Ohio Department of Transportation
Office of Technical Services

PM2.5 SIP Development
Tech Memo 3/25/2008

A. Overview

This report is intended to summarize Ohio Department of Transportation Office of Technical Services methods used to estimate PM 2.5 emissions for SIP development. The method employed is based on previous PM2.5 conformity demonstration work and on "Guidance Document for Creating Annual On-Road Mobile Source Inventories for PM 2.5 Non-Attainment Area for Use in SIPs and Conformity" issued August 2005 by US EPA. The report outlines several acceptable approaches.

PM2.5 Standard

"US EPA has established two standards for PM 2.5, annual and 24-hour. The annual standard is exceeded if the 3-year average of annual mean PM2.5 concentrations is greater than 15 micrograms per cubic meter, the 24-hour standard is exceeded if the 3-year average of the annual 98th percentile concentrations is greater than 65 micrograms per cubic meter." Currently, monitored levels in several regions in the state exceed the standard.

In order to bring Ohio into compliance and meet the standard, the Ohio Environmental Protection Agency (OEPA) hired LADCO to model forecasts of PM emissions. LADCO ran a dispersion model that includes point, area, and mobile sources to test emission reduction strategies. For the transportation component, ODOT provided LADCO with travel demand model forecasts for the Ohio PM non-attainment areas. However, due to differences in the type and resolution of the models, LADCO's emissions estimates will differ from the MPOs and DOT estimates. Since DOT emission forecasts will be used later for transportation conformity demonstrations, it is important that SIP emissions budgets for the transportation sector be consistent with DOT emission estimates. Therefore, it was agreed by interagency consultation early in the process that DOT estimates would be used to establish the transportation PM 2.5 emissions budget.

B. Travel Demand Model

Travel demand models usually replicate average daily travel conditions. In urban areas regional travel demand models are used as the basis for Metropolitan Planning Organization's (MPO) long range transportation plan development, congestion management, and number of other planning studies including air

quality. ODOT also uses regional travel demand models as the basis of traffic forecasts for highway design. Therefore, the models are updated, validated and calibrated on a regular basis. Travel demand models produce roadway segment specific forecasts of freeway and arterial traffic in the entire region. These estimates are based on travel trends in the region as well as population and employment forecasts. For vehicle pollution estimates, vehicle miles of travel (VMT) is derived from travel demand models. Simply stated, VMT from regional travel demand models is multiplied by emission rates generated by USEPA's MOBILE 6.2.

$$\text{Emissions} = \text{VMT} * EF_{st}$$

Note that although PM is insensitive to speed and temperature, at least in MOBILE6.2, NOX, a PM emission precursor, does. Therefore, temperature profiles were needed for the NOX emission estimates. Since travel demand models produce average **daily** conditions, the daily emissions estimate is multiplied by 365 days to produce an annual emissions estimate expressed in tons per year.

C. MOBILE 6.2 Inputs

Temperatures

The single season approach is chosen over the two season approach for setting SIP budgets. It is worth noting that unique temperatures were established for each non-attainment region.

The Two Season Approach

This is more easily explained with an example so temperatures from the Akron area are used here. For conformity demonstration under the interim guidance, it was decided through the interagency consultation process to use a two season approach. That meant creating emission factors for summer and winter. ODOT's post process looks at traffic by hour of day over twenty four (24) hours so the emission factors are generated by hour of day and hence the temperatures are hourly. The following text and table in italics is from "AMATS PM 2.5 Air Quality Conformity Analysis Technical Memo ODOT Modeling & Forecasting 12/20/2005". Temperatures are in degrees Fahrenheit.

Six month average minimum and average maximum temperatures were used to generate two sets of emission factors (fall/winter, spring/summer). Temperatures were computed using 2002 NOAA temperature data downloaded from their web site:
ftp://ftp.ncdc.noaa.gov/pub/data/globalsod/stnlist-sorted.txt
ftp://ftp.ncdc.noaa.gov/pub/data/globalsod/2002/all-2002.tar

Through interagency consultation, it was decided to use data from the Akron Fulton Airport, (724303 KAKR AKRON FULTON OH +4103 -08146 +0326) for the two AMATS counties. The extracted airport data was summarized by month as shown in figure E7. Temperature for each hour of day for 24 hours was estimated using the seasonal average min. and average max temperatures and an average day temperature profile, temperature for each hour of day for 24 hours was computed. Figure E8 shows the temperature data.

Figure E7 – Temperature Data

Season	County	Average Low Temp	Average Hi Temp
Summer	Summit	53.7	78.5
Winter	Summit	29.0	46.7

6:00 AM 0	7:00 AM 1	8:00 AM 2	9:00 AM 3	10:00 AM 4	11:00 AM 5
53.837	57.118	61.278	65.799	69.598	72.424
29.077	31.429	34.411	37.653	40.376	42.402

12:00 PM 6	1:00 PM 7	2:00 PM 8	3:00 PM 9	4:00 PM 10	5:00 PM 11
74.669	76.082	78.123	78.453	78.563	78.217
44.012	45.025	46.488	46.724	46.803	46.555

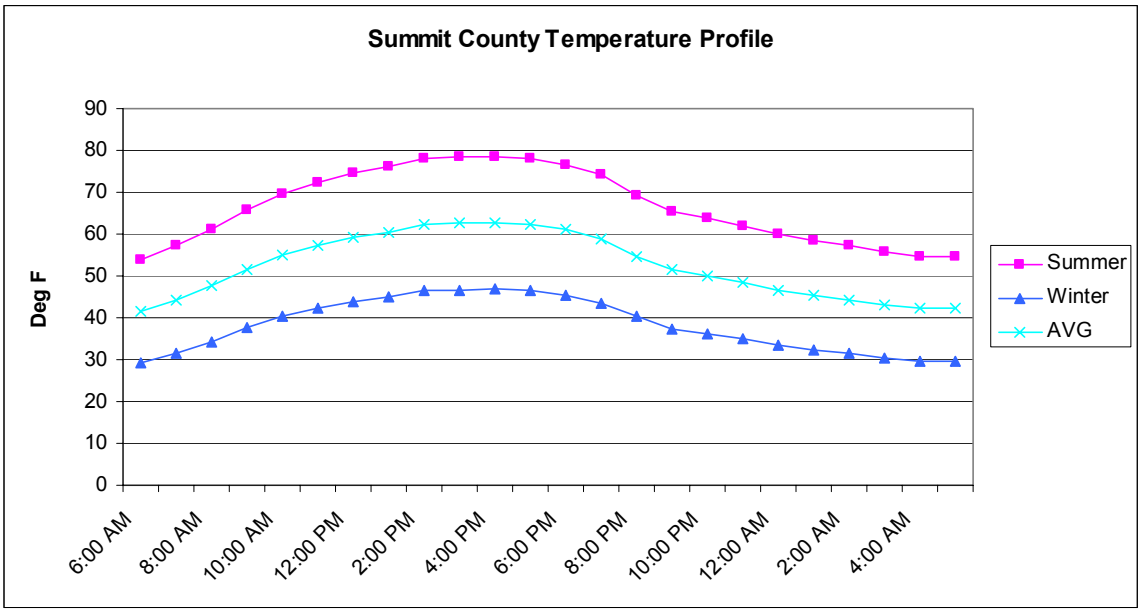
6:00 PM 12	7:00 PM 13	8:00 PM 14	9:00PM 15	10:00 PM 16	11:00 PM 17
76.632	74.120	69.379	65.454	63.806	61.875
45.419	43.618	40.219	37.405	36.223	34.839

12:00 AM 18	1:00 AM 19	2:00 AM 20	3:00 AM 21	4:00 AM 22	5:00 AM 23
59.975	58.468	57.275	55.862	54.700	54.622
33.477	32.397	31.541	30.528	29.696	29.639

Single Season Approach

Temperatures used for the single season approach are representative of 12 months in 2002. The two season approach was initially chosen in the event OEPA wanted to test or implement seasonal SIP strategies. Since seasonal SIP strategies will not be used, the single season approach is preferred because the annual emissions estimate is virtually the same but is straight forward and takes less time. Clark County was used to compare two season and one season results with temperatures. Emissions for Clark County with the annual average temperatures were within 0.4 % of the two season approach. For the single season approach, two season temperatures were averaged to obtain average annual temperatures. So, for 6 AM the average temperature would be computed as follows:

Avg. Temperature (6 AM) = (53.837+29.077)/2 = 41.5



Temperatures for each region are stored electronically in PM25temperatures.xls and available upon request.

Other input

Other inputs were agreed upon by interagency consultation process as summarized below:

Final 05.29.07

Other Areas (excluding NOACA/AMATS and OKI/MVRPC) Ozone M6.2 Inputs

Includes the following counties:
Ohio: Belmont, Columbiana, Delaware, Fairfield, Franklin, Jefferson, Knox, Licking, Lucas,Madison, Mahoning, Pickaway, Trumball, Wood

Fuel Commands	
	Input
Fuel Program	1
Oxygenated Fuels	0.00 0.42 0.00 0.036 2
Fuel RVP	9

Alternative Emission Regulations and Control Measures		
Rebuild Effects	0.1	(0.30 for 2018)

External Conditions Commands	
Calendar Year	All
Evaluation Month	7
Min/Max Temperature	National Climatic Data Center

Vehicle Fleet Characteristic Commands	
Registration Distribution	Variable

D. Post Processing with CMAQ

Emission factors are generated with MOBILE 6 and multiplied by VMT using a post processing program, POSTCMS#. Complete documentation of that process is currently available at http://www.dot.state.oh.us/urban/Download/cmaqr1.doc

To quote the document, with forecasted travel demand model output The POSTCMS# program

1. Breaks 24 hour model volumes into hourly, directional components.
2. Calculates an hourly, directional speed for the link based on the V/C ratio.
3. Calculates various measures of effectiveness for the link including emissions.

In addition to calculation of link based MOE's and emissions, the CMAQ process also calculates those emissions due to intrazonal trips. This is accomplished using program INTRAQ#. This process uses the same intrazonal trip and zonal area files as the old CMAQT process and adds the resultant emissions to the CMAQ reports.

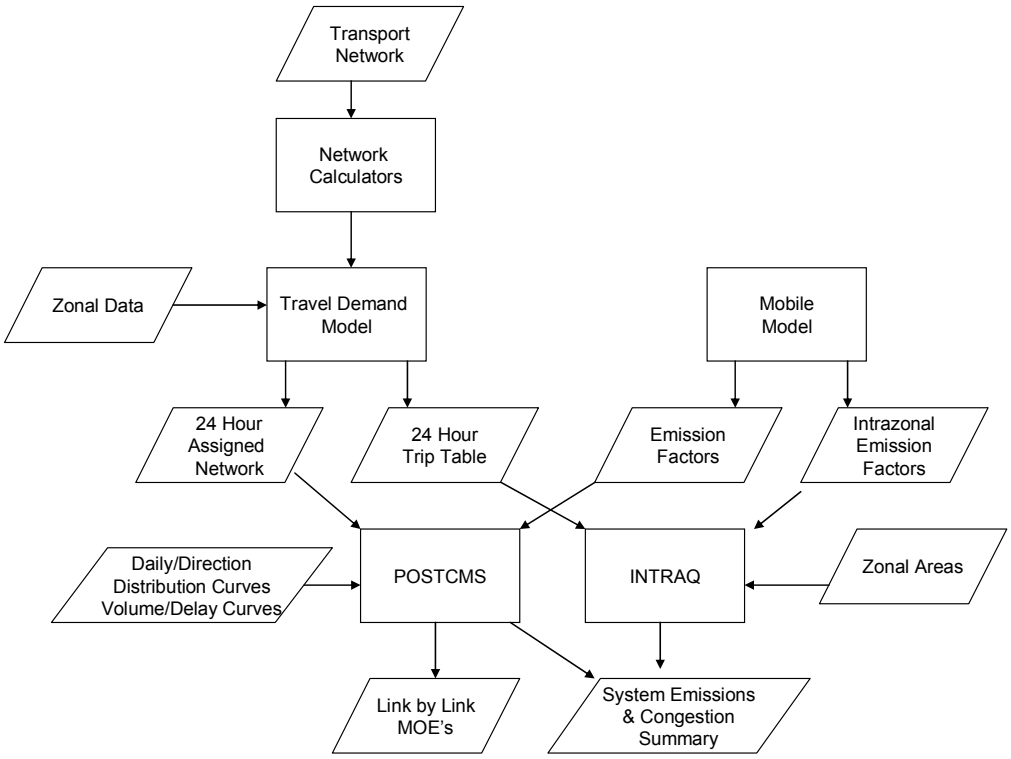


Figure 1. Overall CMAQ Process