Methods for Projecting Air Quality Concentrations for Evaluating Alternative PM2.5 Standards

To forecast future year annual average and daily 98th percentile PM2.5 concentrations we used air quality modeling results from the CAIR/CAMR/CAVR modeling completed as part of the Multi-pollutant Analyses. Details on the PM2.5 model, meteorological inputs, time periods modeled, and procedures for projecting future design values are provided in the CAIR Air Quality Modeling Technical Support Document (EPA, 2005a) and the Multi-Pollutant Analyses Technical Support Document (EPA, 2005b) .

In general, the procedures for projecting both the annual and daily PM2.5 design values are based on using model predictions in a relative sense. In this manner, the 2001 Base Year predictions and the 2015 future predictions with CAIR controls are coupled with ambient data to forecast future concentrations. This approach is consistent with the EPA draft guidance documents for modeling PM2.5 (EPA, 2001).

Annual Average Design Values

The projected annual design values are the same as those presented in the CAIR/CAMR/CAVR Analysis. These projected annual design values were calculated using the Speciated Modeled Attainment Test (SMAT) approach, the details of which can be found in the report "Procedures for Estimating Future PM2.5 Values for the CAIR Final Rule by Application of the (Revised) Speciated Modeled Attainment Test (SMAT)" (EPA, 2004). Below are the steps we followed for projecting future PM2.5 concentrations. These steps were performed to estimate future case concentrations at each FRM monitoring site. The starting point for these projections is a 5 year weighted average design value for each site. The weighted average is calculated as the average of the 1999-2001, 2000-2002, and 2001-2003 design values at each monitoring site. By averaging 1999-2001, 2000-2002, and 2001-2003, the value from 2001 is weighted three times, whereas, values for 2000 and 2002 are each weighted twice, and 1999 and 2003 are each weighted once. This approach has the desired benefits of (1) weighting the PM2.5 values towards the middle year of the five-year period (2001), which is the Base Year for our emissions projections, and (2) smoothing out the effects of year-to-year variability in emissions and meteorology that occurs over the full five-year period. This approach provides a robust estimate of current air quality for use as a basis for future year projections.

Step 1: Calculate quarterly mean ambient concentrations for each of the major components of PM2.5 (i.e., sulfate, nitrate, ammonium, elemental carbon, organic carbon, water, and crustal material) using the component species concentrations estimated for each FRM site. The component species concentrations were estimated using 2002 ambient data from speciation monitors that was interpolated to provide estimates for all FRM sites across the country. The component concentrations information was used to calculate species fractions at each FRM site. The estimated fractional composition of each species (by quarter) was then multiplied by the 5 year weighted average 1999-2003 FRM quarterly mean concentrations at each site (e.g., 20 percent sulfate multiplied by 15.0 µg/m3 of PM2.5 equals 3 µg/m3 sulfate). The end result is a quarterly concentration for each of the PM2.5 species at each FRM site.

Step 2: Calculate quarterly average Relative Reduction Factors (RRFs) for sulfate, nitrate, elemental carbon, organic carbon, and crustal material. The species-specific RRFs for the location of each FRM are the ratio of the 2015 CAIR case to 2001 Base Year quarterly average model predicted species concentrations. The species-specific quarterly RRFs are then multiplied by the corresponding 1999-2003 quarterly species concentration from Step 1. The result is the future case quarterly average concentration for each of these species.

Step 3: Calculate future case quarterly average concentrations for ammonium and particle-bound water. The future case concentrations for ammonium are calculated using the future case sulfate and nitrate concentrations determined from Step 2 along with the degree of neutralization of sulfate (held constant

from the base year). Concentrations of particle-bound water are calculated using an empirical relationship derived from the AIM model using the concentrations of sulfate, nitrate, and ammonium as inputs.
Step 4: Calculate the mean of the four quarterly average future case concentrations to estimate future annual average concentration for each component species. The annual average concentrations of the components are added together to obtain the future annual average concentration for PM2.5.

Step 5: For counties with only one monitoring site, the projected value at that site is the future case value for that county. For counties with more than one monitor, the highest future year value in the county is selected as the concentration for that county.

24-Hour Average Design Values

The daily design values are based on applying a similar projection method. As with the annual design value, monitor data for the years 1999 to 2003 are used as the basis for the projection. There are several steps in the projection for each of the base years of monitoring data:

Step 1: The first step in projecting the daily design value is to identify the maximum daily average PM2.5 concentration in each quarter that is less than or equal to the annual 98th percentile value over the entire year. This results in data for each year for each site which contains one quarter with the 98^{th} percentile value and three quarters with the maximum values from each quarter which are less than or equal to the 98^{th} percentile value.

Step 2: These quarterly PM2.5 concentrations are then separated into their component species by multiplying the quarterly maximum daily concentration at each site by the estimated fractional composition of PM2.5 species, by quarter, based on the observed species fractions from speciation monitors in 2002 (using the same quarterly average fractional species data used in the annual average calculations from above).

Step 3: The component species are then projected by multiplying each species concentration by the quarterly relative reduction factors for each species derived from the 2015 and 2001 PM2.5 air quality modeling (using the same quarterly RRFs that were used in the annual average calculations.)

Step 4: The projected species components are then summed to obtain a PM2.5 concentration for each quarter that represents a potential daily design value. This procedure is repeated for each of the years of monitoring data (1999-2003). The highest daily value for each year at each monitor is considered to be the estimated 98^{th} percentile value for that year.

Step 5: The estimated 98^{th} percentile values for each of the 5 years are averaged over 3 year intervals (1999-2001, 2000-2002, 2001-2003), and then averaged over the three interval averages. This creates a 5 year weighted average for each monitor. The projected daily design value for a county is then calculated as the maximum 5 year weighted average design value across all monitors within a county.

Annual and daily average county level design values were then compared to the potential alternative annual and daily standards and mapped.

References

U.S. EPA, (2001), “Guidance for Demonstrating Attainment of Air Quality Goals for $PM_{2.5}$ and Regional Haze”, http://www.epa.gov/ttn/scram/guidance_sip.htm, Modeling Guidance, DRAFT-PM

U.S. EPA, (2004), “Procedures for Estimating Future PM2.5 Values for the CAIR Final Rule by Application of the (Revised) Speciated Modeled Attainment Test (SMAT)- Updated 11/8/04”.

U.S. EPA, (2005a), “Technical Support Document for the Final Clean Air Interstate Rule; Air Quality Modeling” http://www.epa.gov/cair/pdfs/finaltech02.pdf

U.S. EPA, (2005b), “Methods for Projecting Air Quality Concentrations for EPA’s Mulit-Pollutant Analyses of 2005”, http://www.epa.gov/airmarkets/mp/aqsupport/airquality.pdf