U.S. Department
of Transportation
**Federal Highway
Administration**

FHWA-PD-98-003
DOT-VNTSC-FHWA-97-2

Review of Procedures for Estimating On-Road Mobile Source Emissions Inventories for 1990 Base Year SIPs

November 1997
Final Report

SEEING CLEARLY...A Series of Reports on Transportation and Air Quality

Prepared for

Environmental Analysis Division
Office of Environment and Planning
Federal Highway Administration
U.S. Department of Transportation

Prepared by

Service Assessment Division
Office of Research and Analysis
Volpe National Transportation Systems Center
Research and Special Programs Administration
U.S. Department of Transportation

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

PB98-128838

2. REPORT DATE
November 1997

3. REPORT TYPE AND DATES COVERED
Final Report
January 1996 - November 1996

4. TITLE AND SUBTITLE
Review of Procedures for Estimating On-Road Mobile Source Emissions Inventories for 1990 Base Year SIPs

5. FUNDING NUMBERS
HW765/H7039

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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Research and Special Programs Administration
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8. PERFORMING ORGANIZATION REPORT NUMBER
DOT-VNTSC-FHWA-97-2

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Federal Highway Administration
Environmental Analysis Division
Office of Environment and Planning
400 7th Street, SW
Washington, DC 20590

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
FHWA-PD-98-003

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

This document is available to the public through the National Technical Information Service, Springfield, VA 22161

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

In response to the 1990 Clean Air Act Amendments (CAAA), areas designated as being in violation of the National Ambient Air Quality Standards (NAAQS) were required to submit State Implementation Plans (SIPs) beginning with 1990 Base Year Emissions Inventories. In an effort to support the successful implementation of the CAAA and to provide support to state and local agencies responsible for preparing the On-Road Mobile Source sections of the emission inventories, the Federal Highway Administration (FHWA) is seeking to provide information on the emissions inventory development processes that are being adopted by metropolitan areas throughout the country. This document examines the current practices employed by state environmental and transportation agencies, regional transportation committees, and metropolitan planning organizations in developing on-road mobile emissions inventories in 33 designated nonattainment areas.

The review focuses on the following areas which are critical to estimating on-road mobile emissions: vehicle miles of travel estimation methodology, speed estimation methodology, development of vehicle fleet and travel fractions, trip length, and operating mode fractions. The study also looks at innovative practices in use around the country. The use of specific methodologies discussed herein is relevant to the ongoing requirements for nonattainment areas to submit updated SIPs and emissions budgets.

14. SUBJECT TERMS
Clean Air Act Amendments (CAAA), emissions, National Ambient Air Quality Standards (NAAQS), State Implementation Plan (SIP)

15. NUMBER OF PAGES
52

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18
298-102

PREFACE

Research for this report was conducted by Philip vanderWilden of the Volpe National Transportation Systems Center (Volpe Center). The author is indebted to Jerry Everett of the Federal Highway Administration and Don Pickrell and Beth Deysher, both of the Volpe National Transportation Systems Center, for their careful review and insightful comments on earlier versions of the report. This report has been reviewed by the Environmental Protection Agency's Office of Mobile Sources Technical Support branch. This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

This report is one in a series of publications produced or distributed by the Federal Highway Administration of the U.S. Department of Transportation to address important issues in transportation and air quality planning for metropolitan areas. Copies of this and other reports in this series can be ordered by calling 202-366-2069.

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectare (ha) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gm)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp) = 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup (c) = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

°C=5/9(°F - 32)

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2) = 1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

°F=9/5(°C) + 32

QUICK INCH-CENTIMETER LENGTH CONVERSION

INCHES	0	1	2	3	4	5

CENTIMETERS	0	1	2	3	4	5	6	7	8	9	10	11	12	13

QUICK FAHRENHEIT-CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. C13 10286.

Updated 8/1/96

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AADT	average annual daily travel
ATP	anti-tampering program
AWDT	average week day travel
BOTA	Bridge of the Americas
BPR	Bureau of Public Roads
CAAA	Clean Air Act Amendments of 1990
CALTRANS	California Department of Transportation
CARB	California Air Resources Board
CFR	Code of Federal Regulations
CO	carbon monoxide
DVMT	daily vehicle miles traveled
FAUA	Federal Aid Urbanized Area
FC	functional class
FHWA	Federal Highway Administration
FRN	Federal Register Notices
FTP	federal test procedure
H-GAC	Houston-Galveston Area Council
HBW	home-based work trip
HDDV	heavy duty diesel vehicle
HOV	high occupancy vehicle
HPMS	Highway Performance Monitoring System
I/M	inspection and maintenance
LOS	level-of-service
LTD	light duty trucks
MI/H	miles per hour
MPO	metropolitan planning organization
MWCOG	Metro-Washington Council of Governments
NAAQS	National Ambient Air Quality Standards
NO_X	nitrogen oxides
OMS	Office of Mobile Sources
PCCC	catalyst-equipped vehicle in cold start mode
PCCN	non-catalyst-equipped vehicle in cold start mode
PCHC	catalyst-equipped vehicle in hot start mode
PDN	Paso Del Norte Bridge
RTC	Regional Transportation Commission
RTF	running time factors
SCAG	Southern California Association of Governments
SIP	state implementation plan
SRF	speed reduction factor
TAZ	traffic analysis zone
TCM	transportation control measure
TDF	travel demand forecast models
TRB	Transportation Research Board

USDOT	United States Department of Transportation
U.S. EPA	United States Environmental Protection Agency
V/C	volume-to-capacity
VHT	vehicle hours of travel
VMT	vehicle miles traveled
VNTSC	Volpe National Transportation Systems Center
VOC	volatile organic compounds

1. OVERVIEW

The 1990 Clean Air Act Amendments (CAAA) required areas designated as being in violation of the National Ambient Air Quality Standards (NAAQS) to submit State Implementation Plans (SIP) beginning with 1990 Base Year Emissions Inventories which were due by November 15, 1992. The Emissions Inventories contain measures of pollution by specific categories including stationary point, area, on-road mobile, non-road mobile, and biogenic sources. In an effort to support the successful implementation of the CAAA and to provide support to state agencies responsible for preparing the On-Road Mobile Source sections of the emission inventories, the Federal Highway Administration (FHWA) of the U.S. Department of Transportation (DOT) requested the U.S. DOT Volpe National Transportation Systems Center's (Volpe Center's) assistance in reviewing the on-road mobile source sections of the inventories.

This study examines the current practices employed by state environmental agencies, state departments of transportation, regional transportation committees and metropolitan planning organizations (MPO) in developing the On-Road Mobile emissions inventories. Volpe Center's review focused on the following areas which are critical to estimating On-Road Mobile emissions inventories:

- VMT Estimation Methodology
- Vehicle Fleet and Travel Fractions
- Operating Mode Fractions
- Speed Estimation Methodology
- Trip Length
- Innovative Practices

For the purposes of this study, FHWA selected a subset of ozone and carbon monoxide (CO) nonattainment areas for review focusing on the more severe nonattainment areas but also including a regional representation of all areas throughout the country. 1990 Base Year Emissions inventories were collected by Volpe Center from the ten U.S. EPA Regional Offices and from individual state environmental and transportation agencies. Documents collected and analyzed were the latest available versions of each area's Base Year SIP at the time the study, which was conducted from January to November of 1994. Due to the difficulty in obtaining many documents, FHWA and Volpe Center limited their review to the 33 areas where sufficient documentation was available, as listed in table 1 on the following page.

Table 1. Selected nonattainment areas.

	Nonattainment Area	CO Class	OZ Class		Nonattainment Area	CO Class	OZ Class
1.	Greater Connecticut		Serious	17.	Milw.-Racine,WI		Severe-17
2.	Providence (All RI)		Serious	18.	Sheboygan, WI		Serious
3.	Boston-Lawrence-Worcester, MA	Mod.<12.7	Serious	19.	Cleveland-Akron-Lorain, OH	Mod.<12.7	Moderate
4.	Portsmouth-Dover-Rochester, NH		Serious	20.	Houston-Galveston-Brazoria, TX		Severe-17
5.	New York[1]	Mod.>12.7	Severe-17	21.	Beaumont-PA, TX		Serious
6.	New Jersey[1 & 2]		Severe-15/17	22.	El Paso, TX	Mod.<12.7	Serious
7.	Philadelphia, PA[2]		Severe-15	23.	Denver-Boulder, CO	Mod.>12.7	
8.	Delaware[2]		Severe-15	24.	Missoula, MT	Mod.<12.7	
9.	Washington, D.C.	Mod.<12.7	Serious	25.	Provo, UT	Mod.>12.7	
10.	Baltimore, MD	Mod.<12.7	Severe-15	26.	Salt Lake City, UT		Moderate
11.	Atlanta, GA		Serious	27.	Phoenix, AZ	Mod.<12.7	Moderate
12.	Chicago, IL[3]		Severe-17	28.	Las Vegas, NV	Mod.>12.7	
13.	Gary-Lake County,IN[3]		Severe-17	29.	Reno, NV	Mod.<12.7	Marginal
14.	Detroit-Ann Arbor, MI		Moderate	30.	Anchorage, AK	Mod.>12.7	
15.	Muskegon, MI		Serious	31.	Seattle-Tacoma, WA	Mod.>12.7	Marginal
16.	Minn.-St. Paul, MN	Mod.<12.7		32.	Spokane, WA	Mod.>12.7	
				33.	California Areas-		
					Fresno	Mod.>12.7	
					LA-South Coast AB	Serious	Extreme
					Sacramento Metro	Mod.<12.7	Serious
					San Joaquin Valley		Serious
					San Diego	Mod.<12.7	Severe-15
					SE Desert Modified		Severe-17
					Ventura County		Severe-15

1- as part of the NY-N. New Jersey-Long Island, NY-NJ-CT nonattainment area
2- as part of the Philadelphia-Wilmington-Trenton, PA-NJ-DE-MD nonattainment area
3- as part of the Chicago-Gary-Lake County, IL-IN nonattainment area

2. OVERVIEW OF CAAA LEGISLATION AND GUIDANCE DOCUMENTATION

The 1990 Clean Air Act Amendments (CAAA) were signed into law on November 15, 1990. The CAAA restructured the requirements for areas not in attainment of the NAAQS. Revisions to Title I included changes to the processes for SIP submittals by the states and U.S. EPA review and approval of the SIPs. Sections 182 and 187 of Title I of the CAAA relating to ozone and carbon monoxide nonattainment areas respectively, require designated nonattainment areas to submit a comprehensive, accurate, current inventory of actual emissions from all sources no later than two years after the date of the enactment of the CAAA.

Section 178 of the Act directs the Administrator of the U.S. Environmental Protection Agency (U.S. EPA) to issue guidance documents for the purposes of assisting States in implementing requirements of the Act, including the submission of SIPs. The U.S. EPA's Offices of Air and Radiation, Mobile Sources, and Air Quality Planning and Standards subsequently published a series of guidance documents detailing the recommended procedures and methodologies for preparing emissions estimates including:

- *Emission Inventory Requirements For Ozone State Implementation Plans* (U.S. EPA-450/4-91-010)
- *Emission Inventory Requirements For Carbon Monoxide State Implementation Plans* (U.S. EPA-450/4-91-011).

U.S. EPA also published guidance specific to each of the individual pollution categories included in SIP submittals entitled:

- *Procedures for Emission Inventory Preparation*, Volumes I-V (U.S. EPA-450/4-81-026a-e).

Specific guidance relating to methodologies (vehicle miles traveled, speeds, operating modes, etc.) to be employed in developing the on-road mobile source sections of the SIPs was provided in the following documents:

- *Procedures for Emission Inventory Preparation*, Volume IV: Mobile Sources (U.S. EPA-450/4-81-026d)
- *User's Guide to MOBILE 4.1 (MOBILE Source Emission Factor Model)* U.S. EPA-AA-TEB-91-01).

General requirements relating to the specificity of information on procedures and methodologies required in the SIPs was provided in the Code of Federal Regulations (CFR) under Title 40, Chapter I, Subchapter C, Part 51- Requirements for Preparation, Adoption and Submittal of Implementation Plans. In general, 40 CFR Part 51 requires that the SIP submittals include a level of detail in describing methodologies employed such that the results obtained by the states could be validated by a U.S. EPA review.

The delay in the publication of a number of guidance documents appears to have created subsequent problems for States in attempting to follow U.S. EPA recommended guidelines, although U.S. EPA issued interim guidance in January of 1991 containing most of the information that was subsequently compiled into Volume IV. Two such instances were the delays in publication of the final Volume IV: Mobile Sources, originally scheduled for May of 1991 but not released until July of 1992, and the *User's Guide to MOBILE 4.1* which was subsequently updated to the *User's Guide to MOBILE 5.0* in March of 1993 and again in May 1994.

3. CURRENT PRACTICES

On-road mobile source emissions as modeled by U.S. EPA are a function of two factors: vehicle activity and emissions per unit of activity. Vehicle activity is measured in vehicle miles traveled (VMT) while emissions per unit of activity is measured in grams per mile calculated using U.S. EPA's MOBILE Emission Factor Model. In simple terms, total emissions are the result of the following equation (calculated for each vehicle type, speed, and functional class and then summed, or by using a composite emissions factor):

$$\begin{matrix} \textit{Total On-Road} \\ \textit{Mobile Source Emissions} \end{matrix} = \sum_{Veh.Type,Speed} VMT \times \textit{Emission Factor}_{\textit{grams per mile}}$$

The Volpe Center's review of the on-road mobile source inventories of 33 nonattainment area SIPs focused on the methodologies used to develop inputs to either the VMT or emissions factor part of the above equation. The speed and operating mode under which travel occurs, the type, vehicle age, and travel fraction (VMT mix and mileage accumulation rates) have an important effect on the emissions factor calculated by the MOBILE model. States were directed to use the latest version of MOBILE at the time of submittal of their base year inventory. Of the 33 areas reviewed under this study, the sample of nonattainment areas was relatively evenly divided between different versions of the model as shown in table 2 below (with the exception of U.S. EPA's approval of the State of California's use of the California Air Resource Board (CARB) EMFAC emissions factor model). The use of different versions of MOBILE reflects the widely varying dates of submittal to U.S. EPA of either draft or final base year inventories, from November of 1992 through April of 1994. States are continuing to submit revised inventories constructed with the updated version MOBILE 5.0a as of the publication of this report.

Table 2. U.S. EPA MOBILE model versions used.

Model Version	No. of Areas	% of Areas
4.1	11	33%
5.0	12	36%
5.0a	9	27%
EMFAC	1	3%
Total	33	100%

The discussion under each subheading that follows contains summary results from the Volpe Center's reviews of the methodologies employed in each of the 33 nonattainment areas, indicating why specific procedures were chosen, and whether they followed U.S. EPA's guidelines. The guidance cited under the subheadings below is taken from U.S. EPA's *Procedures for Emission Inventory Preparation*, Volume IV: Mobile Sources unless otherwise noted.

3.1 VEHICLE MILES TRAVELED ESTIMATION

The accurate estimation of VMT is critical to the development of reliable inventories. U.S. EPA and USDOT agreed to endorse FHWA's Highway Performance Monitoring System (HPMS) as the preferred methodology for estimating VMT. HPMS is a statewide and national information system designed to provide highway transportation data for analytical purposes for use by both policy decision makers and transportation planning professionals to measure and monitor the condition, performance, usage, and operating characteristics of the Nation's highways.

States and, in turn, nonattainment areas contained within the State, were directed to base 1990 estimates on unique HPMS sample panels for each Federal Aid Urbanized Area (FAUA) within the state. There were exceptions to this rule in some of the states reviewed as part of this study including California, Connecticut, Michigan, New York, Ohio, and Washington where HPMS data were not adequate. In these cases all of the nonattainment areas located in these states used non-HPMS procedures, or supplemented HPMS estimates with other methodologies.

Of the 33 areas reviewed, the majority of areas used combinations of different VMT estimation methodologies including travel demand forecast (TDF) models and non-HPMS counts, with only 15 percent of areas depending solely on HPMS as shown in figure 1.

An examination of those areas that relied solely on HPMS or used HPMS in combination with either non-HPMS counts or TDF modeling appears to indicate that many areas' HPMS FAUA

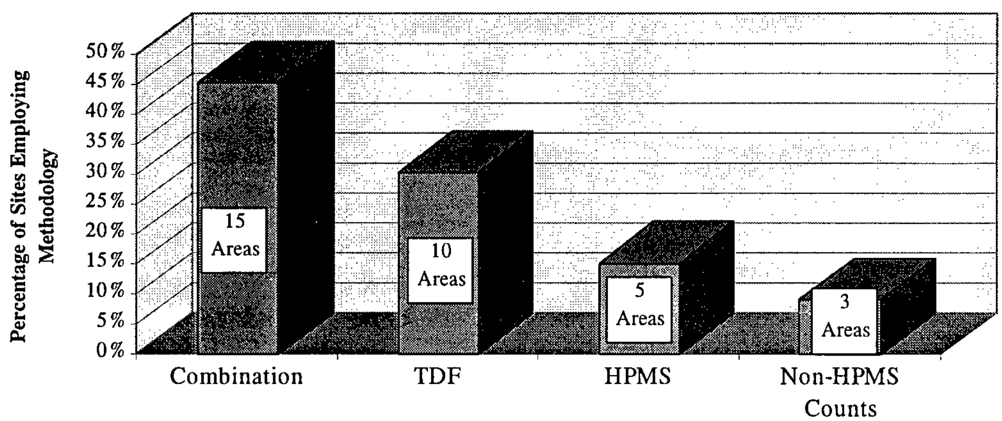

Figure 1. Frequency of VMT methodology.

data were inadequate for air quality analysis purposes when their original base year inventories were submitted. This is illustrated in figure 2 by the overwhelming use of statewide HPMS VMT data. Of the 19 areas partially or solely using HPMS data, only Chicago (which used HPMS data only for those areas not included in their TDF), Seattle and Phoenix employed FAUA data. Where statewide HPMS data were used, the data were commonly disaggregated by area type (urban, small urban, and rural) and functional classification of roadway at the county level or, in certain cases, at the nonattainment area level.

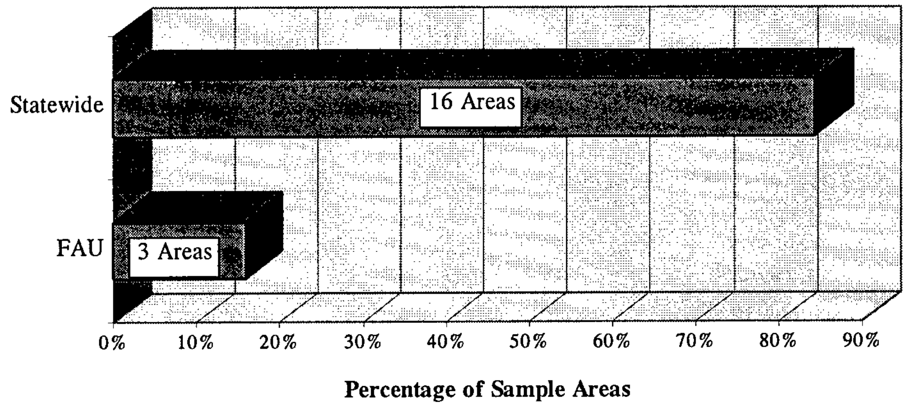

Figure 2. Comparison of use of FAUA vs. statewide HPMS data.

It is important to note that HPMS was not originally designed to serve the travel data needs for air quality analysis. The statewide and FAUA boundaries for which HPMS data are collected frequently differ from the nonattainment area boundaries. Revisions to HPMS in 1993 addressed this issue by introducing a special "donut" area. The donut area sample captures VMT for the area outside of the FAUA or TDF boundary but within the nonattainment area as illustrated in figure 3 below. This made it possible to obtain HPMS VMT estimates for an entire nonattainment area that might include parts or whole areas of one or more urbanized areas.

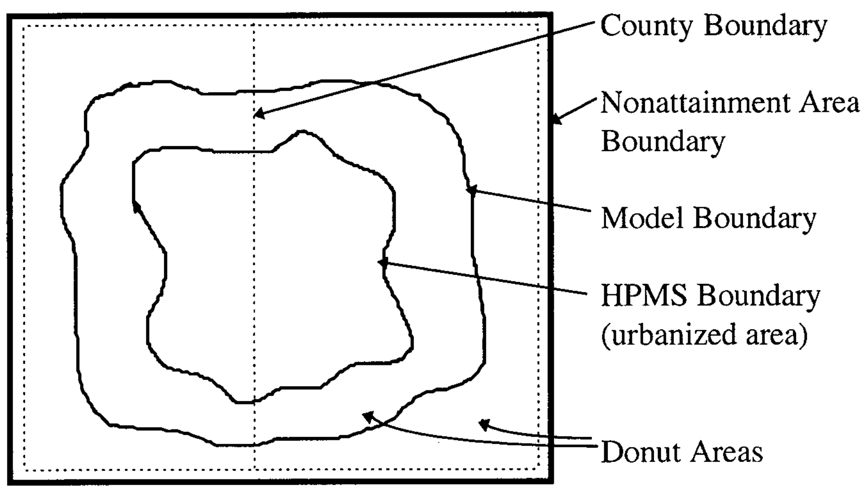

Figure 3. Geographic boundaries.

U.S. EPA's guidance allowed for the use of TDF models as an alternative to HPMS after consultation with U.S. EPA and under certain circumstances which included:

- Urban areas within the state not being sampled separately under HPMS in 1990;
- State DOTs not adequately following HPMS guidance in 1990, resulting in poor quality traffic counts; and,

- States already committing considerable time and resources into using a network based travel demand model and not having adequate time to switch approaches.

TDFs were frequently used in place of HPMS estimates to provide for an expressed desire of greater accuracy and levels of detail. This was particularly true in CO nonattainment areas classified as Moderate>12.7 or above. Of the nine areas falling into this classification, five of these areas used solely TDFs, while three areas used a combination of TDFs and HPMS, with only Fresno utilizing solely HPMS derived VMT data. Comments included in many of these areas' SIPs cited inaccuracies in HPMS estimations versus modeled and observed VMT and a desire for link-specific or traffic analysis zone (TAZ) level detail as rationale for employing TDFs. In the case of CO and Ozone nonattainment areas, this level of detail will be required for future use in modeled grid analysis in their attainment demonstration modeling efforts.

As shown earlier in figure 1, 10 of the 33 sampled areas solely used TDFs. In areas where combinations of methodologies were used, TDF and HPMS were the most common combination as illustrated in figure 4.

In these cases, either HPMS or the TDF methodology was used in a secondary role for one of two frequently cited reasons:

1) HPMS was used to augment TDF estimates for VMT outside of the TDF modeling domain but within the nonattainment area; and,
2) TDFs were used to disaggregate HPMS VMT to the link level for speed estimation or zone specific analysis.

In cases where the HPMS or TDF modeling domain and the nonattainment area boundaries did

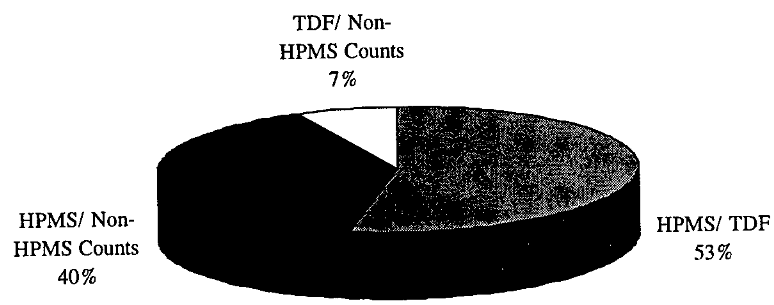

Figure 4. VMT methodology combinations.

not match, U.S. EPA provided guidance to reconcile VMT under any number of scenarios. From the areas reviewed, the need for reconciliation of boundaries occurred most frequently where the TDF modeling domain was either larger or smaller than the nonattainment area. In the case of a modeling domain larger than the nonattainment area, model links located outside the nonattainment area were coded for exclusion from the modeling results. In the event of a modeling domain smaller than the nonattainment area, VMT were typically augmented by statewide HPMS VMT data (for each functional class [FC] of roadway) applied as a ratio of roadway mileage as illustrated in the formula below:

$$SIP\ Area\ VMT = \sum_{FC}\left[\frac{Roadway\ Miles_{SIP\ Area}}{Roadway\ Miles_{State}} \times Statewide\ VMT\right]$$

Nonattainment areas that employed TDFs used a variety of software programs as shown in table 3. A number of states or nonattainment areas have also developed their own computer-based TDFs and travel programs for use in estimating VMT and/or to disaggregate HPMS derived VMT to the transportation network. These states included Connecticut (PERFORM), Philadelphia (Post-processor for Air Quality), Texas (Texas Trip Distribution Package), and New Jersey (Planning System Mileage).

Table 3. Travel demand forecast (TDF) models used.

Model Version	No. of Areas	% of Areas
TRANPLAN	4	21%
UTPS	4	21%
MinUTP	6	32%
Other	5	26%
Total	19	100%

While U.S. EPA encourages the use of TDFs, they specified that any state or nonattainment area that used TDFs to estimate VMT should make modeled VMT consistent with HPMS figures in aggregate. This is a two-step process: (1) TDF VMT, which represents Average Week Day Travel (AWDT), must be adjusted by a factor to Average Annual Daily Travel (AADT); and, (2) the TDF AADT is then made consistent with HPMS AADT. Of the 19 areas that used TDFs either alone or in combination with other methodologies, only 63 percent of those areas made TDF VMT consistent with HPMS. The remaining areas either did not specify whether TDF volumes were made consistent or provided various rationales for not doing so including:

- Differences regarding the inclusion or exclusion of certain roadway segments effecting HPMS totals (as in Cleveland);
- HPMS estimates being considerably lower than observed traffic surveys (as in Las Vegas);
- Their TDF model had been validated to 1990; and,
- HPMS and TDF estimates were with +/-3 percent.

An analysis of VMT from those areas that provided comparative data between TDF and HPMS VMT reveals that while totals were close, large differences existed by facility type of roadway. Table 4 illustrates the range of variation between TDF and HPMS VMT by facility type. For example, TDF VMT on the Freeway/Expressway/Principal Arterial facility type ranged from 31 percent greater than (+) HPMS VMT in Reno, Nevada to 1 percent less than (-) HPMS VMT in Anchorage, Alaska. A number of trends emerge from the data available. TDFs appear to underestimate VMT relative to HPMS to a greater degree as one moves from higher (freeways) to lower (local) level facility types. In the case of VMT on local roads, it is not surprising to have large TDF underestimates compared to HPMS due to the fact that many TDFs do not include local road VMT in their estimates or use centroid connectors as a substitute for local roads. These trends are also consistent with the lesser emphasis on lower level facilities in both TDFs and HPMS (panel coverage decreases with lower level facility types), with a corresponding decrease in the level of confidence in the data for lower facility types.

Table 4. Range of variance between TDF and HPMS VMT estimates.

Facility Type	TDF vs. HPMS Ranges of Variance
Freeway/Expwy./Pr. Art.	+31.2% ~ -1.0%
Minor Arterial	+10.5% ~ -17.6%
Minor/Major Collector	+36.5% ~ -40.8%
Local	+0.7% ~ -109.5%
Totals	+12.5% ~ -6.0%

In order to make TDF VMT consistent with HPMS VMT, states or nonattainment areas typically resorted to one of three measures:

1) Correction factors were developed to factor model results to match HPMS VMT by facility class (as in Salt Lake City) or by county (as in Baltimore).
2) Facility types used in TDFs were stratified to correspond with HPMS roadway types based on similarity of description, road miles, or VMT, and correction factors were then developed to adjusted modeled VMT.
3) Volumes on specific facility types as a percentage of total volumes were calculated comparing HPMS VMT and TDF VMT and then weighted according to staff confidence in the precision of their modeling efforts (as in Anchorage).

Regardless of which VMT estimation methodology was used in developing the emissions inventories, most states and nonattainment areas derived VMT through the typical HPMS and TDF processes. For HPMS, most areas performed a variation of the following processes taken from the New Hampshire SIP. The process is performed using AADT data for each sample section to derive the Daily Vehicle Miles Traveled (DVMT) by functional class. A sample section is a segment of roadway upon which traffic counts are taken. The given sample section length is not required, but it is normally within the ranges prescribed in the FHWA's *HPMS Field Manual.*

Step 1: AADT for each sample section is seasonally adjusted for a selected month. The seasonal adjustment factor is a quotient of the monthly average computed from all months divided by the selected month's AADT (on that functional class of roadway).

$$\frac{Sample\ Section\ AADT}{Seasonal\ Adjustment\ Factor} = \begin{matrix} Seasonally\ Adjusted \\ Sample\ Section AADT \end{matrix}$$

<u>Step 2:</u> The seasonally adjusted sample section AADT from Step 1 then adjusted by its sample length, on a per mile of roadway basis, to yield DVMT for that sample section.

$$\begin{matrix} Seasonally\ Adjusted \\ Sample\ Section AADT \end{matrix} \times \begin{matrix} Section Length \\ (in Miles) \end{matrix} = \begin{matrix} Sample\ Section \\ DVMT \end{matrix}$$

<u>Step 3:</u> Calculate Expansion Factor for each functional class (FC) of roadway.

$$\frac{Total\ Miles of\ Roadway_{FC}}{Total\ Sample\ Section Length Miles_{FC}} = \begin{matrix} Expansion \\ Factor_{FC} \end{matrix}$$

<u>Step 4:</u> Individual sample section DVMT, calculated in Step 2, are then summed by functional class. This is multiplied by the Expansion Factor for the functional class to yield total DVMT for that functional class.

$$\begin{matrix} Total\ Sample \\ Section\ DVMT_{FC} \end{matrix} \times \begin{matrix} Expansion \\ Factor_{FC} \end{matrix} = \begin{matrix} Total\ DVMT \\ by\ Functional\ Class \end{matrix}$$

<u>Step 5:</u> Total DVMT by functional class is adjusted by an HPMS correction factor. The correction factor is the quotient of HPMS DVMT estimates divided by estimated statewide DVMT calculated from steps 1-4 above.

In those areas using TDFs, staff typically followed the four-step modeling process described in general terms below with slight variations in one or more of the steps:

1) *Trip Generation* - using model relationships fitted to socioeconomic, land use, and travel data, the number of trips generated within a TAZ is estimated;
2) *Trip Distribution* - again using travel survey data, origin-destination data is gathered to develop a simulated gravity model between TAZs;
3) *Mode Choice* - again using travel survey data, trips are separated by mode choice (automobile vs. bus, train, etc.); and,
4) *Traffic Assignment* - trips ends are allocated to the transportation network by TAZ and the model assigns routes which will be used for trips between specific TAZs. This final step typically employs a constrained equilibrium or capacity restraint method by which trips are assigned to routes over the network based on the quickest route until which time the number of trips assigned to that route are such that speed is reduced with increasing congestion and alternate routes become preferable.

The TDF process results in VMT estimates by link or TAZ with estimated speeds for each link. These data are then adjusted to reflect seasonal and weekday variations.

As discussed earlier, HPMS and TDFs largely ignore VMT on local roadways. This requires areas to develop alternate means to estimate local VMT. This step is particularly important because local roads can account for as much as 15 percent of total VMT according to U.S. EPA and as confirmed by the sample review in this study. HPMS estimates of local VMT are typically based on state-provided estimates and not on ground counts, while TDFs typically do not include a local road facility class. As a result, local VMT were estimated using various techniques, including some of the following frequently cited methods:

- Local roadway mileage in the nonattainment area as a percentage of statewide local roadway mileage multiplied by statewide local roadway HPMS VMT estimates (Boston, Massachusetts and Portsmouth, New Hampshire);
- Local roadway VMT calculated as an assumed percentage of other or all other functional classifications of roadways (Baltimore, Maryland and Seattle, Washington);
- Travel surveys and local count data (Gary-Lake County, Indiana and Providence, Rhode Island);
- From TDFs using "Centroid Connector" facility type volumes which represents the local street system (Atlanta, Georgia, Reno, Nevada and Houston, Texas).

Finally, as part of the review of VMT estimation practices, this study examined the level of spatial and temporal aggregation of VMT. The treatment of these two factors are often related to the level of detail that will be required for analysis in a nonattainment area. The choice of the level of aggregation of either factor followed similar rationale for certain areas' use of TDFs, namely a stated desire for a greater detail at the link or TAZ level. This level of detail is important for both future photochemical grid modeling requirements for attainment demonstrations and also in order to identify problem congestion sites and measure the potential effectiveness of various transportation control measures (TCM). Figure 5 illustrates a preference for detailed data by the fact that all of the areas reviewed provided some level of spatial aggregation - most typically by functional class of roadway, which was provided in 90 percent of the areas.

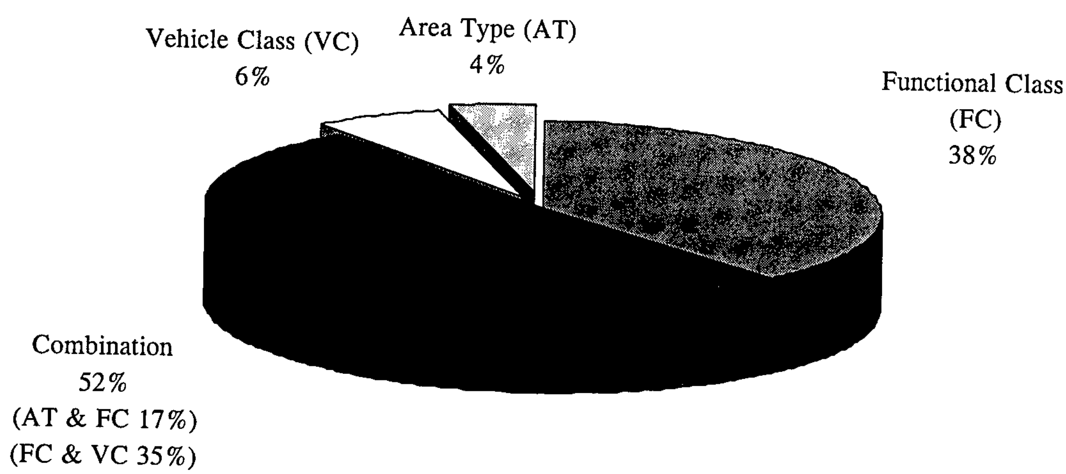

Figure 5. Spatial aggregation of VMT.

The continuing need in many areas for more detailed temporal information is illustrated in figure 6 by the fact that 43 percent of the areas reviewed could only provide 24-hour count data.

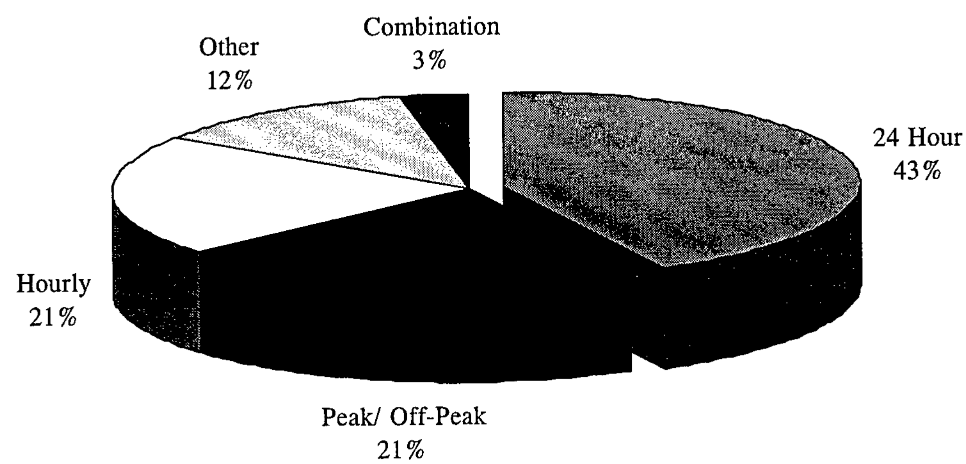

Figure 6. Temporal aggregation of VMT.

3.2 TRAVEL SPEED ESTIMATION

Emissions rates contained in U.S. EPA's MOBILE model are directly linked to the speed at which a vehicle is driven. The MOBILE model calculates emission factors for speeds between 2.5 and 65.0 miles per hour (mi/h), in 0.1 mi/h increments, and reflects the nonlinear relationship between speed and grams per mile emissions rates as illustrated in figures 7 and 8 below. Volatile organic compounds (VOC) exhaust emissions rates tend to increase as speed decreases below 19.6 mi/h (the average speed of the federal test procedure) and as speed increases beyond 55 mi/h (the speed at which VOC emissions are generally at a minimum), while nitrogen oxides (NO_x) exhaust emissions rates also tend to increase as speed decreases below 19.6 mi/h and increases significantly beyond a speed of 48 mi/h.

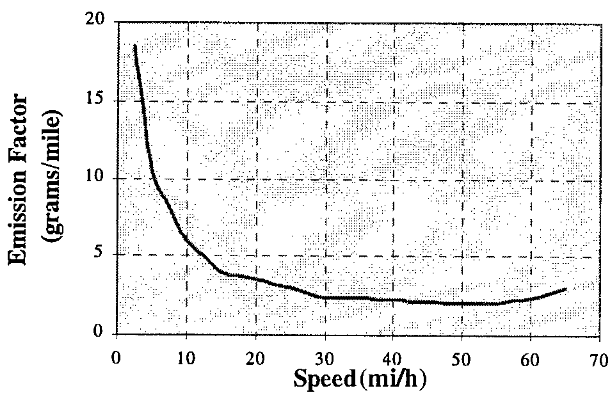

Figure 7. VOC composite exhaust emission factors - MOBILE5A.

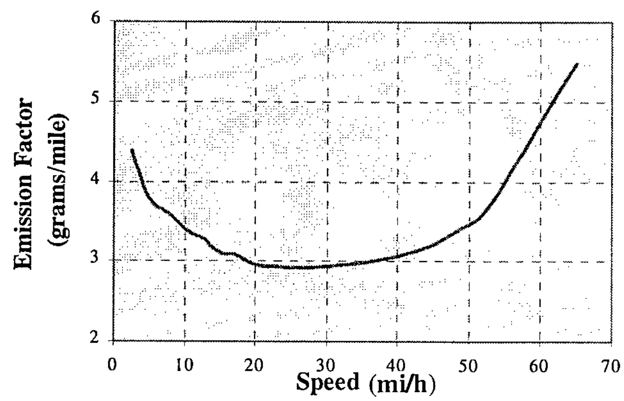

Figure 8. NOx composite exhaust emission factors - MOBILE5A.

Given the critical relationship between speeds and emissions rates, accurate estimation of speeds within a nonattainment area is pivotal to the development of a reliable emissions inventory. U.S. EPA recommended using TDFs to estimate speeds using the output from the TDF through a post-processor. A post-processor is recommended because traffic assignment algorithms within most TDFs are developed to provide optimal assignment of traffic over the network rather than an accurate estimate of speed. Areas using TDFs could use their assignment predicted speeds if they could demonstrate that those speeds approximated observed speeds or speeds estimated using the Transportation Research Board's (TRB) *Highway Capacity Manual.* This was more likely to occur for areas using TDFs which employed the capacity restraint method in their trip assignment phase of the model versus a constrained equilibrium approach.

As illustrated in figure 9 on the following page, 64 percent of the areas reviewed followed U.S. EPA's recommended methodology for developing speeds through the use of modeling techniques. Among alternate speed methodologies, U.S. EPA permits marginal and submarginal nonattainment areas to use national speed estimates from FHWA's *HPMS, Impact Analysis for 1989 Base Year* if no TDF is available. However, figure 9 also indicates that certain areas (Cleveland, Ohio, Providence, Rhode Island, and partially in Atlanta, Georgia and Sheboygan, Wisconsin) used these defaults despite the fact that they were all classified as moderate or above

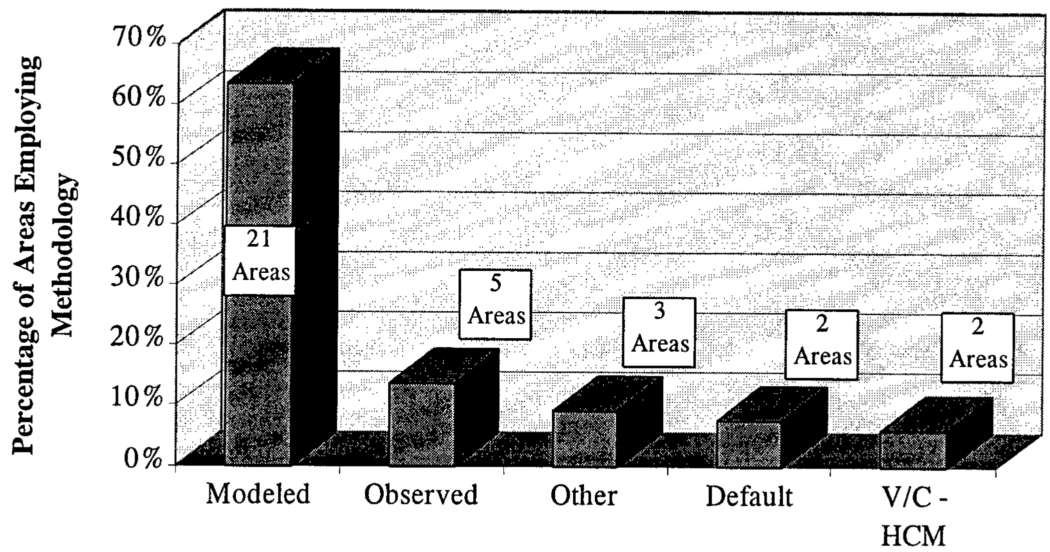

Figure 9. Speed development methodology.

for ozone. Methodologies labeled "Other" included speed estimates developed using a "floating" test car method and developed by staff judgment.

A majority of the 21 areas that used TDFs to estimate speeds also used a post-processor to calculate average speeds by functional classification of roadway or to maintain link-specific speed information in calculating emissions in conjunction with the MOBILE model. Only ten of those areas confirmed that they had validated modeled speeds against measured speeds, while another ten of those areas did not specify whether modeled speeds had been validated. This omission from their SIP methodologies played a part in U.S. EPA's Office of Mobile Sources' findings in their reviews of on-road mobile source sections, as discussed in section 4 of this report.

The application of TDF modeled speeds, averaged by functional class or by individual link, has raised concerns regarding the correct application of MOBILE emission factors to modeled speeds. The MOBILE model emission factors for a given speed are developed to represent the grams per mile emissions for an entire trip at an average speed. MOBILE emissions factors for each average speed are based on a drive cycle designed to replicate a typical trip which includes starts, stops, accelerations and decelerations, while the link level TDF speeds will not include those drive cycle elements. Therefore, if TDF modeled speeds are applied to MOBILE emissions factors, considerable inaccuracies could occur because those TDF speeds may represent only a part of a trip. This discrepancy could have a significant impact on the overall accuracy of the on-road mobile source inventory calculations.

U.S. EPA recommended that the actual methodology to be applied to estimating speeds from TDF outputs follow the guidance provided in the document "Highway Vehicle Speed Estimation Procedures for Use in Emissions Inventories" prepared for U.S. EPA by Cambridge Systematics, Inc. Many of the areas performed a variation of that methodology which relies on the estimated flow rate volume-to-capacity (V/C) ratio as a key measure of the degree of congestion on a link (based on the link's capacity restrained volume loading). In the following excerpt from the Houston-Galveston-Brazoria, Texas SIP, separate procedures are used for freeways and non-freeway streets as illustrated:

Freeway Model

The freeway model focuses on the decay in speed from a free-flow speed to a level of service (LOS E) speed as the level of congestion on the link increases from a zero volume condition to a v/c ratio of 1.00. Using speed reduction factors (SRF) from the *Highway Capacity Manual* corresponding to a given link's V/C ratio resulting from the capacity restrained assignment results, the links congested speed is calculated as follows:

$$S_P = S_{FF} - SRF \times (S_{FF} - S_E)$$

where:

S_P	=	predicted speed for the link
S_{FF}	=	the free-flow (or zero-volume) speed of link
S_E	=	the LOS E speed for the link
SRF	=	the speed reduction factor corresponding to the link's v/c ratio

The Houston-Galveston Area Council (H-GAC) used the speed limit as the free-flow speed. They also recognized the tendencies of drivers in the Houston-Galveston region to exceed the speed limit and therefore, the freeway free-flow speeds also included the following adjustments:

- For urban and inner suburban freeways, the freeway free-flow speed is estimated by adding 3 mi/h to the link's speed limit;
- For suburban freeways, the freeway free-flow speed is estimated by adding 4 mi/h to the link's speed limit;
- For rural freeways, the freeway free-flow speed is estimated by adding 6 mi/h to the link's speed limit.

The LOS E speeds for freeways (by area type) were estimated using observed speeds in the region.

Arterial and Collector Street Model

This model computes average delay per vehicle that would be encountered at a signalized intersection at the level of congestion being experienced (as reflected in the V/C ratio for a link). This delay estimate along with signal spacing information, and the link's free-flow speed estimate is used to compute the average congested speed for a link. The intersection approach delay for random arrivals is computed using the following equations from the *Highway Capacity Manual*:

$$D = 1.3d$$

where:

d	=	average stopped delay (sec./veh.) for random arrivals
D	=	intersection approach delay (sec./veh.)

The intersection stopped delay (d) equation for random arrivals is calculated as follows:

$$d = 0.38\frac{[1-g/C]^2}{[1-(g/C)(X)]} + 173X^2\left[(X-1)+\sqrt{(X-1)^2+(16X/c)}\right]$$

where:

d	=	average stopped delay (sec./veh.) for random arrivals
C	=	cycle length (seconds)
g/C	=	the ratio of the effective green time to cycle length
X	=	the volume to capacity ratio
c	=	lane capacity (vphpl)

H-GAC used the speed limit as the free-flow speed. Arterial and collector free-flow speeds also included the following adjustments:

- For urban and inner suburban streets, the freeway free-flow speed is estimated by multiplying the link's speed limit by 0.85 (0.80 for saturated arterials);
- For suburban streets, the freeway free-flow speed is estimated by multiplying the link's speed limit by 0.90 (0.85 for saturated arterials);
- For rural streets, the freeway free-flow speed is estimated by adding 4 mi/h to the link's speed limit.

After computing a link's intersection delay, the congested speed for the link is computed using the following equation:

$$S_P = \frac{L}{RTF \times \left[\frac{L}{S_{FF}}\right] + \left[\frac{D_S}{3600}\right]}$$

where:

S_P	=	predicted speed for the link (mi/h)
S_{FF}	=	the free-flow (or zero-volume) speed of link (mi/h)
L	=	the segment length (i.e., typical signal spacing in miles)
D_s	=	the average intersection delay (seconds)
RTF	=	factor for converting free-flow travel time to segment running time

The running time factors (RTF) vary by free-flow speed and segment length. The RTFs used by H-GAC were estimated using the segment running time data from the *Highway Capacity Manual.*

Model Extensions

The above two models are used to estimate speeds for v/c ratios less than or equal to 1.00. Since traffic assignments can exceed limits, H-GAC developed extensions derived from the Bureau of Public Roads (BPR) model. The model extension equations for freeways/expressways and arterials and collectors with v/c ratios of over 1.0 as follows:

Freeways/Expressways

$$S_P = S_{P1} \times \frac{1.15}{1.0 + 0.15 \times \left(\frac{V}{C}\right)^4}$$

Arterials and Collectors

$$S_P = S_{P1} \times \frac{1.15}{1.0 + 0.15 \times \left(\frac{V}{C}\right)^2}$$

where:

S_P = predicted speed for the link

S_{P1} = the speed estimated on the link for a V/C ratio of 1.0 using the Houston-Galveston speed model

V/C = the estimated volume over capacity ratio for the link

Local Streets

The estimated speeds for the VMT represented on centroid connectors (local streets) is estimated based on the zone's area type and the length of the centroid connector. The average speed for intrazonal VMT was estimated as the average of the centroid connector speeds for the zone.

The speeds applied and level of detail between urban and rural functional classes varied widely among the areas reviewed in the study. At a minimum, all areas provided speeds by functional class of roadway; however, while some areas provided averages for all vehicles on all roadways (without differentiation of urban from rural), other areas provided ranges of speed by hour or vehicle class for both urban and rural roadways, and for all vehicle types versus heavy duty vehicles only. The resulting range of speeds on urban and rural roadways is presented in table 5. As illustrated in the table, the span between high and low speeds within certain functional classifications is as great as 49 mi/h (as is the case with Urban Principal Arterials).

Table 5. Range of speeds (mi/h) used in on-road mobile inventories.

Road Type	Urban		Rural	
	High	Low	High	Low
Interstate	67.4	25.7	73.5	43.4
Other Freeway & Expressway	63.9	26.0	49.0	48.0
Principal Arterial	57.5	8.5	68.2	21.3
Minor Arterial	39.0	6.0	54.9	21.3
Major Collector	40.0	4.7	55.0	12.6
Minor Collector	44.0	16.0	50.7	12.6
Local	33.0	4.7	48.0	12.6

The differences between high and low speeds reflect the differentiation in the level of detail provided by certain areas including peak versus off-peak, prime versus non-prime (a variation of peak/non-peak), and hourly speeds. The range of speeds also reflects the urban transportation settings in specific cities. For example, all low range speeds for both urban and rural roads in table 5 were found in either the New York City or Denver, Colorado nonattainment areas, while the high range speeds were typically found in less densely populated nonattainment areas, including Provo, Utah, Muskegon, Michigan and Lake County, Indiana.

The spatial and temporal aggregation of speeds involves many of the same considerations discussed earlier with VMT. The treatment of these two factors is again related to the level of detail that will be required for analysis in a nonattainment area. At a minimum, U.S. EPA requires that speeds be estimated separately by functional class of roadway in an effort to group VMT into subsets with approximately equal speeds. The choice of the level of spatial or temporal aggregation of speeds is again similar to the rationale for certain areas' use of TDFs, namely a stated desire for greater levels of detail for attainment demonstration modeling requirements. Because of the direct relationship between speeds and emissions rates, greater detail is also critical to identify hot spots where congestion typically occurs and to enable areas to select those TCM strategies which are most likely to have a mitigating effect.

As shown in figure 10, most areas followed U.S. EPA's guidance by providing some level of spatial aggregation - typically by functional class of roadway, which was provided in 87 percent of the areas. U.S. EPA recommends further disaggregation of speeds by time of day to improve

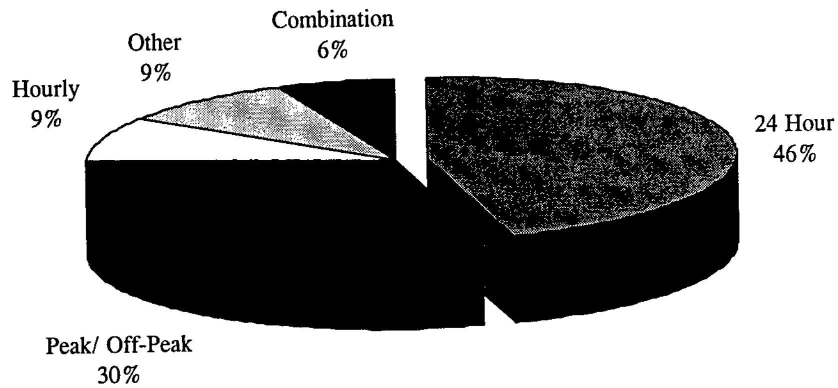

Figure 10. Temporal aggregation of speeds.

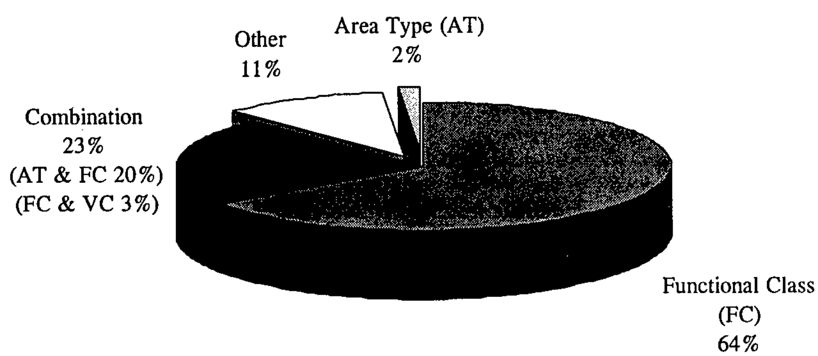

Figure 11. Spatial aggregation of speeds.

the accuracy of the inventory by separately calculating emissions under congested and free-flowing speed periods. As illustrated in figure 11, 54 percent of the areas followed this recommendation by reporting speeds for specific time periods rather than 24 hour average speeds.

U.S. EPA did not require information regarding future speeds in the 1990 Base Year Inventories; however, a few of the areas reviewed did provide some detail worth noting. While the New York nonattainment area projected a slight increase (no more than 1 mi/h) based on an assumption of lower VMT, Philadelphia, Lake County, Indiana, Reno, Nevada, Provo, Utah, and Southern California all predicted a slight decrease in speeds overall. The magnitude of the decline did not typically amount to more than a 1 mi/h reduction on all roadways with two exceptions. Delaware County, which is part of the Philadelphia nonattainment area, reported declines as much as 16.7 mi/h on certain roadways, while sample speed distribution data from the Southern California Area Government's (SCAG) TDF indicated a general decline of speeds in Los Angeles County. In terms of actual speeds in Los Angeles this may not be significant, but the effect on the percentage of traffic falling into specific speed ranges could be significant. As illustrated in table 6 below, the percentage of speeds in Los Angeles County below 20 mi/h is predicted to increase in each five year period, which is critical when we recall that emissions rates increase rapidly as speeds decrease from 19.6 mi/h.

Table 6. SCAG projected speed range percentages of VMT.

Percentage of VMT	1990	1995	2000	2005	2010
<= 20 mi/h	23.7%	27.6%	31.4%	35.2%	39.0%
> 20 mi/h	76.3%	72.4%	68.6%	64.8%	61.0%

3.3 VEHICLE FLEET AND TRAVEL FRACTIONS

Emissions rates contained in the MOBILE model are partially dependent upon the characteristics of the vehicle fleet such as age, type, and usage. For the purposes of this discussion, the vehicle fleet and travel fractions refer to three components: *Registration*, *Mileage Accumulation Rates*, and *VMT Mix*. These components are used individually and in combination as inputs to develop emissions rates for a given vehicle class, to weight vehicle class emissions rates to determine a fleetwide composite emission rate, and to distribute VMT between vehicle classes.

MOBILE uses Registration and Mileage Accumulation Rates data to develop emissions rates by vehicle class. Registration data provides information on the age distribution of the fleet by year (from 1 to 25+ years) of vehicles under each of the eight vehicle classes. Mileage Accumulation Rate data provides the estimated annual mileage accumulated by model year (from 1 to 25+ years) for each of the eight vehicle classes which is a determining factor in the deterioration of vehicle emission performance. These factors are used in combination to determine the weighting of each model year emission rate's contribution to the average emission rate for that class of vehicle.

VMT Mix data provides the fraction of total VMT accumulated by each of MOBILE's eight vehicle classes and is used to determine how individual vehicle class emissions rates are weighted to produce a composite emissions factor for the fleet. For ozone nonattainment areas classified as moderate and above, U.S. EPA requires the areas to develop and use their own local VMT mix and to apply vehicle specific emissions factors instead of a composite emission factor. This is required in order to more accurately represent emissions from a given local fleet. In these nonattainment areas, while VMT mix is not used within MOBILE, VMT mix is often applied

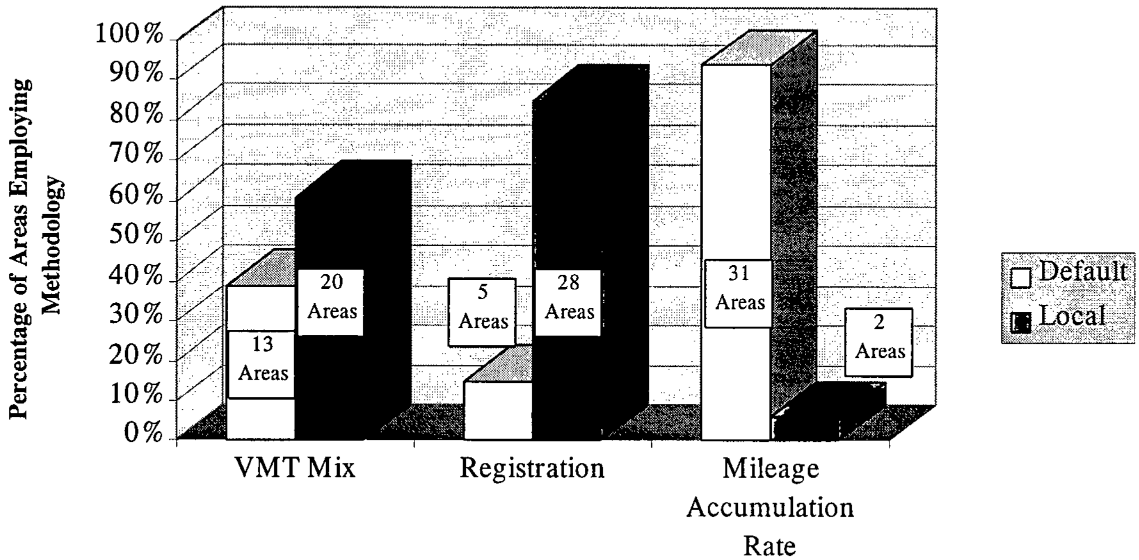

Figure 12. Vehicle emission factor mix inputs.

with a post-processor to allocate VMT on a given functional classification of roadway or link to one of the eight vehicle classifications. In such cases, most areas will run the MOBILE model to create emission factor look up tables for all speeds 2.5 mi/h to 65 mi/h for all eight vehicle types and link that to VMT data grouped by speed and vehicle class in the post-processor.

U.S. EPA also recommends the use of locally specific registration data by age to account for regional differences in the fleet makeup versus the default national averages. However, they do not recommend the input of local mileage accumulation data because of problems with sampling bias and data entry errors. As illustrated in figure 12, the majority of the areas reviewed followed U.S. EPA guidance regarding registration and mileage accumulation inputs, while 61 percent of the areas provided their own VMT mix. The decision of whether or not to provide a local VMT mix was largely dependent on whether a local mix was required due to the area's nonattainment status and the availability of data for use in disaggregating VMT by vehicle class. Of the 20 areas providing local mixes, the mix was calculated using data sources from among the following four choices:

- Vehicle Classification Counts (45%)
- Local Registration Data (25%)
- Site Surveys/Reports (15%)
- Other Unspecified (15%)

Many areas failed to provide detailed descriptions of the actual VMT mix estimation methodologies which was often cited as a factor in U.S. EPA's Office of Mobile Sources findings. However, where adequate detail was provided, the mix was typically calculated by using vehicle classification count information by vehicle type as a percentage of all vehicles to separate VMT into major vehicle classifications (e.g., Light Duty Trucks-LDTs). MOBILE defaults were then applied to further disaggregate the mix into sub-categories and/or between gasoline or diesel fuel types (i.e., LDTs into LD Gas Trucks 1, LD Gas Trucks 2, and LD Diesel Trucks).

The provision of local VMT mix information can have a direct impact on the final emissions inventory calculations by altering the mix versus the national default as is illustrated by the range of VMT mix by vehicle class in figure 13. For example, of the areas reviewed the LDGV VMT mix varied from a low of .591 to a high of .878 (average of .684), while the LDGT1 VMT mix varied from a low of .034 to a high of .292 (average .155). The mix between LDGVs and LDGT1 will result in significantly different emissions within an area dependent upon the chosen mix due to differing emission rates between the two vehicle types. While variations within these two vehicle classes were most pronounced, other lesser variations within vehicle classes could have as great an impact despite accounting for a lower portion of overall VMT as is the case with Heavy Duty Diesel Vehicles (HDDVs) which significantly impact overall NO_x emissions.

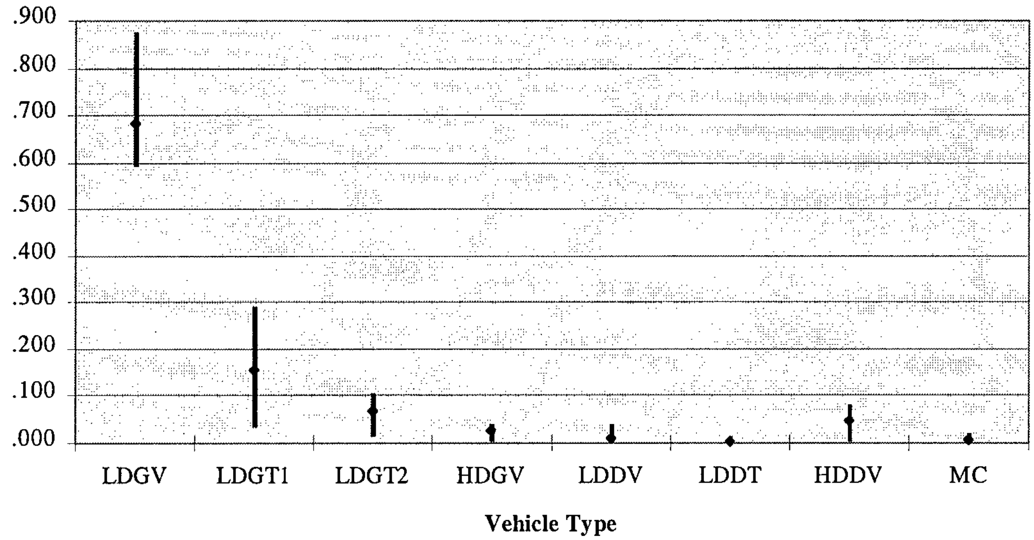

Figure 13. VMT average mix and range of mixes.

The five areas that opted to use default registration data (Greater Connecticut, Portsmouth, New Hampshire, Atlanta, Georgia, Gary-Lake County, Indiana and Chicago, Illinois) provided little information, if any, for the lack of local registration data. Only in the cases of Connecticut and Portsmouth did the SIP specify that local registration data was not available for use in the SIP. In contrast, the two areas that applied locally generated mileage accumulation rates in their SIPs provided descriptions of the methodologies used to develop the local data. In both cases, Anchorage, Alaska and California (collective for all California areas), the states used information derived from their inspection and maintenance (I/M) program records to track mileage accumulation for vehicles between biennial inspection dates and replaced the MOBILE (EMFAC for California) defaults with these rates.

3.4 OPERATING MODE FRACTIONS

Vehicle emissions rates also depend on the mode, or vehicle temperature, of operation during the driving cycle. MOBILE emission factors are based on the Federal Test Procedure (FTP) cycle which is divided into three segments or bags:

1) Cold Start - first 505 seconds of a cold start trip
2) Stabilized - all operation beyond 505 seconds of a trip
3) Hot Start - first 505 seconds of a hot start trip

Emissions are generally at their highest when a vehicle is first started under a cold start mode. Emissions decrease as the vehicle warms up and the catalytic converter and oxygen sensor are heated beyond the ambient air temperature. When vehicles warm to the stabilized mode or bag 2, they are assumed to emit at the lowest rate. Vehicles that are restarted after previous operation without cooling to ambient temperatures will emit at a lower rate than cold starts.

The MOBILE model uses three inputs to indicate vehicle operating mode which represent the percentage of VMT accumulated by non-catalyst vehicles in cold start mode (PCCN), by catalyst-equipped vehicles in hot start mode (PCHC), and by catalyst-equipped vehicles in a cold start mode (PCCC). U.S. EPA's guidance recommends the use of the default MOBILE inputs (PCCN 20.6 percent/PCHC 27.3 percent/PCCC 20.6 percent) in cases when broad geographic areas are being modeled, but recommends local inputs where localized conditions for roadway classifications, limited time periods, or trip lengths varying from the 7.5 mile FTP cycle are being modeled. As shown in figure 14, the majority of areas reviewed used the MOBILE default operating mode inputs in developing their on-road inventory. Once again, the choice to input local data for operating modes was used in areas desiring greater levels of specificity and detail which would be needed for future attainment demonstration modeling efforts.

Areas providing local data often followed U.S. EPA's guidance citing a desire to differentiate by functional class of roadway as in Greater Connecticut and New York City, time periods in

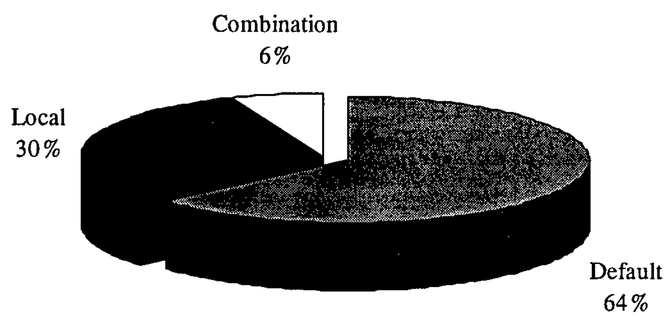

Figure 14. Operating mode inputs.

Washington, D.C. and Denver, Colorado, and to correct for variations in trip length in Baltimore, Maryland, Anchorage, Alaska, and Missoula, Montana. Trip length as related to operating mode is in terms of length in miles (in combination with speeds to determine trip duration in terms of time) which affects the likelihood of trips moving from the cold start to the stabilized operating mode. A review of the range of local inputs in table 7 illustrates the desire to capture the

Table 7. Range of local operating mode inputs.

Operating Mode	Range	
	High	Low
PCCN- Non-Catalyst Vehicles in Cold Start Mode	81.0%	0.0%
PCHC- Catalyst Equipped Vehicles in Hot Start Mode	37.0%	0.0%
PCCC- Catalyst Equipped Vehicles in a Cold Start Mode	81.0%	0.0%

wide variation of local conditions for modeling purposes. The 0.0 percent low range from the table represents both Connecticut's effort to suggest that all travel on interstates, principal arterials and major arterials is in a stabilized operating mode which excludes hot or cold starts, and Anchorage's assertion that because of a shorter trip length and colder ambient temperature conditions, no trips are conducted in the hot start mode (PCHC). The high range operating modes primarily reflect areas' desires to model ambient temperature conditions and, by inference, shorter trip lengths as in the case of Denver, Colorado which projects 81 percent of all VMT to be accumulated in cold start modes during the AM Peak. High range percentages for cold starts (both catalyst and noncatalyst) were consistently applied in the areas where colder ambient temperatures (for winter CO) are common such as Denver, Colorado, Missoula, Montana, and Anchorage, Alaska.

Descriptions of the methodologies employed to derive local operating mode inputs were often incomplete and general. Where information was provided, the majority of areas used either travel survey information to determine the percentages of cold versus hot starts in combination with local registration information (by age) or MOBILE default ratios to determine the technology split between catalyst and noncatalyst equipped vehicles. Other areas utilized information from outside their regions, such as Detroit and Muskegon's use of CALTRANS' (California Department of Transportation) data which was derived from a random test of vehicles which were stopped for inspection.

3.5 TRIP LENGTH DISTRIBUTION

Trip length, as discussed under Operating Mode Fractions, focused primarily on the distance traveled terms of miles (and combined with speeds to calculate duration) as a determining factor in assuming an operating mode under the Federal Test Procedure applied in the MOBILE model. However, trip length in terms of minutes of duration is also used as an input to the MOBILE model in combination with average speeds, input temperature, and fuel volatility to determine running loss evaporative emissions (evaporative VOC emissions during operation). Running loss emissions typically are negligible at first but increase significantly as the duration of the trip is increased and the engine and fuel system become heated.

U.S. EPA guidance suggests the use of MOBILE defaults for trip length unless reliable TDF outputs are available. Trip length within the MOBILE model determines the fraction of VMT that occurs in trips that end within a given number of minutes within the following ranges:

- Under 10 minutes
- 11 to 20 minutes
- 21 to 30 minutes
- 31 to 40 minutes
- 41 to 50 minutes
- 51 minutes and longer

Where available, local inputs can be used to produce more accurate estimates of the benefit of TCMs which might shorten trip lengths without eliminating entire trips. As shown in figure 15 below, the majority of areas reviewed elected to use the MOBILE defaults for trip length with only Baltimore, Maryland, Washington, D.C., Houston, Texas, and Spokane, Washington providing their own inputs.

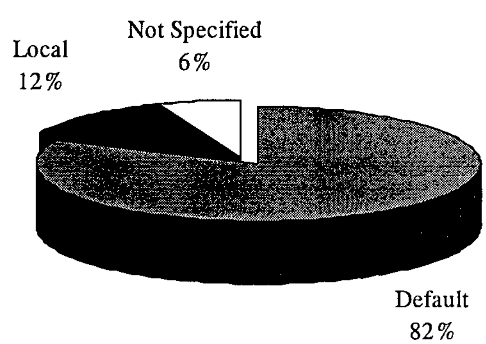

Figure 15. Trip length inputs.

Those areas electing to use local inputs provided little discussion of their rationale for using those inputs and only brief descriptions of their methodologies to develop trip lengths. In general, trip length durations were developed based on the speeds on links applied to trips between origins and destinations to determine the amount of time passed during each trip as in Washington, D.C.'s SIP or less directly by aggregating trips by temporal length and assuming a constant speed across all trip duration increments as in the Baltimore SIP.

While few areas discussed the rationale for their choice, an examination of the difference in local inputs versus the MOBILE default trip lengths is somewhat revealing as illustrated in figure 16 below. It is significant to note that in the three areas that provided comparative data, the fraction of VMT that occurs in the 0-10 and 11-20 minute trip length ranges is substantially higher (as much as 13.2 percent) than the MOBILE defaults, while the fraction of VMT occurring in the 51+ minute range is significantly lower (as much as 29.8 percent). These variations from the MOBILE defaults could translate into large impacts on the resulting running loss evaporative emissions.

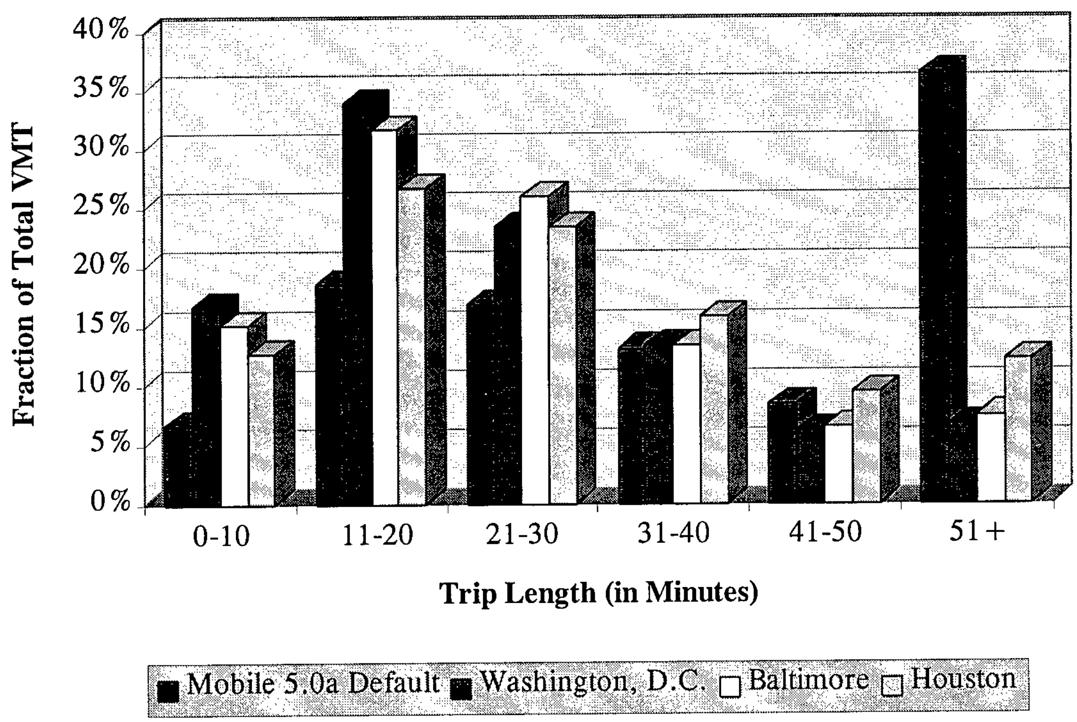

Figure 16. Analysis of MOBILE default trip length vs. local trip lengths.

4. INNOVATIVE PRACTICES

Many of the areas reviewed attempted to develop on-road emissions inventories by using data which included precise levels of detail for use in their future modeling purposes as discussed throughout the preceding subsections. In doing so, a few areas applied particularly innovative techniques in an attempt to capture all elements involved that could potentially effect overall emissions. In these instances, areas often attempted to match specific processes and activities beyond U.S. EPA's requirements resulting in more complete inventories. The following examples taken from the El Paso, Houston, and Washington, D.C. SIPs illustrate some of these innovations in addition to a brief review of California's on-road inventory development process.

4.1 EL PASO, TEXAS - INTERNATIONAL BORDER CROSSING EMISSIONS

In order to calculate emissions generated by vehicles waiting to cross the international bridges in El Paso, the wait time and the associated emission factors are required. The calculation methodology is described below (only included in the ozone inventory but assumed used in the CO inventory as well):

Emissions Factors - To calculate idle emission factors, MOBILE 5.0a was run at a speed of 2.5 miles per hour to obtain emission factors in grams per mile. The CO and No_x emission factors, and the exhaust component of VOC emission factor are then multiplied by 2.5 miles per hour to obtain idle emission factors in grams per hour.

Average Vehicle Wait Time - The U.S. Customs Service provided bridge wait time data which included hourly vehicle count and wait time for seven consecutive days in June 1990 and October 1990. Daily total wait times are calculated by adding the 24 hourly totals as shown in the equation below:

$$\sum_{hour 1}^{24} (Vehicle Count)_{hour} \times (Wait Time)_{hour} = Total\ Daily\ Wait\ Time$$

The daily totals are used to estimate average ozone season weekday wait time. For the Ysleta Bridge and the Paso Del Norte Bridge (PDN), the total daily wait times for the five June weekdays are averaged. For the Bridge of the Americas (BOTA) no June data was provided. The BOTA October data are extrapolated to June using the PDN and Ysleta Bridge data. The average of the extrapolations is the estimated BOTA average daily wait time for June.

The total average daily wait time for the ozone season is the sum of the June average daily wait times for the three bridges. The total average daily wait time is multiplied by the El Paso County VMT mix to obtain total average daily wait time by vehicle type.

Emissions - The wait time and emission rate are multiplied to obtain emissions in tons per day for an average ozone season day for international bridges.

4.2 HOUSTON, TEXAS - EFFECTS OF NONRECURRING CONGESTION AND HIGH OCCUPANCY VEHICLE (HOV) CARPOOLING ON EMISSIONS

H-GAC applied two innovative techniques of note in developing their inventory, nonrecurring congestion and HOV carpooling, briefly described below:

Nonrecurring Congestion - is any nonroutine congestion resulting from accidents or other random incidents. H-GAC's travel demand forecast model does not allow for the estimation of increased emissions due to delay caused by nonrecurring congestion and, therefore, this procedure was developed to capture these emissions. This procedure was applied only to travel occurring on freeways within Harris County as it was felt that these facilities would be the most affected by nonrecurring congestion.

The total freeway delay (measured in vehicle hours of travel [VHT]) as estimated by the travel demand models is separated into VHT occurring at congested speeds (the recurring delay) and the VHT occurring during uncongested conditions. The delay associated with nonrecurring congestion is estimated based upon recurring delay as presented in "Urban Freeway Congestion: Quantification of the Problem and Effectiveness of Potential Solutions" by Jeffrey A. Lindley, (*ITE Journal*, January 1987) and illustrated below:

$$Total\ Freeway\ Delay = 1/3(recurring\ delay) + 2/3(non-recurring\ delay), therefore$$

$$Typical\ Freeway: \quad Nonrecurring\ Delay = 2(recurring\ delay)$$

The nonrecurring delay is then added to the recurring and uncongested delay to establish a new estimate of freeway delay. By dividing the new estimate of freeway VHT into the estimate of travel on freeways (VMT), the average travel speed on freeways is re-estimated to include the effects of nonrecurring congestion.

The increase in emissions is then estimated by applying the appropriate composite emissions factors (for all vehicle types) for the adjusted speed to the estimated freeway VMT. This was performed for each of the four time periods and the total for each scenario were summed and then compared to the summed scenarios without nonrecurring delay included. The percentage difference for the entire day was then applied to the emissions total as a percent change for both VOC and CO.

HOV Carpooling - H-GAC used the TTDP "Mezzo-level" HOV Carpool Model to estimate regionwide home-based work (HBW) trip VMT for 1990. This model serves as an interim HOV demand estimation tool in the H-GAC travel demand estimation procedure pending the completion of METRO's new mode-choice model which will contain a HOV carpool element.

The model applies three sub-models as "shift" models to estimate the carpool demand based on the time savings offered by HOV facilities operating at approximately free-flow speeds versus "normal" highway travel occurring at congested speeds. The models are applied on a regional basis to estimate the total number of work-related (HBW) carpools that would be expected in the region. Survey data from the HOV facilities in Houston have shown that over 90 percent of the demand on HOV facilities is work related. For this reason the "Mezzo-level" HOV Carpool

Model should provide reasonable estimates of HOV carpool demand. Using estimates of 1990 congested speeds on the non-HOV facilities and free-flow speeds (55 mi/h) on the HOV facilities an estimate of approximately 15,000 (2+) carpools was produced by the model.

4.3 WASHINGTON, D.C. - HYBRID METHODOLOGY FOR ESTIMATING TRAVEL, VEHICLE, AND ADDITIONAL EMISSIONS

The Metro-Washington Council of Governments (MWCOG) employed a "hybrid" method in their analysis structure which examines travel, vehicle and additional travel components separately to arrive at total on-road mobile source emissions. The analytical structure is illustrated in table 8 below. For the travel related transportation components, the results from MWCOG's modeling simulation (in addition to HPMS information for local streets) are broken down by hour of day. For the vehicle transportation components, the number of vehicles are used independent of the travel associated with them. For the additional transportation components, for auto access to transit vehicles used in driving to transit parking lots and garages and to carpool lots are known through parking lot counts and then trips and VMT are used to calculate emissions. Bus emissions are based upon VMT and operating speed data provided by the transit operators in the region.

Table 8. MWCOG hybrid method components.

	Transportation Component	x	Emission Factor	=	Emissions
A. Travel	1. Trip Origins		Cold Start Rate (g/trip)		Startup
	2. VMT		Stabilized Rate (g/mile)		Running
	3. Trip Destinations		Hot Soak (g/mile)		Hot Soak
B. Vehicle	4. Number of Vehicles (gasoline fueled)		Diurnal Rate (g/day)		Diurnal Evaporative
	5. Number of Vehicles (gasoline fueled)		Resting Loss (g/day)		Resting Loss
C. Additional	6. Auto Access to Transit		Travel Components (above)		Startup, Running, Hot Soak
	7. Bus VMT		(HDDV) Stabilized Rate (g/mile)		Running

MWCOG developed separate MOBILE 5.0a input files for each of the twelve counties within the Washington Metropolitan Statistical Area (MSA) in order to retain the level of regional detail related to trip origins, trip destinations, and VMT within each of the counties in each step of the travel analysis methodology just described.

4.4 CALIFORNIA - CALIFORNIA AIR RESOURCE BOARD ON-ROAD INVENTORY DEVELOPMENT PROCESS

Motor vehicle emissions inventories are prepared by the California Air Resources Board (CARB) using four computer programs which function together: CALIMFAC, E7FWT, EMFAC, and BURDEN. To calculate emissions, activity factors and emissions factors are required. CALIMFAC provides base emission rates for I/M (inspection/maintenance) and non-I/M vehicles which are input into EMFAC. The emission factors produced by EMFAC are fleet composite emission factors, that is, a single emission factor is produced for the fleet of vehicles described by a vehicle class and technology for a particular calendar year. The fleet composite emission factors change over time as the composition of the class/technology fleet changes over time. To produce the composite emission factors, each emission factor for each model year must be multiplied by a weighting factor to account for the fact that certain model year vehicles are engaged in some emitting activities more than other model year vehicles.

The two major functions of the Weight Program (E7FWT) are: (1) to provide EMFAC with the accumulated mileage by model year (in any particular calendar year) to be used as the deterioration rate multiplier to obtain the "deteriorated" emission rate for a particular model year, and (2) to calculate travel weighting fractions or model year fractions which enable EMFAC to apportion each model years' contribution to the composite emissions factors. EMFAC then calculates emissions rates for the appropriate combinations of vehicle class, technology group, speed, ambient temperature, emission process, and type of emission (as shown in table 9) which are loaded into BURDEN (which functions as a post-processor of all inputs).

While the EMFAC emission factors are specific to vehicle class and technology type, the activity data loaded into BURDEN from various sources including VMT, vehicle populations, and trips taken (hot and cold), are specific to vehicle class only. Therefore, activity (technology) fractions for the 13 vehicle technology types developed in E7FWT are also loaded into BURDEN (via EMFAC) which include fractions for catalyst, non-catalyst, and diesel models of light duty autos (3), light duty trucks (3), heavy duty trucks (3), catalyst and non-catalyst medium duty trucks (2), diesel urban buses (1) and non-catalyst motorcycles (1).

In BURDEN, the appropriate activities are multiplied by the technology fractions developed by E7FWT to provide numbers of trips, VMT, and population of vehicles for each technology type within each vehicle class. BURDEN then multiplies activity factors by vehicle/technology type by EMFAC's emissions factors.

Table 9. EMFAC emission factor output data used in BURDEN.

7 Vehicle Classes	3 Technologies	7 Processes
Light duty auto	Catalyst	Crankcase blowby
Light duty truck	Non-catalyst	Diurnal evaporative
Medium duty truck	Diesel	Resting loss
Heavy duty gas truck		Hot soak evaporative
Heavy duty diesel truck		Cold start incremental
Urban diesel bus		Hot start incremental
Motorcycle		Running emissions
13 Vehicle Speeds	**80 Ambient Temps.**	**7 Emissions Types**
5 mi/h	30 F	Exhaust
10 mi/h	31 F	Total organic gases
15 mi/h	32 F	Carbon monoxide
.	.	Nitrogen oxides
.	.	Particulate matter
60 mi/h	109 F	Evaporative
65 mi/h	110 F	Total organic gases
		Other
		PM - tire wear
		Fuel consumption

The appropriate pairs of EMFAC emission factors and BURDEN activity factors are shown in table 10 below. In cases where process units and activity units do not match, conversion factors are used. BURDEN calculates the inventory estimates for individual counties, vehicle speed distribution, and ambient temperature data. BURDEN can model different ambient temperatures (from 30F-110F), different levels of vehicle activity, and different speed distributions for each appropriate vehicle class, technology group, process, and emission type apportioned among the six periods of the day defined for a planning inventory.

Table 10. EMFAC processes and BURDEN activities.

EMFAC		BURDEN	
Processes	Process Units	Activities	Activity Units
Crankcase blowby	grams/hour	VMT	miles/day
Diurnal evaporative	grams/vehicle hour	Number of vehicles	vehicles
Resting losses	grams/vehicle hour	Number of vehicles	vehicles
Hot soak evaporative	grams/trip	Number of trips	trips/day
Cold start incremental	grams/trip	Cold starts	cold trips/day
Hot start incremental	grams/trip	Hot starts	hot trips/day
Running emissions			
Running exhaust	grams/hour	VMT	miles/day
Evaporative	grams/hour	VMT	miles/day
Tire wear	grams/hour	VMT	miles/day
Fuel consumption	gallon/mile	Lead concentration	grams/gallon
Fuel consumption	gallon/mile	Sulfur concentration	ppm by weight

5. INTER-AGENCY DEVELOPMENT PROCESS

The development of the on-road mobile source emissions inventories was typically a process involving multiple agencies. Depending upon the methodologies employed to derive VMT, as many as three agencies or as few as a single agency might by involved in the inventory process. Of the areas reviewed, there was no single standard process regarding which agency was responsible for a specific piece of information. Section 174 of the CAAA specifies that states certify an organization that will be responsible for preparing the SIPs and that the organization shall include local elected officials and representative of the State air quality planning agency, the State transportation planning agency (State DOT), the metropolitan planning organization (MPO) or regional transportation commission (RTC) responsible for comprehensive transportation planning, and any other organization involved in the process.

Given this legislative direction, State Governors certified a given agency as the lead agency. In the areas review, this was always the state air quality agency which was part of the state environmental protection agency. This agency was typically responsible for coordination and development of the final inventory and running U.S. EPA's MOBILE model. Information such as speeds and VMT were either provided by State DOTs or the MPOs or RTCs depending upon the use of either TDF or HPMS information. In general, the on-road mobile source development process can be illustrated in figure 17 below which shows the agencies most commonly responsible for inputs to the process.

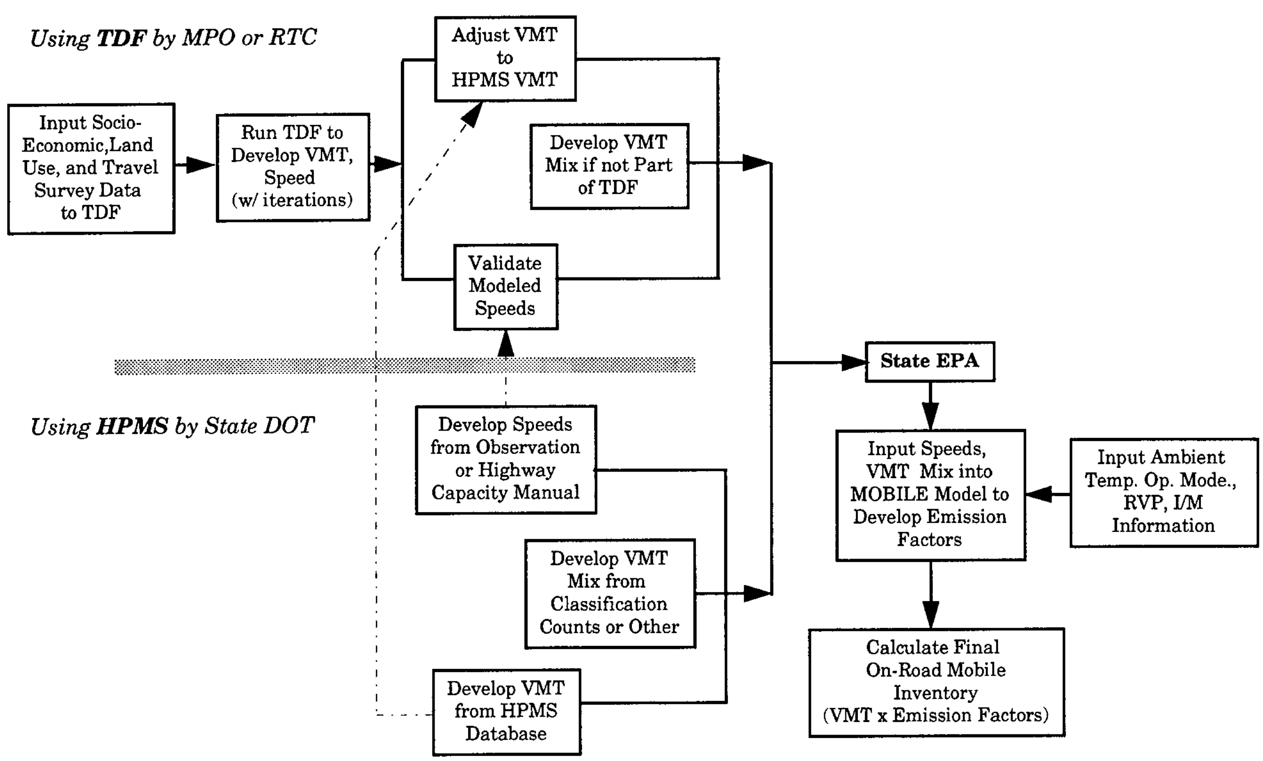

Figure 17. On-road inventory development process.

6. U.S. EPA OFFICE OF MOBILE SOURCES REVIEWS

U.S. EPA's Office of Mobile Sources (OMS) Technical Support Branch reviewed the on-road mobile source section of the 1990 base year SIPs for ozone nonattainment areas serious and above and CO nonattainment areas moderate > 12.7 and above. Of the 33 areas reviewed in this study, the Volpe Center obtained 20 OMS reviews all of which contained recommendations to U.S. EPA regional offices to disapprove the on-road source sections in their current format. Reasons for OMS recommending disapproval were consistent throughout their reviews and could be generally grouped under four subheadings:

- Failure to follow U.S. EPA guidance
- Insufficient specification of data used
- Insufficient documentation regarding methodologies
- Improper application of the MOBILE model or inputs to the model.

Failure on the part of states to follow U.S. EPA guidance primarily fell into three categories. First, if a nonpreferred VMT estimation methodology was used, U.S. EPA required that the state provide the rationale for that choice and verify that the alternative methodology was approved by FHWA as a substitute for HPMS or, in the case of TDFs, the model should have been validated with 1990 factored ground counts. Secondly, U.S. EPA specified that areas above certain nonattainment classifications could not use national default data for items including speeds and registration data. Finally, data were often unacceptable because they might be outside of U.S. EPA expected ranges for such things as the percentage of VMT accumulated on a given functional classification of roadway.

U.S. EPA's procedures regarding review and approval of SIP documents dictates that a reviewer should be able to verify (or recreate) the emissions inventory through the use of the inputs and methodologies provided in the SIP. For that reason, U.S. EPA often cited insufficient specification of data as a reason for recommending disapproval. In many cases, while adequate descriptions of methodologies were provided, states did not include the resulting factors or outputs of those processes. Examples of the most commonly cited missing data items included the following:

- VMT by functional class of roadway
- Volume to capacity calculations
- Expansion factors for HPMS segments
- Seasonal or weekday VMT adjustment factors
- Speeds by functional class of roadway
- Dates and hourly durations of counts

The majority of U.S. EPA's comments regarding methodologies concerned a lack of sufficient detail describing the application of either HPMS or TDFs used in the VMT estimation process. Once again, U.S. EPA needs to be able to recreate the process applied by the states and therefore requires sufficient descriptions of the process. The following list contains the U.S. EPA's most commonly cited deficiencies and corrective measures regarding the uses of HPMS or TDFs and related VMT items :

Highway Performance Monitoring System (HPMS)

- Describe the process for updating older counts to 1990
- Include description of complete panel sample data
- HPMS counts should be performed on a 3-year versus 5-year cycle
- Explicitly describe how VMT outside the FAUA but within the nonattainment area is calculated
- Describe the technique used to disaggregate VMT by functional class
- List the number of volume groups within each functional class of roadway

Travel Demand Forecast Models (TDF)

- TDF VMT volumes should have been adjusted to be consistent with HPMS or describe the deficiencies in HPMS as rationale for not adjusting modeled VMT
- Describe the validation process for the TDF
- Include a description of the geographic boundaries of the TDF
- U.S. EPA recommends the use of constrained equilibrium versus capacity restraint approach in TDFs
- Discuss procedures used to ensure that no link is loaded beyond capacity
- Describe the TDF roadway classification versus HPMS classifications
- TDF model outputs should have been recycled until self-consistent equilibrium trip assignment among zones was achieved
- Provide socioeconomic data used and the age of that data
- Provide documented constrained equilibrium speeds versus volume-to-capacity equations by functional class of roadway

Related VMT Items

- Describe nonattainment area boundary
- Specifically cite the agency responsible for counts and HPMS
- Specify how local VMT were developed and calculated

The application of the MOBILE model and inputs to the model was a final stumbling block to approval for many states in the U.S. EPA's reviews. In certain cases, some of the U.S. EPA comments were concerned with requirements related to specific versions of the model, including the requirement for ozone nonattainment areas using Version 4.1 to interpolate 1990 and 1991 model runs in order to derive July 1 emission factors. Version 5.0 of the MOBILE model allowed direct calculation of a July 1 emission factors and therefore negated the earlier requirement. The majority of deficiencies regarding the application of the MOBILE model were specific to certain inputs or the use of outputs, the most common of which are listed below:

- Describe methodology used to calculate local VMT mix
- Describe methodology used to calculate local operating mode fraction
- Describe methodology used to calculate local trip lengths
- Describe methodology used to calculate local mileage accumulation rates
- Ozone areas moderate and above should not use the composite emission factor and should provide local registration data
- Include methodology employed to calculate ambient temperature and the dates of the maximum and minimum temperatures related to exceedance days
- 1990 registrations should be used
- Refueling emissions should be included in on-road mobile sources and not area sources in order to model the effects of Stage II controls
- Include the market share of oxygenated fuels if greater than 2 percent
- I/M (inspection and maintenance) stringency levels in MOBILE inputs did not match the State's I/M audit report
- ATP (Anti-Tampering Program) items of vehicle equipment to be checked differs from U.S. EPA requirements
- Provide copies of input and output files

While U.S. EPA's Office of Mobile Sources did not perform reviews of every submitted or resubmitted on-road mobile source inventory, the insight gained from their comments may provide future guidance for state's revisions to their on-road mobile source sections.

7. CURRENT U.S. EPA STATUS OF BASE YEAR SIPS AND FUTURE CONSIDERATIONS

Of the 113 ozone nonattainment areas and the 48 carbon monoxide nonattainment areas nationwide, 98 percent of those areas have submitted their base year SIPs as of mid-December 1994. According to U.S. EPA regional offices, many of the base year SIPs have been continually revised and are undergoing final review for pending approval for Federal Register Notices (FRNs). Yet the delay in finalizing the base year SIPs is already having a backlogging effect on U.S. EPA's review of CO Attainment Demonstrations and Ozone 15 Percent Demonstration SIP (which were due November 15, 1992 and 1993, respectively) as well as the Ozone Demonstration SIPs that were due November 15, 1994. Those documents are all contingent for final approval on an approved base year Inventory and, therefore, the backlog is likely to continue into the foreseeable future.

Accurate estimation of VMT and proper use of the U.S. EPA's MOBILE model will continue to play a critical role in the revision and eventual U.S. EPA approval of base year, reasonable further progress and attainment demonstration SIPs. To that end, U.S. EPA and FHWA are continuing with efforts to further improve the accuracy of VMT information as new requirements are put in place. As of the beginning of 1993, all urbanized areas with populations in excess of 200,000 were required to conduct HPMS sample panels for individual FAUAs. This improvement to HPMS data availability will require states to prepare the on-road mobile source base year revisions, periodic inventories (required beginning in 1995 and every 3 years after until redesignation to attainment), and RFP tracking inventories (required beginning in 1996), using VMT estimates that are consistent with HPMS.

On September 30, 1994, and every year thereafter, the nine CO nonattainment areas classified as Moderate > 12.7 or higher were required to submit VMT tracking reports to U.S. EPA regional offices comparing actual (from HPMS) versus projected VMT (from SIPs). The approval of states' SIP documents now and in the future will depend in large part on the states' ability to follow U.S. EPA and FHWA guidance and to provide detailed information in their SIPs as discussed throughout this report. In light of the significant contribution of on-road mobile source emissions to overall emissions in nonattainment areas nationwide, development of the on-road mobile source SIP elements is critical to the overall successful implementation of the CAAA.

REFERENCES

1. *1990 Clean Air Act Amendments*, Public Law 101-549, 101st Congress, November 15, 1990, Title I, Section 183(a)(1).

2. *Emission Inventory Requirements for Ozone State Implementation Plans*, U.S. EPA-450/4-91-010, March 1991.

3. *Emission Inventory Requirements for Carbon Monoxide State Implementation Plans,* U.S. EPA-450/4-91-011, March 1991.

4. *Highway Performance Monitoring System, Field Manual*, FHWA, FHWA ORDER M 5600.1A, Chg. 4, February 1993.

5. *Procedures for Emission Inventory Preparation*, Volumes I-V, U.S. EPA-450/4-81-026a-e, various dates.

6. *Procedures for Emission Inventory Preparation*, Volume IV: Mobile Sources, U.S. EPA-450/4-81-026d, July 1992.

7. *User's Guide to MOBILE 4.1 (MOBILE Source Emission Factor Model),*U.S. EPA-AA-TEB-91-01, July 1991.

8. *User's Guide to MOBILE 5.0 (MOBILE Source Emission Factor Model),* U.S. EPA-AA-AQAB-94-01, May 1994.