Improvements in Emissions Modeling for Source Categories with Significant Ozone Precursor Emissions

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ABSTRACT

During a recent stakeholder process to develop consensus on emission reduction strategies for two areas of Pennsylvania, it was found that a number of source categories had outdated or poor quality emissions estimates. Because some of these source categories were those that were recommended for further VOC and NO_x controls, Pennsylvania sponsored a project to evaluate 1996 emission estimation methods, as well as the use of the emission estimates in the emissions pre-processor (EMS-95) to provide the emission estimates for episode periods that are supplied to the grid-based photochemical modeling that was performed for the area (using CAMx). This project assessed the emission estimation steps (estimate ozone season daily emissions, day-of-week temporal profiles, diurnal profiles, speciation methods, and spatial surrogates) for each source category that emits more than 10 tons per day of either VOC or NO_x Statewide in Pennsylvania. Many improvements were made during this process which resulted in a much better estimate of precursor emission patterns during the ozone episode of interest. Photochemical modeling was performed with and without these inventory changes to judge how ozone estimation was affected.

INTRODUCTION

During the Reading-Lehigh Valley and South Central Pennsylvania ozone stakeholder processes, a number of emission categories were found to have outdated or poor quality estimates[1]. These source categories included gasoline marketing, consumer/commercial solvent use, and other area source volatile organic compound (VOC) categories. Since these estimates can significantly affect strategy implementation, their effectiveness, and resultant air quality changes related to specific stakeholder recommendations, corrections were needed prior to rule implementation and final estimation of air quality improvements.

The purpose of this project is to improve the emissions information being used in regulatory development and grid-based photochemical modeling for the Commonwealth of Pennsylvania for the stakeholder process. This includes evaluating the emission estimation methods for some of the categories where those values are most uncertain, and the speciation, and spatial and temporal allocation factors that are applied to emissions during the emissions pre-processing using EMS-95.

During 1999, the South Central Pennsylvania and the Reading/Lehigh Valley Stakeholders Groups met monthly to discuss and develop recommended air pollution control measures designed to bring these two areas into compliance with the 8-hour average ozone standard. The outcome of these efforts were recommendations for a course of action to attain and maintain the health-based ozone standard, tailored to meet regional needs.

Stakeholders were chosen based on their personal qualifications and their ability to provide appropriate representation and work toward consensus on a broad range of clean air issues.

The base year emissions data used for the stakeholders deliberations were from the 1996 Periodic Emission Inventory that was developed by the Pennsylvania Department of Environmental Protection (PennDEP) staff. This included a point source emissions file with estimates of annual and ozone season daily 1996 ozone precursor emissions (VOC and oxides of nitrogen [NO_x]). The PennDEP supplied a point source 1996 emissions data base that covered most of Pennsylvania. Point source emission files were received separately for Allegheny County and Philadelphia County. These files were supplied by the Allegheny County Health Department and Philadelphia Air Management Services, respectively. Estimates of 1996 highway vehicle emissions were provided by the Pennsylvania Department of Transportation (PennDOT). The 1996 area source emission estimates used in this study were those from a 1996 rate-of-progress emission data base compiled by the PennDEP.

AREA AND NONROAD ENGINE/VEHICLE SOURCES

E.H. Pechan & Associates, Inc.'s (Pechan's) evaluation of area source VOC emission estimation methods focused on source categories that contribute 10 tons per day or more to the Statewide emissions in 1996. These categories were commercial/consumer solvents, architectural surface coating, gasoline marketing, degreasing, automotive refinishing, and waste burning. For most VOC area source categories, the method to be used to provide the best emission estimates often relies on surveys of manufacturers and/or end users. Survey methods are routinely recommended for area sources in the U.S. Environmental Protection Agency's (EPA's) Emission Inventory Improvement Program (EIIP). As these methods are resource intensive, Pechan concentrated on identifying alternative sources of available data for improving emission estimates in Pennsylvania. Findings and recommendations for each of the significant area source categories are summarized below and in Table 1.

Per capita based emission factors and Census population estimates were used by Pennsylvania to estimate 1996 *commercial and consumer solvent* emissions. Because the VOC emission factor of 6.3 pounds per capita that Pennsylvania used was based on 1990 survey data, it was recommended that the emissions for this source category be re-computed using the EIIP recommended 7.84 pounds per capita factor. Activity factors of 7 days per week, and 0.25 summer versus annual used by Pennsylvania were deemed appropriate for this category.

For *architectural surface coating*, a per capita emission factor of 4.6 pounds VOC per person per year was used in the original 1996 Pennsylvania inventory. This emission factor was taken from 1991 EPA guidance. The EIIP recommends surveys to establish both usage and emission factors of water-based and solvent-based paints. Because Pennsylvania did not have the resources to perform such surveys during the study period, per capita emission factor methods were retained for this category. An emission factor of 6.7 pounds per capita was used that represents a combined value for architectural coatings, traffic markings, and two subcategories of industrial maintenance coatings, including high performance maintenance and other special purpose coatings. It was recommended that Pennsylvania continue to use its 7 days per week activity assumption, but also apply a 1.3 multiplier (seasonality factor) to its emission estimates to account for increased activity during the summer compared with other seasons.

For *degreasing*, Pennsylvania used an employee-base emission factor of 87 pounds VOC per employee per year to estimate 1996 emissions. County-level Census Bureau or Pennsylvania Industrial Directory employment data for Standard Industrial Classification (SIC) codes 25 (Furniture and Fixtures), 33-39 (Various Manufacturing), 551 (New Car Dealers),552 (Used Car Dealers), 554 (Gasoline Service Stations), and 753 (Auto Repair) were used as activity indicators. PennDEP had a number of concerns about using published employment data by SIC code to estimate degreasing emissions (and also solvent cleaning) emissions. One concern was the ability of that data to properly represent employment in the applicable industries. Another concern is the observed year-to-year variability in these employment statistics, and that using these data might show dramatic year-to-year changes in emissions that are unlikely to be occurring in practice. As a result, PennDEP was interested in having per capita emission factors to apply as an option. A five day per week activity factor was used for this source category.

Similarly, for *automotive refinishing*, Pennsylvania was interested in switching from its employee-based methods for estimating VOC emissions to a per capita-based method. Previously, a per employee emission factor of 3,519 pounds VOC per employee per year was used along with employment data for SIC code 7532 from the 1995 County Business Patterns was used to estimate emissions. As with degreasing, PennDEP was concerned about the ability of published employment data to properly characterize automotive refinishing VOC emissions in all areas of the Commonwealth. It is estimated that there are many unlicenced automotive refinishing operations throughout Pennsylvania, so using published employment data for this industry would be expected to underestimate VOC emissions in that area. The appropriate per capita emission factor is 2.3 pounds per capita for this category. This value is consistent with the factor being used to estimate emissions for the Ozone Transport Commission study of VOC and NO_x model rule adoption. A five day per week activity factor was used for this source category.

Recommendations for improving 1996 Pennsylvania area source and nonroad engine/vehicle emission estimates are summarized by source category in Table 1. This table lists the recommended emission estimation methods by source category, and it also notes the new data collection that needs to be performed by PennDEP staff in order to successfully implement the recommended method. There may be cases where the PennDEP chooses not to implement the recommended methods to re-estimate its 1996 emissions.

However, these methods are equally valid for preparing 1999 area and nonroad emission estimates. For the majority of the nonroad mobile source categories, 1996 revised Pennsylvania emission estimates were developed using the EPA NONROAD model[2]. The NONROAD model estimates emissions for diesel, gasoline, liquefied petroleum gasoline and compressed natural gas-fueled nonroad equipment types. The model was run for Pennsylvania counties for 1996, specifying typical summer weekday emissions as the output. The Reid vapor pressure and temperature values are county-specific. The fuel sulfur and oxygen contents are default values. For the recreational marine category, State-level NONROAD model default equipment populations for Pennsylvania were replaced with 1996 county boat populations obtained from Pennsylvania's Fish and Boat Commission. Table 2 compares the before and after VOC and NO_x emission estimates for the area source and nonroad engine/vehicle categories that were evaluated for this project. Estimates of Pennsylvania Statewide VOC emissions increased by about 350 tons per day, with most of this difference being in the nonroad emission estimates.

POINT SOURCES

Relatively few modifications were made to the 1996 point source emissions data base, but there are a couple of adjustments worth mentioning. Cement kilns are a significant point source NO_x emitter in the Lehigh Valley of Pennsylvania, so special attention was given to estimating base (and future year) emissions for these facilities. Comments on the base year 1996 emission estimates were received from the cement producers in the area, either as written comments provided to EPA on the NO_x State Implementation Plan (SIP) Call data base, or comments provided on materials presented at the ozone stakeholder meetings. It is recommended that States in the SIP Call region use comments on their SIP Call-affected sources to improve their base year NO_x emission estimates, if they have not already done so.

Secondly, Pennsylvania estimates ozone season daily (i.e., weekday) emissions by dividing the annual emission estimates by the number of operating days during the year. This method provides reasonable estimates for facilities/units that operate continuously during the year. However, it overestimates emissions (NO_x emissions) for peaking units that operate only a few days per year. Some adjustments were made by

Pechan to ozone season daily NO_x estimates in the Pennsylvania point source file to correct these conversion problems.

HIGHWAY VEHICLES

Highway vehicle emission estimates for Pennsylvania that are used in State periodic emission inventories, SIPs, and transportation conformity analyses are prepared by a contractor team under PennDOT sponsorship[3]. In order to estimate both the rate at which emissions are being generated and to estimate vehicle miles traveled (VMT) (a measure of vehicle activity), Pennsylvania examines its roadway network and vehicle fleet composition. For ozone precursor inventories, computations are performed for a typical summer (July) weekday.

Emission calculation involves using computer models both to (1) simulate vehicle travel on the Commonwealth's roadway system, and (2) to estimate vehicle emission rates at different travel speeds and operating conditions. The 1996 highway vehicle emission factors for Pennsylvania were estimated using MOBILE5, the U.S. Environmental Protection Agency's (EPA's) mobile source emission factor model. MOBILE5 is a FORTRAN program that calculates average in-use fleet emission factors for ozone precursors for each of eight categories of vehicles under various conditions affecting in-use emission levels (e.g., ambient temperatures, average vehicle speeds, gasoline volatility) as specified by the model user.

Pennsylvania also uses the Post Processor for Air Quality (PPAQ) in its highway vehicle emission calculations. PPAQ consists of a set of programs that perform the following functions:

- Analyze highway operating conditions;
- Calculate highway speeds;
- Compile VMT and vehicle type mix data;
- Prepare MOBILE runs; and
- Calculate emission quantities from MOBILE emission factor outputs and accumulated highway VMT.

Recommendations for Improving Pennsylvania's Highway Vehicle Emission Inventory Modeled with EMS-95 - The EMS-95 model has been used by PennDEP to perform emission preprocessing for input to air quality modeling. Although the data used to calculate the 1996 Pennsylvania highway vehicle emission inventory were prepared at a relatively high level of detail, the inputs provided to the EMS-95 model have not reflected all of the detail available from data collected by PennDOT. Inputs provided representing the MOBILE model inputs sufficiently represent the data used in the inventory development, and no changes are recommended to these files.

In addition to the MOBILE model inputs, three types of files have been supplied as EMS-95 inputs for Pennsylvania air quality modeling: a VMT file, a speed file, and a VMT mix by vehicle type file. The VMT file contains average July weekday VMT summed by roadway type and county. Similarly, the speed file contains average speeds by roadway type and county. The VMT mix file contains the VMT mix by vehicle type by roadway type.

The average weekday VMT is then distributed within the EMS-95 model by hour, using default hourly VMT profiles. By contrast, the current Pennsylvania highway vehicle emission inventories have been calculated using VMT data by county, roadway type, and four daily time periods. Similarly, adjustments are made within EMS-95 to calculate VMT for the specific days of the week needed for modeling a given episode using default daily temporal profiles.

Pechan examined the level of detail of the highway vehicle related data used by PennDOT and the ability of EMS-95 to handle such data inputs. To improve the accuracy of the highway vehicle emissions calculated within EMS-95 and to more closely duplicate the procedures used by PennDOT in estimating emissions, Pechan recommends that PennDEP perform its air quality modeling using the data inputs as discussed below. This will improve consistency among conformity, rate-of-progress inventories, and modeling inventories for highway vehicles.

Speed Data

Because the emission factors calculated by MOBILE are not linear with speed, significant differences in emissions, and in the resulting air quality, could occur when comparing the daily emission outputs from EMS with those in the Pennsylvania inventory. One of the single most important factors for improving the accuracy of the emissions processing within EMS-95 is the use of speed at the lowest level of detail available. The Pennsylvania inventory uses speeds that vary by the four daily time periods, roadway type, and county. However, an average daily speed by roadway type and county has been used as the EMS speed input. This speed is then used within EMS for that entire day. By instead supplying the speeds that have actually been used in developing the Pennsylvania highway vehicle inventory, at the time period, roadway type, county level of detail, emissions calculated in EMS should correspond more directly with those calculated in the Pennsylvania inventory. Although the Pennsylvania highway vehicle inventory is calculated for four time periods, the speed data are available by county, roadway type, and hour. We recommend using these hourly speed data in the Pennsylvania air quality modeling, since hourly differences in emissions resulting from differences in speeds could significantly affect ozone predictions, where hourly emission differences are important due to the timing of ozone formation. In addition, the use of speed inputs by hour rather than time period does not increase the size of data files to be supplied to EMS-95.

VMT Temporalization

PennDOT collects VMT data showing VMT variations by the hour of day, day of week, and month of year for ten different traffic pattern groups: urban interstates, rural interstates, urban principal arterials, rural principal arterials, urban minor arterials and collectors, North rural minor arterials, Central rural minor arterials, North rural collectors, Central rural collectors, and special recreational. Baker Transportation (a PennDOT contractor) uses these data in the development of the Pennsylvania highway vehicle emission inventory. The current Pennsylvania air quality modeling used EMS-95 defaults for hourly, day of week, and month of year VMT adjustments.

VMT data are currently supplied to EMS-95 as average July weekday VMT by county and roadway type. No changes are needed in this input. However, it is recommended that the State supply Pennsylvania-specific inputs to EMS-95 that would be used to break the VMT down by hour and to allocate VMT to specific days of the week, or months of the year. The data needed to perform the daily allocations are: state ID, county ID, area type (urban or rural), facility type, emission classification (diurnal or other), and 24 factors representing the fraction of daily VMT occurring in each hour. These files could easily be prepared based on the data currently used by PennDOT. Similarly, the Pennsylvania-specific data should be used for the daily and monthly VMT adjustment factors. The data needed in this EMS-95 input file includes: state ID, county ID, area type (urban or rural), facility type, fractional VMT value associated with each of the seven days of the week, and then the fractional VMT values associated with each of the 12 months of the year. Care must be taken, however, to ensure that these adjustment factors are keyed to the VMT being supplied (i.e., if the VMT data supplied are average July weekday VMT, then the daily and monthly VMT adjustment factors must use that VMT as the base, not the annual average daily VMT).

VMT by Vehicle Type

It is also recommended that VMT allocations to the MOBILE vehicle types be modified to use EPA's latest estimates of VMT distribution among the light-duty classes of vehicles. This should be incorporated in

EMS-95 by starting with the Pennsylvania Roadway Management System auto versus truck VMT percentages by county, functional roadway class, and hour of day. These data should then be allocated to each of the eight MOBILE5 vehicle types using the procedure discussed above and supplied to EMS-95 by county, functional roadway class, and hour.

Gridding Recommendations - Recommendations for modifications to the gridding procedures currently used in the Pennsylvania air quality modeling consider that PennDEP is not ready at this time to switch to the Unified Grid (This is planned in the near future.), or in switching to a link-level network. The current EMS-95 modeling used in Pennsylvania already includes major interstates assigned as line sources. Two options could be considered at this time. The improvements that are likely to be obtained from further refinements to the spatial allocations of the highway vehicle emissions data may be small in terms of observed air quality changes. The first option is to use TIGER line files, which would add principal arterials as line sources. The second option is the procedure currently being developed by EPA to improve grid-level surrogates used for allocating VMT. Since EPA's data will be developed for the Unified Grid, Pennsylvania would need to replicate this procedure to obtain inputs that match the current Pennsylvania grid. At this time, the benefits of using EPA's approach to gridding VMT in Pennsylvania is unclear. The biggest benefits of this approach are expected to be seen in larger Western States, where old or incorrect TIGER line files had previously been used and county sizes are much larger and less populated. Nevertheless, this approach would still provide some level of refinement to the current gridding for the secondary road classes. Thus, Pechan recommends that Pennsylvania wait to incorporate this approach at the time that it switches to the Unified Grid, and instead recommends either the use of the TIGER line files or no changes at this time to the spatial allocation for highway vehicle emissions.

Heavy-Duty Diesel Defeat Device Recommendations

NO_x emissions from heavy-duty diesel vehicles (HDDVs) are currently underestimated in the Pennsylvania emission inventory because the effects of heavy-duty diesel defeat devices are not considered. Pechan recommends applying adjustment factors to correct these emissions. Alpine Geophysics has already (under projects for EPA) developed code to incorporate the NO_x emissions effects of the heavy-duty diesel defeat devices in EMS-95, although some modifications might be needed for Pennsylvania where we are not assuming a 1-to-1 correspondence between speed and roadway type. The data are in the form of multiplicative adjustment factors that vary by speed and roadway classification. These factors are designed to be multiplied by the HDDV NO_x emission factors, or emissions.

SPECIATION PROFILES

The speciation profiles for the most important Pennsylvania area source categories that were used in the stakeholders analysis were found to be outdated, and should be replaced with profiles that better represent the reactivity of compounds used in these industries during the 1990s. For example, for the commercial/consumer solvents area source category, either new SPECIATE or Air Resources Board (ARB) profiles should be used to derive a new set of CB-IV adjustment factors. For architectural coatings, none of the SPECIATE profiles used in the stakeholders analysis captures the recent trend toward lower VOC content coatings. ARB is developing a revised speciation profile for this source category which should be available by the end of 2000. This new profile should be used to derive a new set of CB-IV adjustment factors.

For gasoline marketing, speciation profiles should be changed to account for modern gasoline formulations and to distinguish the characteristics of the Federal reformulated gasoline sold in the five county Philadelphia area from gasoline sold in the rest of Pennsylvania. Pechan recommends using profile 2450 for reform gas areas, and profile 2453 for the remainder of Pennsylvania to establish CB-IV adjustment factors for EMS-95. Continuing efforts to update the reformulated gasoline profile are recommended, especially with

Phase 2 Federal RFG being sold in 2000, and beyond. For degreasing activities, Pechan recommends dividing the industry to split automotive repair from manufacturing. Selection of a new speciation profile will depend on the level of disaggregation. For the autobody refinishing category, ARB's profile best represents changes in auto refinish coatings that occurred in the mid-1990s, and this profile should be used in any new Pennsylvania modeling exercises.

TEMPORAL PROFILES

The assessment of temporal profiles used in EMS-95 during the stakeholder modeling focused on area source/nonroad categories and the largest point source NO_x emitters in Pennsylvania (electric power producers). The analysis of *area source profiles* showed the following:

1) In the stakeholder modeling, three profiles were applied to estimate hourly emissions from daily. Profile 26 is applied to most of the important source categories: nonroad 2-stroke engines, solvent utilization, and fuel combustion. Profile 26 indicated no activity until 8:00 a.m., a flat profile from 8:00 a.m. until 10:00 p.m., then the highest activity from 10:00 p.m. until midnight.
2) Profile 24 was applied to marine vessels and other combustion, like wildfires and managed burning. It allocates equal emissions to all hours of the day.
3) Profile 27 was applied to nonroad 4-stroke engines. It has two levels of activity. The higher level of activity is at night, with slightly lower activity during daylight hours.
4) For day-of-week allocations, five different profiles were assigned, but they all represent the same allocation level – namely, all days of the week are equal.

There have been recent improvements in the temporal profiles used in EMS-95. It is recommended that these improved profiles be used in future ozone modeling for the stakeholder areas. Some of these improved profiles are listed below.

Profile Number	Assigned Source Categories
33	Gasoline Service Stations
37	Construction Equipment, Open Burning, AIM Coatings and Solvents
48	Commercial Aircraft
70	2-Stroke Recreational Vehicles and Pleasure Craft

There have also been improvements in the day-of-week allocation profiles for area source/nonroad categories that are recommended for use in future Pennsylvania modeling inventories.

For *point sources*, the Pennsylvania 1996 and 2007 point source files that Pechan provided to Alpine during the ozone stakeholder process contained no operating schedule information (only seasonal throughput) and no weekly, or daily, profile codes. As a result, the EMS-95 modeling files for Pennsylvania point sources used flat profiles for all point sources: electricity generating unit (EGU) and non-EGU. Recommended improvements that should be made before the next modeling is performed in Pennsylvania include assigning profiles to all EGU units based on profiles developed by Lake Michigan Air Directors Consortium (LADCO) for *base load, near base load, most common, additional peaking, strong peaking, or peaking load* units. EGUs in Pennsylvania should be examined and the appropriate profile assigned. For non-EGUs, assign the profiles used in OTAG for other point sources. Alternatively, obtain operating schedule information, if available, and use this to determine daily and hourly profile codes.

Because of the importance of large, coal-fired EGU sources in the Pennsylvania NO_x inventory, hourly NO_x emissions data from EPA's Emission Tracking System/Continuous Emission Monitoring (ETS/CEM) data base were evaluated to determine whether hourly NO_x emission estimates provided by EMS-95 using profile assignments would be significantly improved by using ETS/CEM data directly for an episode period. This analysis was performed for the seven highest NO_x emitting facilities in Pennsylvania. This analysis compared actual measured hourly NO_x emissions for June 18 through August 12, 1997 to those that would be estimated by EMS-95 using diurnal profile assignments by plant type/unit type. *This is the episode period that is to be used by Mid-Atlantic Regional Air Management Administration (MARAMA) States for 8-hour ozone standard-related modeling.*

An analysis was also performed to compare predicted model output with actual emissions as reported through ETS/CEM. Because it was cumbersome to analyze all 55 days for each of the 18 boilers, data from one week (seven days) at each plant were examined to compare hourly emissions. The following equation was used to replicate the model results:

Equation (1) Hourly NO_x emissions (tons) = (NO_x tons/day) x (7 days per week) x (day-of-week profile) x (hourly profile)

where

NO_x is the NET96 ozone season daily value in tons per day and the multiplier of 7 provides for weekly emissions so the day-of-week fraction can be applied.

Therefore, for Montour-Boiler 1, the equation for the first hour on Monday through Friday would then be:

Equation (2) Hourly NO_x emissions = (27.2 tpd) x (7) x (0.147) x (0.03243);
= (27.2 tpd) (1.029) (0.03243) = 0.907 tpd at hour 1

Figures 1 through 3 compare the emissions pre-processor estimated hourly NO_x emissions with those from ETS/CEM data for Montour-Boiler 1 for three consecutive days during June 1997.

Pechan's analyses showed that the available diurnal profiles, if correctly assigned, provide an adequate representation of hourly NO_x emissions and day-of-week emission changes at these large, coal-fired units. There are occasions when the standard profiles miss some short-term emission spikes, but unless these differences are occurring at many units at the same time, not capturing them is unlikely to affect modeling results. A potential use of ETS/CEM data, though, is in correcting the NO_x emission estimates from the NET 96 emissions file to the time period of interest. It is recommended that Pennsylvania consider using ETS/CEM data for all Pennsylvania EGUs for which it is available to re-estimate ozone season daily emissions for the applicable 5 month ozone season, or the base year ozone episode period of interest.

If Pennsylvania wants to use the hourly ETS/CEM data directly in EMS-95, it should be noted that there are instances in the ETS/CEM data where complete days are missing. This indicates that either the unit was not operating during this period (emissions were zero), or EPA could have found enough data errors for the time period that it was decided not to report these days. Recommended solutions to the *missing day* problem include contacting the utility company to access their hourly data for the period in question, filling in missing data with hourly data from previous or succeeding days, or using default profiles for time periods with missing data.

An analysis of the relationship between ambient temperature and large, coal-fired EGU unit NO_x emissions found that there was no direct correlation. Baseload units were used in this analysis. Correlations between temperature and emissions may have been found if peaking units were evaluated.

CONCLUSIONS

States may not want to invest the money necessary to perform the surveys suggested by EIIP guidance for estimating area source emissions. The alternative is to use either employment based or population based emission factors. With the likelihood of more regional modeling being performed in the next few years, it is advisable to have States within the same region using common area source emission estimation methods. States and Regional Planning Organizations should consider cooperatively funding studies to survey area sources to improve the emission estimates for the most important, and most likely to be controlled, sources.

The NONROAD model produces emission estimates that are higher than estimated previously using methods from 1991 EPA guidance. Whenever a State starts using the NONROAD model, it needs to consider using it to recompute previous years of its emission inventories in order to avoid discontinuities in making year-to-year comparisons.

Pennsylvania is one example of a State that has not used all of the information at its disposal to ensure that its highway vehicle emissions are properly spatially and temporally resolved when using EMS-95. States and metropolitan planning organizations need to work actively with emission modelers to incorporate appropriate temporal, spatial, and vehicle speed profiles in future photochemical modeling simulations.

New speciation profiles have become available in the past 2 to 3 years that should provide much improved estimates of the species in modern solvents. It is especially important to make the change to these new profiles for future year photochemical modeling. There is a substantial need for more and better profiles in the future.

It is unfortunate that the area source temporal profiles used in the Pennsylvania stakeholder modeling and the Ozone Transport Assessment Group effort do not conform with expected activity from many of these source categories. Better temporal profiles are available in many old and new references.

Modelers should consider using hourly NO_x emission estimates available from continuous emission monitoring data to characterize emissions from large electric power generating units. However, matching power facility units with hourly emission profiles by unit type (baseload, peaking, etc.) provides reasonable representations of hourly emissions for most situations.

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Table 1. Recommendations by source category.

Area Source Category	Recommended Emission Estimation Method	New Data Collection Required by PennDEP
Commercial and Consumer Solvents	Use EIIP recommended VOC emission factors.	
Architectural Surface Coating	Use Pennsylvania per capita usage factors, 1996 county populations, and EIIP emission factors. For clean-up solvents, apply CARB usage and emission factors.	1. Use EIIP methods to generate 1996 usage factors for water and solvent-based paints. 2. Establish VOC contents of Pennsylvania sold paints.
Gasoline Marketing	Stage I: Use the 0.3 lb VOC/1000 gallons emission factor without applying a control efficiency. Stage II: Use MOBILE5 to compute an appropriate emission factor for Philadelphia Five County area.	Determine where pressure-vacuum valves have been installed at service stations (counties).
Degreasing	Apply emission factors broken out by industry sector.	Determine number of employees by SIC codes listed in Table 2.
Automotive Refinishing	Use the national EIIP emission estimate allocated to counties using employment data by SIC or North American Industry Classification System code.	
Open Burning of Waste	Use EIIP recommended emission factors.	Some investigation of residential, commercial/institutional, and industrial open burning activity by area of Pennsylvania. Track activity by season.
Lawn and Garden Equipment	NONROAD model	Substitute local equipment population/ activity data if available.
Industrial, Construction, and Farm Equipment	NONROAD model	Substitute local equipment population/ activity data if available.
Recreational Equipment - Snowmobiles	NONROAD model	Use Pennsylvania registration data, substitute State equipment population data.
Recreational Marine	NONROAD model	Use Pennsylvania registration data, substitute State equipment population data.
Other NONROAD Model Categories	NONROAD model	Run EPA's NONROAD model to obtain a complete inventory by category, engine, and fuel type.
Aircraft	Use the FAA EDMS model.	Collect LTO data for various aircraft types operating at each airport.
Commercial Marine	EPA Procedures Guidance, 1989	Evaluate updated data on port activity, especially for Philadelphia and Pittsburgh. Review recent EPA reports on this subject.
Locomotives	EPA Procedures Guidance, 1992	Refine existing emission estimates based on data concerning traffic density and fuel consumption for specific railroads; include emissions from yard locomotives as well as line haul.

Table 2. Comparison of original and revised Pennsylvania Statewide area source emission estimates.

	Original 1996 Pennsylvania Estimates VOC (tpd)	Revised 1996 Estimates VOC (tpd)	Original 1996 Pennsylvania Estimates NO_x (tpd)	Revised 1996 Estimates NO_x (tpd)
Architectural Surface Coating	100	104.5		
Auto Refinishing	54	52.8		
Degreasing	78	96.0		
Consumer Products	104	129.5		
Gasoline Marketing				
Stage I	0.5	2.0		
Stage II	62	51.0		
Off-Highway				
Non-road Gasoline	168.5	424.5	41.1	17.4
Non-road Diesel	19.7	56.1	132.9	355.9
Aircraft	15.5	28.0	6.2	27.0
Marine Vessels	0.0	1.0	0.0	16.0
Railroads	1.9	7.0	44.3	61.0
Non-road Other	0.0	0.0	0.0	38.3

Figure 1. Actual versus modeled hourly NOx emissions-Montour-Boiler 1: Friday, June 20, 1997.

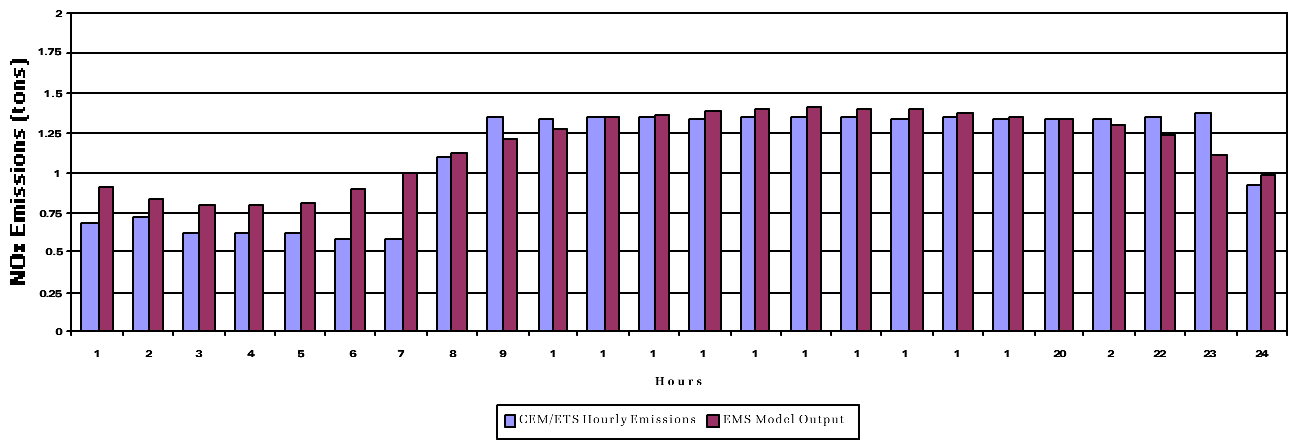

Figure 2. Actual versus modeled hourly NOx emissions-Montour-Boiler 1: Saturday, June 21, 1997.

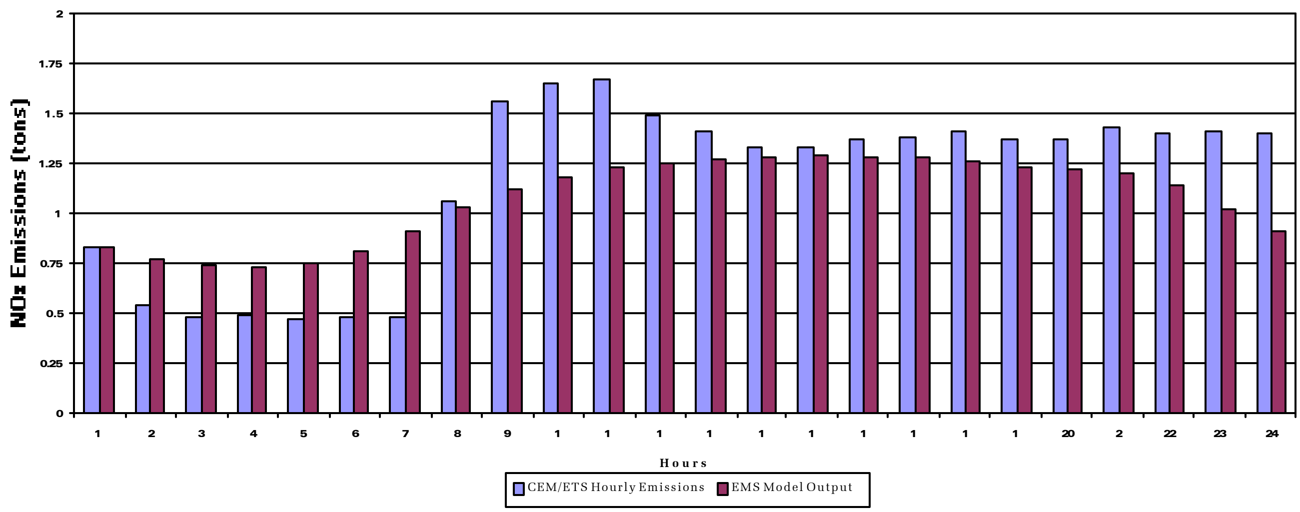

Figure 3. Actual versus modeled hourly NOx emissions-Montour-Boiler 1: Sunday, June 22, 1997