DRAFT REVIEW OF HISTORIC AND CURRENT INVENTORY METHODS FOR MOBILE SOURCES

Visibility Improvement — State and Tribal Association of the Southeast (VISTAS) Inventory Review

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I. INTRODUCTION/BACKGROUND

The purpose of this report is to document the review of existing or developing emission inventory efforts that could be used for regional haze studies. Prior to the review of existing inventories, this report first summarizes the findings of an earlier analysis entitled "Assessment of Emissions Inventory Needs for Regional Haze Plans," (MARAMA, 2001). For this current effort, Pechan reviewed inventory development documentation for the following mobile source emission inventories:

- U.S. Environmental Protection Agency (EPA) (1999 National Emission Inventory [NEI])
- Southern Appalachian Mountains Initiative (SAMI [1990])
- Texas Commission on Environmental Quality (TCEQ) (formerly the Texas Natural Resources Conservation Commission [TNRCC])
- Visibility Improvement –State and Tribal Association of the Southeast (VISTAS) state, local, and tribal (S/L/T) air agencies

Strengths and weaknesses in all of these various inventory methods associated with their use in regional haze modeling were identified. For the onroad sector, the inventory methods are generally broken down into the VMT components and the inputs to emission factor models. For each nonroad inventory, the procedures used for estimating emissions for nonroad engines currently included in EPA's draft NONROAD model are typically discussed first, followed by a discussion of procedures for aircraft, commercial marine vessels (CMVs), and locomotives.

II. REVIEW OF EXISTING INVENTORIES

A. MARAMA

The report "Assessment of Emissions Inventory Needs for Regional Haze Plans," (MARAMA, 2001) provides an evaluation of current inventory methods and recommendations for improvement in the eastern U.S. The objectives of this report were to summarize the current knowledge of pollutants and emission sources that contribute to regional haze, describe the methods used in developing the 1996 National Emission Trends (NET) inventory (Version 3.12) and the weaknesses associated with those methods relative to regional haze, recommend activities that could be undertaken to improve regional haze emission inventories, and to prioritize recommended tasks for inventory improvement. Relevant findings of this report related to the onroad and nonroad sectors are discussed below.

1. Findings of MARAMA relevant to onroad sector

In the southeastern U.S., this study found that onroad vehicles account for nearly 32 percent of NOx emissions. Onroad gasoline vehicles account for approximately 7 percent of the NH_3 emissions totals in the area. Onroad vehicles also contribute to PM_{10}, $PM_{2.5}$, and SO_2, but are less important contributors when compared to other source categories.

Weaknesses pointed out in this report for the onroad sector include the VMT estimates in rural areas, vehicle mix information, and emission factors for PM, SO_2, and NH_3. Improvements that have been made in VMT estimation and the mix of VMT by vehicle class in and around urban ozone nonattainment areas have not been made for rural areas. In addition, the report recommends that improvements be made to the magnitude and temporal patterns of rural highway diesel vehicles, in particular on rural highways. The report points out that the recent increases in the use of light trucks and sport utility vehicles have not been captured in many model runs. It should be noted that the 1999 NEI does include updated information vehicle mix information, and in the aggregate, should capture the appropriate portion of light trucks and sport utility vehicles in the VMT mixes. Due to the impact that changes in the VMT mix can have on an emissions inventory, it is important that States and local areas make their best attempts at classifying VMT by vehicle class. The inventory reviewed in this report was calculated using MOBILE5a and PART5 for onroad emission factors. The current version of the NEI uses MOBILE6 to calculate emission factors for onroad vehicles. While MOBILE6 significantly improves the estimation of NOx emission factors, the PM, SO_2, and NH_3 emission factors are of approximately the same quality as those in PART5 and estimated in the 1996 NET.

For the southeastern States, the report lists the following items as high priority improvement activities for the onroad inventory:

- updating local diesel VMT,
- updating vehicle mixes to adjust for the increased fraction of truck and sport utility vehicles, and
- assessing available local data for rural area VMT.

The report recommends that work be undertaken to improve onroad VMT for rural interstate links, rural feeder links, and rural arterial links to improve the distribution of haze-related pollutants. In addition, the collection of vehicle speed data on by day of week and time of day on these roadway types could be important to improving regional haze inventories. The report recommends investigating less costly methods for collecting these data such as aerial photography or remote sensing.

2. Findings of MARAMA relevant to nonroad sector

The report "Assessment of Emissions Inventory Needs for Regional Haze Plans," included a description of procedures and evaluation of the 1996 National Emission Trends (NET) inventory, Version 3.12 (MARAMA, 2001). The methods used to develop nonroad sector emissions for the NEI (formerly the NET) have improved since this evaluation.

This report recognizes that nonroad sources represent significant sources of particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers ($PM_{2.5}$), sulfur dioxide (SO_2), and oxides of nitrogen (NO_x) in both the Ozone Transport Commission (OTC) and Southeastern States Air Resource Managers, Inc. (SESARM) regions, and that these sources also contribute to volatile organic compound (VOC) emissions. The following recommendations were made related to improving nonroad mobile activity and emissions.

Activity data for nonroad activities can be improved significantly with local data. Projects to develop activity data for nonroad mobile sources should proceed as follows:

- Evaluate the types of data that may be available.
- Determine the ease of collecting such information and the frequency with which the information is available.
- Compare local activity estimates to the results obtained using the allocation procedures in the current NEI methodologies.

Opportunities for improving data sources should be coordinated with EPA's Office of Air Transportation and Quality's (OTAQ) and Office of Air Quality Planning and Standards (OAQPS) to ensure that these data are compatible with available emission factors. If significant differences are discovered in actual nonroad activities and the NEI allocation strategies, appropriate data should be collected and compiled. These recommendations will be considered in the context of our recommendations (see Section V).

B. NEI

1. Onroad

This section describes the development of and the strengths and weaknesses associated with Version 2 of EPA's NEI. Figures 1 through 5 (attached) summarize the emissions from SO_2, NO_x, VOC, $PM_{2.5}$, and NH_3, respectively by vehicle category. These figures illustrate that different vehicle categories are important for different pollutants. Figures 6 through 10 (attached) show the distribution of these emissions at the county level.

a) How was the NEI developed?

Version 2 of EPA's 1999 NEI was prepared in the summer of 2002. The onroad sector includes emission factors calculated using EPA's MOBILE6 emission factor model. On-road emissions for all criteria pollutants (carbon monoxide [CO], NO_x, VOC, PM_{10}, $PM_{2.5}$, SO_2, and ammonia [NH_3]) are calculated by multiplying an appropriate emission factor in grams per mile by the corresponding VMT in millions of miles. Emission estimates include calculations by month, county, road type (for 12 road types), and vehicle type (for the 28 MOBILE6 vehicle types). The MOBILE6 model used is the publicly available version from OTAQ website (http://www.epa.gov/otaq/m6.htm). This model incorporates both MOBILE6.0 (EPA, 2002a), which is used to estimate emission factors of VOC, CO, and NO_x, and MOBILE6.1 (EPA, 2002b), which is used to calculate emission factors of PM_{10}, $PM_{2.5}$, SO_2, and NH_3.

EPA gave states the ability to provide VMT or emissions to be included in these calculations. A number of states provided EPA with 1999 annual VMT data reported by roadway type and by the 8 MOBILE5 vehicle types in NEI Input Format (NIF). Of the VISTAS states, Version 2 of the 1999 includes local VMT data from Alabama, Mississippi, and Tennessee (Hamilton County only). For each state, the VMT data were expanded from the MOBILE5 8 vehicle type level to the MOBILE6 28 vehicle type level, in the same manner as discussed below for the national VMT. These expanded state-provided VMT data then replaced the VMT data for the corresponding states or counties that was developed based on the Highway Performance Monitoring System (HPMS) data discussed below, and monthly and annual emissions of the seven criteria pollutants were calculated using MOBILE6 emission factors in the same manner as the remaining states.

Data Used in Estimating 1999 VMT for the NEI

To develop VMT for 1999, EPA relies on 1999 data supplied by the Federal Highway Administration (FHWA) and publicly available data from FHWA's *Highway Statistics 1999* (FHWA, 2000). From *Highway Statistics 1999*, EPA uses Table VM-2 "Functional System Travel - 1999; Annual Vehicle-Miles" (http://www.fhwa.dot.gov/ohim/hs99/tables/vm2.pdf). This table contains state-level summaries of miles of annual travel in each state by functional system and by rural and urban areas. Rural VMT is provided on a state level for the following six roadway types: interstate, other principal arterial, minor arterial, major collector, minor collector, and local. Urban VMT is provided on a state level for the following six roadway types: interstate, other freeways and expressways, other principal arterial, minor arterial, collector, and local. EPA also uses Table VM-1 "Annual Vehicle Distance Traveled in Miles and Related Data - 1999; by Highway Category and Vehicle Type" from *Highway Statistics 1999*. This table provides annual VMT separated by rural and urban areas broken down into the following vehicle categories: passenger cars, motorcycles, buses, other 2-axle 4-tire vehicles, single-unit 2-axle 6-tire or more trucks, and combination trucks. In addition to these publicly available tables, FHWA provides EPA with daily VMT by urban area (areas with a population of 50,000 or more) in each of the six urban roadway categories as listed for Table VM-2, broken down by urban area and state. This data is similar to that in Table HM-71 from *Highway Statistics 1999* with the exception that Table HM-71 does not break down multi-state urban areas into the portion in each state. Finally, FHWA provides EPA with a data file containing roadway mileage by county and each of the 12 roadway classes listed above.

In addition to the FHWA data, EPA uses 1990 population data in developing the VMT database. The EPA relies upon two tables in the Bureau of the Census 1990 Number of Inhabitants (CNOI) documents as the source for population data for the years 1999 (BOC, 1992). The first is "Table 3: Population of Counties by Urban and Rural Residence." This table lists the urban population living inside census-defined urban areas, the urban population living outside census-defined urban areas, and the rural population for each county. The other is "Table 13: Population of Urban Areas." This table divides an urban area's population among the counties that contain portions of that urban area.

NEI VMT Allocation Procedure

VMT is the activity factor EPA uses to estimate on-road vehicle emissions; therefore, the development of a VMT database is critical to the estimation process. Starting with state VMT totals for each year, EPA allocates VMT by county, roadway type, and vehicle type. There are four basic steps in this process: (1) allocate state-level rural VMT by roadway type to county/roadway type level; (2) allocate large urban area VMT by roadway type to the county/roadway type level; (3) allocate remaining state-level small urban VMT by roadway type to the county/roadway type level; and (4) allocate county/roadway type level VMT to each of the

28 MOBILE6 vehicle classes for each county and roadway type combination. Each of these steps is described in more detail in the following sections.

State-level rural VMT for interstates is allocated to the county level based on the fraction of the state's total rural interstate mileage within each county. The remaining rural VMT are allocated from the state level to the county level based on rural population. Urban VMT is allocated to the counties making up the urban area within the selected state. This allocation is performed based on the fraction of the state/urban area's population within a given county. The amount of small urban VMT within a state is calculated by subtracting the resultant average annual VMT for urban areas totaled by state and roadway type, from the total urban VMT by state and roadway type that is reported in Table VM-2 of *Highway Statistics 1999* (FHWA, 2000). This calculation results in small urban VMT by state and roadway type. Small urban VMT by roadway type is then allocated to counties within the state based on each county's small urban population fraction. For all roadway types, with the exception of local roads and rural interstates, the allocations from the state to the county are only applied to counties that contain nonzero for the selected roadway type. For example, if a county has no mileage from the urban collector roadway category, no VMT will be assigned to that county on the urban roadway type.

Once the VMT is allocated by county and roadway type, the VMT data are then further allocated to the 28 MOBILE6 vehicle categories. EPA's OTAQ provided a national allocation of HPMS to MOBILE5 vehicle categories. This was done based on the distribution of the 1999 rural and urban VMT among the six HPMS vehicle types found in Table VM-1 ("Annual Vehicle Distance Traveled in Miles and Related Data - 1999 - by Highway Category and Vehicle Type") of FHWA's *Highway Statistics 1999* (FHWA, 2000) (http://www.fhwa.dot.gov/ohim/hs99/tables/vm1.pdf) and the mapping of these HPMS vehicle categories to the 28 MOBILE6 vehicle types. First, the VMT totals for each of the six HPMS vehicle categories were calculated as a fraction of the total VMT. This calculation was performed separately for the rural VMT and the urban VMT. The resulting 1999 VMT fractions for rural VMT and urban VMT are shown in Table 1. Next, EPA assigned each of the 28 MOBILE6 vehicle types to one of the 6 HPMS vehicle categories, as shown in Table 1. Using the default MOBILE6 VMT fractions for 1999, the MOBILE6 VMT fractions were renormalized among all MOBILE6 vehicle types mapped to a given HPMS vehicle category. Then the HPMS VMT fractions for rural and urban roads were separately multiplied by the renormalized MOBILE6 VMT fractions for all MOBILE6 vehicle types included within a given HPMS vehicle category.

Table 1 lists the resulting rural and urban VMT fractions for 1999 for each of the MOBILE6 vehicle types. Finally, each of the VMT records in the 1999 VMT database, at the state/county/roadway type level of detail was then multiplied by the fraction of VMT in each of the corresponding MOBILE6 vehicle type categories to obtain total annual VMT at the state/county/roadway type/MOBILE6 vehicle type level.

The resulting annual county-level, vehicle, and roadway type-specific VMT data were temporally allocated to months during the emission calculations. EPA used seasonal 1985 National Acid Precipitation Assessment Program (NAPAP) temporal allocation factors to apportion the VMT to the four seasons (EPA, 1990). Monthly VMT data were obtained using a ratio between the number of days in a month and the number of days in the corresponding season. These temporal factors are shown in Table 2.

Table 1. Allocation of VMT from HPMS Vehicle Categories to MOBILE6 Vehicle Types for Version 2 of the 1999 NEI

HPMS Vehicle Category	HPMS 1999 VMT Fractions		MOBILE6 Vehicle Type	1999 VMT Fractions	
	Rural	Urban		Rural	Urban
Passenger Cars	0.5499	0.6048	LDGV	0.5483	0.6030
			LDDV	0.0016	0.0017
Motorcycles	0.0042	0.0038	MC	0.0042	0.0038
Other 2-Axle 4-Tire Vehicles	0.3307	0.3375	LDGT1	0.0513	0.0524
			LDGT2	0.1708	0.1744
			LDGT3	0.0520	0.0531
			LDGT4	0.0239	0.0244
			LDDT12	0.0004	0.0004
			LDDT34	0.0010	0.0010
			HDGV2B	0.0232	0.0237
			HDDV2B	0.0079	0.0081
Single-Unit 2-Axle 6-Tire or More Trucks	0.0339	0.0211	HDGV3	0.0013	0.0008
			HDGV4	0.0008	0.0005
			HDGV5	0.0016	0.0010
			HDGV6	0.0034	0.0021
			HDGV7	0.0017	0.0010
			HDDV3	0.0036	0.0022
			HDDV4	0.0028	0.0017
			HDDV5	0.0012	0.0007
			HDDV6	0.0070	0.0043
			HDDV7	0.0107	0.0066
Combination Trucks	0.0770	0.0310	HDGV8A	0.0000	0.0000
			HDGV8B	0.0000	0.0000
			HDDV8A	0.0169	0.0068
			HDDV8B	0.0602	0.0242
Buses	0.0044	0.0018	HDGB	0.0010	0.0004
			HDDBT	0.0014	0.0006
			HDDBS	0.0019	0.0008
Total	1.0000	1.0000	Total	1.0000	1.0000

Table 2. VMT Seasonal and Monthly Temporal Allocation Factors used in the 1999 NEI

Vehicle Type	Roadway Type	Seasonal VMT Factors			
		Winter	Spring	Summer	Fall
LDV, LDT, MC	Rural	0.2160	0.2390	0.2890	0.2560
LDV, LDT, MC	Urban	0.2340	0.2550	0.2650	0.2450
HDV	All	0.2500	0.2500	0.2500	0.2500

Vehicle Type	Roadway Type	Monthly VMT Factors											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
LDV, LDT, MC	Rural	0.0744	0.0672	0.0805	0.0779	0.0805	0.0942	0.0974	0.0974	0.0844	0.0872	0.0844	0.0744
LDV, LDT, MC	Urban	0.0806	0.0728	0.0859	0.0832	0.0859	0.0864	0.0893	0.0893	0.0808	0.0835	0.0808	0.0806
HDV	All	0.0861	0.0778	0.0842	0.0815	0.0842	0.0815	0.0842	0.0842	0.0824	0.0852	0.0824	0.0861

MOBILE6 Inputs

- **Temperature—** The temperature data used in the 1999 NEI MOBILE6 modeling include monthly average daily maximum and minimum temperature for each state for 1999. These data were obtained from The National Climatic Data Center (NCDC, 2000). One city from each state, chosen to be the most representative of the average conditions within the state, was used to represent that particular state's temperature conditions.

  Reid Vapor Pressure (RVP)—Monthly RVP inputs were used in the MOBILE6 runs. These RVP data were based on 1999 January and July RVP data from each of the cities included in the Alliance of Automobile Manufacturers (AAM) fuel surveys (AAM, 1999) combined with information on counties with low RVP programs or reformulated gasoline. July RVP values were generally assigned from May through September. For the remaining months, RVP values were interpolated between the January and June RVP data based on state-level American Society for Testing and Materials (ASTM) RVP limits by month.

- **Speed and Facility Types--** The average speeds by roadway type and vehicle modeled in the NEI are shown in Table 3. Within MOBILE6, emission factor adjustments by speed also depend on the MOBILE6 roadway type being modeled. There are four MOBILE6 roadway types: freeways, arterials, locals, and freeway ramps. The 12 roadway types shown in Table 3 were assigned to one of these MOBILE6 roadway types. The MOBILE6 freeway roadway type was assigned to rural interstates, urban interstates, and urban other freeways and expressways. The MOBILE6 arterial roadway type was assigned to rural other principal arterials, rural minor arterials, rural major collectors, rural minor collectors, rural locals, urban other principal arterials, urban minor arterials, and urban collectors. The MOBILE6 local roadway type was assigned to urban locals.

Table 3. Average Speeds by Road Type and Vehicle Type Used in the 1999 NEI (mph)

Rural

	Interstate	Principal Arterial	Minor Arterial	Major Collector	Minor Collector	Local
LDV	60	45	40	35	30	30
LDT	55	45	40	35	30	30
HDV	40	35	30	25	25	25

Urban

	Interstate	Other Freeways & Expressways	Principal Arterial	Minor Arterial	Collector	Local
LDV	45	45	20	20	20	20
LDT	45	45	20	20	20	20
HDV	35	35	15	15	15	15

- **Control Programs—**Control programs including inspection and maintenance (I/M) programs, reformulated gasoline, and oxygenated fuel were modeled based on information collected by EPA of the counties included in these programs and the specific program inputs. In addition, the National LEV program was modeled in Northern Virginia, starting in 1999, as this portion of the state is included in the Ozone Transport Region, which adopted that LEV program earlier than the remainder of the nation. National control programs, such as the Tier 1 emission standards, are included in the MOBILE6 defaults and no additional inputs were needed to model these.

- **Other—**The MOBILE6 default registration distributions, diesel sales fractions, mileage accumulation rates, and humidity inputs were used for all states in the 1999 NEI MOBILE6 modeling. All of the VISTAS states were modeled as low altitude areas.

b) Strengths/Weaknesses

Strengths –

- The NEI includes consistent methodologies for estimating emission factors across the country.

- The VMT data, except that provided by Alabama, Mississippi, and Hamilton County, TN, were allocated to the county level using a consistent methodology.

- Version 2 of the NEI was calculated using the most current emission factor model available.

- The NEI sufficiently captures most control programs such as reformulated gas, emission standards, I/M programs, and oxygenated fuel programs

Weaknesses –

- Because some of the population allocation data are still based on the 1990 Census, the method used to allocate VMT from the state-level to the county-level may not capture current trends. This method is also less accurate than the modeling tools that metropolitan areas generally use to estimate VMT.

- The NEI uses national VMT mixes by vehicle type and does not reflect regional or local differences in the VMT mixes.

- The 1999 NEI Version 2 does not incorporate locally derived inputs such as registration distributions, VMT mixes, and diesel sales fractions.

- The NEI uses national temporal allocation factors.

- Speed inputs are based on national data from early 1990's. Actual average speeds by roadway type may deviate significantly from these averages.

- The county-level coverage of I/M programs has not been updated recently and may not reflect actual 1999 I/M program coverage.

- The use of a single temperature station per state may not be representative of conditions throughout state, particularly in mountainous and coastal areas.

2. Nonroad

a) How was the NEI developed?

NONROAD Model Engines

EPA used the Lockdown C draft version of the NONROAD model to estimate emissions for the majority of nonroad engines. The NONROAD model provides emission estimates for hydrocarbon (HC), NO_x, CO, SO_2, PM_{10}, and $PM_{2.5}$. The model reports various HC species, including VOC, and breaks out the HC emissions according to exhaust and evaporative components. PM_{10} is assumed to be equivalent to total PM, and $PM_{2.5}$ is assumed to be 92 percent of PM_{10} for gasoline and diesel-fueled engines, and 100 percent of PM_{10} for liquefied petroleum gas (LPG) and compressed natural gas (CNG) engines.

VOC, NO_x, CO, SO_2, PM_{10}, $PM_{2.5}$ were developed using emission estimates from two emission inventories including: 1) a 1996 county-level inventory, developed using EPA's October 2001 draft NONROAD model; and 2) an updated 1999 national inventory, based on EPA's May 2002 draft Lockdown C NONROAD model (Pechan, 2002). Table 4 presents a summary of the input values used for the national NONROAD model runs.

Table 4. Summary of Input Values for 1999 National NONROAD Model Runs

Model Input	Season	1999 Value
Reid Vapor Pressure (RVP)	Summer	8.1 psi
RVP	Fall & Spring	9.7 psi
RVP	Winter	13.1 psi
National Diesel Fuel Sulfur	All Seasons	2,700 ppm
California Diesel Fuel Sulfur	All Seasons	120 ppm

NOTES: psi = pounds per square inch; ppm = parts per million

Using the 1996 county-level emission estimates, seasonal and daily county-to-national ratios were then developed for application to updated national estimates per season estimated for 1999. National, source classification code (SCC)-level emissions for each of the four seasons were then multiplied by the season-specific county-to-national emissions ratios. The following formula represents how an updated 1999 county-level annual emissions inventory was developed for a given SCC and pollutant.

$$E_{Ann, Cty, y} = \sum_{S} [(E_{S, Cty, 1996} \div E_{S, N, 1996}) * E_{S, N, y}]$$

Where: E = Emissions, tons
Ann = Annual
S = Season (winter, spring, summer, fall)
Cty = County
N = National
y = year of inventory (e.g., 1999)

In this manner, the county-level distribution assumed for the 1996 inventory is normalized to the updated national, SCC-level totals for 1999. This approach ensures that the sum of all county-level emissions for any year are equivalent to the national-level estimates and are distributed to the counties according to the 1996 distribution.

EPA also incorporated state-submitted data from California for all NONROAD model categories, daily emissions data from Pennsylvania for recreational marine and aircraft ground support equipment, and annual and daily emissions data from Texas for select equipment categories.

The NONROAD model does not contain emission factors to calculate NH_3 emissions; therefore, we used national fuel consumption estimates generated by the NONROAD model and applied NH_3 emission factors for diesel and noncatalyst gasoline vehicles as appropriate. Similar to other pollutant emissions, national NH_3 emissions were then distributed to counties using the 1996 nonroad inventory, based on the October 2001 draft NONROAD model.

Compared to catalyst-equipped onroad engines and agricultural-related area sources, nonroad engines are not a significant source of NH_3. Based on the 1999 NEI, the major nonroad category contributing to NH_3 is CNG engines. However, in recent discussions with OTAQ, it is likely that these emissions are overestimated for the 1999 NEI based on the units in which CNG fuel consumption estimates are expressed in the NONROAD model (Harvey, 2002).

Aircraft, CMVs, and Locomotives

The following sections describe methods used to estimate aircraft, CMVs, and locomotives. Additional details on the methods used for these categories are provided in the report "Documentation for Aircraft, Commercial Marine Vessel, Locomotive, and Other Nonroad Components of the National Emissions Inventory," (ERG, 2002).

Aircraft

Commercial aircraft estimates were developed by obtaining landing and takeoff (LTO) data from the Federal Aviation Administration (FAA), combined and entered into the *FAA Emissions and Dispersion Modeling System (EDMS), Version 4.0*. Not all commercial aircraft in the FAA activity data could be matched to aircraft in EDMS. Therefore, average emission factors for a single LTO were developed and applied to unmatched LTOs. Emissions for matched and unmatched aircraft were combined to estimate total commercial aircraft emissions for HC, NO_x, CO, and SO_2. VOC emissions were estimated by applying a VOC/HC conversion factor to the HC emissions.

General aviation, air taxi, and military aircraft emission estimates were developed using LTO activity data from the FAA Air Traffic and Activity Data System. The commercial aircraft activity data were reviewed to identify any smaller aircraft that would be considered air taxis. The LTOs for these aircraft were subtracted from the FAA's air taxi LTO estimates to ensure no double counting.

EPA fleet average emission factors were applied to the LTO data to estimate national emissions. $PM_{2.5}$ emissions were assumed to be 69 percent of PM_{10}. VOC emissions were estimated by applying a VOC/HC conversion factor to the general aviation, air taxi, and military HC emissions.

For all aircraft categories, national-level emissions were then allocated to counties using airport activity data from FAA's Terminal Area Forecast system (TAF) database of over 2,000 airports in the United States and a geographic information system (GIS) database from the Bureau of Transportation Statistics (BTS) which contains airport-level data with latitude and longitude coordinates. The two data sources were matched to identify the county where each airport is located. Using airport-specific LTO data by aircraft type, the percentage of national activity was calculated for each airport for each aircraft type.

CMVs

Commercial marine diesel emissions were developed by obtaining 2000 emission estimates for all pollutants except SO_2 from EPA/OTAQ's marine diesel regulatory background documentation (*Draft Regulatory Impact Analysis - Control of Emissions from Compression-Ignition Marine Engines*, EPA, 1998). To estimate emissions for 1999, 2000 estimates were backcast using growth factors obtained from the draft RIA cited above. Steam-powered residual CMV emission estimates were developed by obtaining fuel usage data from OTAQ and applying fuel-based emission factors (EPA, 1989). A similar method was used for diesel SO_2 emissions. National diesel usage was estimated assuming a sulfur content of 0.25 percent and EPA emission factors.

National diesel emissions were disaggregated into port and underway emissions estimates based on the assumption that 75 percent of distillate fuel is consumed within the port, while the remaining fuel is consumed while underway, consistent with EPA guidance. National residual emissions were disaggregated into port and underway emissions estimates based on the assumption that 25 percent of residual fuel is consumed within the port, while the remaining fuel is consumed while underway (EPA, 1989).

To allocate to counties, port emissions were assigned to the 150 largest U.S. ports based on activity obtained from the U.S. Army Corps of Engineers. The percentage of total traffic for each port was calculated by dividing the port-level traffic by the total traffic.

Underway emissions are assigned to counties based on a county=s shipping lane traffic, which is reported in BTS=s *National Transportation Atlas Databases-1999* as thousand tons per mile traveled for each shipping lane link in the United States. These data were obtained from BTS=s data compact disk (CD) (BTS-CD26).

The 1999 CMV spatial allocation factors were developed using this ship lane traffic data. Where navigable rivers form a county or state boundary, the shipping lane traffic is proportioned to individual counties based on the length of shore line that is shared. For example, if two counties shared a navigable river as a statutory boundary, and both counties have the same length of shoreline, the shipping traffic would be split between the two counties with 50 percent of the activity being assigned to each county. Shipping lanes that were not within counties, for example in the ocean, were associated to states based on BTS assignments. These waterway weights were then evenly distributed among the counties within these states that had navigable waterways. All shipping activity is summed at the county-level and compared with national shipping activity to determine what portion of activity can be attributed to individual counties. These proportions are used in disaggregating the national CMV emission estimates to the county level.

Locomotives

Locomotive emissions were estimated by obtaining U.S. distillate fuel oil sales from the Department of Energy. Activity was disaggregated into four locomotive categories (Class I, Class II/III, passenger, and commuter) based on national-level length-density ratios for each category. California state emissions estimates were calculated separately due to California using a fuel with a lower sulfur level than typical locomotive fuel.

HC, CO, NO_x, and PM emissions were calculated by multiplying fuel-based emission factors with the national locomotive fuel consumption data. VOC emissions were estimated by applying a VOC/HC conversion factor to the HC emissions. The SO_2 emission factor was developed by multiplying the percent sulfur content in fuel (0.25 percent for the United States, excluding California; and 0.005 percent for California), by the molecular weight of SO_2, and by the density of the diesel fuel (7.05 lbs/gallon).

National-level emissions were then allocated to counties using county-specific locomotive traffic data obtained from the Department of Transportation (DOT). Railroad GIS data were obtained from the BTS's *National Transportation Atlas databases-1999* CD (BTS-CD26). Rail activity traffic data are provided in terms of a range of ton miles traveled for every railway link in the United States. The rail traffic values for each link were converted from ranges to average values. These rail activity values were calculated for all railway tracks in individual counties and summed up to the county level. County totals were compared to national railroad totals to get the portion of railroad traffic occurring in individual counties. These proportions were used to disaggregate the national locomotive emission estimates to individual counties.

The county-specific data were available for each locomotive category except for yard locomotives. These emissions were spatially allocated to urban counties with Class I locomotive activity.

b) Strengths/Weaknesses

Strengths –

- The NONROAD model was developed by EPA/OTAQ using the best available national activity data and emission factors, and applying an emission estimation methodology that accounts for equipment population by horsepower and the associated activity level (load factors and hours of use).

- For aircraft, CMVs, and locomotives, the local activity estimates are based on surrogate indicators that are an improvement over county allocation factors used in prior national emissions inventories.

- Use of GIS data provides for spatial resolution of emissions at the subcounty level, even though emissions, for example, for a specific airport in a county, are summed with emissions for any other airports in that county. The preservation of subcounty resolution of emissions may be beneficial in preparing emission modeling inputs.

Weaknesses –

- The NONROAD model
  - Relies on model defaults for estimates of equipment population and activity.
  - 1999 NEI was developed by running NONROAD at the national level and allocating emissions to counties using the results of an alternate year county-level inventory (1996). However, it should be noted that the 1996 county-level inventory was developed by running state and some county-specific input files to account for variations in temperature and fuel characteristics.
  - NH_3 and $PM_{2.5}$ emissions are based on limited nonroad or related onroad engine test data
- Aircraft, CMVs, and Locomotives
  - Due to the top-down emission estimation methodology, county-level surrogate indicators may not accurately represent local activity for these categories.
  - Temporal profiles to reflect variations in seasonal or monthly activity are assumed to be constant throughout the year.
  - $PM_{2.5}$ or PM_{10} emission estimates were not developed/reported due to lack of PM emission factors for commercial aircraft within the FAA's EDMS.

NH_3 emission estimates were not developed for these nonroad categories.

C. SAMI

The Southern Appalachian Mountains Initiative (SAMI) prepared a 1990 base year emission inventory for use in evaluating air quality in the Southeast and its impact on Class 1 areas in the Southern Appalachian national park and wilderness areas. The 1990 base year emission inventory was developed in the late 1990s. The Ozone Transport Assessment Group (OTAG) Inventory was chosen as the starting point for the SAMI 1990 base year inventory. However, to account for the additional pollutants and annual coverage needed by SAMI, the OTAG inventory was supplemented with data from the 1990 NET emission inventory. The pollutants included in the SAMI inventory are VOC, NO_x, CO, SO_2, PM_{10}, $PM_{2.5}$, NH_3, elemental carbon, organic carbon, primary sulfates and nitrates, and base cations. The geographical scope of the SAMI 1990 base year inventory was the 38-State eastern U.S. region. Annual emissions were calculated, and seasonal emissions were prepared for use in air quality modeling. The development of the onroad and nonroad sectors of this inventory are summarized below, along with an evaluation of strengths and weaknesses of the onroad and nonroad portions of this inventory.

1. Onroad

a) How was the SAMI onroad inventory developed

On-road vehicle criteria pollutant emissions in the SAMI Inventory are the same as those that were included in the 1990 NET Inventory. VMT data for this source category included the State-supplied OTAG VMT data, supplemented with HPMS VMT data for States or areas that did not supply their own VMT data to OTAG. The VISTAS States that supplied their own VMT data were Florida, Georgia, and North Carolina. The OTAG daily VMT estimates were converted to annual VMT estimates using the default Regional Oxidant Model (ROM) SCC-specific summer weekday temporal allocation factor to calculate full summer season VMT and then used the seasonal allocation factors to estimate annual VMT. These annual VMT were also converted to monthly VMT using the same seasonal temporal allocation factors and the number of days per month in each season. Emission factors for VOC, NO_x, and CO were calculated using EPA's MOBILE5a emission factor model. Emission factors for PM_{10}, $PM_{2.5}$, and SO_2 were calculated using EPA's PART5 model. NH_3 emission factors were calculated by vehicle type at the national level using test data on emission factors from Volkswagen. The MOBILE5a input files included State or area specific data, such as inspection and maintenance (I/M) programs or registration distributions, extracted from MOBILE5 input files supplied by the States for OTAG. MOBILE5a-based information was provided for Georgia, and portions of Kentucky, North Carolina, and Florida. The MOBILE5a emission factors were calculated by area or State, month, vehicle type, and road type. To simulate average monthly conditions, historical 1990 speed and Reid vapor pressure (RVP) data were used for each State. These emission factors were multiplied by the corresponding monthly VMT data at the county/vehicle type/road type level. PART5 emission factors were calculated only at the annual level, since these emission factors do not vary by month. The specific procedures and inputs used in calculating the 1990 onroad emissions included in the SAMI Inventory are discussed below.

Temperature--The temperature data used in all of the MOBILE5a input files were obtained from the National Climatic Data Center[43] and included an average daily maximum and minimum temperature for each State for each month for the year. A single city was selected from each State to represent the State's temperature conditions.

Reid Vapor Pressure (RVP)—RVP data were apportioned to each State by month based on January and July RVP values from each of the 23 cities included in the American Automobile Manufacturer's Association (AAMA) fuel surveys,[44] and an OMS listing which matched each nonattainment area throughout the United States with the corresponding AAMA survey city whose RVP should be used to represent that nonattainment area. Statewide RVP values were then interpolated to each month of the year by interpolating the January and July RVP values based on the ASTM schedule of seasonal and geographical volatility classes.

Speed--Nine different speeds were modeled to represent each road type/vehicle type combination. These speeds are the same as those used in the 1999 NEI.

Registration Distribution—For areas that did not supply a local registration distribution, a national registration distribution was included in all of the MOBILE input files, based on national 1990 registration data by model year and vehicle type.

I/M Programs—I/M programs were modeled based on I/M program summaries developed by EPA's Office of Mobile Sources. In areas that supplied I/M inputs, these inputs replaced the EPA-based inputs. These characteristics can vary by State, nonattainment area, or county.

b) Strengths/Weaknesses

Strengths

- The SAMI 1990 base year onroad inventory incorporated State and local data where available.

Weaknesses

- The emission factor models available at the time of the SAMI modeling (MOBILE5 and PART5) are now outdated and likely produced underestimates of onroad emissions.

- The SAMI base year is 1990. Onroad conditions and control programs have advanced significantly from 1990 to 2002. Thus, direct comparisons between the SAMI 1990 base year inventory and the VISTAS 2002 base year inventory would not be meaningful

2. Nonroad

a) How was the SAMI nonroad inventory developed

The 1990 SAMI nonroad inventory was based primarily on state-supplied data, with 1990 Interim Inventory data filling in the data gaps (SAMI, 1999). The development of the 1990 Interim Inventory data for nonroad engines is presented below. Methods used by states to develop their own emission estimates were not provided, so it is not possible to evaluate the quality of these estimates relative to the default Interim Inventory estimates.

Nonroad Engines

Nonroad mobile source emissions in the 1990 Interim Inventory were based on 1990 nonroad emissions compiled by EPA's Emission Factor and Inventory Group (EFIG). The EFIG nonroad data contained total emissions for nonroad sources at the county level. These emissions included all nonroad sources except aircraft, CMVs, and railroads. The EFIG nonroad emissions were based on the EPA's Office of Mobile Sources (OMS) nonroad emission inventories for 27 nonattainment areas (NAAs) (EPA, 1992). The OMS inventories contained 1990 emissions at the SCC-level for each county within the 27 NAAs. These nonroad data did not include emissions for SO_2.

A two-step process was used to convert the OMS NAA emissions to county-SCC-level emissions. The first step used the OMS 1990 nonroad emissions for the 27 ozone NAAs to estimate nonroad emissions for the rest of the country. The second step used the EFIG total nonroad emissions for each county to create the 1990 county-SCC-level nonroad emissions.

Step 1. Creation of National County-Level 1990 Nonroad Emissions

OMS prepared 1990 nonroad emission inventories for 27 ozone and six CO NAAs. (Data from the CO NAAs were not used because they did not include VOC and NO_x emissions.) Each NAA inventory contained county-level emissions for 279 different equipment/engine type combinations for each county in the NAA. The following methodology was used to create 1990 nonroad emissions for the entire country:

- VOC, NO_x, and CO per capita emission factors were developed for each NAA by summing each pollutant's emissions for all equipment/engine categories for all counties within the NAA and dividing by the NAA population.

- For counties entirely within one of the 27 NAAs, the emissions in the OMS inventories were used.

- For counties partially in one of the 27 NAAs, emissions were calculated by multiplying the NAA per capita emission factor by the total county population.

- All other counties were assigned a surrogate NAA based on geography and climate, and emissions were calculated by multiplying the surrogate NAA per capita emission factors by the total county population.

Step 2. Distribution of Total Nonroad Emissions to SCCs

The resulting emissions from Step 1 represent total county nonroad emissions. Emissions were distributed to the appropriate SCCs using the following methodology:

- An SCC was assigned to each of the 279 equipment/engine type combinations in the OMS inventories.

- For each of the 27 OMS inventories, the percentage of emissions from sources assigned to each of the 27 SCCs was calculated.

- Each county's total nonroad emissions were distributed to the 27 SCCs using the SCC percentages from its surrogate NAA.

Aircraft, CMVs, and Locomotives

1990 Interim Inventory emissions from aircraft, CMVs, and railroads were estimated from the area source portion of the 1985 National Acid Precipitation Assessment Program (NAPAP) inventory. Emissions from the 1985 NAPAP inventory were projected to 1990 based on the Bureau of Economic Analysis (BEA) historic earnings data or other growth indicators. Growth indicators were assigned based on the source category, and are presented in Table 5. All growth factors were calculated as the ratio of the 1990 data to the 1985 data for the appropriate growth indicator.

Table 5. Nonroad Source Growth Indicators

NAPAP SCC	Category Description	Data Source	Growth Indicator
45	Railroad Locomotives	AAR	Railroad ton-miles (national)
46	Aircraft LTOs- Military	BEA	Military
47	Aircraft LTOs - Civil	FAA	Aircraft - civil
48	Aircraft LTOs - Commercial	FAA	Aircraft - commercial
49	Vessels - Coal	Corps of Engineers	Cargo tonnage (national)
50	Vessels - Diesel Oil	Corps of Engineers	Cargo tonnage (national)
51	Vessels - Residual Oil	Corps of Engineers	Cargo tonnage (national)

When creating the 1990 emissions inventory, changes were made to emission factors from the 1985 inventory for some sources. The 1990 emissions for CO, NO_x, SO_2, and VOC were calculated using the following steps:

(1) projecting 1985 controlled emissions to 1990 using the appropriate growth factors;

(2) calculating the uncontrolled emissions using control efficiencies from the 1985 NAPAP inventory; and

(3) calculating the final 1990 controlled emissions using revised emission factors.

The 1990 PM_{10} emissions were calculated using the total suspended particulate (TSP) emissions from the 1985 NAPAP inventory. The 1990 uncontrolled TSP emissions were estimated in the same manner as the other pollutants. 1990 PM_{10} estimates were calculated from the TSP emissions by applying SCC-specific uncontrolled particle size distribution factors. Controlled PM_{10} emissions were estimated in the same manner as the other pollutants.

Emission factors for several sources were updated in the 1990 NET to reflect recent technical improvements in AP-42 and other emission inventory guidance documents. Railroad emission factors were updated for all four pollutants. Emission factors were given for line-haul locomotives and yard (switch) locomotives. However, because only one set of emission factors was required for railroads, the separate emission factors for line-haul and yard locomotives were weighted by fuel usage, obtained from the Association of American Railroads (AAR). SO_2 emission factors for aircraft were also updated to reflect a lower fuel sulfur content.

b) Strengths/Weaknesses

Strengths –

- Nonroad inventories for 27 NAAs were based on best available data at the time
- Updated emission factors for locomotives and for aircraft emissions (SO_2) were used.

Weaknesses –

- In general, the recommended procedures and available tools to estimate nonroad emissions have been updated and improved since this inventory effort.
- Nonroad engine emissions were available only for a limited number of areas. Emissions extrapolated to non-surveyed areas of the United States using population as a basis, which may not be an appropriate indicator of nonroad engine activity for many equipment types.
- Nonroad engine emissions did not include emissions for SO_2 or $PM_{2.5}$.
- Aircraft, CMVs, and locomotive emissions for 1985 were estimated for the year 1990 by growing emissions using surrogate growth indicators.
- Documentation of spatial allocation of aircraft, CMVs, and locomotive emissions to counties is missing or lacking in sufficient detail to evaluate this component of the inventory.

D. 1999 Nonroad Inventory for TCEQ

1. How was the TCEQ nonroad inventory developed?

The TCEQ contracted with ENVIRON International Corporation to prepare a statewide 1999 emissions for nonroad source categories (TCEQ, 2001). The inventory included annual and ozone season day emissions for VOC, NO_x, CO, SO_2, PM_{10}, and $PM_{2.5}$.

To develop this inventory, the June 2000 draft version of the NONROAD model was run for all counties in Texas, using county-specific temperature and fuel inputs. In addition, for specific equipment categories described below, activity data were developed to replace the model default values.

- Construction and mining equipment: For diesel equipment greater than 25 horsepower, equipment populations by county and hours of use were derived from the Houston area construction and mining survey, performed for 10 equipment use/ownership categories. The survey data were extrapolated to other Texas counties using surrogates that indicate the amount of construction activity occurring in a given county. The surrogates varied depending on the equipment use/ownership category and included dollar valuation of permits, human population, and number of Mining and Aggregate employees.

- Airport ground support equipment (GSE): GSE populations were estimated on the basis of detailed data on LTO cycles by air carrier and aircraft type at each airport, and used in the NONROAD model to estimate GSE emissions.

- Recreational marine: NONROAD default equipment population for recreational marine equipment were replaced with Texas state-level registration data obtained from the Texas Parks and Wildlife Department and allocated to the county level with water surface area from the NONROAD default allocation input files.

For other categories not included in the NONROAD model, the following procedures were used.

Aircraft estimates were developed in conjunction with the Texas Transportation Institute. Commercial aviation and military aircraft were estimated using FAA's EDMS, using aircraft operations data by aircraft and engine type as input, available from the BTS. The operations data for military aircraft corresponded to public-use airports only. General aviation emissions were estimated using forecasted LTO data from FAA's TAF report and AP-42 fleet average emission factors.

Locomotive emissions were developed using statewide fuel consumption estimates from the Energy Information Administration (EIA), normalized to the national fuel consumption estimate available from the American Association of Railroads, since national EIA estimates were thought to underestimate fuel consumption. State-level emissions were then allocated to Texas counties using an estimate of relative activity of freight transfers (ton-mile) within each county. A rail freight density rating was obtained along each rail route from the U.S. DOT National Transportation Atlas. Published emission factors were then applied to the county-level fuel consumption estimates.

CMV emissions were derived from Texas-specific activity estimates of the number of vessels, annual activity, and average power for ocean-going vessels (OGVs), tugs, ferries, and push boats.

In 1999, EPA conducted the following studies: "Commercial Marine Activity for Deep Sea Ports in the United States," (EPA, 1999a), and "Commercial Marine Activity for Great Lake and Inland River Ports in the United States," (EPA, 1999b). These studies provide activity profiles for select ports, and present a method for an inventory preparer to allocate detailed time-in-mode activity data from a Typical Port to another similar port. Activity profiles for a Typical Port include: 1) number of vessels in each category; 2) vessel characterization, including propulsion size (horsepower), capacity tonnage, and engine age; 3) number of hours at each time-in-mode associated with cruising, reduced speed, maneuvering, and hotelling.

For calculating OGV emissions, the TCEQ methodology used detailed data from the EPA study on deep sea ports for the Port of Corpus Christi to estimate vessel characteristic data for Beaumont Port, and used data for Tampa Port in Florida for Port Arthur, Matagorda, and

Brownsville. Base emission factors (in grams per horsepower-hour [g/hp-hr]) for HC, NO_x, CO, and PM were applied to the activity estimates. The emission factors were developed by EPA/OTAQ to support their RIA for controlling marine diesel engines.

For tugs, ferries, push boats, and dredging, activity were obtained from Volume 5 of the Navigation Data Center and U.S. Waterway Data CD provided by the Army Corps of Engineers. The source of the g/hp-hr emission factors applied to these activity estimates was not provided. Commercial fishing vessel emissions were estimated by scaling 1990 emissions to 1999 using National Marine Fisheries Service data on fish landings.

a) Strengths/Weaknesses

Strengths –

- Default activity inputs in NONROAD model replaced with actual data for select categories.

- NONROAD model emissions were adjusted for Texas-specific rules, but no details were provided on the procedure for doing the adjustment.

- For commercial aircraft, detailed LTO data by aircraft and engine type were obtained for 27 commercial airports in Texas.

- Temporal profiles developed to estimate ozone season day emissions for commercial aircraft and general aviation were based on airport operations data.

- Detailed vessel characteristic data were used to develop OGV activity estimates for the Ports of Corpus Christi and Beaumont.

Weaknesses –

- NONROAD model category emissions based on the June 2000 draft version of NONROAD model; default activity inputs used for majority of categories.

- For construction equipment, uncertainty results from extrapolating Houston-area survey data to the entire state of Texas, including the representativeness of the activity surrogates, especially for equipment in the rental market. In addition, permit valuation may not reflect actual project valuation.

- For all aircraft categories, PM_{10} and $PM_{2.5}$ emission estimates were not available; estimated using NO_x to PM ratios based on the 1999 NEI, Version 100.

- For military aircraft, emissions from operations at military bases are not included in the inventory; military aircraft operations at public-use airports are uncertain and based on limited data.

- For railroads, activity data at both the state and county-level estimated using publicly available sources since contacts with the railroads did not yield a more detailed activity data set (only 2 Class I railroads responded to survey; many regional and local railroads did not).

- For railroads, a distinction between line haul and switch yard activity was not made.

- For CMVs, activity data for four ports were estimated using more detailed data for similar, but larger, ports. Therefore, the vessel power for these smaller ports may be overestimated compared to the actual vessels calling on these ports.

- Estimates of dredging and commercial fishing activity are uncertain.

III. REVIEW OF ONROAD S/L/T AGENCY SUBMITTALS

This section summarizes the information that S/L/T agencies have provided to VISTAS for possible use in the preparation of the 2002 onroad emission inventory. Submittals related to the onroad sector were received from all ten VISTAS States. After summarizing the information provided by each state, questions raised by the submittals or requests for other information is included. The state summaries only discuss inputs relevant to the 2002 emission inventories. For example, many states submitted temperature information. However, in most cases, that temperature information applies to ozone season modeling and does not represent actual temperatures that occurred in 2002. The inclusion of such data is not referenced here.

A. Alabama

Alabama's onroad submittal to VISTAS consisted of 1999 vehicle miles traveled (VMT) data submitted to the 1999 NEI. Thus, these VMT data are provided at the county, vehicle type, and road type level of detail. Alabama also provided average annual VMT growth rates for each county. These growth rates were based on Alabama HPMS VMT data from 1990 through 2001 at the county level.

Follow-up

Does Alabama have any MOBILE6 inputs available, even if only for certain counties in the state? Are there any I/M programs or low sulfur fuel programs in Alabama?

B. Florida

Florida provided daily 2001 VMT by county and roadway type. No VMT mix information by vehicle type is available for Florida. Florida provided summer and winter RVP values for the state. No I/M, reformulated gasoline, oxygenated fuel, or low sulfur fuel programs are present in Florida. Florida indicated that seasonal and daily VMT adjustment factors are available by county in a lengthy hard copy format, but these were not provided at the present. 2001 highway vehicle emission totals for Palm Beach were provided, but no detail on how these emissions were calculated was provided

Follow-up

Does Florida have any VMT temporal adjustment factor information available? Does Florida have any speed or registration distribution information available for any areas in the state?

C. Georgia

The Georgia submittal included significant information on the fuel in Georgia. Phase I of Georgia's gasoline program was in place in 2002 in 25 counties. This gasoline has a low sulfur content and a low RVP value. In addition, all gasoline sold throughout Georgia year-round is oxygenated. The I/M program inputs applicable in 2002 and later years for the program that was present in the 13-county Atlanta NAA were provided in MOBILE6 format. A MOBILE6-formatted registration distribution, based on 1999 registration data, applicable to the Atlanta NAA was provided. All other counties in the state should use the MOBILE6 default registration distribution. Statewide speeds for use in 2002 by roadway type were provided. Sample MOBILE6 input files were included in the Georgia submission, covering all counties in the state.

2002 summer day VMT is provided for each county by roadway type. For the Atlanta area and the rest-of-state area, 1999 VMT mixes have been projected to 2002 and are provided in MOBILE6 format. Twelve monthly and seven weekly VMT adjustment factors have also been provided for each roadway type. These factors apply statewide. With these factors, the VMT provided can be adjusted to any day of the year. In addition, temporal factors for allocating daily VMT to four time periods have been provided for the Atlanta area. Documentation has also been provided describing how many of these data sets were developed.

Follow-up

It is unclear from the Georgia submittal whether the Georgia Phase 1 gasoline RVP is 7.0 pounds per square inch (psi) year-round or just during the ozone season. Otherwise, the Georgia submission appears to be complete and covers all requested data elements.

D. Kentucky

Kentucky provided information for 15 of the counties in the state and no information for the remaining counties. For these counties, the information provided includes speed by roadway type, summer RVP, an indication of whether the reformulated gasoline (RFG) program is implemented in that county, I/M program inputs where applicable. The I/M program inputs are in MOBILE5 format.

More detailed data were provided for Jefferson County (the Louisville area). The VMT data provided for Jefferson County includes VMT by vehicle type, roadway type, and season for 2002. The vehicle type information includes heavy-duty diesel vehicle (HDDV) subcategory breakdowns. A MOBILE6 input file was provided for Jefferson County. This input file included speed, vehicle type, and facility type VMT distributions, summer fuel program inputs, I/M program inputs, and a registration distribution.

Follow-up

Is any VMT data available, even just county totals, for the remaining counties in the state? Have the I/M program inputs been converted to MOBILE6 format? Do any of the remaining counties have either I/M or RFG programs? The Jefferson County documentation mentions that their modeling includes adjustments for VMT from the Indiana portion of Louisville. If the MOBILE6 inputs are provided for the VMT originating from vehicles registered in Indiana, we could model both MOBILE6 files weight the resulting emission factors according to the fraction of the VMT that corresponds to each area.

E. Mississippi

Mississippi provided 2000 annual VMT data by county, roadway type, and vehicle type. No VMT temporal adjustment factors are available in Mississippi. Mississippi has no control programs in the state.

Follow-up

Is any registration distribution or speed information available in Mississippi?
Mississippi provided VMT data that is used in the 1999 NEI. Can the annual growth rate calculated from 1999 to 2000 be used to project VMT to 2002?

F. North Carolina

Daily VMT totals by roadway type were provided for each county in 2001. A 2002 VMT mix by vehicle type was provided for each roadway type. These VMT mixes apply statewide. MOBILE5 2001 input files were provided, covering the entire state. These input files included local registration distributions, I/M inputs where applicable, and speeds and VMT mixes by vehicle type. Summer and winter RVP values were also supplied.

Follow-up

North Carolina contacts have indicated that MOBILE6 inputs may be available soon. Please provide these when they become available. It was unclear from the documentation provided which counties had an I/M program in 2002. Please review the spreadsheet provided by Pechan summarizing this information and correct if necessary. Are any seasonal or daily VMT allocation factors available for North Carolina? Can North Carolina provide either preliminary 2001 VMT data or VMT data from additional historical years so that growth to 2002 can be calculated?

G. South Carolina

South Carolina provided annual VMT data for each county in the state by roadway type for each year from 1997 through 2001. Several years of projected VMT data were also provided. South Carolina indicated that no I/M programs or reformulated gasoline programs are present in the state. In addition, South Carolina recommended obtaining ozone season RVP data from EPA's website.

Follow-up

Does South Carolina have access to VMT mix information by vehicle type or temporal allocation factors by season or day of week? Does South Carolina have any vehicle registration data or information on vehicle speeds available?

H. Tennessee

Tennessee provided extensive documentation of all of the inputs supplied.

Tennessee provided VMT data for each year from 1990 through 1999 by county and roadway type. In addition, VMT mixes by vehicle type at the MOBILE6 vehicle type level were provided for years 1998 through 2030. MOBILE6 input files were provided covering all counties in the state. These input files included registration distributions, I/M program inputs where applicable, speed distributions, VMT fractions by vehicle type, and summer RVP values.

For Hamilton County (the Chattanooga area), in addition to the above inputs, 2000 daily VMT data were provided by roadway type, along with monthly VMT adjustment factors for each roadway type.

Davidson County (the Nashville area) provided daily 2000 VMT by roadway type and zone, vehicle mix by roadway type, and speeds by roadway type and zone. In addition, this county provided VMT adjustment factors for each weekday in June, July, and August.

Shelby County (the Memphis area) provided 1999 daily VMT by roadway type and VMT mixes for each roadway type. Speeds were provided by roadway type for 2003. MOBILE5-based inputs, including the I/M program inputs were provided. Monthly VMT adjustment factors for June, July, August, November, December, and January were provided for each day of the week by roadway type.

Follow-up

It is unclear as to how the temporal VMT factors provided by Davidson County should be used. Further explanation or an example calculation would be helpful.

I. Virginia

Virginia provided annual and ozone season day 1999 VMT by county, vehicle type, and roadway type. This file also included the corresponding speed for each VMT record. A summary of 1999 VOC, NO_x, and CO emissions was provided annually and for an ozone season day for each county in the state. Individual county-level registration distribution files were provided in MOBILE6 format for counties in the Hampton Roads, Richmond, and Northern Virginia areas. MOBILE6 input files were provided for counties in these three areas including VMT mixes by vehicle type, summer 2002 fuel information including RFG where applicable, and speeds. I/M program information was provided for Northern Virginia.

Follow-up

Does Virginia have information available to grow the 1999 VMT to 2002? Are any seasonal or daily VMT factors available for Virginia?

J. West Virginia

West Virginia provided VMT data by roadway type for each county in the state for years from 1980 through 2001. In addition, West Virginia also provided VMT mix by vehicle type data for the state as a whole at the roadway type level. The state indicated that there are no I/M or reformulated gasoline programs in the state and that the ozone season RVP level is 9.0 psi.

Follow-up

Is any speed information, registration distribution information, or VMT temporal adjustment factor information available in West Virginia?

IV. REVIEW OF NONROAD S/L/T AGENCY SUBMITTALS

A. Alabama

Alabama developed 1999 annual and daily railroad emissions for VOC, NO_x, and CO, and submitted these estimates for incorporation into the 1999 NEI. There was no documentation provided to describe the procedures used to develop these estimates. Line haul locomotive NO_x emissions for Pickens Cty (County FIPS 107) and Tuscaloosa Cty (FIPS 125) appeared to be high relative to emissions for other counties in Alabama, as well as the United States.

B. Florida

For Palm Beach County, 2001 CO, NO_x, PM, oxides of sulfur (SO_x), and VOC emission estimates were provided for nonroad engines, aircraft (except PM), CMVs, and locomotives. Nonroad engine emissions were reported as a sum total, and not broken out by equipment category. There was no documentation provided to describe the procedures used to develop these estimates.

C. Kentucky

Kentucky provided documentation for the development of a 2000 nonroad emissions inventory for Kentucky's ozone maintenance areas (i.e., Marshall County and a portion of Livingston County, Daviess County and a portion of Hancock County, Edmonson County, Fayette and Scott Counties, Boyd County and a portion of Greenup County).

Emissions for NONROAD model source categories were estimated using EPA's draft NONROAD Model (June 2000 version) in accordance with EPA Region 4 direction. Model default input values for RVP and temperature were replaced with more representative local values.

FAA's EDMS Version 4.04 was used to calculate emissions for commercial aircraft. Annual average temperature inputs for EDMS were obtained from the National Oceanic and Atmospheric Administration's (NOAA) 2000 Climatological Data Annual Summary for Kentucky. Commercial LTO annual information was obtained from the FAA's, *Airport Activity Statistics of Certificated Route Air Carriers for 2000.* 2000 aircraft operations for air taxi, general aviation, and military aircraft were obtained from the Kentucky airport master record. Emissions for these aircraft types were estimated by multiplying the number of LTOs for each type of aircraft by fleet-average emission factors. In addition, seasonal adjustment factors to determine typical summer day (TSD) emissions were developed based on contacts with local airports.

For Kentucky NAAs, 2000 locomotive fuel consumption for both line haul and yard locomotives was obtained from a survey of maintenance areas. Fuel consumption was then multiplied by EPA-recommended emission factors to estimate annual HC, NO_x, CO, SO_x, PM emissions. Activity for railroad locomotives was considered to be uniform throughout the year.

Nonroad activity data were also compiled and provided to Pechan. No emission estimates were provided with these data. Pechan will consider how to use these activity data to improve the nonroad inventory.

D. South Carolina

For aircraft and NONROAD model categories, South Carolina developed 1999 annual and daily emissions for HC, NO_x, CO, and SO_x and submitted these estimates for incorporation into the 1999 NEI, Version 2.0. Aircraft estimates were incorporated, but NONROAD model estimates were not. There was limited documentation provided to describe the procedures used to develop these estimates.

Aircraft emission estimates were generated using the FAA's Aircraft model, presumably EDMS. South Carolina contacted commercial and military bases to collect data on air activity. A description of methods used to develop the NONROAD model inventory was not provided. Because it was not incorporated into the NEI, this inventory was likely based on the June 2000 draft NONROAD model, but with no replacement of default equipment population or activity data.

E. Tennessee

Hamilton County (Chattanooga)

Hamilton County developed 1999 annual and daily emissions for commercial, general aviation, and military aircraft and submitted these estimates for incorporation into the 1999 NEI, Version 2.0. Emission estimates for HC, NO_x, CO, and SO_x were developed using FAA's EDMS model.

Commercial marine activity data were also compiled and provided to Pechan. No emission estimates were provided with these data. Pechan will consider how to use these activity data to improve the CMV inventory.

Davidson County

Davidson County provided 1999 annual and daily nonroad emission estimates for aircraft, locomotives, and NONROAD model categories. It is unclear whether aircraft and locomotive estimates were incorporated into the 1999 NEI, Version 2.0; NONROAD model estimates were not. Emission estimates for HC, NO_x, CO, SO_x, and primary PM_{10} were developed for aircraft and locomotives.

There was some documentation provided to describe the procedures used to develop these estimates. Aircraft emissions were developed from the Metro Nashville Airport Authority study of Nashville International Airport and John Tune airport. Activity data were also obtained from Cornelia Fort airport; fleet average AP-42 emission factors were applied to these airport LTO's. Locomotive emissions were based on line haul and yard activity data obtained from CSX Railroad. Nonroad engine emissions were developed based on EPA's "33-City Study" (EPA, 1992). Emissions data for Atlanta area were apportioned to Davidson County using human population as the multiplier.

Shelby, Tipton, Lauderdale, Dyer, and Lake Counties

For Shelby, Tipton, Lauderdale, Dyer, and Lake counties a commercial marine emissions inventory was scheduled to be completed in December 2002 by the University of Tennessee. The year of inventory and the procedures to be used were not specified, but the University of Tennessee believed the criteria emissions attributed to CMVs for these five counties were overestimated. The emission levels they reported for annual 1999 NO_x emissions for Shelby county (73,891 tons per year [tpy]), however, do not reflect Version 2.0 of the 1999 NEI. Annual NO_x emissions for Shelby county in the NEI, Version 2.0 are approximately 6,966 tpy. Emission maps representing the 1999 NEI for CMVs, and other nonroad categories, are provided and discussed in Section V of this report.

V. SUMMARY OF RECOMMENDATIONS FOR VISTAS

A. Onroad

The inventory methods for the onroad sector for the reviewed inventories (NEI and SAMI) used similar inventory methods and included full coverage of the onroad sector sources. The use of local data, supplied by the VISTAS S/L/T agencies, will greatly increase the representativeness of the VISTAS inventory over these previous inventories. At this point, it appears that county-level VMT totals have been provided throughout the region, with the exception of the rural counties in Kentucky. In addition, in many cases, the VMT provided has been distributed by roadway type and/or vehicle type. These distributions are important in determining the magnitude of the VISTAS onroad emissions. Some areas have also been able to supply temporal allocations for their VMT. Our overall recommendations related to VMT are as follows:

- For States that do not have access to 2002 VMT data, determine the best previous year of data and grow VMT to 2002 based on historical VMT trends, ensuring that the distribution of VMT by roadway type and vehicle type are representative for that area.
- For areas without VMT distribution information, use a VMT mix composite based on the distributions from similar States in the region or a regionwide composite, with different mixes for urban and rural areas.
- S/L/T agencies should investigate the feasibility of obtaining temporal VMT data. Many state Departments of Transportation (DOTs) actually have some data available on vehicle counts by season.
- Kentucky should continue to pursue the availability of county-level VMT information for the remaining counties.

For the 2002 VISTAS inventory, MOBILE6 input files will be developed following the general structure of the inputs for the 1999 NEI, but incorporating all available local information. MOBILE5 inputs provided by the S/L/T agencies will be converted to MOBILE6. However, if additional work has by done recently by the agencies in performing these conversions, it would be best for those agencies to provide the MOBILE6 inputs.

- If they have not already done so, State agencies should request a download of their State's registration database. The data of the download should be noted so that the registration distributions can be adjusted to a July 1 2002 date (as needed by MOBILE6). The vehicle registration distributions are an important input that most states should be able to obtain data on from their Department of Motor Vehicles.
- States should review the I/M and control program coverage by county that was sent out under separate cover to the VISTAS contacts and make corrections as needed. Also, ensure that any I/M inputs provided applied in the 2002 calendar year.
- More significant efforts might be made in the future by taking advantage of the various weight categories included in MOBILE6 for heavy duty trucks. Any registration information that can be obtained on registrations and diesel sales fractions by model year could make a significant impact on the emissions if these inputs vary from those included in the MOBILE6 defaults.
- As with the VMT temporal data, may State DOTs also have information on speeds for various roads in the State. If these data can be obtained, it would represent an improvement over the NEI defaults, which were developed nationally, based on data from the early 1990s.

B. Nonroad

The inventory methods reviewed above all have relative strengths, and most have limitations related to regional haze pollutant coverage, as well as the spatial and temporal allocation of emissions. After consideration of the methods used to develop nonroad sector inventories for the nation, or for specific states or counties, we have developed recommendations related to the nonroad sector. These recommendations may change depending on the timing of development of the 2002 regional haze inventory, and on resource constraints.

- VISTAS member S/L/Ts should review the 1999 NEI, Version 2.0 for representativeness.

This is consistent with suggestions made for improving nonroad sector emissions in the OTC and SESARM region (MARAMA, 2001). The 2002 NEI may be developed within the needed time frame to support development of a VISTAS regional haze inventory, but the geographic allocation reflected in the 2002 NEI is likely to be comparable to the 1999 NEI for many categories. For developing default emission estimates (i.e., not State-supplied), significant changes to the draft NONROAD model geographic allocation indicators are not expected, and the spatial surrogates for allocating 2002 aircraft, CMV, and rail will likely be derived from the same sources of data as the 1999 NEI. If SCC-specific NEI estimates are determined to be representative for certain States or counties, efforts should be focused on those other categories and areas that are identified to be less representative.

Pechan has provided emission maps in Appendix A that provide 1999 NEI, Version 2.0 county-level emissions for the following select pollutant/SCC combinations:

- CO Emissions for Aircraft
- SO_2 Emissions for Commercial Marine Vessels
- $PM_{2.5}$ Emissions for Diesel Construction
- $PM_{2.5}$ Emissions for Diesel Farm
- VOC Emissions for Gasoline Lawn and Garden
- VOC Emissions for Gasoline Recreational Marine
- NO_x Emissions for Locomotives

NONROAD Model Engines

Input files for the latest public draft version of NONROAD will be developed as described in the work plan to account for differences in temperature and fuel characteristics among states, or counties within states if appropriate.

Based on the inventory review and the October 2002 information request to VISTAS S/L/Ts, state or local equipment population/activity data are not readily available to replace the model default activity estimates. As such, efforts would need to be initiated and conducted to develop these improved inputs for the VISTAS region.

- Consider performing local surveys of activity for construction equipment; potentially extrapolating to rest of State using procedures described in TNRCC inventory report. Guidance for conducting these surveys of construction equipment and applying results to other areas is also being developed by NESCAUM (Cooper, 2002).

Aircraft, CMVs, and Locomotives

The NEI is developed using top-down methods for these categories. As such, VISTAS should consider improving the activity data and developing bottom-up inventories for certain areas and categories. This may be especially important for those counties identified to border Class I areas.

Aircraft

- Commercial aircraft activity is typically available from published sources (e.g., FAA's *Airport Activity Statistics of Certificated Route Air Carriers*). Efforts by S/L/T agencies should be focused on identifying and accounting for non-commercial activity, especially military aircraft operations at military bases or public-use airports.

- Where available, use of EDMS emission factors for matched aircraft is encouraged for non-commercial aircraft as well, in place of fleet-average AP-42 emission factors.

- Using latitude and longitude data for commercial airports compiled for the NEI, airports could be inventoried as "point" sources.

Locomotives

- Rail companies operating with a state or local area should be contacted to obtain estimates of fuel consumption directly, or data to calculate fuel consumption (e.g., gross ton-miles (GTM) and gallons of fuel consumed per GTM).

- Location of switchyards and distinction of yard activity from line-haul locomotive activity should be made.

CMVs

- CMV activity at larger ports should be reviewed and refined. EPA's 1999 guidance for developing inventories should be considered in accounting for the vessel types, average vessel size, and time-in-mode for each vessel category (EPA, 1999a; EPA, 1999b). Detailed data presented in the EPA guidance for Typical Ports in the VISTAS region can be reviewed and methods to extrapolate the data to other smaller ports can be considered, similar to methods used by TCEQ to develop CMV emissions for the state of Texas.

Additional recommendations

- Compile and apply any state-supplied data to improve temporal profiles for NONROAD model and other nonroad categories.

- Methods and available emission factors to estimate $PM_{2.5}$ and PM_{10} emissions for commercial aircraft, and NH_3 emissions for all nonroad sources need to be identified.

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