In this assessment tool, we are assuming a linear relationship between NO_x emissions and ozone concentrations. This assumption is reasonable because the changes in NO_x emissions and ozone concentrations are small (a few ppb), and the results are "bracketed" using two modeled scenarios. Over this range, a majority of the nonlinearity in the relationship between emissions and concentrations is directly accounted for by the air quality model.

[13] The illustrative control case is an EGU NO_x ozone-season emission budget sensitivity scenario, reflecting emission reductions in the 23 eastern states that the EPA proposes to regulate under this rule.

air quality impact per ton basis), regardless of source sector or the location of the particular emission source within the state where the ton was reduced. For example, reducing one ton of NO_x emissions from the power sector is assumed to have the same downwind ozone reduction as reducing one ton of NO_x emissions of from the mobile source sector. For this rule, we are examining all emission reductions within a 2017 time-frame. Consequently, only reductions from the power sector are anticipated. Because the calibration factor is based only on modeling of 2017 with only emission reductions from the power sector, the calibration factor and thereby calibrated ozone AQAT better represents changes in emissions in the power sector.

Because the tool is only being used over a fairly narrow range (for which a calibration factor has been developed), and because other options such as using CAMx to model all other scenarios is cost and time-prohibitive, EPA proposes to use ozone AQAT as a cost-effective tool for estimating the downwind ozone reductions due to upwind NO_x emission reductions for the air quality input to the multi-factor test for this rule. Other options, such as directly scaling the results (i.e., an "uncalibrated ozone AQAT") will likely greatly overestimate the air quality impacts of emission reductions.

Section C.2, below, is a technical explanation of the construction of the ozone AQAT. Readers who prefer to access the results of the analysis using the ozone AQAT are directed to section C.3.

2. Details on the construction of the ozone AQAT

(a) Overview of the ozone AQAT

This section describes the step-by-step development process for the ozone AQAT. All of the input and output data can be found in the Excel worksheets described in Appendix B. In the ozone AQAT, EPA links state-by-state NO_x emission reductions (from IPM) with CAMx modeled ozone contributions in order to predict ozone concentrations at different cost thresholds at monitoring sites with projected nonattainment and/or maintenance problems in the 2017 base case. The reduction in ozone contributions and resulting air quality improvement were then considered in a multi-factor test for defining significant contribution to nonattainment and interference with maintenance. In the analysis for a given receptor, emissions were reduced in only those upwind states that were "linked" to that receptor (i.e., contributed an air quality impact at or above the 1 percent -- of the NAAQS standard -- air quality threshold) as well as the state that contained that receptor (regardless of that state's contribution). For a discussion of the 1% threshold, see preamble section V.

Specifically, the key estimates from the ozone AQAT for each receptor are:

- The ozone contribution as a function of emissions at each cost threshold, for each upwind state that is contributing above the 1 percent air quality threshold and the state containing the receptor.
- The ozone contribution under base case NO_x emissions (i.e., the IPM 5.14 base case), for each upwind state that is not above the 1 percent air quality threshold for that receptor. These base level emissions may be different/reduced in other scenarios (i.e., the IPM 5.15 base case) due to projected changes in the EGU sector (see section B and references therein for additional details).

- The non-anthropogenic (i.e., background, boundary, biogenic, and wildfire) ozone concentrations (these are assumed to be constant and equal to the contributions from the 2017 source apportionment modeling (using IPM v. 5.14).

The results of the ozone AQAT analysis for each cost threshold can be found in section C.3 of this document.

(b) Data used to construct the ozone AQAT for this rule

Several data sources were used to construct the calibrated ozone AQAT for this rule. Three data sources provide the necessary initial information to construct the uncalibrated versions of the ozone AQAT. The uncalibrated versions of the ozone AQAT were used to create estimates of ozone response under NO_x emissions defined by the illustrative control case. The datasets required to construct the ozone AQAT included: the 2017 base case ozone-season NO_x emission inventories from all source sectors used in the source apportionment CAMx air quality modeling (this includes all anthropogenic sources and excludes biogenic sources and wildfires); the CAMx 2017 ozone-season contributions for each upwind state to each downwind receptor; and the 2017 illustrative control case ozone-season NO_x emissions inventories from all source sectors. An additional dataset, 2017 ozone concentrations from CAMx for the illustrative control case, was used to compare the ozone AQAT-estimated ozone concentrations for this scenario to the corresponding air quality modeling results, and develop calibration factors to align the response of ozone to changes in NO_x emissions in the ozone AQAT with the response predicted by CAMx. These calibration factors were then used to create a "calibrated" ozone AQAT. Finally, EGU ozone-season NO_x emissions (from IPM) at each cost threshold were used to generate ozone AQAT air quality results using the calibrated ozone AQAT. The base case emissions inventories for the 2017 base case (using both versions 5.14 and 5.15 versions of IPM for EGUs), as well as the CAMx 2017 base case source apportionment air quality modeling results are discussed in preamble section V. The ozone-season NO_x EGU emissions for each cost threshold (projected using IPM), including the base case, are listed in Table B-2 and described in section B of this TSD.

As described in the Air Quality Modeling TSD and the preamble, the air quality contributions and emissions were modeled for all states[14] in the contiguous US. Thus, in the ozone AQAT, these states had the possibility of making reductions in emissions leading to changes in air quality contributions at the downwind receptors. Additionally, due to the modeling domain, the ozone AQAT is only able to estimate changes in ozone concentrations from monitors within these states[15].

(c) Detailed outline of the process for constructing and utilizing the ozone AQAT

The ozone AQAT was created and used in a multi-step process. First, a version of the ozone AQAT was created specifically for calibration. As described in the following paragraphs, the ozone AQAT simulated the response of ozone to reductions in emissions of NO_x. Next, the

[14] The District of Columbia was also modeled.

[15] Because the illustrative control case does not include emission changes in some upwind states (e.g., states in the western portion of the domain), calibration factors developed for these states, and the resulting changes in air quality, may not be representative.

relative ozone response from the ozone AQAT was calibrated to the ozone response from CAMx using the change in emissions from the 2017 base case to the illustrative control case. Next, the calibrated ozone AQAT was used to evaluate the ozone response of emission reductions for each NO_x cost threshold assessed. At each cost threshold, the state-specific calibrated ozone estimates were combined with other constituents from the base case resulting in estimated ozone design values.[16]

The illustrative control case played a key role in calibrating the assessment tool for use in the rule. One intent of this control scenario was to create a calibration point within the range of all emission reductions examined by EPA using the assessment tool. This calibration point was used to create site-specific calibration factors so that the response of ozone concentrations to upwind NO_x emission changes would more-closely align with ozone estimates from CAMx. To fill this role, EPA used the results of IPM modeling of an illustrative control case[11] with similar level and geographic distribution to the control remedy for this rule (except using IPM version 5.14 to estimate EGU emissions). Among other reasons, this scenario served to develop the calibration points for the assessment tool which allowed EPA to reasonably assess the downwind impacts of NO_x reductions both more and less stringent than the illustrative control case.

In order to facilitate understanding of the calibration process, EPA is including an example monitor for evaluation in this text: monitor number 240251001 in Harford County, Maryland, with a 2017 base case predicted ozone average design value of 81.3 ppb and maximum design value of 84.0 ppb. Additional details for all monitors can be found in the referenced tables in the docket.

<u>(1) Create an uncalibrated version of the ozone AQAT for calibration</u>

To create the version of the ozone AQAT for calibration, EPA used emissions and contributions to estimate the change in predicted ozone due to NO_x emission reductions under the illustrative control case relative to the 2017 base case.

First, EPA calculated ozone-season state-level 2017 base case total NO_x emissions from all source sectors. These emissions estimates were used for the CAMx 2017 source apportionment modeling. This emissions data is divided into multiple source sectors for the purposes of air quality modeling: power sector point (from v 5.14 IPM), non-power sector point, non-point, onroad, nonroad, C3 marine, alm, and fires (see the Emissions Inventory TSD[17] for additional details on the emissions inventories used in the CAMx air quality modeling). The state-level total NO_x emissions are the sum of emissions from all these source sectors. Next, EPA calculated the ozone-season 2017 total NO_x emissions across all source sectors for the illustrative control case. EPA calculated the ratio of the emissions for the illustrative control case to the total emissions for the base case for each state modeled in CAMx. More information on the emissions inventories can be found in the preamble and in the Notice of Data Availability, or NODA[18]. The total emissions data and resulting ratios can be found in Table C-1.

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[16] Details on procedures for calculating average and maximum design values can be found in the Air Quality Modeling TSD.

[17] "Technical Support Document (TSD) Preparation of Emissions Inventories for the Version 6.2, 2011 Emissions Modeling Platform", available at www.epa.gov/ttn/chief/emch/2011v6/2011v6_2_2017_2025_EmisMod_TSD_aug2015.pdf

[18] "Notice of Availability of the Environmental Protection Agency's Updated Ozone Transport Modeling Data for the 2008 Ozone National Ambient Air Quality Standard (NAAQS)" (July 23, 2015), available at http://www.epa.gov/airtransport/pdfs/FR_Version_Transport_NODA.pdf

For each monitor, "uncalibrated" change in concentration is found by multiplying the 2017 base case ozone contribution by the difference in the ratio of emissions. The difference in the ratio of emissions is calculated as the ratio of total ozone-season NO_x emissions in the illustrative control case to the 2017 base case scenario minus 1. Thus, if the illustrative control case has smaller emissions, the net result is a negative number. When the change in concentrations are summed across all states, the result is the total "uncalibrated" change in concentration.

Table C-1. 2017 Base Case and 2017 Illustrative Control Case Ozone Contributions for Monitor Number 240251001 in Harford County, Maryland, as well as Total NO_x Emissions from all Source-Sectors for Each State.

State/Source	2017 Base Case Ozone Contributions (ppb)	2017 Base Case NO_x Emissions (tons)	2017 Illustrative Control Case NO_x Emissions (tons)	Ratio of Illustrative Control Case Emissions to Base Case Emissions	Difference between the Illustrative Control Case Emissions and Base Case Emissions as a Fraction of Base Case Emissions	Estimated 2017 Contribution of Ozone (Uncalibrated Ozone AQAT) (ppb)
AL	0.4053	88,805	85,721	0.97	-0.03	-0.01
AZ	0.0958	71,906	71,906	1.00	0.00	0.00
AR	0.2264	69,737	69,039	0.99	-0.01	0.00
CA	0.1106	236,322	236,322	1.00	0.00	0.00
CO	0.1942	90,756	90,756	1.00	0.00	0.00
CT	0.011	17,672	17,672	1.00	0.00	0.00
DE	0.1559	7,786	7,786	1.00	0.00	0.00
DC	0.7334	2,252	2,252	1.00	0.00	0.00
FL	0.1141	177,514	177,513	1.00	0.00	0.00
GA	0.3035	103,536	103,526	1.00	0.00	0.00
ID	0.0349	27,893	27,893	1.00	0.00	0.00
IL	0.672	148,178	147,770	1.00	0.00	0.00
IN	1.8904	139,133	127,487	0.92	-0.08	-0.16
IA	0.1933	70,467	70,045	0.99	-0.01	0.00
KS	0.285	79,939	79,513	0.99	-0.01	0.00
KY	1.973	106,830	97,311	0.91	-0.09	-0.18
LA	0.2597	173,330	172,886	1.00	0.00	0.00
ME	0.0005	17,576	17,576	1.00	0.00	0.00
MD	24.619	46,029	45,312	0.98	-0.02	-0.38
MA	0.0037	35,369	35,369	1.00	0.00	0.00
MI	0.8339	131,486	124,374	0.95	-0.05	-0.05
MN	0.1142	89,328	89,332	1.00	0.00	0.00
MS	0.1596	54,832	54,706	1.00	0.00	0.00
MO	0.5299	101,035	99,736	0.99	-0.01	-0.01
MT	0.0688	38,504	38,504	1.00	0.00	0.00
NE	0.1569	70,005	70,005	1.00	0.00	0.00
NV	0.0279	28,192	28,192	1.00	0.00	0.00
NH	0.0009	8,932	8,932	1.00	0.00	0.00
NJ	0.4374	52,743	52,031	0.99	-0.01	-0.01
NM	0.1688	65,263	65,263	1.00	0.00	0.00
NY	0.4009	109,910	107,416	0.98	-0.02	-0.01
NC	0.4684	98,064	91,850	0.94	-0.06	-0.03
ND	0.0848	74,118	74,118	1.00	0.00	0.00
OH	4.0022	160,110	150,516	0.94	-0.06	-0.24
OK	0.4683	131,763	129,215	0.98	-0.02	-0.01
OR	0.0232	40,507	40,507	1.00	0.00	0.00
PA	6.0769	174,664	147,166	0.84	-0.16	-0.96
RI	0.0006	5,845	5,844	1.00	0.00	0.00
SC	0.1097	55,897	55,846	1.00	0.00	0.00
SD	0.0587	22,192	22,192	1.00	0.00	0.00

TN	0.7044	85,759	85,693	1.00	0.00	0.00
TX	1.0563	467,245	465,179	1.00	0.00	0.00
UT	0.0942	66,486	66,486	1.00	0.00	0.00
VT	0.0015	5,473	5,473	1.00	0.00	0.00
VA	5.3016	87,754	87,514	1.00	0.00	-0.01
WA	0.0327	75,833	75,833	1.00	0.00	0.00
WV	2.9988	64,839	53,954	0.83	-0.17	-0.50
WI	0.2178	75,047	75,035	1.00	0.00	0.00
WY	0.2063	68,864	68,864	1.00	0.00	0.00
TRIBAL	0.0436	26,717	26,717	1.00	0.00	0.00
CNMX	0.7368			1.00	0.00	0.00
OFFSHORE	0.4494			1.00	0.00	0.00
FIRE	0.3074			1.00	0.00	0.00
ICBC	16.652			1.00	0.00	0.00
BIOG	6.0915			1.00	0.00	0.00

(2) Calibrate the ozone response in the ozone AQAT using CAMx modeling of the 2017 base and 2017 illustrative control case

Next, the estimate of the monitor specific ozone responses under the illustrative control case was used to calibrate the ozone AQAT to CAMx. First, the changes in ozone predicted by the ozone AQAT and CAMx for the average design values were calculated for each monitor for the illustrative control case relative to the 2017 base case concentrations. The difference from CAMx was then divided by the difference from the ozone AQAT, resulting in a monitor-specific calibration factor (see Table C-2 for an example calculation). The calculation of these monitor-specific calibration factors provided EPA with the ability to align the ozone response predicted by the ozone AQAT to the ozone response predicted by CAMx at a level of NO_x reductions that EPA expected to be close to the range of all emission reductions examined by EPA.

The ozone AQAT and CAMx concentration differences can be found in the "ozone_AQAT.xlsx" excel workbook on worksheet "2017 contributions uncalibrated" in columns BN and BO, respectively. The calibration factor can be found in column BP of the aforementioned excel worksheet.

Table C-2. Ozone Contributions in the 2017 Base Case and 2017 Illustrative Control Case Calibration Scenario from CAMx and Uncalibrated Ozone AQAT for Monitor Number 240251001 in Harford County, Maryland (See Table C-1). These Values are then Used to Create a Calibration Factor.

	2017 Base Case Ozone Concentration (ppb)	**Estimated 2017 Illustrative Control Case Calibration Scenario Ozone Concentration (ppb)**	**Estimated Change in Concentration**
CAMx	81.369	80.469	-0.900
Ozone AQAT	81.369	78.803	-2.566
Calibration Factor – Change in Concentration from CAMx Divided by Change in Concentration from the Ozone AQAT			0.3508

<u>(3) Create a calibrated version of the ozone AQAT for cost threshold analysis</u>

Next, EPA created the calibrated version of the ozone AQAT for the cost threshold analysis. EPA used emissions, air quality ozone contributions, and calibration factors to estimate the change in predicted ozone due to NO_x emission reductions under each cost threshold evaluated. First, as described in step 2, EPA calculated ozone-season state-level 2017 base case total NO_x emissions. EPA calculated the state-level total emissions using both IPM v5.14 as well as v5.15. Thus, in all cost threshold simulations, the contributions for all states were adjusted (either to the base level or to a cost level using IPM v5.15). Next, because the emissions from all other sectors are constant, EPA focused on the differences in EGU emissions between each cost threshold and the 2017 base case using IPM v 5.14 (see Table B-3 for the emission differences)[19]. Finally, EPA calculated the ratio of the emission differences to the total[20] NO_x emissions for the 2017 base case (using IPM v. 5.14) for each state modeled in CAMx (see Table C-1). More information on the emissions inventories can be found in preamble and in the NODA.

For each cost threshold level analyzed, on a receptor-by-receptor basis, the emissions change for each upwind state is associated with one of two cost threshold levels (either the IPM v5.15 base case emissions level or the particular threshold cost level) depending on whether the upwind state is "linked" to that receptor or if the receptor is located within the state. States that are contributing above the air quality threshold (i.e., greater than or equal to 1 percent

[19] We note that the total ozone-season NO_x emissions from the IPM "all units" outputs used in the assessment tool air quality analysis and the EGU emissions used in the CAMx air quality modeling were slightly different (i.e., some "all units" emissions are apportioned to different sectors in the emission inventory used in CAMx). However, within ozone AQAT, because the difference in emissions were consistently calculated using IPM's "all units", the resulting air quality estimates are not affected.
[20] The total emissions from all anthropogenic sources (excluding Biogenics and Fires), coinciding with the emissions that were "tagged" in the source-apportionment modeling

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contribution of ozone) to the monitor, as well as the state containing the monitor, make NO_x emissions reductions available at the particular threshold level. The emissions for all other states are adjusted to the IPM v 5.15 base case level (from the IPM v. 5.14 base case level).

For the three regulatory control alternatives, all states were adjusted to the emission levels in the case, regardless of whether the state was "linked". These scenarios examine the emission results when budgets have been applied to the 23-state geography.

For each monitor, the predicted 2017 change in contribution of ozone from each state is calculated by multiplying the state specific 2017 IPM v5.14 base case ozone contribution by the calibration factor as well as by the ratio of the change in emissions (Table B-3, for either the cost threshold level or the IPM v. 5.15 base case level depending on whether the state is linked and divided by the total 2017 IPM v. 5.14 base case emissions for all sectors (Table C-1)). This calibrated change in ozone is then added to the ozone contribution from the 2017 IPM v5.14 base case modeling. The result is the "calibrated" total ozone contribution.

For each monitor, these state-level "calibrated" contributions are then summed to estimate total ozone contribution from the states in the CAMx modeling domain. Finally, "other" modeled ozone contributions ("TRIBAL", "CNMX", "OFFSHORE", "FIRE", "ICBC", and "BIOG") are added from the 2017 IPM v. 5.14 base case modeling to the state contributions to account for other sources of ozone affecting the modeling domain. The total ozone from all the states and "other" contributions equals the average design values estimated in the assessment tool. The maximum design values were estimated by multiplying the estimated average design values by the ratio of the modeled 2017 IPM v5.14 base case maximum to average design values.

Generally, as the cost threshold value increased, the estimated average and maximum design values at each receptor decreased. In the assessment tool, the estimated value of the average design value was used to estimate whether the location will be out of attainment, while the estimated maximum design value was used to estimate whether the location will be out of maintenance. The area was noted as having a nonattainment or maintenance issue if its estimated air quality level was greater than or equal to 76 ppb.

3. Description of the results of the analysis using the assessment tool for the approach.

This section describes the results of the IPM v5.15 base case and cost threshold analysis using the ozone AQAT. In section C.2 of this TSD, we described the construction of the ozone AQAT to estimate the air quality impacts of various levels of EGU NO_x emissions.

As described in section B, EPA examined a number of different emission scenarios: the IPM 5.15 base case; the illustrative control case; cost threshold levels of $500/ton, $1,300/ton, $3,400/ton, $5,000/ton, $6,400/ton, and $10,000/ton; and three regulatory control alternatives (i.e., proposed EGU NO_x emissions budgets, and more and less stringent alternatives).

The average and maximum design values (ppb) estimated using the assessment tool for each identified receptor for each cost threshold level can be found in Tables C-3 and C-4, respectively. The monitors are in alphabetical order by state. No monitors are estimated to have resolved their average design value problems (i.e., estimated nonattainment) at any of the NO_x cost thresholds examined when examined across the IPM v. 5.15 scenarios. However, the average design value for two monitors dropped below 76 ppb in the transition from the IPM v. 5.14 to IPM v. 5.15 base cases[21].

[21] Monitors 360850067 in Richmond, New York and 390610006 in Hamilton, Ohio.

Many monitors are projected to have maintenance issues at all cost levels. However, some monitors have their maintenance issues solved at various cost levels. In the IPM 5.15 base case, Monitors 261630019 in Wayne County, Michigan, 340230011 in Middlesex, New Jersey, 420031005 in Allegheny, Pennsylvania, and 480850005 in Colin, Texas are estimated to not have maintenance issues. No states appear to be solely linked to these receptors.

Examining the incremental difference in receptors at the $500/ton cost threshold (where non-linked states are kept at IPM v5.15 emission levels), we estimate that maintenance problems for monitors 340290006 in New Jersey and 211850004 in Kentucky would be resolved. However, no states are linked solely to these receptors.

At the $1,300/ton cost threshold, five additional monitors are projected to be clean. These are monitors 211110067 in Kentucky, 240053001 in Maryland, 340150002 in New Jersey, 390610006 in Ohio, and 482010026 in Texas. North Carolina is linked solely to monitor 240053001 in Baltimore Maryland.

At the $3,400/ton cost threshold, one additional monitor 481211032 in Texas is estimated to have a clean maintenance value. No states are solely linked to this monitor.

No additional monitors are projected to be clean until the $10,000/ton level, where one monitor, 421010024 in Pennsylvania, is projected to have a clean maintenance value. At the $6,400/ton cost level, Tennessee was linked solely to this monitor.

In the assessment of air quality using the calibrated assessment tool, we are able to estimate the relative contributions of particular upwind states contributing to a particular estimated design values. As noted, at each of the cost levels up to $10,000/ton, we also compared each state's adjusted ozone concentration against the 1% air quality threshold. Aside from North Carolina at $1,300/ton and Tennessee at $10,000/ton, where their final monitor is clean, we did not see instances where a state's contributions dropped below 1% of the NAAQS for all of its linkages.

Lastly, once the budgets for the rule were established (based on the results of the multi-factor test) and IPM was used to model compliance with the rule, it was possible to estimate air quality concentrations at each downwind receptor using the ozone AQAT for each of the three regulatory control alternatives. Average and maximum design value estimates for the "less stringent alternative", the "proposed emissions budgets", and the "more stringent alternative" can be found in Tables C-5 and C-6. The design value results (i.e., which receptors are estimated to have nonattainment and/or maintenance problems) for the proposed emissions budgets scenario are similar to that of the $1,300/ton cost threshold.

Table C-3. Average Ozone DVs (ppb) for NO_x Cost Thresholds ($/ton) Assessed Using the Ozone AQAT.

Monitor Identification Number	State	County	CAMx 2017 5.14 Base Case (ppb)	Assessment Tool Average Ozone Design Values (ppb).						
				5.15 Base Case	$500	$1,300	$3,400	$5,000	$6,400	$10,000
90010017	Connecticut	Fairfield	75.8	75.6	75.6	75.3	75.3	75.3	75.3	75.3
90013007	Connecticut	Fairfield	77.1	76.9	76.8	76.5	76.5	76.5	76.5	76.4
90019003	Connecticut	Fairfield	78.0	77.9	77.8	77.5	77.5	77.5	77.5	77.5
90099002	Connecticut	New Haven	77.2	77.1	77.1	76.9	76.9	76.9	76.9	76.9
211110067	Kentucky	Jefferson	75.8	74.6	73.9	72.9	72.8	72.8	72.7	72.5
211850004	Kentucky	Oldham	73.7	72.5	71.8	70.7	70.7	70.6	70.5	70.3
240053001	Maryland	Baltimore	73.2	73.3	73.0	72.5	72.4	72.4	72.3	72.3
240251001	Maryland	Harford	81.3	81.4	81.1	80.5	80.4	80.4	80.3	80.3
260050003	Michigan	Allegan	75.5	75.1	75.0	74.9	74.9	74.9	74.8	74.8
261630019	Michigan	Wayne	74.0	73.5	73.4	73.3	73.2	73.2	73.2	73.2
340071001	New Jersey	Camden	74.2	73.8	73.6	72.6	72.6	72.6	72.6	72.6
340150002	New Jersey	Gloucester	75.1	74.7	74.5	73.4	73.3	73.3	73.3	73.3
340230011	New Jersey	Middlesex	73	72.5	72.3	71.2	71.2	71.1	71.1	71.1
340290006	New Jersey	Ocean	73.9	73.4	73.2	72.1	72.1	72.1	72.0	72.0
360810124	New York	Queens	75.7	75.4	75.3	74.8	74.8	74.8	74.8	74.8
360850067	New York	Richmond	76.3	75.9	75.7	74.9	74.9	74.8	74.8	74.8
361030002	New York	Suffolk	79.2	79.0	79.0	78.7	78.7	78.7	78.7	78.7
390610006	Ohio	Hamilton	76.3	74.7	73.4	71.7	71.6	71.6	71.5	71.2
420031005	Pennsylvania	Allegheny	75.3	74.5	74.2	72.2	72.2	72.2	72.2	72.1
421010024	Pennsylvania	Philadelphia	75.1	74.6	74.3	72.8	72.8	72.8	72.7	72.7
480391004	Texas	Brazoria	81.4	81.2	81.1	81.1	81.1	81.0	81.0	81.0
480850005	Texas	Collin	74.9	74.6	74.6	74.5	74.5	74.4	74.4	74.4
481130069	Texas	Dallas	74.0	73.7	73.7	73.6	73.6	73.5	73.5	73.5
481130075	Texas	Dallas	75.8	75.5	75.5	75.5	75.4	75.4	75.4	75.4
481210034	Texas	Denton	76.9	76.7	76.7	76.6	76.6	76.6	76.5	76.5
481211032	Texas	Denton	75.1	74.9	74.9	74.8	74.7	74.7	74.7	74.7
482010024	Texas	Harris	75.9	75.8	75.8	75.8	75.8	75.7	75.7	75.7
482010026	Texas	Harris	73.5	73.4	73.4	73.4	73.3	73.3	73.3	73.3
482010055	Texas	Harris	75.4	75.3	75.3	75.2	75.2	75.2	75.2	75.2
482011034	Texas	Harris	76.8	76.7	76.7	76.6	76.6	76.6	76.6	76.6
482011039	Texas	Harris	78.2	78.1	78.1	78.0	78.0	78.0	78.0	78.0
482011050	Texas	Harris	74.6	74.5	74.5	74.4	74.4	74.4	74.4	74.4
484390075	Texas	Tarrant	75.5	75.3	75.2	75.2	75.1	75.1	75.1	75.1
484392003	Texas	Tarrant	79.6	79.4	79.3	79.3	79.2	79.2	79.2	79.2
484393009	Texas	Tarrant	78.6	78.4	78.4	78.3	78.3	78.2	78.2	78.2
484393011	Texas	Tarrant	74.5	74.2	74.2	74.1	74.0	74.0	74.0	74.0
551170006	Wisconsin	Sheboygan	77.0	76.7	76.6	76.6	76.6	76.5	76.5	76.5

Table C-4. Maximum Ozone DVs (ppb) for NO_x Cost Thresholds ($/ton) Assessed Using the Ozone AQAT.

Monitor Identification Number	**State**	**County**	**CAMx 2017 5.14 Base Case (ppb)**	**Assessment Tool Maximum Ozone Design Values (ppb).**						
				5.15 Base Case	**$500**	**$1,300**	**$3,400**	**$5,000**	**$6,400**	**$10,000**
90010017	Connecticut	Fairfield	78.4	78.2	78.1	77.8	77.8	77.8	77.8	77.8
90013007	Connecticut	Fairfield	81.4	81.2	81.1	80.8	80.8	80.7	80.7	80.7
90019003	Connecticut	Fairfield	81.1	80.9	80.9	80.6	80.5	80.5	80.5	80.5
90099002	Connecticut	New Haven	80.2	80.1	80.0	79.9	79.9	79.9	79.9	79.9
211110067	Kentucky	Jefferson	78.6	77.3	76.6	75.6	75.5	75.4	75.4	75.1
211850004	Kentucky	Oldham	77.3	76.0	75.3	74.2	74.1	74.1	74.0	73.7
240053001	Maryland	Baltimore	76.2	76.3	76.0	75.4	75.4	75.3	75.3	75.2
240251001	Maryland	Harford	84.0	84.1	83.8	83.2	83.1	83.0	83.0	83.0
260050003	Michigan	Allegan	78.5	78.1	78.0	77.9	77.9	77.8	77.8	77.8
261630019	Michigan	Wayne	76.2	75.7	75.6	75.4	75.4	75.4	75.4	75.4
340071001	New Jersey	Camden	78.1	77.6	77.4	76.4	76.4	76.4	76.4	76.3
340150002	New Jersey	Gloucester	77.5	77.1	76.8	75.7	75.7	75.6	75.6	75.6
340230011	New Jersey	Middlesex	76.3	75.8	75.6	74.4	74.4	74.4	74.4	74.3
340290006	New Jersey	Ocean	76.6	76.1	75.8	74.7	74.7	74.7	74.7	74.6
360810124	New York	Queens	77.6	77.3	77.2	76.7	76.7	76.7	76.7	76.7
360850067	New York	Richmond	77.8	77.4	77.3	76.5	76.4	76.4	76.4	76.4
361030002	New York	Suffolk	80.8	80.6	80.6	80.3	80.3	80.3	80.3	80.3
390610006	Ohio	Hamilton	79.1	77.4	76.1	74.4	74.3	74.2	74.1	73.8
420031005	Pennsylvania	Allegheny	76.5	75.7	75.4	73.4	73.3	73.3	73.3	73.3
421010024	Pennsylvania	Philadelphia	78.4	77.9	77.6	76.1	76.0	76.0	76.0	75.9
480391004	Texas	Brazoria	82.3	82.1	82.1	82.0	82.0	82.0	81.9	81.9
480850005	Texas	Collin	76.0	75.8	75.8	75.7	75.6	75.6	75.6	75.6
481130069	Texas	Dallas	78.0	77.7	77.7	77.6	77.5	77.5	77.5	77.5
481130075	Texas	Dallas	76.7	76.5	76.4	76.4	76.3	76.3	76.3	76.3
481210034	Texas	Denton	79.4	79.2	79.2	79.1	79.0	79.0	79.0	79.0
481211032	Texas	Denton	76.3	76.0	76.0	76.0	75.9	75.9	75.8	75.8
482010024	Texas	Harris	78.5	78.4	78.4	78.3	78.3	78.3	78.3	78.3
482010026	Texas	Harris	76.1	76.0	76.0	75.9	75.9	75.9	75.9	75.9
482010055	Texas	Harris	77.0	76.9	76.9	76.8	76.8	76.8	76.7	76.7
482011034	Texas	Harris	77.8	77.6	77.6	77.6	77.5	77.5	77.5	77.5
482011039	Texas	Harris	80.2	80.0	80.0	80.0	79.9	79.9	79.9	79.9
482011050	Texas	Harris	76.2	76.1	76.1	76.0	76.0	76.0	76.0	76.0
484390075	Texas	Tarrant	76.4	76.2	76.2	76.1	76.1	76.0	76.0	76.0
484392003	Texas	Tarrant	82.1	81.8	81.8	81.7	81.7	81.6	81.6	81.6
484393009	Texas	Tarrant	78.6	78.4	78.4	78.3	78.3	78.2	78.2	78.2
484393011	Texas	Tarrant	76.6	76.3	76.3	76.2	76.2	76.1	76.1	76.1
551170006	Wisconsin	Sheboygan	79.4	79.2	79.1	79.0	79.0	79.0	79.0	79.0

Table C-5. Average Ozone DVs (ppb) Three Remedy Control Alternatives Assessed Using the Assessment Tool.

Monitor Identification Number	State	County	CAMx 2017 5.14 Base Case (ppb)	Assessment Tool Average Ozone Design Values (ppb).		
				Less Stringent Alternative	Proposed Emissions Budgets	More Stringent Alternative
90010017	Connecticut	Fairfield	75.8	75.5	75.2	75.2
90013007	Connecticut	Fairfield	77.1	76.8	76.5	76.5
90019003	Connecticut	Fairfield	78.0	77.8	77.5	77.5
90099002	Connecticut	New Haven	77.2	77.1	76.9	76.9
211110067	Kentucky	Jefferson	75.8	74.0	72.9	72.9
211850004	Kentucky	Oldham	73.7	71.8	70.8	70.8
240053001	Maryland	Baltimore	73.2	73.0	72.4	72.4
240251001	Maryland	Harford	81.3	81.1	80.5	80.4
260050003	Michigan	Allegan	75.5	75.0	74.9	74.9
261630019	Michigan	Wayne	74.0	73.4	73.3	73.3
340071001	New Jersey	Camden	74.2	73.6	72.6	72.6
340150002	New Jersey	Gloucester	75.1	74.5	73.4	73.3
340230011	New Jersey	Middlesex	73.0	72.3	71.1	71.1
340290006	New Jersey	Ocean	73.9	73.1	72.1	72.0
360810124	New York	Queens	75.7	75.3	74.8	74.8
360850067	New York	Richmond	76.3	75.7	74.9	74.8
361030002	New York	Suffolk	79.2	79.0	78.7	78.7
390610006	Ohio	Hamilton	76.3	73.4	71.8	71.8
420031005	Pennsylvania	Allegheny	75.3	74.2	72.2	72.2
421010024	Pennsylvania	Philadelphia	75.1	74.3	72.8	72.8
480391004	Texas	Brazoria	81.4	81.2	81.1	81.1
480850005	Texas	Collin	74.9	74.6	74.5	74.5
481130069	Texas	Dallas	74.0	73.7	73.6	73.6
481130075	Texas	Dallas	75.8	75.5	75.5	75.5
481210034	Texas	Denton	76.9	76.7	76.6	76.6
481211032	Texas	Denton	75.1	74.9	74.8	74.8
482010024	Texas	Harris	75.9	75.8	75.8	75.8
482010026	Texas	Harris	73.5	73.4	73.4	73.4
482010055	Texas	Harris	75.4	75.3	75.2	75.2
482011034	Texas	Harris	76.8	76.7	76.6	76.6
482011039	Texas	Harris	78.2	78.1	78.0	78.0
482011050	Texas	Harris	74.6	74.5	74.4	74.4
484390075	Texas	Tarrant	75.5	75.2	75.2	75.2
484392003	Texas	Tarrant	79.6	79.3	79.3	79.3
484393009	Texas	Tarrant	78.6	78.4	78.3	78.3
484393011	Texas	Tarrant	74.5	74.2	74.1	74.1
551170006	Wisconsin	Sheboygan	77.0	76.6	76.6	76.6

Table C-6. Maximum Ozone DVs (ppb) Three Remedy Control Scenarios Assessed Using the Assessment Tool.

Monitor Identification Number	State	County	CAMx 2017 5.14 Base Case (ppb)	Assessment Tool Maximum Ozone Design Values (ppb).		
				Less Stringent Alternative	Proposed Emissions Budgets	More Stringent Alternative
90010017	Connecticut	Fairfield	78.4	78.1	77.8	77.8
90013007	Connecticut	Fairfield	81.4	81.1	80.7	80.7
90019003	Connecticut	Fairfield	81.1	80.9	80.5	80.5
90099002	Connecticut	New Haven	80.2	80.0	79.8	79.8
211110067	Kentucky	Jefferson	78.6	76.7	75.6	75.6
211850004	Kentucky	Oldham	77.3	75.3	74.2	74.2
240053001	Maryland	Baltimore	76.2	76.0	75.4	75.4
240251001	Maryland	Harford	84.0	83.8	83.1	83.1
260050003	Michigan	Allegan	78.5	78.0	77.9	77.9
261630019	Michigan	Wayne	76.2	75.6	75.4	75.4
340071001	New Jersey	Camden	78.1	77.4	76.4	76.4
340150002	New Jersey	Gloucester	77.5	76.9	75.7	75.7
340230011	New Jersey	Middlesex	76.3	75.6	74.4	74.4
340290006	New Jersey	Ocean	76.6	75.8	74.7	74.7
360810124	New York	Queens	77.6	77.2	76.7	76.7
360850067	New York	Richmond	77.8	77.3	76.4	76.4
361030002	New York	Suffolk	80.8	80.6	80.3	80.3
390610006	Ohio	Hamilton	79.1	76.1	74.4	74.4
420031005	Pennsylvania	Allegheny	76.5	75.4	73.4	73.4
421010024	Pennsylvania	Philadelphia	78.4	77.6	76.1	76.0
480391004	Texas	Brazoria	82.3	82.1	82.0	82.0
480850005	Texas	Collin	76.0	75.8	75.7	75.7
481130069	Texas	Dallas	78.0	77.7	77.6	77.6
481130075	Texas	Dallas	76.7	76.5	76.4	76.4
481210034	Texas	Denton	79.4	79.2	79.1	79.1
481211032	Texas	Denton	76.3	76.0	76.0	76.0
482010024	Texas	Harris	78.5	78.4	78.3	78.3
482010026	Texas	Harris	76.1	76.0	75.9	75.9
482010055	Texas	Harris	77.0	76.9	76.8	76.8
482011034	Texas	Harris	77.8	77.6	77.6	77.6
482011039	Texas	Harris	80.2	80.0	80.0	80.0
482011050	Texas	Harris	76.2	76.1	76.0	76.0
484390075	Texas	Tarrant	76.4	76.2	76.1	76.1
484392003	Texas	Tarrant	82.1	81.8	81.7	81.7
484393009	Texas	Tarrant	78.6	78.4	78.3	78.3
484393011	Texas	Tarrant	76.6	76.3	76.2	76.2
551170006	Wisconsin	Sheboygan	79.4	79.1	79.0	79.0

Appendix A: IPM Runs Used in Transport Rule Significant Contribution Analysis

Table A-1 lists IPM runs used in the significant contribution analysis. The IPM runs can be found in the docket for this rulemaking.

Table Appendix A-1. IPM Runs Used in Transport Rule Significant Contribution Analysis

Run Name	Run Description
5.14_Base_Case	Base Case model run, which includes the national Title IV SO_2 cap-and-trade program; NO_x SIP Call regional ozone season cap-and-trade program; the Cross-State Air Pollution trading programs, and settlements and state rules. This is based on AEO estimates from 2014.
5.14_OS_NOx_ 500_CT	Imposes a marginal cost of $500 per ton of ozone season NO_x in all states starting in 2017. Also forces all extant and currently operating SCR to operate at “full operation”. Created using IPM v5.14.
5.14_OS_NOx_ 1300_CT	Imposes a marginal cost of $1,300 per ton of ozone season NO_x in all states starting in 2017. Also forces all extant and currently operating SCR to operate at “full operation” and all non-operating SCR are returned to “full operation”. Units without SOA combustion controls upgraded to SOA combustion controls. Created using IPM v5.14.
5.14_OS_NOx_ 3400_CT	Imposes a marginal cost of $3,400 per ton of ozone season NO_x in all states starting in 2017. Also forces all extant and currently operating SCR to operate at “full operation” and all non-operating SCR are returned to “full operation”. Units without SOA combustion controls upgraded to SOA combustion controls. Units with SNCR “fully operate” those controls. Created using IPM v5.14.
5.14_OS_NOx_ 5000_CT	Imposes a marginal cost of $5,000 per ton of ozone season NO_x in all states starting in 2017. Also forces all extant and currently operating SCR to operate at “full operation” and all non-operating SCR are returned to “full operation”. Units without SOA combustion controls upgraded to SOA combustion controls. Units with SNCR “fully operate” those controls. Created using IPM v5.14.
5.14_OS_NOx_ 6200_CT	Imposes a marginal cost of $6,200 per ton of ozone season NO_x in all states starting in 2017. Also forces all extant and currently operating SCR to operate at “full operation” and all non-operating SCR are returned to “full operation”. Units without SOA combustion controls upgraded to SOA combustion controls. Units with SNCR “fully operate” those controls. Created using IPM v5.14.
5.14_OS_NOx_ 10000_CT	Imposes a marginal cost of $10,000 per ton of ozone season NO_x in all states starting in 2017. Also forces all extant and currently operating SCR to operate at “full operation” and all non-operating SCR are returned to “full operation”. Units without SOA combustion controls upgraded to SOA combustion controls. Units with SNCR “fully operate” those controls. Created using IPM v5.14.
5.14_OS_NOx_Illustrative_Control_Case	Imposes the state emission limits with variability limits derived from the $1,300 per ton of NO_x case were applied to states covered by this proposal. Units with SCRs operate them at “full operation” and units with SCRs that are not operating return them to “full operation”. Units without SOA combustion controls upgraded to SOA combustion controls. Created using IPM v5.14. This run is also called the “Illustrative Control Case”
5.15_Base_Case	Base Case model run, which includes the national Title IV SO_2 cap-and-trade program; NO_x SIP Call regional ozone season cap-and-trade program; the Cross-State Air Pollution trading programs, and settlements and state rules. This is based on AEO estimates from 2015 and includes the final Clean Power Plan.
5.15_OS_NOx_500_CT	Imposes a marginal cost of $500 per ton of ozone season NO_x in all states starting in 2017. Also forces all extant and currently operating SCR to operate at “full operation”. Created using IPM v5.15.
5.15_OS_NOx_1300_CT	Imposes a marginal cost of $1,300 per ton of ozone season NO_x in all states starting in 2017. Also forces all extant and currently operating SCR to operate at “full operation” and all non-operating SCR are returned to “full operation”.

	Units without SOA combustion controls upgraded to SOA combustion controls. Created using IPM v5.15.
5.15_OS_NOx_3400_CT	Imposes a marginal cost of $3,400 per ton of ozone season NO_x in all states starting in 2017. Also forces all extant and currently operating SCR to operate at “full operation” and all non-operating SCR are returned to “full operation”. Units without SOA combustion controls upgraded to SOA combustion controls. Units with SNCR “fully operate” those controls. Created using IPM v5.15.
5.15_OS_NOx_5000_CT	Imposes a marginal cost of $5,000 per ton of ozone season NO_x in all states starting in 2017. Also forces all extant and currently operating SCR to operate at “full operation” and all non-operating SCR are returned to “full operation”. Units without SOA combustion controls upgraded to SOA combustion controls. Units with SNCR “fully operate” those controls. Created using IPM v5.15.
5.15_OS_NOx_6400_CT	Imposes a marginal cost of $6,400 per ton of ozone season NO_x in all states starting in 2017. Also forces all extant and currently operating SCR to operate at “full operation” and all non-operating SCR are returned to “full operation”. Units without SOA combustion controls upgraded to SOA combustion controls. Units with SNCR “fully operate” those controls. Created using IPM v5.15.
5.15_OS_NOx_10000_CT	Imposes a marginal cost of $10,000 per ton of ozone season NO_x in all states starting in 2017. Also forces all extant and currently operating SCR to operate at “full operation” and all non-operating SCR are returned to “full operation”. Units without SOA combustion controls upgraded to SOA combustion controls. Units with SNCR “fully operate” those controls. Created using IPM v5.15.
5.15_OS_NOx_Less_Stringent	Imposes the budgets with variability limits derived from the $500 per ton of NO_x case were applied to states covered by this proposal. Units with SCRs operate them at “full operation”. Created using IPM v5.15.
5.15_OS_NOx_Proposed	Imposes the budgets with variability limits derived from the $1,300 per ton of NO_x case were applied to states covered by this proposal. Units with SCRs operate them at “full operation” and units with SCRs that are not operating return them to “full operation”. Units without SOA combustion controls upgraded to SOA combustion controls. Created using IPM v5.15.
5.15_OS_NOx_More_Stringent	Imposes the budgets with variability limits derived from the $3,400 per ton of NO_x case were applied to states covered by this proposal. Units with SCRs operate them at “full operation” and units with SCRs and SNCRs that are not operating return them to “full operation”. Units without SOA combustion controls upgraded to SOA combustion controls. Created using IPM v5.15.

Appendix B: Description of Excel Spreadsheet Data Files for the Significant Contribution Analysis

EPA placed the following Excel workbook file in the Transport Rule docket.

The annual and quarterly emissions for all AQAT simulations can be found in this file. sensitivity_tool.xlsx. This workbook contains a number of worksheets.

State-level emission totals used in the modeling

- “2017eh (base)” contains state and source-sector specific ozone-season NO_x emission totals for the 5.14 base case. Column D, “TOTAL w/o beis, fires” is an input in the tool.
- “2017eh (illustrative control)” contains state and source-sector specific ozone-season NO_x emission totals for the illustrative control case. Column D, “TOTAL w/o beis, fires” is an input in the tool for use in development of the calibration factor.
- “State Level Emissions” are the total ozone-season NO_x emissions from IPM for the various base, cost thresholds (CT), and regulatory control alternatives. The results include totals for “all units” and for all fossil units greater than 25 MW for 2018. Results also include totals for “all units” for 2017 (the sum of the results for 2018 plus the values from “2017 additions”).
- “2017 additions” includes emissions from units that are projected to remain in operation in 2017, but are retired in 2018.
- “IPM Summary” contains the emission difference (in tons) between the 5.14 base case for all units and each of the other scenarios.
- “emission fractions” contains the emission difference as a fraction of the 2017 5.14 base case total emissions without beis and fires. These fractions are directly used in the tool. Column E contains the emission fraction for the illustrative control case (used in calibration of the tool).

Air quality modeling design values from CAMx

- “CAMx O3 DVs” contains design values for three scenarios (the 2011 case, the 2017 IPM v. 5.14 base case, and the 2017 illustrative control case”. The average and maximum design values are shown using one decimal place and to four decimal places”.

State-level ozone contributions

- “2017 contributions (orig)” includes the original contributions with five decimal places of resolution. The truncated shortened version of these contributions equal the truncated base case average design value. See the Air Quality Modeling TSD and the preamble for details about the contributions.
- “2017 contributions (scaled)” adjusts the “2017 contributions (orig)” using the ratio of the four decimal place base case design value to the one decimal place base case design value.
- “2017 contributions” contains a copy of the “2017 contributions (scaled)” contributions. These contributions are used throughout the rest of the assessment tool.

Air quality estimates

- “Summary DVs” contains the average and maximum design value estimates (truncated to one decimal place) for receptors that were nonattainment or maintenance in the 2017 base case air quality modeling. Monitors that are at or above 76.0 ppb are shaded.

- “2017 contributions uncalibrated”. Contains the unadjusted estimated change in concentration resulting from the difference in emissions between the 2017 5.14 base case and the illustrative control case. The calibration factor is calculated in column BP. The ratio of the maximum to average design value for the base case is found in column BU. This fraction is used in the other air quality worksheets to adjust the average design value to a maximum value.
- “515 base” contains the estimated state-by-state and receptor-by-receptor air quality contributions and design values for the 2017 IPM v. 5.15 base case emissions. All states are adjusted to the 5.15 base case emission level regardless of whether they are “linked” to a specific monitor.
- “500 CT” contains the contributions and design values for the $500/ton cost threshold analysis (where non-linked states were adjusted to the IPM v. 5.15 base case emission level).
- “1300 CT” contains the contributions and design values for the $1,300/ton cost threshold analysis (where non-linked states were adjusted to the IPM v. 5.15 base case emission level).
- “3400 CT” contains the contributions and design values for the $3,400/ton cost threshold analysis (where non-linked states were adjusted to the IPM v. 5.15 base case emission level).
- “5000 CT” contains the contributions and design values for the $5,000/ton cost threshold analysis (where non-linked states were adjusted to the IPM v. 5.15 base case emission level).
- “6400 CT” contains the contributions and design values for the $6,400/ton cost threshold analysis (where non-linked states were adjusted to the IPM v. 5.15 base case emission level).
- “10000 CT” contains the contributions and design values for the $10,000/ton cost threshold analysis (where non-linked states were adjusted to the IPM v. 5.15 base case emission level).
- “Less stringent” contains the estimated state-by-state and receptor-by-receptor air quality contributions and design values for the $500/ton policy case emissions. All states are adjusted to this emission level regardless of whether they are “linked” to a specific monitor.
- “Proposed budgets” contains the estimated state-by-state and receptor-by-receptor air quality contributions and design values for the $1,300/ton policy case emissions. All states are adjusted to this emission level regardless of whether they are “linked” to a specific monitor.
- “More stringent” contains the estimated state-by-state and receptor-by-receptor air quality contributions and design values for the $3,400/ton policy case emissions. All states are adjusted to this emission level regardless of whether they are “linked” to a specific monitor.
- The “10000 CT (links)”, “6400 CT (links)”, “5000 CT (links)”, “3400 CT (links)”, “1300 CT (links)”, “500 CT (links)”, “515 Base (links)”, “More stringent (links)”, “Proposed budgets (links)”, “Less stringent (links)” worksheets assess the linkages for the 1% threshold. A contribution is set to zero if the maximum design value is less than 76.0 ppb or if it is a contribution from the state containing the monitor (i.e., “home” state). Compare rows 4 and 5 to look for linkages that affect whether a state is no longer linked

to a monitor that continues to have air quality issues. A value of 1 indicates that the state is "linked". Note that we are particularly interested in states where there is a value of 1 in row 4 and no value in row 5.

Appendix C: Description of 2017 Adjustments to 2018 IPM EGU Ozone-Season NO_X Emissions Data

To calculate the 2017 emissions for the base case, uniform NO_X cost threshold cases, proposed remedy and alternative cases, and produce a flat files for air quality modeling, EPA started with the 2018 Base Case results and made modifications to emissions of units in three categories as described in the table below.

Table Appendix C-1. Description of 2017 ozone-season NO_X Adjustment Calculation

2017 ozone-season NO_X Adjustment Case	**How 2017 Adjustments Were Calculated**
SCR Operation/Installation	For units that had an SCR in 2018 but were assumed to not operate (or be installed) in 2017, EPA recalculated the NO_X emissions for the unit with the 2018 heat input and the 2016 emissions rate
Retirement	For units projected to retire in 2018, emissions from the 2016 run year were included in the 2017 emissions For uniform NO_X cost threshold cases and policy alternative cases, emissions from units with SCRs were determined by multiplying their heat input in the 2016 run year by their optimized NO_X removal rate.
Coal-To-Gas	For units that had implemented coal-to-gas retrofit options in 2018 and had not dispatched, emissions from the 2016 run year were incorporated. However, if the coal-to-gas retrofit options had dispatched in 2018, then the NO_X emissions were calculated based on the 2018 fuel use and 2016 NO_X rate.

The tables below lists the units that were affected by these changes and for each case the number of tons of ozone season NO_X added to the 2018 results to calculate the 2017 ozone season NO_X emissions. Units may not have added emissions in every case. Separate tables are provided to show adjustments for IPM v5.14 and IPM v5.15 cases. These adjustments are summarized at the state level in Appendix E.

Table Appendix C-2. Incremental ozone season NO_X emissions added to 2018 IPM v5.14 cases to calculate 2017 ozone season NO_X emissions.

NEEDS ID	**Reason for Adjustment (Ozone Transport Base Case)**	**Base Case Incremental Ozone Season NOx (tons)**	**Reason for Adjustment (Illustrative Control Case)**	**Proposed Remedy Case Incremental Ozone Season NOx (tons)**
113_B_2	SCR Retrofit	922	SCR Retrofit	590
113_B_3	SCR Retrofit	918	SCR Retrofit	864
113_B_4	SCR Retrofit	1344	SCR Retrofit	1265

160_B_2	SCR Retrofit	829	SCR Retrofit	639
160_B_3	SCR Retrofit	1205	SCR Retrofit	1140
1710_B_3		0	SCR Retrofit	0
1893_B_1		0	SCR Retrofit	1
1893_B_2		0	SCR Retrofit	1
1893_B_4	SCR Retrofit	509	SCR Retrofit	509
2442_B_4	SCR Retrofit	4734	SCR Retrofit	4734
2442_B_5	SCR Retrofit	4850	SCR Retrofit	4850
2817_B_1	SCR Retrofit	240	SCR Retrofit	240
2963_B_3313	SCR Retrofit	1176	SCR Retrofit	153
6030_B_1	SCR Retrofit	593	SCR Retrofit	467
6030_B_2	SCR Retrofit	461	SCR Retrofit	310
6076_B_1	SCR Retrofit	961	SCR Retrofit	595
6076_B_2	SCR Retrofit	935	SCR Retrofit	573
6101_B_BW91	SCR Retrofit	905	SCR Retrofit	905
6204_B_1	SCR Retrofit	1085	SCR Retrofit	1085
6204_B_2	SCR Retrofit	1062	SCR Retrofit	1062
6204_B_3	SCR Retrofit	1390	SCR Retrofit	1390
879_B_52		0	SCR Retrofit	528
1378_B_1	Retirement	1257	Coal-To-Gas	1257
1378_B_2	Retirement	1163	Coal-To-Gas	1163
1378_B_3	Retirement	5390	Coal-To-Gas	5390
469_B_4	Coal-To-Gas	1666	Coal-To-Gas	1666
10676_B_5	Retirement	185	Retirement	129
667_B_1	Coal-To-Gas	166	Retirement	165
667_B_2	Coal-To-Gas	195	Retirement	194
1077_G_3	Retirement	24	Retirement	24
1394_B_1	Retirement	3	Retirement	3
1394_B_2	Retirement	4	Retirement	4
1394_B_5	Retirement	10	Retirement	10
1507_B_1	Retirement	4	Retirement	4
1507_B_2	Retirement	3	Retirement	3
1507_B_3	Retirement	3	Retirement	3
1507_B_4	Retirement	22	Retirement	22
1571_B_1	Retirement	710	Retirement	710
1619_B_3	Retirement	0	Retirement	0
1619_B_4	Retirement	8	Retirement	8
170_B_4	Retirement	51	Retirement	51

1769_B_7	Retirement	618	Retirement	618
1769_B_8	Retirement	604	Retirement	604
1769_B_9	Retirement	613	Retirement	613
2324_B_4	Retirement	975	Retirement	975
271_B_5	Retirement	1	Retirement	1
271_B_6	Retirement	1	Retirement	1
477_B_5	Retirement	1020	Retirement	1020
6181_B_1	Retirement	544	Retirement	544
6181_B_2	Retirement	252	Retirement	252
6183_B_SM-1	Retirement	332	Retirement	332
170_B_1*		0	Adjustment for state assurance level specification error	-170
170_B_2*		0	Adjustment for state assurance level specification error	-394
2408_B_1*		0	Adjustment for state assurance level specification error	-230
56963_G_E101*		0	Adjustment for state assurance level specification error	-53
56963_G_E102*		0	Adjustment for state assurance level specification error	-53
6641_B_1*		0	Adjustment for state assurance level specification error	-69
6641_B_2*		0	Adjustment for state assurance level specification error	-66

*Seven units had emissions revised downward for air quality modeling purposes because of mis-specified state assurance levels in the modeling. These adjustments were determined by a subsequent model run, “5.14_OS_NOX_Proposal_AQ2” that can be found in the docket.

Table Appendix C-3. Incremental ozone season NO_X emissions added to 2018 IPM v5.15 results to calculate 2017 ozone season NO_X emissions.[22]

Reason for 2017 Adjustment	
Retirement	
SCR Retrofit	
C2G	

NEEDS ID	Base Case	$500/ton Cost Threshold	$1300/ton Cost Threshold	$3400/ton Cost Threshold	$5000/ton Cost Threshold	$64000/ton Cost Threshold	$10,000/ton Cost Threshold	Less Stringent Alternative	Proposed Remedy Case	More Stringent Alternative
10676_B_3							86			
10676_B_5	129	129	129	129	129	129	129	129	129	129
113_B_2	580	580	592	876	835	825	846	594	594	594
113_B_3	874	874	874	874	874	874	874	874	874	874
113_B_4	1,280	1,280	1,280	1,280	1,280	1,280	1,280	1,280	1,280	1,280
1378_B_1	2,420	1,499	1,499	1,499	1,499	1,499	1,499	2,420	1,499	1,499
1378_B_3	2,964	2,964	670	670	670	670	670	2,964	670	670
1394_B_1	17	17	17	17	17	17	17	17	17	17
141_B_1	20	20	20	20	20	20	20	20	20	20
141_B_3	39	39	39	39	39	39	39	39	39	39
1507_B_1	4	4	4	4	4	4	4	4	4	4
1507_B_2	3	3	3	3	3	3	3	3	3	3
1507_B_3	3	3	3	3	3	3	3	3	3	3
1507_B_4	17	17	17	17	9	5	4	17	17	17
1571_B_1	587	296	293	293	293	293	293	296	296	296
1571_B_2	955	955	955	955	955	955	955	955	955	955
1572_B_1	1,180	1,180	1,180	1,058	1,058	1,058	1,058	1,180	1,180	1,071
1572_B_3	240	240	240	218	218	218	218	240	240	220
1599_B_1			0.89					0.19	0.20	
1619_B_3	0.60	0.96	0.68	0.98	0.92	0.53	0.14	0.62	0.62	0.60
1619_B_4	82	131	94	134	126	73	20	85	85	82

[22] This table shows adjustments at the NEEDS unit level. The calculated adjustments at the IPM model plant level can be found in the file "IPM v5.15 2017 Emissions Adjustments" in the docket for this rule.

170_B_4	51	51	51	51	51	51	51	51	51	51
1710_B_3	4	0.24	0.27	0.15	0.17	0.17	0.18	4	4	0.24
1743_B_1				142	381	366	158			
1769_B_7	1,836	1,836	1,836	1,836	1,836	1,836	1,836	1,836	1,836	1,836
2104_B_3	510	560	508	506	506	597	742	619	629	665
2104_B_4	521	563	702	995	995	995	995	521	521	498
2107_B_1							158			
2324_B_4	975	975	975	975	975	975	975	975	975	975
2442_B_4	4,734	4,734	4,734	4,734	4,734	4,662	4,615	4,734	4,734	4,734
2442_B_5	4,850	4,850	4,850	4,850	4,850	4,778	4,719	4,850	4,850	4,850
2454_G_1	80	80	80	80	80	80	80	80	80	80
271_B_5	1	1	1	1	1	1	1	1	1	1
2817_B_1	240	240	240	240	240	240	240	240	240	240
2963_B_3313	154	154	154	146	146	136	136	154	154	154
315_B_2	32	32	32	32	32	32	32	32	32	32
350_B_1	6	6	6	6	6	6	6	6	6	6
356_B_8	9	9	9	9	9	9	9	9	9	9
469_B_4	1,666	1,666	1,666	1,666	1,666	1,666	1,666	1,666	1,666	1,666
470_B_2	3	3	3	7	3	3	1	3	3	3
50976_B_AAB01	82	62	77					175	308	269
562_B_4	0.47	0.47	0.47	0.47				0.47	0.47	0.47
564_B_1							271			
6021_B_C2			8		5		0.26			
6030_B_1	2,031	2,031	2,031	2,031	1,956	1,893	2,031	2,031	2,031	2,031
6030_B_2	218	218								
6076_B_1	595	595	595	595	587	587	587	595	595	595
6076_B_2	573	573	573	573	573	573	573	573	573	573
6101_B_BW91	905	905	905	905	905	905	881	905	905	905
6165_B_1							815			
6181_B_2			33	100	100	100	101			
6204_B_1	851	856	874	1,084	1,079	1,063	974	851	852	852
6204_B_2	1,062	1,062	1,062	1,062	1,062	1,057	1,026	1,062	1,062	1,062
6204_B_3	1,390	1,390	1,390	1,390	1,390	1,390	1,368	1,390	1,390	1,390
667_B_1	361	361	361	361	361	361	361	361	361	361
676_B_2	6	6	6	6	6	6	6	6	6	6

861_B_01	21	21	8					17	13	
879_B_62	2	2	1					2	2	2
Total	**35,161**	**34,075**	**31,680**	**32,472**	**32,566**	**32,331**	**33,430**	**34,869**	**31,793**	**31,619**

Table Appendix C-4. Reason for each 2017 adjustment by unit and case (text version)

Reason for 2017 Adjustment	
Retirement	R
SCR Retrofit	SCR
C2G	C2G

NEEDS ID	Base Case	$500/ton Cost Threshold	$1300/ton Cost Threshold	$3400/ton Cost Threshold	$5000/ton Cost Threshold	$64000/ton Cost Threshold	$10,000/ton Cost Threshold	Less Stringent Alternative	Proposed Remedy Case	More Stringent Alternative
10676_B_3							R			
10676_B_5	R	R	R	R	R	R	R	R	R	R
113_B_2	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
113_B_3	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
113_B_4	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
1378_B_1	R	R	R	R	R	R	R	R	R	R
1378_B_3	R	R	R	R	R	R	R	R	R	R
1394_B_1	R	R	R	R	R	R	R	R	R	R
141_B_1	R	R	R	R	R	R	R	R	R	R
141_B_3	R	R	R	R	R	R	R	R	R	R
1507_B_1	R	R	R	R	R	R	R	R	R	R
1507_B_2	R	R	R	R	R	R	R	R	R	R
1507_B_3	R	R	R	R	R	R	R	R	R	R
1507_B_4	R	R	R	R	R	R	R	R	R	R
1571_B_1	R	R	R	R	R	R	R	R	R	R
1571_B_2	R	R	R	R	R	R	R	R	R	R
1572_B_1	R	R	R	R	R	R	R	R	R	R
1572_B_3	R	R	R	R	R	R	R	R	R	R
1599_B_1			R					R	R	
1619_B_3	R	R	R	R	R	R	R	R	R	R
1619_B_4	R	R	R	R	R	R	R	R	R	R

170_B_4	R	R	R	R	R	R	R	R	R	R
1710_B_3	R	SCR	SCR	C2G	C2G	C2G	C2G	R	R	SCR
1743_B_1				R	R	R	R			
1769_B_7	R	R	R	R	R	R	R	R	R	R
2104_B_3	R	R	R	R	R	R	R	R	R	R
2104_B_4	R	R	R	R	R	R	R	R	R	R
2107_B_1							SCR			
2324_B_4	R	R	R	R	R	R	R	R	R	R
2442_B_4	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
2442_B_5	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
2454_G_1	R	R	R	R	R	R	R	R	R	R
271_B_5	R	R	R	R	R	R	R	R	R	R
2817_B_1	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
2963_B_3313	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
315_B_2	R	R	R	R	R	R	R	R	R	R
350_B_1	R	R	R	R	R	R	R	R	R	R
356_B_8	R	R	R	R	R	R	R	R	R	R
469_B_4	R	R	R	R	C2G	R	R	R	R	R
470_B_2	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
50976_B_AAB01	R	R	R					R	R	R
562_B_4	R	R	R	R				R	R	R
564_B_1							R			
6021_B_C2			SCR		SCR		SCR			
6030_B_1	R	R	R	R	C2G	C2G	R	R	R	R
6030_B_2	C2G	C2G								
6076_B_1	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
6076_B_2	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
6101_B_BW91	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
6165_B_1							R			
6181_B_2			R	R	R	R	R			
6204_B_1	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
6204_B_2	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
6204_B_3	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
667_B_1	R	R	R	R	R	R	R	R	R	R
676_B_2	R	R	R	R	R	R	R	R	R	R

861_B_01	R	R	R					R	R	
879_B_62	SCR	SCR	SCR					SCR	SCR	SCR

Appendix D: Ozone-Season NO_x Emissions Budgets for IPM Modeling

To best model the three regulatory control alternatives in IPM, EPA did not include the 2017 budget adjustments in the state budgets. Table Appendix D-1 shows the proposed 2017 state budgets and the equivalent 2018 transport region and state emission constraints used for IPM analysis in the IPM v5.15 model platform. Data for the state budgets and assurance levels that were developed for the air quality modeling using the IPM v5.14 platform appear in table appendix D-2.

Table Appendix D-1. Ozone-Season NO_X Emissions Budgets For IPM v5.15 Modeling

		Less Stringent Alternative Budgets				Proposed Budgets				More Stringent Alternative Budgets			
	2016-2017 Budgets (CSAPR Phase 1)	**2017 Budgets**	**2017 Assurance Level**	**2018 Emission Allowances For IPM**	**2018 IPM Emissions Constraint (Assurance Level) for IPM**	**2017 Budgets**	**2017 Assurance Level**	**2018 Emission Allowances For IPM**	**2018 IPM Emissions Constraint (Assurance Level) for IPM**	**2017 Budgets**	**2017 Assurance Level**	**2018 Emission Allowances For IPM**	**2018 IPM Emissions Constraint (Assurance Level) for IPM**
Alabama	31,623	11,886	14,382	11,886	14,382	9,979	12,075	9,979	12,075	9,931	12,017	9,931	12,017
Arkansas	15,110	7,038	8,516	6,987	8,454	6,949	8,408	6,898	8,347	6,101	7,382	6,051	7,322
Illinois	21,208	12,144	14,694	12,121	14,667	12,078	14,614	12,069	14,604	11,992	14,510	11,992	14,511
Indiana	46,526	33,483	40,514	33,483	40,515	28,284	34,224	28,284	34,224	27,585	33,378	27,585	33,378
Iowa	16,370	8,614	10,423	8,614	10,423	8,351	10,105	8,351	10,105	8,118	9,823	8,118	9,823
Kansas		9,278	11,226	9,278	11,226	9,272	11,219	9,272	11,219	9,259	11,203	9,259	11,203
Kentucky	34,421	32,783	39,667	28,320	34,268	21,519	26,037	19,350	23,413	20,945	25,343	18,776	22,719
Louisiana	18,115	15,861	19,192	15,844	19,171	15,807	19,127	15,790	19,106	15,378	18,607	15,360	18,586
Maryland	7,179	4,026	4,871	2,155	2,607	4,026	4,871	2,160	2,613	4,026	4,871	2,160	2,614
Michigan	27,529	22,022	26,647	20,186	24,425	19,115	23,129	17,279	20,907	18,624	22,535	16,646	20,142
Mississippi	12,429	6,083	7,360	6,083	7,360	5,910	7,151	5,910	7,151	5,487	6,639	5,487	6,639
Missouri	21,944	15,380	18,610	14,257	17,251	15,323	18,541	14,113	17,077	15,240	18,440	13,740	16,625
New Jersey	3,930	2,016	2,439	2,016	2,439	2,015	2,438	2,015	2,438	2,011	2,433	2,011	2,433
New York	10,369	4,607	5,574	4,607	5,575	4,450	5,385	4,450	5,385	4,391	5,313	4,391	5,313
North Carolina	20,312	12,278	14,856	12,278	14,856	12,275	14,853	12,275	14,853	10,705	12,953	10,705	12,953
Ohio	40,149	20,194	24,435	20,194	24,435	16,660	20,159	16,660	20,159	16,637	20,131	16,637	20,131
Oklahoma	22,694	16,215	19,620	16,215	19,620	16,215	19,620	16,215	19,620	16,215	19,620	16,215	19,620
Pennsylvania	52,057	38,270	46,306	38,270	46,306	14,387	17,408	14,387	17,408	14,358	17,373	14,358	17,373
Tennessee	11,462	5,520	6,679	5,520	6,679	5,481	6,632	5,481	6,632	5,449	6,593	5,449	6,593
Texas	65,560	58,492	70,775	58,492	73,819	58,002	70,183	57,970	70,143	55,864	67,595	55,764	67,475
Virginia	14,452	6,955	8,416	6,955	8,416	6,818	8,250	6,818	8,250	5,834	7,059	5,834	7,059
West Virginia	24,287	22,932	27,748	22,932	27,748	13,390	16,202	13,390	16,202	12,367	14,964	12,367	14,964
Wisconsin	14,540	5,588	6,761	5,588	6,761	5,561	6,729	5,561	6,729	5,511	6,668	5,511	6,669
Region cap	**532,266**	**371,665**		**362,281**		**311,867**		**304,677**		**302,028**		**294,347**	

Budgets in GREY indicate states where budgets were limited based on 2014 emissions.

Table Appendix D-2. Ozone-Season NO_X Emissions Budgets For IPM v5.14 Modeling

		Budgets For IPM v5.14 Modeling	
	2016-2017 Budgets (CSAPR Phase 1)	**2018 Emission Allowances s for IPM**	**2018 IPM Assurance Level for IPM**
Alabama	31,623	10,474	12,673
Arkansas	15,110	9,105	11,017
Delaware		683	827
Illinois	21,208	14,109	17,072
Indiana	46,526	28,460	34,437
Iowa	16,370	9,234	11,174
Kansas		9,558	11,565
Kentucky	34,421	25,918	31,361
Louisiana	18,115	17,425	21,085
Maryland	7,179	2,389	2,891
Michigan	27,529	22,152	26,804
Mississippi	12,429	7,369	8,917
Missouri	21,944	15,215	18,410
New Jersey	3,930	2,676	3,238
New York	10,369	4,313	5,218
North Carolina	20,312	12,435	15,047
Ohio	40,149	17,951	21,720
Oklahoma	22,694	18,899	22,868
Pennsylvania	52,057	21,664	26,213
Tennessee	11,462	5,988	7,246
Texas	65,560	64,020	77,464
Virginia	14,452	7,261	8,786
West Virginia	24,287	13,687	16,562
Wisconsin	14,540	7,676	9,288
Region cap	**532,266**	**348,663**	

Appendix E: Detailed Budget Calculations

See the spreadsheet “Ozone Transport Policy Analysis TSD Appendix E” for detailed calculations of state budgets and assurance levels.

Appendix F: State Generation Constraint Analysis

As described in Preamble section VI, the EPA limited generation shifting potential to units within each state in IPM as an analytic proxy designed to respect the feasibility of near-term generation shifting in light of these potential near-term out-of-merit order dispatch constraints. The EPA conducted a separate analysis similar to the $1,300 per ton cost threshold scenario, except without limiting IPM's ability to shift generation between states.[23]
The resulting state level emissions and calculated budgets from this scenario are compared to those of the $1,300 per ton cost threshold run and proposed budgets in Table F-1.
Overall, removing the state generation limit constraints in IPM achieve only an additional 1686 tons of ozone season NO_X emissions reductions. The resulting state budgets were minimally affected, at most seeing a 2.7% decrease in any individual state budget. The transport regional cap decreased by only 636 tons, or 0.2%.[24]

Table F-1. Comparison of state level ozone season NO_X emission reductions from affected sources and resulting state budgets between the $1300 per ton cost threshold cases with and without state level generation constraints.

		2018 IPM $1,300 per ton Cost Threshold Scenario Emissions from Affect Units (tons)			**Resulting 2017 Budgets of Two Scenarios**		
Proposal States	**State**	**As Proposed With State Generation Limits**	**No State Generation Limits**	**Delta**	**Proposed Budgets**	**Budgets Based On No State Generation Limit Scenario**	**Delta**
Y	Alabama	9,708	9,709	1	9,979	9,974	-5
Y	Arkansas	6,069	5,955	-115	6,949	6,863	-86
	Connecticut	407	407	0	325	325	0
	Delaware	477	477	0	610	610	0
	District of Columbia	0	0	0	0	0	0
	Florida	18,369	18,511	142	18,414	18,455	41
	Georgia	7,157	7,299	142	7,307	7,358	51
Y	Illinois	9,541	9,732	191	12,078	11,957	-121
Y	Indiana	29,575	29,732	158	28,284	28,626	342
Y	Iowa	7,488	7,487	-1	8,351	8,353	2
Y	Kansas	10,894	10,818	-76	9,272	9,247	-25
Y	Kentucky	13,076	13,081	5	21,519	21,528	9
Y	Louisiana	10,762	10,671	-91	15,807	15,926	119
	Maine	234	234	0	150	150	0
Y	Maryland	2,775	2,766	-10	4,026	4,026	0
	Massachusetts	778	672	-107	720	684	-36
Y	Michigan	15,180	14,743	-437	19,115	18,978	-136

[23] IPM Output files for this scenario can be found in the docket as "5.15_OS_NOx_1300_CT_NoGenLimit"
[24] Details of the budget calculations for 5.15_OS_NOx_1300_CT_NoGenLimit can be found in the docket as "Budget Calculations For 1300CT No State Gen Limit Scenario.xlsx"

	Minnesota	8,999	9,014	14	7,884	7,795	-90
Y	Mississippi	7,574	7,328	-246	5,910	5,766	-144
Y	Missouri	14,843	14,649	-194	15,323	15,406	82
	Nebraska	13,770	13,766	-4	10,284	10,284	0
	New Hampshire	140	140	0	106	106	0
Y	New Jersey	2,931	2,930	0	2,015	2,014	-1
Y	New York	4,664	4,556	-108	4,450	4,394	-57
Y	North Carolina	12,513	11,951	-563	12,275	12,041	-234
	North Dakota	10,808	10,270	-538	15,063	14,964	-99
Y	Ohio	18,149	18,131	-18	16,660	16,733	73
Y	Oklahoma	17,269	17,279	10	16,215	16,215	0
Y	Pennsylvania	14,773	14,905	132	14,387	14,412	25
	Rhode Island	202	218	17	190	197	7
	South Carolina	4,542	4,668	125	5,082	5,067	-14
	South Dakota	297	297	0	386	386	0
Y	Tennessee	5,441	5,441	0	5,481	5,481	0
Y	Texas	54,557	54,583	26	58,002	57,913	-89
	Vermont	3	3	0	61	61	0
Y	Virginia	6,656	6,793	136	6,818	6,810	-8
Y	West Virginia	14,475	13,916	-560	13,390	13,028	-362
Y	Wisconsin	5,221	5,295	74	5,561	5,540	-21
	Total of 23 Proposed States	**294,135**	**292,450**	**-1,686**	**311,867**	**311,231**	**-636**