Technical Support Document
for EPA's Multi-Pollutant Analysis

Methods for Projecting Air Quality Concentrations for EPA's Multi-Pollutant Analyses of 2005

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Prepared by:
Office of Air and Radiation
U.S. Environmental Protection Agency

I. Introduction

The EPA has conducted a comprehensive analysis of various multi-pollutant proposals that have been introduced in the Senate. The proposals are designed to reduce emissions from the power sector, and EPA has agreed to perform detailed modeling for five legislative proposals and to present that information along with modeling results of EPA's recent regulatory approach to reducing emissions from the power sector. The analysis is based on air quality, health benefits, and power sector modeling projections and estimates for each proposal for the years 2010, 2015, and 2020. The following proposals and regulations were analyzed:

1. The Clean Power Act (Jeffords, S.150 in 109^{th})
2. The Clean Air Planning Act (Carper, S.843 in 108^{th})
3. The Clear Skies Act of 2005 (Inhofe, S.131 in 109^{th})
4. The Clear Skies Act of 2003 (Inhofe, S.485 in 108^{th})
5. The Clear Skies Act of 2005 (Manager's Mark of S.131 in 109^{th})

In addition to these five scenarios, EPA analyzed the Clean Air Interstate Rule (CAIR), the Clean Air Mercury Rule (CAMR), and the Clean Air Visibility Rule (CAVR) which were rules promulgated by EPA in 2005. EPA also modeled a projection scenario without the EGU emissions reductions associated with CAIR-CAMR-CAVR (i.e., the CAIR-CAMR-CAVR baseline). The utility emissions forecasts for 2010, 2015, and 2020 for each of the seven scenarios were determined from simulations of the Integrated Planning Model (IPM).

This technical support document reports the methods for projecting air quality concentrations for the scenarios in EPA's multi-pollutant analysis. Concentrations of $PM_{2.5}$ and 8-hour ozone were determined for 2010, 2015, and 2020 for each scenario. These concentration forecasts were used to project the extent of future $PM_{2.5}$ and/or ozone nonattainment and to enable EPA to perform a benefits analysis. Although utility emissions were modeled for each of the seven scenarios, EPA ran air quality models to predict future concentrations for the following four scenarios:

- Clean Air Planning Act (S.843)
- Clear Skies (Inhofe, S.131)
- CAIR-CAMR-CAVR
- Baseline

The $PM_{2.5}$ and ozone concentrations for the other three scenarios (i.e., Clean Power Act, CSA 2003, and CSA 2005) were determined using an extrapolation technique, as described below. In the remainder of this document we use the term "modeled" to refer to those concentrations/scenarios that were actually simulated with air quality models and we use "extrapolated" to refer to concentrations/scenarios for which we applied the extrapolation technique.

II. Air Quality Modeling

To forecast ozone and $PM_{2.5}$ concentrations for the four modeled scenarios we used the same air quality modeling platform as we used for CAIR. Details on the development of emissions inventories for non-EGU sources included in this platform are provided in the following report: Clean Air Interstate Rule Emissions Inventory Technical Support Document.[1] Details on the $PM_{2.5}$ and ozone models, meteorological inputs, time periods modeled, and procedures for projecting future nonattainment are provided in the following report: Technical Support Document for the Final Clean Air Interstate Rule - Air Quality Modeling.[2] Note that ozone was not modeled for locations in the western United States as part of CAIR. In this regard, for the multi-pollutant analysis we estimated 2010, 2015, and 2020 ozone concentrations for the West[3] using results from western ozone modeling conducted as part of EPA's Nonroad Engine Rule. These 2010, 2015, and 2020 western ozone concentration estimates were used to represent expected future concentrations for each of the scenarios examined in the multi-pollutant analysis.

III. Extrapolation Technique

An extrapolation technique was used to estimate future $PM_{2.5}$ and ozone concentrations for the three extrapolated scenarios (i.e., the Clean Power Act, Clear Skies 2003, and Manager's Mark). This technique was applied to estimate concentrations at individual ozone and/or $PM_{2.5}$ monitoring sites for the purpose of projecting future attainment/nonattainment of the annual $PM_{2.5}$ and/or 8-hour ozone National Ambient Air Quality Standards (NAAQS).[4] Air quality concentrations for Clear Skies 2003 and Manager's Mark were determined using the modeling results from the Clear Skies Inhofe and future baseline scenarios. Concentrations for the Clean Power Act were determined using the modeling results from the Clean Air Planning Act and future baseline scenarios. The rationale and support for pairing the scenarios in this manner for the purpose of estimating air quality for the extrapolated scenarios are described in the report "Methods for Projecting Health Benefits."

The extrapolation technique was only applied to forecast concentrations for locations in the East. In the West, future year ozone concentrations were based on modeling from the

[1]EPA Docket #: OAR-2003-0053-2047.

[2]EPA Docket #: OAR-2003-0053-2151.

[3] For the purposes of this analysis, the West includes the following States: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

[4] The extrapolation technique used to estimate the monetized benefits for the extrapolated scenarios are described in the report "Methods for Projecting Health Benefits."

Nonroad Engine Rule, as indicated above. For $PM_{2.5}$, our multi-pollutant air quality modeling did provide $PM_{2.5}$ concentrations for locations in the West. However, we did not extrapolate these modeled data to estimate western $PM_{2.5}$ concentrations for the extrapolated scenarios. Rather, we used the $PM_{2.5}$ concentrations from the Clear Skies Inhofe scenario to represent $PM_{2.5}$ concentrations for the Clear Skies 2003 and Manager's Mark scenarios. Similarly, we used the modeled $PM_{2.5}$ in the West from the Clean Air Planning Act to represent $PM_{2.5}$ concentrations in the West for the Clean Power Act. The rationale for this approach is as follows. California and Montana are the only two States in the West with $PM_{2.5}$ nonattainment areas. In Montana, the nonattainment problem is associated with local residential wood combustion. In California, where current $PM_{2.5}$ concentrations in nonattainment areas are well above the NAAQS, the three extrapolated scenarios provide relatively small emissions reductions, if any, beyond those in the modeled scenarios.

The extrapolation procedures for estimating future year $PM_{2.5}$ concentrations at monitoring sites in the East involved using the emissions reductions for the extrapolated scenarios to scale the sulfate[5] and nitrate reductions from the corresponding modeled scenarios. As part of this technique, sulfate concentrations were scaled using SO_2 emissions reductions and nitrate concentrations were scaled using NO_x emissions reductions. The steps in the extrapolation technique are described in the pages below using the extrapolated 2010 Manager's Mark scenario and the modeled 2010 Inhofe scenario to illustrate the approach. The $PM_{2.5}$ concentration data used in the example calculations are for a single monitoring site. The extrapolation technique was applied on a site-by-site basis for each $PM_{2.5}$ monitoring included in the analysis.

Steps in the Extrapolation Technique to Estimate PM2.5 Concentrations Using the 2010 Manager's Mark Scenario as an Example.

Step 1. Calculate the Reduction in Annual Total SO2 and NOx Emissions (tons) for each Modeled Scenario.

Calculate the reduction in SO_2 emissions and NO_x emissions in 2010, 2015, and 2020 across the eastern U.S. for each modeled scenario by taking the difference in emissions between the modeled scenario and the corresponding future baseline (i.e., 2010, 2015, and 2020).[6]

	2010 Baseline EGU Emissions (East)	2010 Inhofe EGU Emissions (East)	2010 Inhofe Emissions Reduction (East)
SO_2	9,495,174	5,752,593	3,742,581
NO_x	3,167,363	1,854,681	1,312,682

e.g., (9,495,174 – 5,752,593) = 3,742,581 tons

[5]Includes sulfate ion, ammonium, and particle bound water.

[6]For the purpose of this analysis, the eastern U.S. is defined as including all States from Texas to North Dakota eastward to the East Coast.

Step 2. Calculate the Reduction in Sulfate and Nitrate per Ton Reduction in SO2 and NOx Emissions, respectively, for each Modeled Scenario.

Calculate the modeled reduction in sulfate by site per ton of SO_2 emissions reduction in the East. Apply the same approach to determine the reduction in modeled nitrate by site per ton of NO_x emissions. Perform these calculations for 2010, 2015, and 2020 for each PM2.5 monitoring site in the East.

2010 Inhofe Emissions Reduction (tons)		Projected Concentrations of Sulfate and Nitrate ($\mu g/m^3$)				
	From Step 1		2010 Baseline	2010 Clear Skies Inhofe	Reduction in Concentration	Concentration Change Per Ton of Emissions
SO_2	3,742,581	Sulfate	8.10	6.88	1.22	3.26×10^{-7}
NO_x	1,312,682	Nitrate	0.20	0.17	0.03	0.22×10^{-7}

e.g., (8.10 – 6.88) = 1.22 $\mu g/m^3$ and (1.22 / 3,742,581) = 3.26×10^{-7} $\mu g/m^3$ per ton

Step 3. Calculate the Reduction in SO2 and NOx Emissions (tons) for each Extrapolated Scenario.

Calculate the reduction in 2010, 2015, and 2020 SO_2 emissions and NO_x emissions across the eastern U.S. for the extrapolated scenario by taking the difference in emissions between the extrapolated scenario and the corresponding future baseline (i.e., 2010, 2015, and 2020) emissions.

	2010 Baseline EGU Emissions (East)	2010 Manager's Mark EGU Emissions (East)	2010 Emissions Reduction for Manager's Mark (East)
SO_2	9,495,174	5,669,193	3,825,981
NO_x	3,167,363	1,852,885	1,314,478

e.g., (9,495,174 – 5,669,193) = 3,825,931 tons

Step 4. Calculate the Estimated Reduction in Sulfate and Nitrate for each Extrapolated Scenario.

Multiply the SO2 emissions reduction for the extrapolated scenario by the corresponding[7] sulfate change per ton calculated in Step 2 to yield the estimated reduction in sulfate for the extrapolated scenario. Apply this procedure for nitrate using the reduction in NOx emissions for the extrapolated scenario and the nitrate change per ton. Perform these calculations for 2010, 2015, and 2020 for each PM2.5 monitoring site in the East.

2010 Emissions Reduction for Manager's Mark (*From Step 3*)		2010 Concentration Change Per Ton of Emissions (*From Step 2*)		Reduction in Sulfate and Nitrate ($\mu g/m^3$) for 2010 Manager's Mark	
SO_2 (tons)	3,825,981	Sulfate	3.26×10^{-7}	Sulfate	1.25
NO_x (tons)	1,314,478	Nitrate	0.22×10^{-7}	Nitrate	0.03

e.g., $(3{,}825{,}981 \times 3.26 \times 10^{-7}) = 1.25\ \mu g/m^3$

Step 5. Calculate the Sulfate and Nitrate Concentrations ($\mu g/m^3$) for each Extrapolated Scenario.

Subtract the estimated reduction in sulfate concentration for the extrapolated scenario from the appropriate future year baseline concentration to yield the sulfate concentration for the extrapolated scenario in that year. Apply the same procedures to estimate the nitrate for the extrapolated scenario. Perform these calculations for 2010, 2015, and 2020 for each PM2.5 monitoring site in the East.

	2010 Baseline Concentration	Estimated Reduction in Concentration for 2010 Manager's Mark (*from Step 4*)	Estimated Concentration for 2010 Manager's Mark
Sulfate	8.10	1.25	6.85
Nitrate	0.20	0.03	0.17

e.g., $(8.10 - 1.25) = 6.85\ \mu g/m^3$

[7] The concentrations from the modeled Inhofe scenario were paired with the concentrations from the extrapolated Clear Skies 2003 and Manager's Mark Scenarios. Similarly, the concentrations from the modeled Clear Air Planning Act were paired with the concentrations from the extrapolated Clean Power Act.

Step 6. Calculate the PM2.5 Concentrations (μg/m^3) for each Extrapolated Scenario.

Add the sulfate and nitrate concentrations for the extrapolated scenario to the concentration of the other components of $PM_{2.5}$, from the corresponding modeled scenario to yield the $PM_{2.5}$ concentration for the extrapolated scenario. Perform these calculations for 2010, 2015, and 2020 for each PM2.5 monitoring site in the East.

Sulfate for 2010 Manager's Mark (*From Step 5*)	Nitrate for 2010 Manager's Mark (*From Step 5*)	Other $PM_{2.5}$ Components from 2010 Inhofe	2010 Manager's Mark $PM_{2.5}$
6.85	0.17	6.83	13.85

e.g., (6.85 + 0.17 + 6.83) = 13.85 μg/m^3

The extrapolation technique for estimating 8-hour ozone concentrations for the three extrapolated scenarios is similar to the steps used for extrapolating $PM_{2.5}$. However, for ozone we extrapolated 8-hour concentrations at each monitoring site directly, compared to the approach for $PM_{2.5}$ in which we extrapolated the individual component species of $PM_{2.5}$ (e.g., sulfate) in separate calculations, then summed the components to calculate $PM_{2.5}$. Also, for ozone we used summer season NOx emissions versus the annual emissions which were used in the extrapolation of $PM_{2.5}$.