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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

October 17, 2000

TECHNICAL MEMORANDUM

TO: EPA Air Docket A-99-06

FROM: Eric O. Ginsburg, Senior Program Advisor (MD-14)
Emissions Monitoring and Analysis Division, OAQPS

SUBJECT: Air Quality Analyses to Accompany the Final Rule for Heavy Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements

The purpose of this memorandum is to provide additional information concerning analyses of air quality that are currently planned or underway, using measured ambient air quality data and air quality dispersion modeling. These analyses are being undertaken to update information provided at the time the notice of proposed rulemaking was published on the need for this rule. The analyses will provide input data for the Regulatory Impact Analysis (RIA) accompanying the final rule, and provide technical support for air quality improvements resulting from the emission reductions anticipated as a result of implementation of the final rule. Technical procedures, methods, and air quality models that have been documented elsewhere will not be described here in detail, but references are provided to where further information about them may be obtained.

As described further below, we are using a combination of measured and modeled air quality to estimate the potential for current and future population exposure to unhealthful levels of air quality, as indicated by the national ambient air quality standards (NAAQS) for 1-hour averages of ozone and 24-hour and annual averages of PM10. Reflecting the current scientific literature concerning the health effects attributable to human exposures to fine particulate matter and longer-term concentrations of ozone, we are also estimating air quality within a range of annual average concentrations of fine particulate matter (expressed as PM2.5) and 8-hour peak daily average concentrations of ozone. These analyses will be used to provide relevant information concerning the need for additional reductions in emissions to attain and maintain the ozone and PM10 NAAQS, to reduce exposures to harmful levels of ozone and fine particulate matter, and to provide input to estimate the effects of improvements in air quality on public health and welfare.

Emissions Inventories (full documentation is provided in "Procedures for Developing Base Year and Future Year Mass and Modeling Inventories for the Heavy-Duty Diesel (HDD) Rulemaking," which is being placed in the docket concurrently with this memorandum)

Mass emission inventories of oxides of nitrogen (NOx), volatile organic compounds, oxides of sulfur (SOx), carbon monoxide, primary particulate matter with an aerodynamic diameter less than or equal to 10 micrometers and 2.5 micrometers (PM10 and PM2.5), and ammonia, are being prepared for the 1996 base year using the National Emission Trends 1996 Version 3.11 emissions inventory as the basis for stationary source emissions. For ozone and particulate matter, projected base case inventories are being prepared for the years 2007, 2020, and 2030. Projected inventories to reflect vehicle emissions after controls are in place are also being prepared for the years 2007, 2020, and 2030. Revised emission factor multipliers supplied by the Office of Transportation and Air Quality (OTAQ) are being applied to simulate the results expected from the MOBILE6 mobile emissions model currently under development but not yet available for application. The adjustments and multipliers included adjustments to account for revisions to model year emission factors, fleet mix by vehicle class, horsepower-hour to VMT conversion factors, age distribution, vehicle miles traveled by age, excess NOx emissions for the existing heavy duty diesel fleet, and fuel economy. These changes were largely reflected in the national emission estimates presented in the draft RIA. The current effort will extend them to the county-level inventory.

Air Quality Analyses

Ozone

Current Air Quality

Current air quality statistics for 1-hour concentrations of ozone are being derived from measurements at the National, and State and Local, Air Monitoring Systems (NAMS and SLAMS) reporting to EPA's Aerometric Information Retrieval System, which have been posted as o3coupdt.pdf on EPA's web site at http://www.epa.gov/oar/aqtrnd99/ and will provide the basis for estimates of populations living in designated nonattainment areas recording violations of the 1-hour NAAQS in 1997-99.

For more prolonged concentrations of ozone, we are identifying, for each metropolitan county, the number of days in 1997-99 in which peak 8-hour concentrations fall within one of several ranges: 0.080-0.119 ppm, 0.090-0.119 ppm, 0.100-0.119 ppm, and greater than or equal to 0.120 ppm. Using this information, we will identify the total populations living in metropolitan counties in which peak 8-hour concentrations fall within these ranges, using 1998 U.S. Department of Commerce, Bureau of Census population estimates. This analysis is similar to the one performed for the notice of proposed rulemaking and described in the technical memorandum submitted to this docket on April 25, 2000 by Phil Lorang, Environmental Engineer, Air Quality Strategies and Standards Division, but differs in the following ways:

1. This analysis is not limited to only those metropolitan counties meeting the 1-hour NAAQS, as was the case for the April 25, 2000 memorandum. Irrespective of the occurrences of exceedances of the level of the 1-hour NAAQS, the potential exists for the public to be exposed to levels of ozone for more prolonged periods, i.e., 6 to 8 hours or more, which have been associated with a range of health effects, including lung function decrements, respiratory symptoms, and pulmonary inflammation.

2. This analysis relies on updated population estimates from the U.S. Bureau of the Census for the year 1998, which is more relevant to the air quality period of record being considered.

3. This analysis examines air quality over the 3-year period of 1997-99 and may thus be more likely to reflect air quality and meteorological conditions which are more representative over the long term, or less subject to fluctuations in any given year.

Future Air Quality

Regional modeling for 6 different scenarios (1996 base, 2007 base, 2020 base and control, 2030 base and control) is being performed separately for the eastern and western regions of the United States, using the variable-grid Urban Airshed Model (UAM-V) and the meteorological inputs simulated for the Tier 2 rulemaking. UAM-V is a photochemical grid model that numerically simulates the effects of emissions, advection, diffusion, chemistry, and surface removal processes on pollutant concentrations within a three-dimensional grid. Because past applications in the western region have resulted in predictions which did not meet EPA's model performance criteria, we plan to evaluate model performance for the western region in order to determine whether it is appropriate to apply UAM-V and incorporate results for this region of the country into the air quality and benefits assessments. Other than the emissions inventory inputs, this ozone modeling is following the same protocol as used for the final RIA for the Tier 2 Gasoline Sulfur rulemaking applications in 1999.

Two different types of analyses are being performed for future 1-hour ozone concentrations: we are estimating the absolute concentrations of ozone in the modeling domain to identify those areas in which the model predicts one or more exceedances of the 1-hour ozone NAAQS for each of the relevant scenarios. We are also deriving relative reduction factors (RRF) from the relative change between base and future year concentrations predicted by the model for each of the future scenarios. These RRFs will then be applied to the 1997-99 design value concentrations measured at appropriate ambient monitors to provide future air quality predictions calibrated by the monitoring data.

To estimate future prolonged ozone air quality, we are also developing RRFs by monitor which will be applied to current measured peak daily 8-hour concentrations to estimate for each future base and control case the number of metropolitan counties in which future daily maximum 8-hour concentrations are predicted to fall within specified concentration ranges for a given number of days (e.g., $\geq$ 2 days within the range of 0.08-0.119 ppm).

Particulate Matter

Modeling for the entire United States for 5 scenarios (1996, 2020 base and control, 2030 base and control) is being performed using the Regulatory Modeling System for Aerosols and Deposition (REMSAD) to estimate concentrations of both PM10 and PM2.5. REMSAD is a 3-dimensional grid-based air quality model which simulates particulate specie concentrations from primary emissions and secondary formation processes. The model is designed for estimating long-term concentrations and deposition of these pollutants over large spatial scales. REMSAD version 5.0 with the micro CB-IV chemical mechanism is being used for this analysis. A copy of the current version of the users guide is attached. We will provide a compact disc containing the model code and emissions preprocessor code for inclusion in the docket, accompanied by instructions for interested individuals on how to obtain their own copies from EPA. Modeling is being performed for a domain covering the continental United States using a 36-km grid cell resolution and 8 vertical layers. Meteorological data for these model runs were derived from simulations of the Mesoscale Model, version 5 (MM5) for the year 1996.

We indicated in the notice of proposed rulemaking for this rule that we would evaluate the benefits of the rule using the Source-Receptor Matrix (S-RM), a method which employs a set of fixed coefficients to predict annual average air quality for each county in the United States attributable to emissions from each modeled source. The S-RM was also used at the time of proposal for estimating future particulate concentrations. However, in the proposal, we also relied on the results of modeling conducted during the Tier 2 rule using REMSAD to estimate the populations living in areas across the country in which levels of fine particulate matter were predicted to reach a range of different annual average concentrations. REMSAD is more technically sophisticated than S-RM in terms of pollutant transport on a regional and national scale and it simulates the nonlinear multi-pollutant interactions involved in the ozone chemistry and aerosol formation processes. REMSAD has been used by the Agency in several recent assessments, including the Report to Congress, "The Benefits and Costs of the Clean Air Act 1990 to 2010," EPA-410-R-99-001, November, 1999, called for by Clean Air Act section 812. Because REMSAD represents the more technically sophisticated modeling approach and is the best model currently available for this type of regulatory application, we are conducting air quality analyses for PM for the air quality needs assessment and for the economic benefits assessment using REMSAD instead of S-RM.

We intend to evaluate model performance through comparisons of 1996 model predictions to ambient measurements taken from available 1996 monitoring networks. Based on our evaluation of performance, results may be applied to current and future air quality in one of several ways, described below.

Current air quality

Using ambient air quality data reported to AIRS from NAMS and SLAMS, we are identifying those areas currently designated as nonattainment for the PM10 NAAQS and measuring violations of the NAAQS in 1997-99. Additionally, we are identifying those areas that are currently designated as attainment or unclassifiable under the PM10 NAAQS but which measured violations during 1997-99.

At the beginning of 1999, State environmental agencies begin operating a broad network of monitoring stations for the measurement of fine particulate matter (measured as particulate matter having an aerometric diameter less than or equal to 2.5 micrometers, or PM2.5), using the Federal Reference Method for PM2.5 mass established when the PM2.5 national ambient air quality standard was promulgated (62 FR 38763, July 18, 1997). The data that has been submitted to EPA from this network are accessible via the internet on EPA's website (http://www.epa.gov/airsweb/monvals.htm). Monitors are generally located within metropolitan statistical areas, although some monitors intended to measure upwind PM2.5 concentrations are located outside of metropolitan areas. Monitors in this network report a 24-hour average PM2.5 concentration for each day of successful monitoring.

At present, virtually all States have completed the quality assurance review and certification process. Data which have been certified as valid are considered to be reliable, although for the purposes of characterizing air quality in areas to which people may be exposed, there must also be a sufficient number of valid samples during the period in question. For the purposes of this analysis, we are only including data certified by the States as valid, and are including only data from sites recording eleven or more valid samples in each calendar quarter. These data would not be sufficient for determining attainment or nonattainment with the PM2.5 NAAQS, which would require 3 years of data, if implemented. However, they are sufficient for the purpose of estimating the number of people who lived in monitored counties in 1999 in which annual average concentrations of PM2.5 equal or exceed certain specified values. Additionally, based on the results of the model performance evaluation described above, we may provide modeled estimates of air quality nationwide, using 1996 REMSAD grid-specific estimates. While these approaches do not provide direct comparability in terms of the year of record or geographic areas covered, together they may provide a more reasonable and geographically complete approximation of current PM2.5 air quality for the entire nation than the use of one method alone.

PM10 and PM2.5 air quality data are available to the public at http://www.epa.gov/airsdata/monitors.htm.

Future Air Quality

Using REMSAD-predicted changes in 24-hour and annual average PM10 air quality between the 1996 base and future base and control scenarios, we are developing RRFs to apply to current monitoring data to derive future expected concentrations. The RRFs to be applied to the PM10 24-hour design values will be determined by calculated changes in the 1996 second highest 24-hour average predicted PM10 concentration between the 1996 base and each future base and control scenario. The second highest predicted concentration is being used for the 24-hour PM10 RRFs since this corresponds to how the design value would be determined using a single year of data. Annual RRFs will be calculated using the change in annual average

REMSAD-predicted PM10 concentrations and applied to the annual average PM10 air quality data.

Similar to the way in which we are estimating air quality for PM10, we expect to develop RRFs from REMSAD-predicted changes in annual average PM2.5 concentrations from 1996 to projected future base and control scenarios, and apply them to monitored concentrations to estimate future concentrations on a county-level basis. Additionally, based on the outcome of model performance evaluations, we may develop grid cell-specific absolute concentration estimates for future base and control scenarios as well.

Estimating Air Quality Changes for RIA Benefits Estimates

EPA will calculate concentration changes in ozone, NOx and particulate matter in 2030 in the base and control cases at the grid cell level and then use those results in its Criteria Air Pollutant Modeling System (CAPMS) and related environmental/welfare benefits modeling systems to estimate benefits. Details of how this is done appears in Chapter VII: Benefit-Cost Analysis of the RIA for the Tier 2 Final Rule and supporting technical support documents.

Attachment

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