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Guidelines for Review of Highway Source Emission Inventories for 1982 State Implementation Plans

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GUIDELINES FOR REVIEW OF HIGHWAY SOURCE EMISSION INVENTORIES FOR 1982 STATE IMPLEMENTATION PLANS

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I. INTRODUCTION

BACKGROUND

One of the most important inputs to 1982 State Implementation Plans (SIP's) is an accurate base year emission inventory of hydrocarbons (HC) and nitrogen oxides (NOx). The Environmental Protection Agency has indicated that the base year for the emission inventories should be 1980. It is particularly important that such inventories be accurate as they will be used to forecast future emissions levels within an urban area, will be the basis for determining reductions in HC and NOx emissions for alternative transportation policies and projects between 1980 and 1987, and will form the basis of determining whether Reasonable Further Progress is being made toward meeting the ozone air quality standard.

This manual is particularly concerned with the adequacy of HC and NOx emission inventories for highways. Areas required to submit 1982 SIP's are currently developing such inventories. Experience has shown that many different estimation procedures, data sources, and assumptions are likely to be used in inventory development. It is particularly important that the inputs and outputs of these analyses and the methodology used be reviewed in a timely manner to insure that the highway source estimates for each non-attainment area are reasonable.

OBJECTIVE

This manual presents procedures and data to assist EPA, state, and local agencies in assessing the adequacy of HC and NOx highway source emission inventories for 1980, the base year of interest in preparing 1982 SIP submissions. The procedures presented herein provide a basis for reviewing: (1) the reasonableness of the travel and related inputs (e.g. fleet mix, cold/hot start fractions) used to estimate HC and NOx emissions, and (2) the reasonableness of the emissions estimates themselves. The procedures are applicable to urban areas with a population greater than 200,000 people.

This manual presents and documents a six step process for performing the reasonableness assessments noted above. The manual: (1) identifies key factors that affect mobile source emissions and sources of data for conducting the assessments; and (2) presents guidelines for further examining potential problems uncovered in this type of review.

The manual should be used to review the adequacy of the mobile source inventories for each non-attainment area as soon as such estimates are available from the responsible agencies. Such timely review will minimize problems of uncovering deficiencies when it is costly to correct them or when time constraints preclude revising the estimates.

USE OF MANUAL

Although the manual attempts to provide a straight forward sequence of steps for performing this review for each non-attainment area of interest, it is important that the person applying the review procedures familiarize himself with the travel and emissions estimation procedures used in the urban area under review. This is particularly important because some urban areas may be using data and estimation techniques of a unique nature. If so, it may be necessary to supplement or adjust the procedures, worksheets, etc., in this manual.

Section II discusses the important factors affecting emissions and the type of procedures that may be used to estimate HC and NOx emissions from highway sources.

Some urban areas have already developed base year HC and NOx emission inventories, while other areas are currently preparing them. The most current reports, technical memoranda, and other applicable documentation on such inventories should be obtained from MPO's, state agencies or other participants in the transportation-air quality planning process.

In most instances, applying the procedures in this manual will take less than two person days per urban area. For urban areas which have done a thorough job of documenting such inventories, this review may take one person day of effort.

The manual presents an extensive set of criteria for evaluating the reasonableness of inputs used to estimate the emissions inventories as well as the emission estimates themselves. IT IS PARTICULARLY IMPORTANT TO NOTE THAT IF A VARIABLE FOR A GIVEN URBAN AREA LIES OUTSIDE THE "REASONABLE RANGE" CITED IN THE MANUAL, IT DOES NOT NECESSARILY MEAN THE ESTIMATE IS ERRONEOUS. IF A VARIABLE LIES OUTSIDE THE REASONABLE RANGE, THE VARIABLE OR DATA IN QUESTION SHOULD BE EXAMINED FURTHER TO ASCERTAIN IF IT IS ERRONEOUS OR INAPPROPRIATE, OR IF THE TRAVEL AND OTHER CHARACTERISTICS OF THE URBAN AREA IN QUESTION ARE UNUSUAL RELATIVE TO MOST OTHER AREAS. Typically, previously collected travel survey data from that urban area can be used in making such checks for "uniqueness".

The reasonableness criteria presented in this manual have been stratified by urban area population and geographic region of the nation to attempt to account for the effects of such variables on travel and emissions.

ORGANIZATION OF MANUAL

Section II of the manual briefly reviews the important factors affecting HC and NOx emissions from highway sources, and describes the basis of the reasonableness criteria used in the manual. Section III presents the procedures for reviewing emission inventory inputs and outputs. Appendix A contains the reasonableness criteria in the form of an extensive series of tables, graphs, etc. Appendix B documents the data sources and procedures used to develop the reasonableness criteria in Appendix A, while Appendix C defines selected terminology used in the manual. Appendix D contains an example of completed worksheets. Appendix E contains blank worksheets for reproduction.

II. FACTORS AFFECTING BASE YEAR HC AND NOx EMISSIONS ESTIMATES

This section has three major objectives. First, it describes the principal types of estimation procedures that can be used to estimate highway vehicle emissions. Second, it briefly reviews the factors which affect highway emissions. Third, it describes the basis of criteria used to assess the reasonableness of the inputs to and outputs of the emission inventories.

MODELS FOR CALCULATING HIGHWAY EMISSIONS

Three types of models, each utilizing different forms of travel data, are available to estimate highway emissions: Link-based, Trip-based, and Hybrid models.

Link-based models compute emissions for individual links (or groups of links with similar characteristics) in the highway network. Detailed travel information (e.g. VMT, speed) is required for each link. Emissions from individual links are added to produce total emissions for the entire urban area or for selected subareas. Link-based models use output from traffic assignments or from traffic counts. Link-based models assume that trip-end-related emissions (cold/hot start and hot soak) are spread over the entire trip, rather than occur at the origin or destination. This assumption limits the usefulness of this method for evaluating some transportation control measures. Link-based models are widely used and can produce an acceptable highway vehicle emission inventory.

Trip-based models compute emissions for an entire urban area or large geographic subarea (e.g. county). Trip-based models are the least data intensive, using the total number of trip ends, average trip length and average operating speed to estimate highway emissions. Trips can be stratified by purpose (e.g. home-based, non-home-based). This model uses average values for cold/hot fractions for the urban area (or subarea); therefore it can not distinguish between trip-end related emissions and travel-related emissions. This model has difficulty accounting for thru-trips (i.e., trips that do not begin or end in the urban area or subarea). Trip-based models are of very limited usefulness for evaluating impacts of transportation control measures. Trip-based models can produce an acceptable highway vehicle emissions inventory.

Hybrid models estimate travel-related (stable mode) emissions for each link in the highway network, and separately estimate trip-end-related (cold/hot start, hot soak) emissions for the geographic unit in which they occur. This model is

conceptually correct, but is not used extensively because it is the most data intensive. In addition to detailed link information, detailed trip information on small geographical units (e.g. traffic analysis zones) is required. The hybrid model is the most useful model for evaluating impacts of transportation control measures, and can produce an acceptable highway vehicle emission inventory.

The emission models can be used for different trip purposes and types. For example, the hybrid model could be used for home-based network trips, while the trip-based model could for other trips (non-home-based network trip, thru trips, non-network (local) trips). Emission estimates from each model would be added to produce total emissions for the urban area.

FACTORS AFFECTING HIGHWAY EMISSIONS ESTIMATES

The type of travel data required to estimate emissions depends on the emission model used. Table 1 identifies the travel data used in each of the emission models. Link-based models require link-specific data, while trip-based models use aggregated data. Hybrid models require link-specific data and detailed trip end information.

Factors, such as percent of vehicles towing trailers, or air conditioners are of much less significance than the variables identified in Table 1.

It is essential that the individual performing the review determine which model, or combination of models is used in the urban area under review, because it will influence which information should be collected and examined in making the reasonableness assessment described in Section III.

CRITERIA FOR ASSESSING REASONABLENESS

In order to perform a thorough assessment of the base year HC and NOx emission inventories, it is necessary to examine both the inputs to and outputs of the emission estimation process, as well as to review the methodology used to develop the travel data. Such an assessment should produce reasonable assurances that the emission inventory is accurate.

TABLE 1

TRAVEL–RELATED DATA AFFECTING EMISSION MODELS

DATA ITEM	MODEL TYPE		
	LINK–BASED	TRIP–BASED	HYBRID
Areawide VMT		●	
Link Specific VMT	●		●
Areawide Average Vehicle Operating Speed		●	
Link Specific Vehicle Operating Speed	●		●
Total Number of Trip Ends in Urban Area		●	
Number of Trip Ends by Geographical Unit *			●
Areawide Average Daily Trip Length		●	
Areawide Average Percent VMT in Cold/Hot/Stable Mode	●	●	
Number of Trips With Catalyst and Non-Catalyst Vehicles Started With Engine-off Longer Than 4 hours *			●
Number of Trips With Catalyst Vehicles Started With Engine Off Less Than 1 hour *			●

● Indicates data item of major concern

* By geographical unit (e.g. traffic analysis zone)

It is not possible to conduct an assessment simply by compiling aggregate estimates for the types of variables listed in Table 1. Rather, it is necessary to express many of these variables not as absolutes or aggregate values, but in the form of unit values (e.g., VMT/capita, emissions/VMT) or percentage distributions to determine their reasonableness. For example, determining that an urban area produces 7 million VMT daily is not as useful as knowing the VMT/capita for the urban area in question. Data are available in the literature to determine reasonable ranges for the per capita figure, but criteria for the former variable (e.g., total daily VMT) are not generally available for 1980.

The following presents several examples showing the unit values, percentage distributions, and other stratifications of factors affecting emissions that are applied in Section III:

Variable	Form of Variable for Assessing Reasonableness
VMT	VMT Per Capita Percent VMT by Functional Highway Class Percent VMT by Vehicle Class
Average Daily Vehicle Operating Speed (ADOS)	ADOS by Functional Highway Class ADOS Systemwide
Total Vehicle Trips	Vehicle Trips Per Capita
Average Trip Length	Average Trip Length by Time of Day
VMT in Cold/Hot/Stable Operating Conditions	Percent of Daily VMT in Each Operating Mode
Age of Vehicle Fleet	Percent of Travel by Vehicle Class and Model Year
HC & NOx Emissions	HC and NOx Emissions per VMT

A set of numerical criteria have been developed to assess the reasonableness of the inputs to and outputs of the emission inventories, such as those illustrated above. The sources of such reasonableness criteria include published reports and studies developed by:

- U.S. Environmental Protection Agency (EPA),
- Federal Highway Administration (FHWA),
- Urban Mass Transportation Association (UMTA),
- National Cooperative Highway Research Program (NCHRP),
- the Office of the Secretary of USDOT, and
- other agencies and institutions.

It is not possible to develop reasonableness criteria for small geographic subareas of each urban area, or for different times of the day. The variability of such data is too large to produce ranges of reasonable values that would be of any use. This manual, therefore, uses areawide, average daily values as the basis for the reasonableness review.

The reader should briefly review the tables and figures presented in Appendices A and B to familiarize himself with the types of reasonableness criteria available for use in Section III.

III. PROCEDURE FOR REVIEWING EMISSION INVENTORY INPUTS AND OUTPUTS

This section presents a six step procedure for reviewing the reasonableness of the base year (i.e., 1980) HC and NOx mobile source emission inventories for urban areas with a population greater than 200,000 people. The first part of this section presents a brief overview of this procedure, while the second part of this section presents detailed instructions, worksheets, and other supporting materials for applying the procedures. Reviewers are strongly encouraged to review the discussion in Section I under the heading "Use of Manual" in conjunction with reading and applying the procedures in this section.

OVERVIEW OF PROCESS

Figure 1 outlines the six step process for assessing the reasonableness of the base year HC and NOx mobile source emission inventories, and the inputs used to construct such inventories. In Step 1, the person conducting the assessment should familiarize himself with the data and techniques used to estimate base year travel characteristics and mobile source emissions for the urban area in question. This review should be sufficiently detailed to determine the types of estimation procedures and data being used to estimate factors such as VMT and average operating speeds.

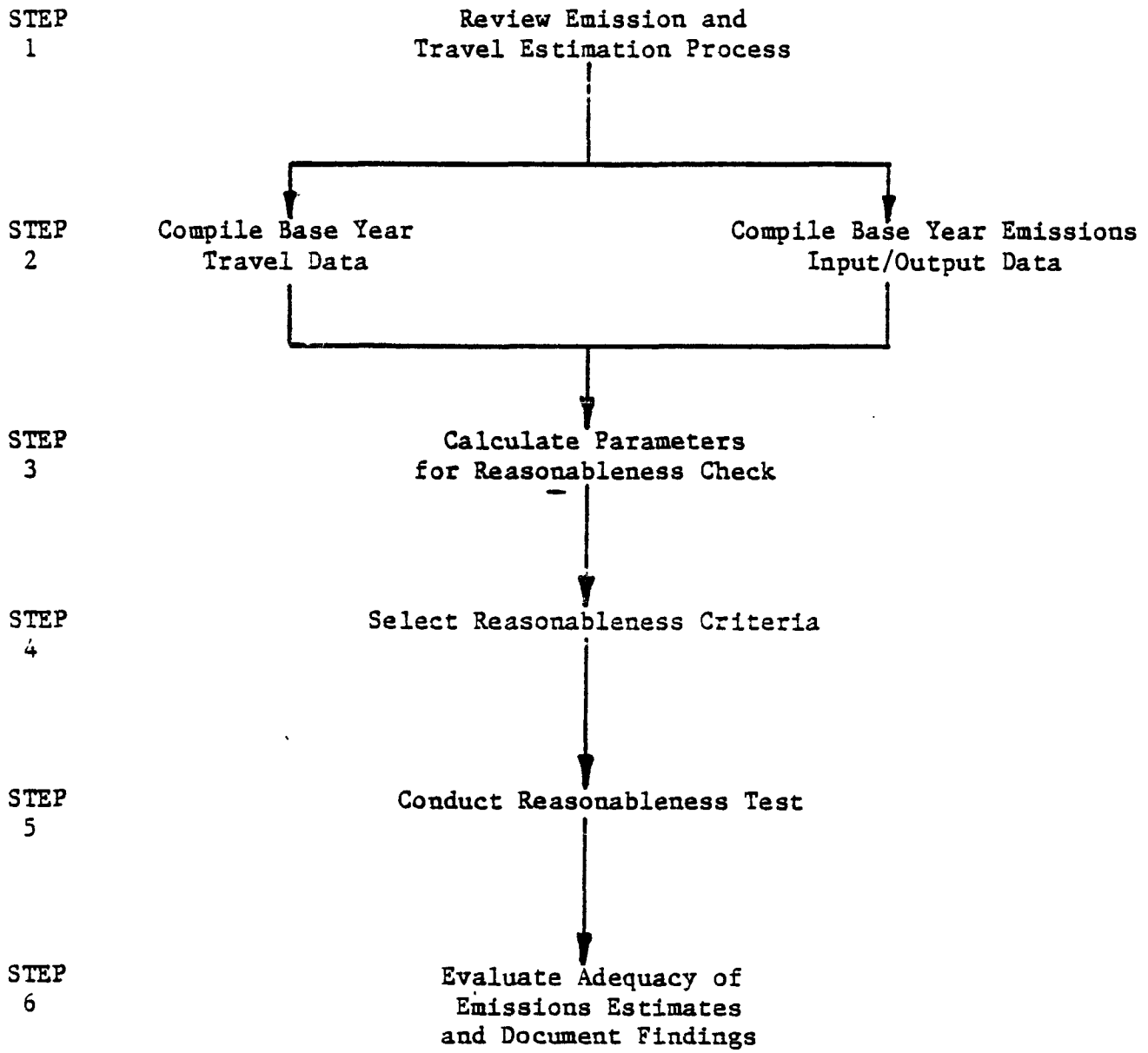
In step 2, the reviewer will compile base year travel and emission estimates and supporting data from reports, memoranda, or other sources documenting the 1980 HC and NOx mobile source emission inventories. This manual presents standardized worksheets for recording such information.

In step 3, the information compiled in Step 2 will be analyzed and tabulated to develop a series of parameters (e.g., VMT per capita, emissions per VMT) that will ultimately be used to assess the reasonableness of the emission inventories. A set of worksheets and directions are presented to facilitate conducting this step.

In step 4, the reviewer will select applicable reasonableness criteria from Appendix A to assess the adequacy of the emission inventories for the urban area in question. The reasonableness criteria are typically presented in the form of tables and graphs which document ranges for parameters such as VMT per capita, average daily vehicle operating speed by functional classification, and cold/hot/stabilized operating condition fractions. These ranges are based on data and analyses compiled from widely distributed studies conducted by EPA, FHWA, UMTA, and other agencies.

FIGURE 1

EMISSIONS INVENTORY REVIEW PROCESS



Guidelines for selecting applicable reasonableness criteria are presented later in this section.

Step 5 involves assessing the reasonableness of the emission estimates using the data from steps 3 and 4. The worksheets used for this purpose provide space for noting particular parameters that lie outside commonly encountered ranges. As noted in Section I, if a parameter does not lie within the range in question, this does not necessarily indicate that the parameter is incorrect. Rather, this means that the parameter in question should be examined further to ascertain if it is erroneous or if it reflects the unique travel or other characteristics of the urban area in question.

In step 6, the recommendation of the reviewer regarding the adequacy and reasonableness of the emission inventories should be developed and documented. This should include recommendations for improving the emission inventories when this is applicable.

The detailed worksheets and direction for applying this six step process are presented below.

STEP-BY-STEP DESCRIPTION OF ASSESSMENT PROCESS

Step 1: Review Emissions and Travel Estimation Process

Once an urban area has been selected for review, the appropriate MPO should be contacted to obtain reports, memoranda, or other information documenting the development of the base year HC and NOx mobile source emission inventories. These materials should be quickly reviewed to familiarize the reviewer with the types of techniques and data sources used to estimate travel and other inputs to the emissions inventories. For example are traffic counts, sketch planning techniques, or the conventional 4-step transportation analysis process being used to estimate base year travel characteristics? Similarily, what are the accuracy and completeness of the data and assumptions used as inputs to the estimation procedures? The type of emission estimation model used (e.g., MOBILE 2 or a special purpose technique) and the critical inputs to such a model (e.g., cold/hot/stabilized fractions, fleet mix) should also be assessed. If possible, an in-depth model and data assessment should be performed.

This review should determine:

- if there are any clearly inappropriate techniques or data sources used to develop the emission estimates; and

- if there are features of the techniques and data sources used that will require special consideration in assessing the adequacy of the emission inventories. For example, if a procedure other than MOBILE 1 or 2 is used to estimate emission rates by type of vehicle, the reviewer should determine the critical variables affecting emissions in that procedure and include such variables in his review.

This review should be conducted and documented using the Methodology Review sheet which is found on the three next pages.

The questions listed on the Methodology Review Sheet are intended to aid the reviewer in focusing on important analytical issues that can affect the adequacy of the HC and NOx highway emissions inventories. Most of the questions on the sheet are self-explanatory. However, several questions warrant further explanation. Although question 4 only requires "checking" the type of procedure used to estimate highway emissions, this determination should be carefully made as it will affect the types of data, assumptions, and modelling procedures that should be examined for the urban area in question, as well as responses to questions 5 through 8.

Question 8 is a particularly important question which is intended to identify and describe any major deficiencies in the travel and emissions estimation procedures. These deficiencies should be discussed and resolved with the agency responsible for preparing the emissions inventory. Where possible, the reviewer should point out potential solutions to the problems identified in the review.

Step 2: Compile Base Year Travel and Emissions Data

The reports, memoranda, and other information compiled in step 1 should be used to complete the applicable sections of Worksheets 1, 2a, 2b, and 2c. It should be noted that the source of the information requested in these worksheets should be entered in the space provided. Appendix D illustrates how Worksheets 1, 2, and 3 are completed for a typical urban area.

Begin Worksheet 1 by filling in the name of the urban area to be reviewed, and the abbreviation of the region of the country that includes that urban area. Figure 2 identifies the boundaries of the five regions of the nation used in this manual.

Reviewer - _____

Date - _____

METHODOLOGY REVIEW SHEET

1. Urban Area - _____

2. **What agency developed the base year HC and NOx emissions inventories for highway sources?**
   (List agency name, address and telephone number.)

   _____

   _____

   _____

3. a) **For what base year have the emissions inventories been established?** _____

   b) **If 1980 is not the base year for the emission inventories, indicate why another year was used.**

   _____

   _____

   _____

4. **What type of procedure was used to estimate highway emissions? (Check one)**

   ☐ - **Link-based procedure ***
   ☐ - **Trip-based procedure ***
   ☐ - **Hybrid procedure ***
   ☐ - **Other (Please explain below)**

   _____

   _____

   _____

* **Section II of this manual describes each of these procedures in more detail.**

5. a) How were VMT and vehicle operating speeds estimated for use in developing the emissions inventories? (e.g. Are the estimates based on traffic counts and travel time surveys or are they based on estimates from the travel forecasting procedures used for urban transportation planning?)

b) Are there any elements of the travel estimation procedures that are questionable?

c) What year's data was used to calibrate the travel estimation procedures cited in Question 5a?

d) When were the procedures cited in question 5a last validated (i.e., checked to determine if they can reproduce observed traffic flows)?

6. Are estimates of "off-network" VMT (e.g., VMT on links normally not included in a computerized highway network) accounted for in the highway emissions inventories? If yes, briefly describe how the VMT and corresponding operating speeds estimates for each travel were determined.

7. a) What procedure was used to estimate mobile source emission factors? (Check one)

☐ MOBILE 1

☐ MOBILE 2

☐ Other procedure (Enter name of procedure) _____

b) If "Other" was checked in question 7a, describe and assess the adequacy of the procedure.

_____

_____

_____

8. Based on the above, summarize and briefly discuss any major deficiencies in the travel and emissions estimation procedures used by this urban area.

_____

_____

_____

WORKSHEET 1

TRAVEL DATA FOR REASONABLENESS ASSESSMENT

NAME OF URBAN AREA _____

REGION OF COUNTY (SEE FIGURE 2) _____

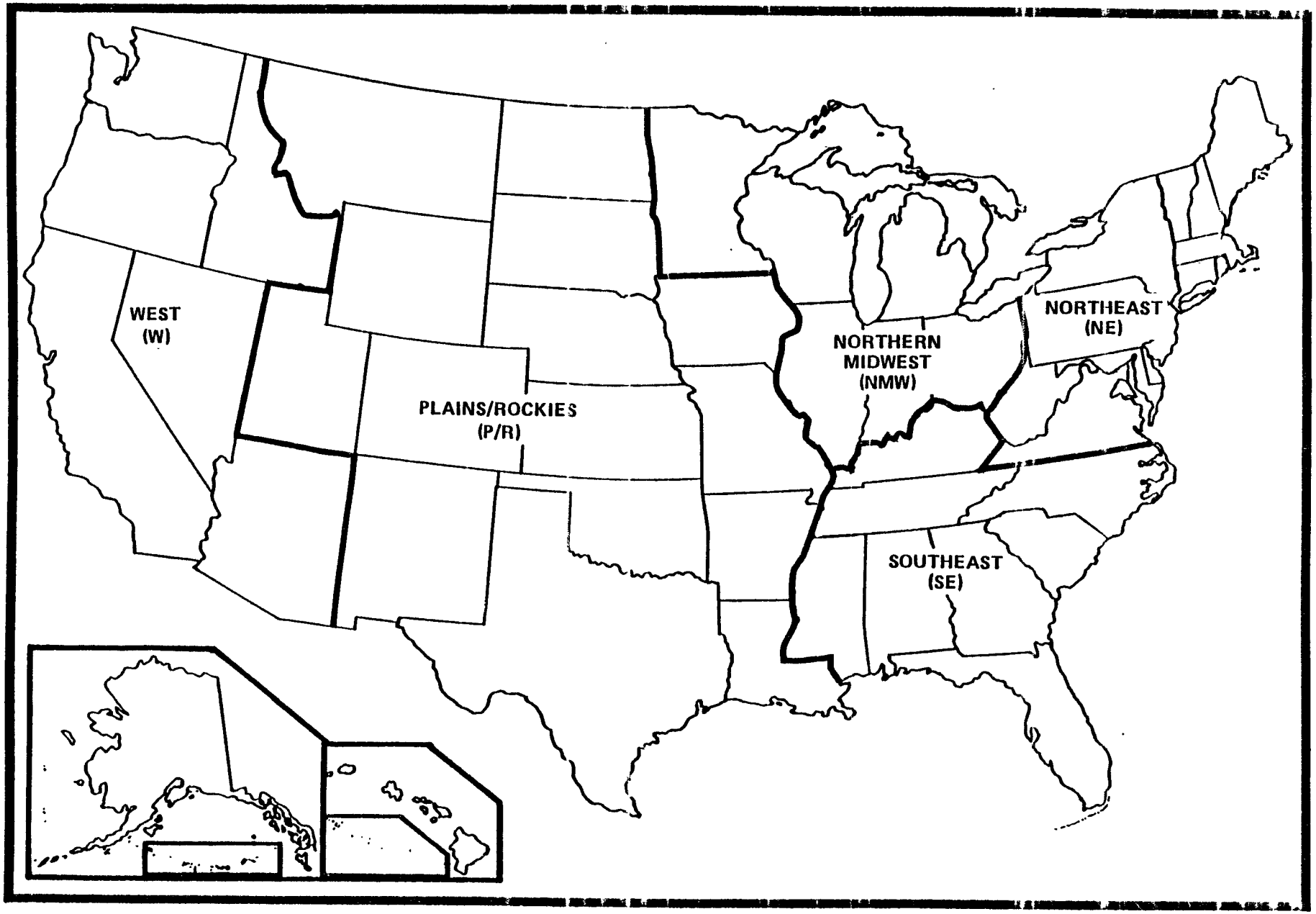
VARIABLE	ESTIMATE FOR BASE YEAR VALUE	UNITS	SOURCE
1. Population		1,000's	
2. Average Daily VMT by Functional Class *		1,000's of vehicle miles	
a) Interstate		(000)	
b) Principal Arterial		(000)	
c) Minor Arterial		(000)	
d) Collectors		(000)	
e) Local		(000)	
f) Total		(000)	
3. Average Daily VMT by Vehicle Class **		1,000's of vehicle miles	
a) LDV		(000)	
b) LDT 1 (< 6000 lbs.)		(000)	
c) LDT 2 (> 6000 lbs.)		(000)	
d) HDG		(000)	
e) HDD		(000)	
f) MC		(000)	
g) Total		(000)	
OR			
h) Auto		(000)	
i) Truck		(000)	
j) Total		(000)	
4. Average Daily Operating Speeds (24 hrs.) by Functional Class *		in miles per hour	
a) Interstate		mph	
b) Principal Arterial		mph	
c) Minor Arterial		mph	
d) Collector		mph	
e) Local			
OR			
f) Average Daily Speed for the System (where-s-e aren't available.)		mph	
5. Average Daily Trip Length		minutes	
6. Average Daily Vehicle Trips		in 1,000's	
a) Passenger Vehicles		(000)	
b) Trucks		(000)	
7. Seasonal Adjustment Factor			

* Functional classifications, see Appendix C.

** MOBILE 1 vehicle classifications, see Appendix C.

FIGURE 2

BOUNDARIES OF THE FIVE ASSESSMENT REGIONS



Variable 1: Population

Enter the base year (1980) population for the urban area under study in the appropriate column. The value written should represent thousands of people, with the source of the population estimate being placed in the final column.

Variable 2: Average Daily VMT by Functional Classification*

If available, enter the total VMT driven in the urban area for an average summer day, for each of the five functional classifications in rows 2a through 2e. All VMT values in row 2 should be in units of thousands of vehicle miles of travel per day. Also, include the source of the data in the final column. If VMT is not available by functional classification, but is available in other stratifications, enter the available VMT estimates and write in the new stratifications alongside the estimates. If VMT estimates are not available for any stratifications of the highway system, enter N.A. in the applicable rows.

In all cases, place the urban area's total VMT in row 2f.

Variable 3: Average Daily VMT by Vehicle Classification**

If available, VMT per average summer day should be entered by vehicle classification in rows 3a through 3g. The vehicle classifications in these rows correspond to those used in MOBILE 1. It is assumed that the MOBILE 2 categories, LDDV and LDDT contributed negligibly to the production of HC and NOx for 1980.

If VMT data do not exist by vehicle classification, but are available for "autos" and "trucks", enter such estimates in rows 3h through 3j. (In this case, truck is defined as all non-LDV and motorcycle vehicles.) Any different classification than those stated should be noted along with the source of information. Only one of the two series of rows (i.e., 3a through 3g, or 3h through 3j) need be completed.

---

*For functional classification definitions, see Appendix C.
**See Appendix C for definition of MOBILE 1 vehicle classifications.

Variable 4: Average Daily Operating Speed by Functional Classification

In rows 4a through 4e, the average daily vehicle operating speeds should be recorded for each of the functional classifications. If VMT in rows 2a through 2e is stratified other than by functional classification, average daily operating speeds should be reported for the same classifications used in rows 2a through 2e. The stratifications of the highway system used should be noted for rows 4a through 4e.

If only a single average daily systemwide speed is available, enter this estimate in row 4f. As in VMT per vehicle class, do only one of the above two options, a stratified speed, or an average daily systemwide speed.

Variable 5: Average Daily Trip Length

This value is optional, depending on the emissions methodology used (see Section II). For example, trip length may be used for hot/cold/ stable fraction computation, or in trip-based emissions calculations. If it is used in the urban area being examined, place the value in minutes in row 5 and list the source of the information. For urban areas estimating hot/cold/stable fractions in another manner, this row may be left blank.

Variable 6: Average Daily Vehicle Trips

Vehicle trips may be used in estimating trip-end-related HC emissions. If this parameter was used in estimating emissions, enter it in rows 6a and 6b, in units of thousands of trips.

Variable 7: Seasonal Adjustment Factor

This factor is the value used to transform average daily vehicle miles of travel into average daily VMT for an average summer day. Enter this factor in row 7.

This completes the information needed for Worksheet 1.

Worksheet 2a should be completed next. It includes space for entering information as in Worksheet 1, and also provides space for entering reasonableness criteria as described in step 3 of this section. As with Worksheet 1, start by filling in the name of the urban area being reviewed.

WORKSHEET 2a

EMISSION FACTOR INPUTS AND EMISSION INVENTORY OUTPUTS, REASONABLENESS ASSESSMENT

NAME OF CITY_____

VARIABLE	ESTIMATE FOR BASE YEAR VALUE	UNITS	CRITERIA	FINDINGS
8. Average Daily Cold/ Hot Operating Fractions a) Cold Mode Catalyst b) Hot Mode Catalyst c) Cold Mode Non-catalyst		Percent % % %	See Table 2	
9. Meteorological Data a) Summertime Temperature b) Summertime Humidity		^{o}F Grains/lb.	See Table 9 Indicate Source	
10. Total Annual Highway Emissions a) HC b) NO_x		Tons Tons	None None	

Variable 8: Average Daily Cold/Hot Operating Fractions

If available, enter in rows 8a through 8c, the values used for average daily percentage of VMT in: (a) cold mode for catalyst equipped vehicles; (b) hot mode for catalyst equipped vehicles; and (c) cold mode for non-catalyst equipped vehicles. Include the source of this information in the "Findings" column. If the cold/hot operating fractions are expressed in units other than those noted in Worksheet 2a, the reviewer should enter this information in the form that is available and document the source.

Variable 9: Meteorological Data

Place the summertime temperature and the ambient humidity used in the emission calculations in rows 9a and 9b, respectively. The source of the estimates should also be noted. (The mean daily temperatures presented in Table 9 in Appendix A are intended to be used for assessing the reasonableness of this variable and to not represent temperatures that should be used by each urban area.)

Variable 10: Total Highway Source Emissions

In row 10a, enter the total annual HC emissions for the base year from highway sources. Total annual NOx emissions from highway sources should be entered in row 10b.

Variable 11: Fraction of VMT by Vehicle Classification and by Model Year

Worksheet 2b need not be filled out if the percentage of VMT within each vehicle classification is the same as the national averages used as defaults in MOBILE 1. If this is the case, state the fact in the space marked "Findings" at the bottom of the table in this worksheet.

If values other than those in MOBILE 1 are used, place the fraction, (not percent), attributed to each model year in the appropriate box in Worksheet 2b.

Variable 12: Vehicle Emission Rates by Functional Classification

In Worksheet 2c, enter the HC and NOx emission rates in the "estimate" columns (in grams/VMT) for each highway functional classification if such information is available. For

WORKSHEET 2b

VARIABLE 11: FRACTION OF VMT PER VEHICLE CLASSIFICATION BY MODEL YEAR

AGE	LDV		LDT 1		LDT 2		HDG		HDD		MC	
	B.Y.E. *	N.A.V. **	B.Y.E.	N.A.V.	B.Y.E.	N.A.V.	B.Y.E.	N.A.V.	B.Y.E.	N.A.V.	B.Y.E.	N.A.V.
1		.106		.093		.061		.061		.102		.107
2		.142		.136		.116		.116		.178		.286
3		.133		.126		.116		.122		.168		.216
4		.123		.129		.115		.124		.149		.140
5		.108		.097		.090		.098		.101		.085
6		.092		.082		.081		.088		.081		.051
7		.077		.075		.075		.079		.067		.036
8		.064		.057		.062		.063		.046		.025
9		.050		.044		.050		.049		.031		.021
10		.035		.031		.042		.040		.021		.016
11		.023		.023		.033		.030		.016		.005
12		.016		.015		.022		.020		.009		.003
13		.010		.018		.025		.021		.008		.008
14		.007		.016		.023		.019		.006		.000
15		.004		.014		.020		.016		.006		.000
16		.003		.012		.018		.014		.004		.000
17		.002		.011		.016		.012		.003		.000
18		.002		.009		.014		.011		.002		.000
19		.002		.008		.012		.010		.002		.000
20		.002		.007		.010		.009		.001		.000

Findings:

* B.Y.E. = Base Year Estimates

** N.A.V. = National Averages Used as Default Values in Mobile*f* .

WORKSHEET 2c

VARIABLE 12: VEHICLE EMISSION RATES BY FUNCTIONAL CLASS (GM/VMT)

HIGHWAY CLASSIFICATION	COMPOSITE EMISSIONS		TOTAL AUTO EMISSIONS		TOTAL TRUCK EMISSIONS	
	ESTIMATE	CRITERIA	ESTIMATE	CRITERIA	ESTIMATE	CRITE
		See Fig. 3 or 9 for HC See Fig. 4 or 10 for NOx		See Fig. 5 or 11 for HC See Fig. 6 or 12 for NOx		See Fig. 7 or 1 See Fig. 8 or 1
Speed ____ (MPH) INTERSTATE						
Non-Methane HC						
NOx						
Speed ____ (MPH) PRINCIPAL ARTERIAL						
Non-Methane HC						
NOx						
Speed ____ (MPH) MINOR ARTERIAL						
Non-Methane HC						
NOx						
Speed ____ (MPH) COLLECTOR						
Non-Methane HC						
NOx						
Speed ____ (MPH) LOCAL						
Non-Methane HC						
NOx						
Speed ____ (MPH) TOTAL						
Non-Methane HC						
NOx						

Findings:

Directions: Enter the average daily operating speeds from rows 4a through 4e (in Worksheet 1) in the first column. If MOBILE 1 was used to compute emissions factors, use figures 3 through 8 in Appendix A to select appropriate reasonableness criteria. If MOBILE 2 was used, see Fig.'s 9 through 14 in Appendix A. Draw a vertical line, on the appropriate figures for HC and NOx at the average vehicle operating speed for each VMT stratification. The intersection of the vertical line with the two solid curves in each figure determines the reasonableness range for that VMT stratification. That range should then be placed in the appropriate column and row in the Table. For VMT stratification by other functional classes, use this Table and method, but note the new column headings in the space marked "Findings". For an example of this procedure see Appendix D and Figures 3 and 4.

those urban areas using the MOBILE 1 or 2 fleet classifications, emission rates should be for the composite vehicle fleet, and should include all travel and trip-end related emissions. Separate rates for HC and NOx should be listed.

Those urban areas not using MOBILE 1 or 2 composite emissions should place their emission rates in the auto/truck columns provided, unless a composite emission rate has been calculated.

If an urban area did not develop emission rates by functional classification, the reviewer should note this and enter and document the emission rates used by the urban area on Worksheet 2c. Detailed directions for completing Worksheet 2c are presented on the worksheet itself.

Step 3: Calculate Parameters for the Reasonableness Check

In this step, the information compiled in step 2 will be converted to a form suitable for assessing the reasonableness of the emissions inventory.

The first part of this step requires completing Worksheet 3 using the information entered on Worksheet 1.

Variable 13: Daily VMT/Capita

Divide total daily VMT (from row 2f in Worksheet 1) by the urban area's population (from row 1 in Worksheet 1), and enter the result in units of vehicle miles per person on Worksheet 3.

Variable 14: Percent VMT by Functional Class

If rows 2a through 2e are completed on Worksheet 1, divide each of these values by the value in row 2f and multiply by 100 to obtain the percentages of VMT by functional class.

Variable 15: Percent VMT by Vehicle Class

If rows 3a through 3g were used in Worksheet 1, divide each of these entries by the value in row 3g, multiply by 100 to obtain a percentage value, and enter the percentages in rows 15a through 15f on Worksheet 3. If rows 3h through 3j were completed in Worksheet 1, divide 3h and 3i by 3j, and multiply by 100 to obtain a percentage value. These values should be entered in rows 15g and 15h of Worksheet 3.

Variable 16: Total VMT

Place the value from either row 3g or 3j of Worksheet 1 into row 16 of Worksheet 3.

WORKSHEET 3

REASONABLENESS ASSESSMENT FOR TRAVEL DATA

VARIABLE	BASE YEAR REASONABLENESS MEASURES		CRITERIA	FINDINGS
	MEASURE	COMPUTATION		
13. Daily VMT/Capita	mi/per.	(2f÷1a)	See TABLE 3 mi/ person	
14. Percent VMT by Functional Class			See TABLE 4 (Percent)	
a) Interstate	%	(2a÷2f)	%	
b) Principal Arterial	%	(2b÷2f)	%	
c) Minor Arterial	%	(2c÷2f)	%	
d) Collector	%	(2d÷2f)	%	
e) Local	%	(2e÷2f)	%	
15. Percent VMT By Vehicle Class			(Percent)	
a) LDV	%	(3a÷3g)	78-89 %	
b) LDT (< 6000 lbs.)	%	(3b÷3g)	5-12 %	
c) LDT (> 6000 lbs.)	%	(3c÷3g)	2.5-6 %	
d) HDG	%	(3d÷3g)	1.5-4.5 %	
e) HDD	%	(3e÷3g)	2.5-7.5 %	
f) MC	%	(3f÷3g)	0-1 %	
OR				
g) Auto	%	(3h÷3i)	78-89 %	
h) Truck	%	(3i ÷3i)	10-22 %	
16. Total VMT	1,000 mi/day	(3g or i)	See 2f, worksheet 1 1,000 mi/day	
17. Vehicle Operating Speed by Functional Class			See TABLE 5 (miles/hour)	
a) Interstate		(4a)	mph	
b) Principal Arterial		(4b)	mph	
c) Minor Arterial		(4c)	mph	
d) Collector		(4d)	mph	
e) Local		(4e)	mph	
OR				
f) Average Vehicle System Speed		(4f)	See TABLE 6 mph	
18. Average Daily Trip Length	min.	(5a)	See TABLE 7 (minutes)	
19. Vehicle Trips/Capita				
a) Passenger Vehicles	Trip/per.	(6a÷1a)	1.8-2.4 Trips/per.	
b) Trucks	Trip/per.	(6b÷1a)	.27-.48 Trips/per.	
20. Seasonal Adjustment Factor	———	(7a)	See TABLE 8	

Variable 17: Vehicle Operating Speed by Functional Class

If available, transfer the data from rows 4a through 4e of Worksheet 1, into the applicable rows of Worksheet 3. If this information does not exist, transfer the information in row 4f of Worksheet 1 to row 17f in Worksheet 3.

Variable 18: Average Daily Trip Length

If there is a value in row 5a of Worksheet 1, transfer it to row 18 of Worksheet 3. Otherwise, leave this row blank.

Variable 19: Vehicle Trips Per Capita

If there is information in rows 6a and 6b of Worksheet 1, divide each by row 1a (population) of Worksheet 1 and enter the resulting values in rows 19a and 19b. Otherwise, leave this row blank.

Variable 20: Seasonal Adjustment Factor

Transfer the value from row 7a of Worksheet 1 to row 20 in Worksheet 3.

Step 4: Select Reasonableness Criteria

In this step, the reviewer will select criteria for assessing the reasonableness of the emission inventories inputs and outputs. Suggested reasonableness criteria are presented in Tables 2 through 9, and Figures 3 through 14 in Appendix A. The column labeled "Criteria" in Worksheets 2a, 2b, 2c, and 3 indicates the appropriate source of the criteria (e.g., Table 4) entering the value of the criteria.

In Appendix A many, but not all, criteria are provided on the basis of the urban area's population size and its geographic location in the country. Other criteria are provided on a national basis, and the remainder are already listed on Worksheets 2b and 3.

Appendix D illustrates how the "Criteria" column has been completed in Worksheets 2a, 2b, 2c, and 3 based on the information compiled in Steps 2 and 3. For example, in Worksheet 3, the criteria for variable 13 (i.e., daily VMT/capita) for an urban area of 1,750 million people in the NMW region was found in Table 3, and the range of 12-17 VMT/capita was entered in

Worksheet 3. For variable 17, Table 4 presents the average daily vehicle operating speed by functional classification. This table was used to identify reasonable criteria for vehicle operating speed for the size and geographic location of the urban area in question. The identification of values for other reasonableness criteria are also simple "look ups" in Appendix A.

Step 5: Conduct Reasonableness Test

In this step, the inputs to and outputs from the base year HC and NOx emissions inventories are to be compared with the corresponding reasonableness criteria to determine if any inputs or outputs appear unreasonable or "out of line" relative to applicable data available in secondary sources.

Provided the travel and emission estimation processes used are conceptually sound, parameters that lie within the range of each criteria should be considered reasonable. Parameters outside the noted ranges need additional study on an individual basis. Such variables are not necessarily wrong, as many area specific factors can effect the travel and emission patterns of an urban area, creating unique situations.

If a parameter is questionable, (whether it lies outside the "reasonable" range or not), additional comparisons should be made with other available data for the urban area in question. Use the documentation included in the emission inventory and the other reports collected in step 1 to determine if unusual travel patterns may exist in that area, (e.g., New York City's high public transit usage), and compare it with other related factors in the inventory to help determine if it is representative of the actual situation.

In the spaces labled "Findings" in Worksheets 2 and 3, the reviewer should list comments and general conclusions from the comparisons of the reasonableness criteria, and the parameters derived from the inventory.

Step 6: Evaluate Adequacy of Emissions Estimates and Document Findings

The reviewer should work with the applicable agency in each urban area to determine the reasons why selected variables were outside the reasonableness ranges. In instances when a satisfactory reason cannot be found, recommendations for correcting the problem(s) should be requested from the responsible agency.

APPENDIX A

TABLES FOR REASONABLENESS RANGES

TABLE 2

AVERAGE DAILY COLD/HOT OPERATING
PERCENTAGE OF VMT BY AVERAGE TRIP LENGTH

Operating Mode	Average Trip Length (Minutes)			
	10 min.	15 min.	20 min.	25 min.
Cold Non-Catalytic	30%	17%	10%	8%
Hot Catalytic	27%	18%	14%	11%
Cold Catalytic	43%	27%	15%	13%

Based on: The Determination of Vehicular Cold and Hot Operating Fractions for Estimating Highway Emissions, by G.W. Ellis, et. al., 1978, page II-14, and Characteritics of Urban Transportation Demand-A Handbook for Transportation Planners, by Wilbur Smith and Associates for FHWA/DOT, 1978, page 62.

TABLE 3
REASONABLENESS RANGES FOR
AVERAGE DAILY VMT/CAPITA
BY REGION AND URBAN AREA SIZE

Urban Area Population (Population in millions)	Daily VMT/CAPITA (miles/Person)
Northeast (N.E.)	
2+	14-18
1-2	12-15
.5-1	11-17
.2-.5	13-21
Southeast (S.E.)	
2+	15-21
1-2	15-21
.5-1	16-19
.2-.5	16-22
Northern Midwest (NMW)	
2+	12-18
1-2	12-17
.5-1	13-16
.2-.5	13-17
Plains and Rockies (P/R)	
2+	14-21
1-2	15-22
.5-1	16-22
.2-.5	12-21
West (W)	
2+	17-20
1-2	18-19
.5-1	16-18
.2-.5	15-19

From 1974 National Transportation Report, Urban Data Supplement, DOT, May 1976, As adjusted by PMM&Co.

TABLE 4
REASONABLENESS RANGES FOR
PERCENT DAILY VMT BY REGION, FUNCTIONAL
CLASSIFICATION AND SIZE OF URBAN AREA

Region and Urban Area Population (millions)	Percent VMT by Functional Classification				
	Interstate	Primary Arterial	Minor Arterial	Collector	Local
N.E. 2+	10-16	40-47	18-22	5- 8	15-23
1-2	13-21	38-52	12-21	6-10	7- 8
.5-1	14-29	20-38	18-24	7-10	5-16
.2-.5	16-30	28-36	11-25	5-10	7-18
S.E. 2+	10-18	20-40	20-28	5-11	14-23
1-2	10-31	20-46	21-23	8-14	14-23
.5-1	10-18	21-39	17-27	6-12	16-40
.2-.5	12-22	27-43	22-41	5-11	4-21
NMW 2+	16-25	22-43	22-27	8- 9	9-15
1-2	18-23	25-38	17-25	5- 9	14-20
.5-1	27-35	21-36	16-27	5-10	9-15
.2-.5	10-16	35-45	17-32	7-11	9-19
P/R 2+	15-25	25-41	15-25	5- 8	12-18
1-2	17-35	29-43	14-26	4- 8	7-17
.5-1	14-29	25-37	13-28	4- 6	10-22
.2-.5	15-27	25-47	12-29	5-10	4-17
W 2+	17-20	25-42	21-22	5- 7	9-14
1-2	29-32	21-29	14-29	8-16	9-11
.5-1	10-21	31-41	22-35	6-10	5-10
.2-.5	12-18	48-57	14-24	6- 9	9-18

From 1974 National Transportation Report, Urban Data Supplement, DOT, 1976, pg

TABLE 5
REASONABLENESS RANGES FOR
AVERAGE DAILY VEHICLE OPERATING SPEED BY REGION, FUNCTIONAL
CLASSIFICATION AND SIZE OF URBAN AREA

Region and Urban Area Population (millions)	Average Daily Vehicle Operating Speed by Functional Classification				
	Interstate	Principal Arterial	Minor Arterial	Collector	Local
N.E. 2+	45-50	25-35	20-30	20-30	10-20
1-2	45-50	25-30	20-25	20-25	15-20
.5-1	45-50	25-35	20-30	20-30	15-25
.2-.5	45-50	30-35	25-35	20-30	15-25
S.E. 2+	45-50	25-35	20-30	20-30	15-25
1-2	35-50	25-30	20-25	20-25	20-25
.5-1	45-50	30-40	25-30	20-30	15-25
.2-.5	45-50	30-40	25-35	20-30	20-30
NMW 2+	45-50	30-40	25-30	20-25	15-25
1-2	45-50	30-40	25-30	20-25	15-20
.5-1	45-50	30-35	25-30	15-25	15-20
.2-.5	45-50	30-40	25-35	20-30	15-25
P/R 2+	45-50	30-35	25-30	20-25	15-20
1-2	45-50	30-40	20-30	20-25	10-20
.5-1	45-50	30-35	20-25	20-25	15-25
.2-.5	45-50	25-35	20-30	20-35	20-30
W 2+	45-50	35-40	25-30	20-25	15-20
1-2	45-50	25-45	25-30	25-30	15-20
.5-1	45-50	30-35	30-35	25-30	20-25
.2-.5	45-50	25-35	20-30	20-30	15-25

TABLE 6

REASONABLENESS RANGES FOR
AVERAGE DAILY OPERATING SPEED FOR THE SYSTEM (MPH)

Region	Averge Daily Operating Speed
N.E.	20-35
S.E.	20-35
NMW	25-35
P/R	25-35
W	25-35

From 1974 National Transportation Report, Urban Data Supplement, DOT, 1976, as adjusted by PMM&Co.

TABLE 7

AVERAGE DAILY TRIP LENGTH
(MINUTES)
BY REGION AND URBAN POPULATION

Region and Urban Area Population (millions)		Average Trip Length (minutes)
N.E.	2+	13-16
	1-2	12-16
	.5-1	10-13
	.2-.5	11-15
S.E.	2+	13-19
	1-2	15-19
	.5-1	10-18
	.2-.5	6-14
NMW	2+	10-14
	1-2	12-14
	.5-1	8-11
	.2-.5	7-13
P/R	2+	11-13
	1-2	10-13
	.5-1	12-18
	.2-.5	8-14
W	2+	11-12
	1-2	10-15
	.5-1	9-14
	.2-.5	9-15

From 1974 National Transportation Report, Urban Data Supplement, DOT, May 1976, as adjusted by PMM&Co.

TABLE 8

REASONABLENESS RANGES FOR SEASONAL TRAFFIC ADJUSTMENTS, BY REGION

REGION	SEASONAL ADJUSTMENT FACTOR
N.E.	1.04 - 1.15
S.E.	.90 - 1.15
NMW	1.00 - 1.15
P/R	1.00 - 1.15
W	.90 - 1.15

From Federal Highway Administration Statistics, 1975 through 1979.

TABLE 9

NORMAL DAILY MEAN TEMPERATURE BY URBAN AREA (DEGREES F)
(1941-1970)

NORMALS 1941-70	JUL	AUG
BIRMINGHAM, ALABAMA	81.1	80.7
BIRMINGHAM, ALABAMA	79.9	79.2
HUNTSVILLE, ALABAMA	79.5	79.0
MOBILE, ALABAMA	81.6	81.5
MONTGOMERY, ALABAMA	81.0	80.7
ANCHORAGE, ALASKA	57.8	55.9
ANNETTE, ALASKA	57.8	58.3
BARROW, ALASKA	38.7	37.6
BARTER ISLAND, ALASKA	40.0	38.9
BETHEL, ALASKA	54.7	52.3
BETTLES, ALASKA	57.9	51.9
BIG DELTA, ALASKA	59.4	54.8
COLD BAY, ALASKA	50.1	51.3
FAIRBANKS, ALASKA	60.7	55.4
GULKANA, ALASKA	56.9	53.2
HOMER, ALASKA	52.3	52.4
JUNEAU, ALASKA	55.7	54.3
KING SALMON, ALASKA	54.6	53.8
KODIAK, ALASKA	54.1	54.9
KOTZEBUE, ALASKA	52.9	50.7
MC GRATH, ALASKA	58.2	53.5
NOME, ALASKA	50.1	48.2
ST. PAUL ISLAND, ALASKA	45.7	47.5
TALKEETNA, ALASKA	57.9	54.6
UNALAKLEET, ALASKA	54.0	51.9
VALDEZ, ALASKA	53.3	52.0
YAKUTAT, ALASKA	53.4	52.9
FLAGSTAFF, ARIZONA	65.6	63.6
PHOENIX, ARIZONA	91.2	89.1
TUCSON, ARIZONA	86.3	83.8
WINSLOW, ARIZONA	78.3	76.1
YUMA, ARIZONA	93.7	92.8
FORT SMITH, ARKANSAS	82.2	81.4
LITTLE ROCK, ARKANSAS	81.4	80.6
NO. LITTLE ROCK, AR	81.4	80.5
BAKERSFIELD, CALIFORNIA	83.9	81.6
BISHOP, CALIFORNIA	76.6	74.1
BLUE CANYON, CALIFORNIA	68.1	66.8
EUREKA, CALIFORNIA	58.3	57.0
FRESNO, CALIFORNIA	80.6	78.3
LONG BEACH, CALIFORNIA	72.2	73.3
LOS ANGELES, CA - INTL AP	68.5	69.5
LOS ANGELES, CA - CITY	73.2	74.1
MOUNT SHASTA, CALIFORNIA	67.8	66.0
OAKLAND, CALIFORNIA	63.1	63.5
RED BLUFF, CALIFORNIA	82.3	79.9
SACRAMENTO, CALIFORNIA	75.2	74.1
SANDBERG, CALIFORNIA	74.0	73.0
SAN DIEGO, CALIFORNIA	69.6	71.4
SAN FRANCISCO, CA - INTL AP	62.5	63.0

NORMALS 1941-70	JUL	AUG
SAN FRANCISCO, CA - CITY	58.5	59.4
SANTA MARIA, CALIFORNIA	62.1	62.3
STOCKTON, CALIFORNIA	76.7	75.3
ALAMOSA, COLORADO	65.0	62.7
COLORADO SPRINGS, COLORADO	70.7	69.1
DENVER, COLORADO	73.0	71.6
GRAND JUNCTION, COLORADO	78.7	75.4
PUEBLO, COLORADO	76.4	74.5
BRIDGEPORT, CONNECTICUT	73.8	72.7
HARTFORD, CONNECTICUT	72.7	70.4
WILMINGTON, DELAWARE	75.8	74.1
WASHINGTON, DC - DULLES AP	75.3	73.6
WASHINGTON, DC - NATIONAL AP	78.7	77.1
APALACHICOLA, FLORIDA	81.4	81.5
DAYTONA BEACH, FLORIDA	81.0	81.1
FORT MYERS, FLORIDA	82.5	82.8
JACKSONVILLE, FLORIDA	81.0	81.0
KEY WEST, FLORIDA	84.6	84.7
LAKELAND, FLORIDA	81.6	81.9
MIAMI, FLORIDA	82.3	82.9
ORLANDO, FLORIDA	81.4	81.8
PENSACOLA, FLORIDA	81.8	81.8
TALLAHASSEE, FLORIDA	81.1	81.1
TAMPA, FLORIDA	81.9	82.2
WEST PALM BEACH, FLORIDA	81.9	82.3
ATHENS, GEORGIA	78.1	78.4
ATLANTA, GEORGIA	78.0	77.5
AUGUSTA GEORGIA	80.4	79.6
COLUMBUS, GEORGIA	80.6	80.3
MACON, GEORGIA	81.4	80.8
ROME, GEORGIA	78.7	78.1
SAVANNAH, GEORGIA	81.1	80.6
HILO, HAWAII	75.3	75.9
HONOLULU, HAWAII	80.1	80.7
KAHULUI, HAWAII	78.2	78.8
LIHUE, HAWAII	78.4	79.1
BOISE, IDAHO	74.5	72.2
LEWISTON, IDAHO	73.4	71.5
POCATELLO, IDAHO	71.5	68.5
CAIRO, ILLINOIS	80.7	78.2
CHICAGO, IL - O HARE AP	71.9	71.1
CHICAGO, IL - MIDWAY AP	74.7	73.7
MOLINE, ILLINOIS	74.5	72.8
PEORIA, ILLINOIS	75.1	73.5
ROCKFORD, ILLINOIS	72.8	71.5
SPRINGFIELD, ILLINOIS	76.1	74.4
EVANSVILLE, INDIANA	77.8	76.2
FORT WAYNE, INDIANA	73.0	71.3
INDIANAPOLIS, INDIANA	75.0	73.2
SOUTH BEND, INDIANA	72.3	71.0

TABLE 9 (continued)

NORMAL DAILY MEAN TEMPERATURE BY URBAN AREA (DEGREES F)
(1941-1970)

NORMALS 1941-70	JUL	AUG
BURLINGTON, IOWA	75.4	73.8
DES MOINES, IOWA	75.1	73.3
DUBUQUE, IOWA	71.7	70.3
SIOUX CITY, IOWA	75.3	73.5
WATERLOO, IOWA	72.6	70.8
CONCORDIA, KANSAS	77.9	77.2
DODGE CITY, KANSAS	79.2	78.1
GOODLAND, KANSAS	75.8	74.1
TOPEKA, KANSAS	78.2	77.2
WICHITA, KANSAS	80.7	79.7
CINCINNATI AP-COVINGTON, KY	75.6	74.4
LEXINGTON, KENTUCKY	78.2	76.0
LOUISVILLE, KENTUCKY	76.8	75.8
BATON ROUGE, LOUISIANA	82.0	81.6
LAKE CHARLES, LOUISIANA	82.4	82.2
NEW ORLEANS, LOUISIANA	81.8	81.9
SHREVEPORT, LOUISIANA	83.2	83.2
CARIBOU, MAINE	64.8	62.3
PORTLAND, MAINE	68.0	66.4
BALTIMORE, MARYLAND	76.6	74.8
BLUE HILL OBSERVATORY - MA	71.1	69.4
BOSTON, MASSACHUSETTS	73.3	71.3
WORCESTER, MASSACHUSETTS	70.1	68.1
ALPENA, MICHIGAN	65.5	64.2
DETROIT, MI - CITY AP	73.3	71.8
DETROIT, MI - METRO AP	72.3	70.8
FLINT, MICHIGAN	69.7	68.2
GRAND RAPIDS, MICHIGAN	71.5	70.0
HOUGHTON LAKE, MICHIGAN	66.2	64.8
LANSING, MICHIGAN	70.9	69.5
MARQUETTE, MICHIGAN	66.3	65.5
MUSKEGON, MICHIGAN	70.0	69.0
SAULT STE. MARIE, MICHIGAN	63.8	63.2
DULUTH, MINNESOTA	65.6	64.1
INTERNATIONAL FALLS, MINNESOTA	65.8	63.2
MINNEAPOLIS-ST.PAUL, MINNESOTA	71.9	70.2
ROCHESTER, MINNESOTA	70.1	68.6
SAINT CLOUD, MINNESOTA	70.2	68.4
JACKSON, MISSISSIPPI	81.7	81.2
MERIDIAN, MISSISSIPPI	81.2	80.7
COLUMBIA, MISSOURI	77.3	76.0
KANSAS CITY, MISSOURI	77.5	76.5
KANSAS CITY, MO	81.5	79.8
SAINT JOSEPH, MISSOURI	78.2	76.5
ST. LOUIS, MISSOURI	78.6	77.2
SPRINGFIELD, MISSOURI	77.8	77.1
BILLINGS, MONTANA	71.8	70.1
GLASGOW, MONTANA	70.5	69.0
GREAT FALLS, MONTANA	69.3	67.4
HAVRE, MONTANA	69.9	68.0

NORMALS 1941-70	JUL	AUG
HELENA, MONTANA	67.9	66.2
KALISPELL, MONTANA	64.3	62.5
MILES CITY, MONTANA	74.4	72.5
MISSOULA, MONTANA	66.6	65.0
GRAND ISLAND, NEBRASKA	76.3	75.0
LINCOLN, NEBRASKA	77.3	75.6
NORFOLK, NEBRASKA	75.5	73.8
NORTH PLATTE, NEBRASKA	74.3	73.0
OMAHA, NEBRASKA	77.2	75.6
OMAHA (NORTH), NEBRASKA	75.1	73.7
SCOTTSBLUFF, NEBRASKA	73.7	71.6
VALENTINE, NEBRASKA	74.1	72.5
ELKO, NEVADA	69.5	67.0
ELY, NEVADA	67.2	65.5
LAS VEGAS, NEVADA	89.6	87.4
RENO, NEVADA	69.3	66.9
WINNEMUCCA, NEVADA	71.0	67.8
CONCORD, NEW HAMPSHIRE	69.7	67.2
MT. WASHINGTON, NH	48.8	47.0
ATLANTIC CITY, NEW JERSEY	75.1	73.4
NEWARK, NEW JERSEY	76.4	74.6
TRENTON, NEW JERSEY	75.9	73.9
ALBUQUERQUE, NEW MEXICO	78.7	76.6
CLAYTON, NEW MEXICO	73.6	72.4
ROSWELL, NEW MEXICO	79.2	77.9
ALBANY, NEW YORK	72.0	69.6
BINGHAMTON, NEW YORK	69.1	67.3
BUFFALO, NEW YORK	70.1	68.4
NEW YORK, NY - CENTRAL PARK	76.6	74.8
NEW YORK, NY - JFK AP	75.1	73.6
NEW YORK, NY - LA GUARDIA AP	76.7	74.9
ROCHESTER, NEW YORK	71.2	69.3
SYRACUSE, NEW YORK	71.5	69.7
ASHEVILLE, NORTH CAROLINA	73.5	72.8
CAPE HATTERAS, NORTH CAROLINA	78.0	77.5
CHARLOTTE, NORTH CAROLINA	78.5	77.7
GREENSBORO, NORTH CAROLINA	77.2	76.0
RALEIGH, NORTH CAROLINA	77.5	76.5
WILMINGTON, NORTH CAROLINA	80.4	79.5
BISMARCK, NORTH DAKOTA	70.8	69.2
FARGO, NORTH DAKOTA	70.7	69.2
WILLISTON, NORTH DAKOTA	70.1	68.5
AKRON, OHIO	71.7	70.3
CINCINNATI, OHIO	76.2	75.1
CLEVELAND, OHIO	71.4	70.0
COLUMBUS, OHIO	73.6	71.9
DAYTON, OHIO	74.6	73.0
MANSFIELD, OHIO	73.5	72.1
TOLEDO, OHIO	72.3	70.8
YOUNGSTOWN, OHIO	70.7	69.2

TABLE 9 (continued)

NORMAL DAILY MEAN TEMPERATURE BY URBAN AREA (DEGREES F)

(1941-1970)

NORMALS 1941-70	JUL	AUG
OKLAHOMA CITY, OKLAHOMA	81.6	81.1
TULSA, OKLAHOMA	82.1	81.4
ASTORIA, OREGON	60.0	60.3
BURNS, OREGON	68.4	68.1
EUGENE, OREGON	66.9	66.1
MEDFORD, OREGON	71.7	70.4
PENDLETON, OREGON	73.5	71.5
PORTLAND, OREGON	67.1	66.6
SALEM, OREGON	66.6	66.1
SEXTON SUMMIT, OREGON	63.6	63.1
GUAM, PACIFIC	78.4	78.1
JOHNSTON ISLAND, PACIFIC	80.8	81.2
KOROR ISLAND, PACIFIC	81.1	81.2
KWAJALEIN ISLAND, PACIFIC	82.8	82.5
MAJURO, MARSHALL IS, PACIFIC	81.0	81.6
PAGO PAGO, AMERICAN SAMOA	78.3	78.2
PONAPE ISLAND, PACIFIC	80.0	80.1
TRUK, CAROLINE IS, PACIFIC	80.7	80.9
WAKE ISLAND, PACIFIC	82.0	82.6
YAP ISLAND, PACIFIC	81.2	81.0
ALLENTOWN, PENNSYLVANIA	74.1	71.7
ERIE, PENNSYLVANIA	68.7	67.5
HARRISBURG, PENNSYLVANIA	76.1	73.8
PHILADELPHIA, PENNSYLVANIA	76.8	74.8
PITTSBURGH, PA - INTL AP	71.9	70.2
PITTSBURGH, PA - CITY	74.6	73.0
AVOCA, PENNSYLVANIA	72.2	70.0
WILLIAMSPORT, PENNSYLVANIA	72.9	70.9
SAN JUAN, PUERTO RICO	80.9	81.3
BLOCK ISLAND, RHODE ISLAND	69.5	69.2
PROVIDENCE, RHODE ISLAND	72.1	70.4
CHARLESTON, SOUTH CAROLINA	80.2	79.6
COLUMBIA, SOUTH CAROLINA	81.2	80.2
GREENVILLE-SPARTANBURG, SC	78.3	77.5
ABERDEEN, SOUTH DAKOTA	71.8	70.6
HURON, SOUTH DAKOTA	73.7	72.1
RAPID CITY, SOUTH DAKOTA	72.6	71.6
SIOUX FALLS, SOUTH DAKOTA	73.3	71.8
BRISTOL-JOHNSON CITY, TN	75.2	74.2
CHATTANOOGA, TENNESSEE	78.8	78.0
KNOXVILLE, TENNESSEE	78.2	77.3
MEMPHIS, TENNESSEE	81.6	80.4
NASHVILLE, TENNESSEE	79.6	78.5
OAK RIDGE, TENNESSEE	77.0	76.1
ABILENE, TEXAS	83.9	83.6
AMARILLO, TEXAS	78.7	77.6
AUSTIN, TEXAS	84.6	84.7
BROWNSVILLE, TEXAS	84.4	84.1
CORPUS CHRISTI, TEXAS	84.8	85.1
DALLAS-FORT WORTH, TEXAS	84.8	84.9

NORMALS 1941-70	JUL	AUG
DEL RIO, TEXAS	86.7	86.1
EL PASO, TEXAS	82.3	80.5
GALVESTON, TEXAS	83.2	83.3
HOUSTON, TEXAS	83.3	83.4
LUBBOCK, TEXAS	79.7	78.4
MIDLAND-ODESSA, TEXAS	82.3	81.0
PORT ARTHUR, TEXAS	83.0	83.1
SAN ANGELO, TEXAS	84.7	84.5
SAN ANTONIO, TEXAS	84.7	84.7
VICTORIA, TEXAS	84.4	84.5
WACO, TEXAS	85.6	85.7
WICHITA FALLS, TEXAS	85.8	85.5
MILFORD, UTAH	74.3	72.6
SALT LAKE CITY, UTAH	76.7	74.5
BURLINGTON, VERMONT	69.8	67.4
LYNCHBURG, VIRGINIA	75.8	74.4
NORFOLK, VIRGINIA	78.3	76.9
RICHMOND, VIRGINIA	77.9	76.3
ROANOKE, VIRGINIA	75.2	74.1
OLYMPIA, WASHINGTON	63.6	62.8
QUILLAYUTE, WASHINGTON	59.0	58.8
SEATTLE, WA - URBAN SITE	65.7	64.9
SEATTLE, WA - INTL AP	64.5	63.8
SPOKANE, WASHINGTON	69.7	68.0
STAMPEDE PASS, WASHINGTON	56.2	55.7
WALLA WALLA, WASHINGTON	75.6	73.6
YAKIMA, WASHINGTON	70.7	68.6
BECKLEY, WEST VIRGINIA	70.0	68.8
CHARLESTON, WEST VIRGINIA	75.0	73.6
ELKINS, WEST VIRGINIA	68.7	67.4
HUNTINGTON, WEST VIRGINIA	75.3	73.9
PARKERSBURG, WEST VIRGINIA	75.2	73.8
GREEN BAY, WISCONSIN	69.2	67.7
LA CROSSE, WISCONSIN	72.8	71.4
MADISON, WISCONSIN	70.1	68.7
MILWAUKEE, WISCONSIN	69.9	68.2
CASPER, WYOMING	71.0	69.6
CHEYENNE, WYOMING	69.1	67.6
LANDER, WYOMING	70.6	69.0
SHERIDAN, WYOMING	70.4	68.2

FIGURE 3

MOBILE 1
COMPOSITE FLEET EMISSION RANGES
NON-METHANE HC
gm/VMT

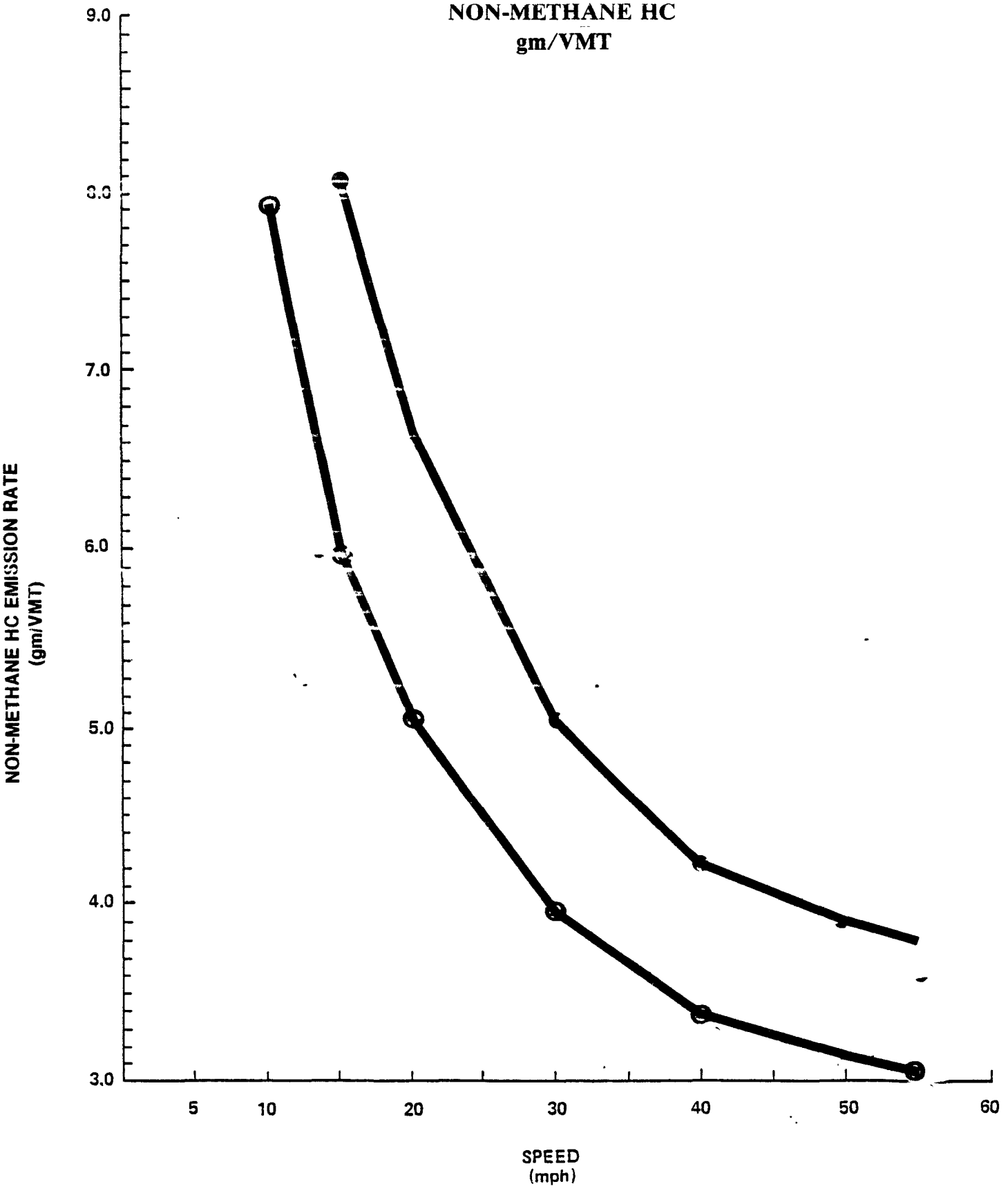


FIGURE 4

MOBILE 1
COMPOSITE FLEET EMISSION RANGES
NOx
gm/VMT

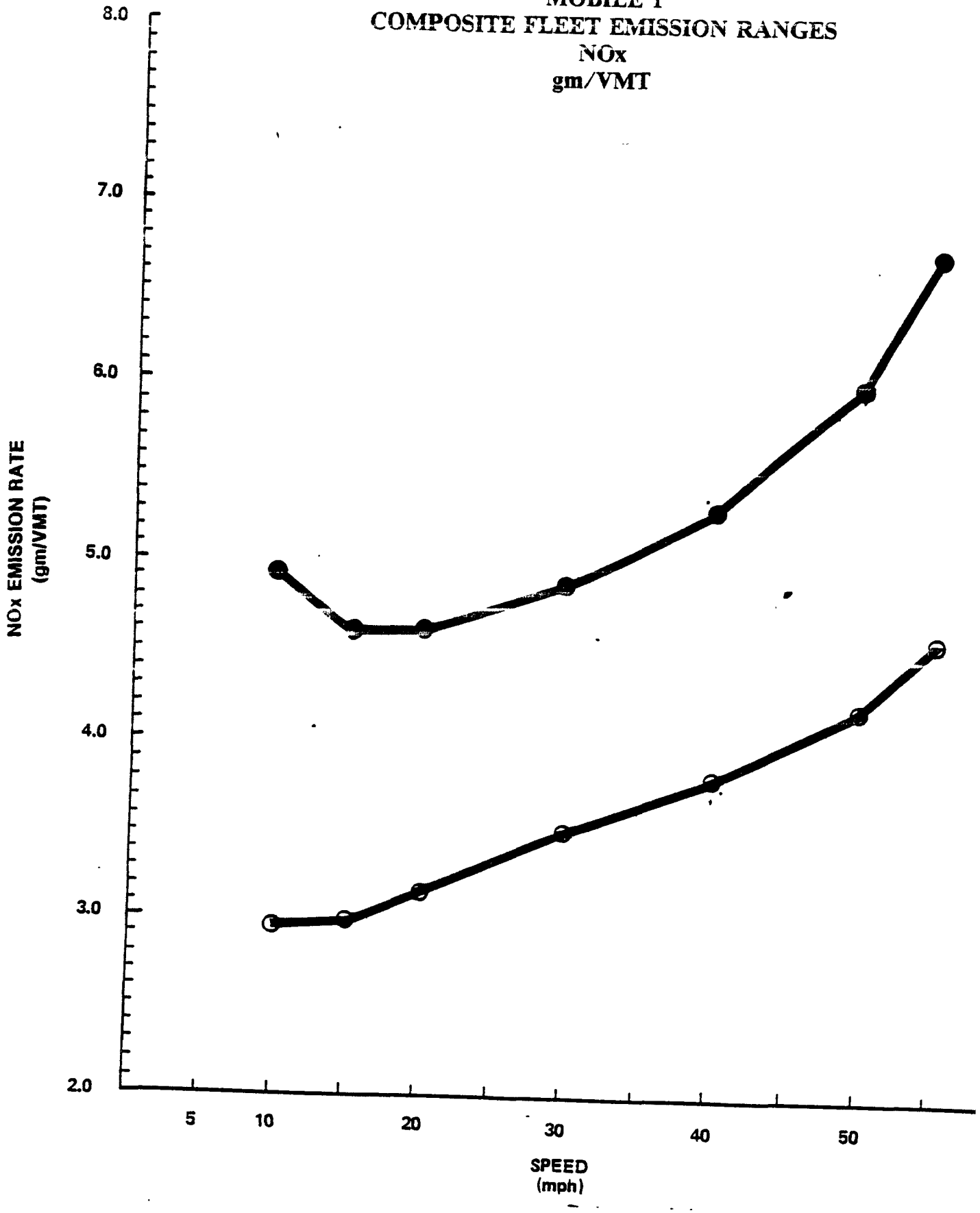


FIGURE 5

MOBILE 1
TOTAL EMISSION RATE RANGES
AUTOMOBILES
NON-METHANE HC
gm/VMT

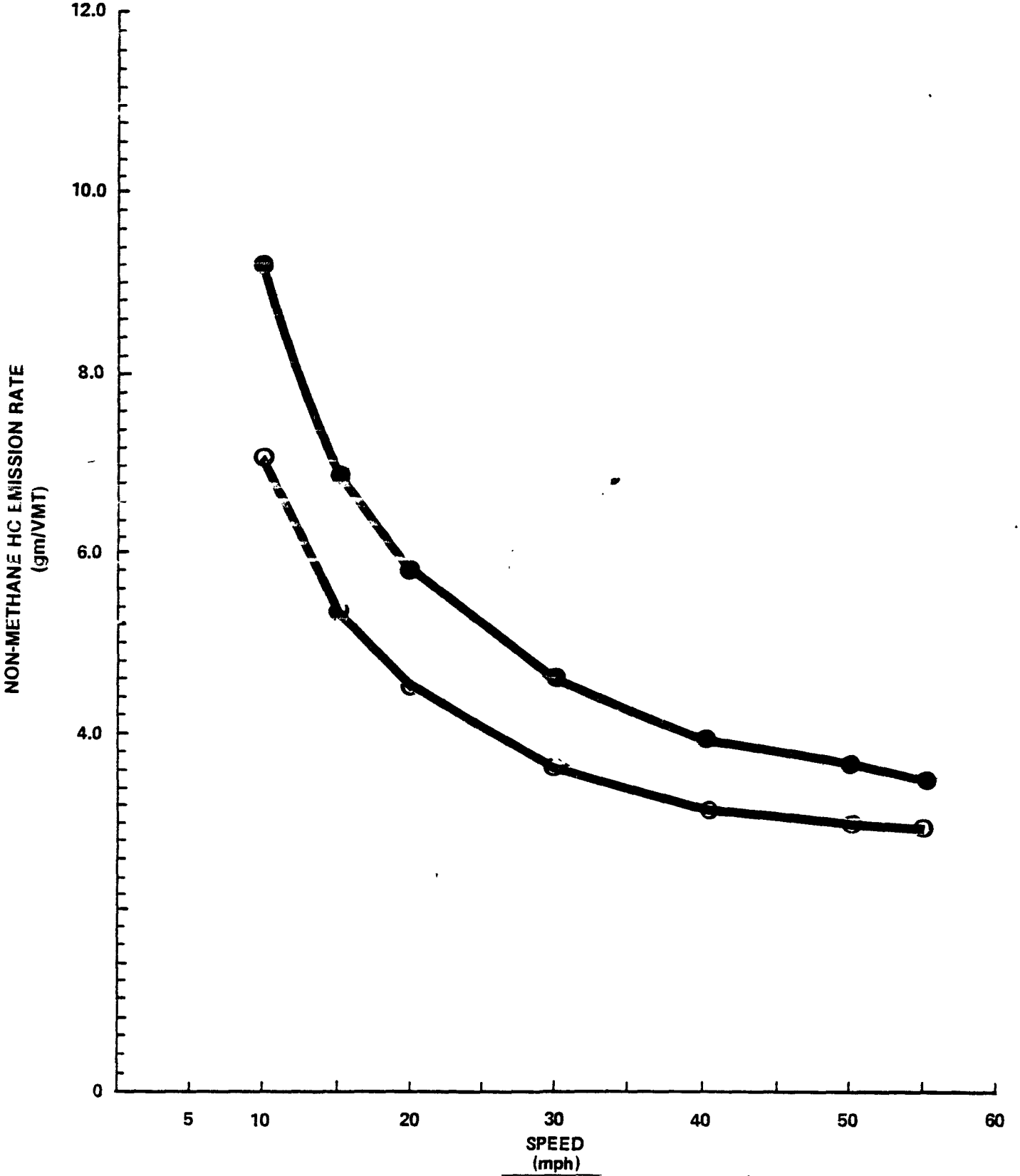


FIGURE 6

MOBILE 1
TOTAL EMISSION RATE RANGES
AUTOMOBILES
NOx
gm/VMT

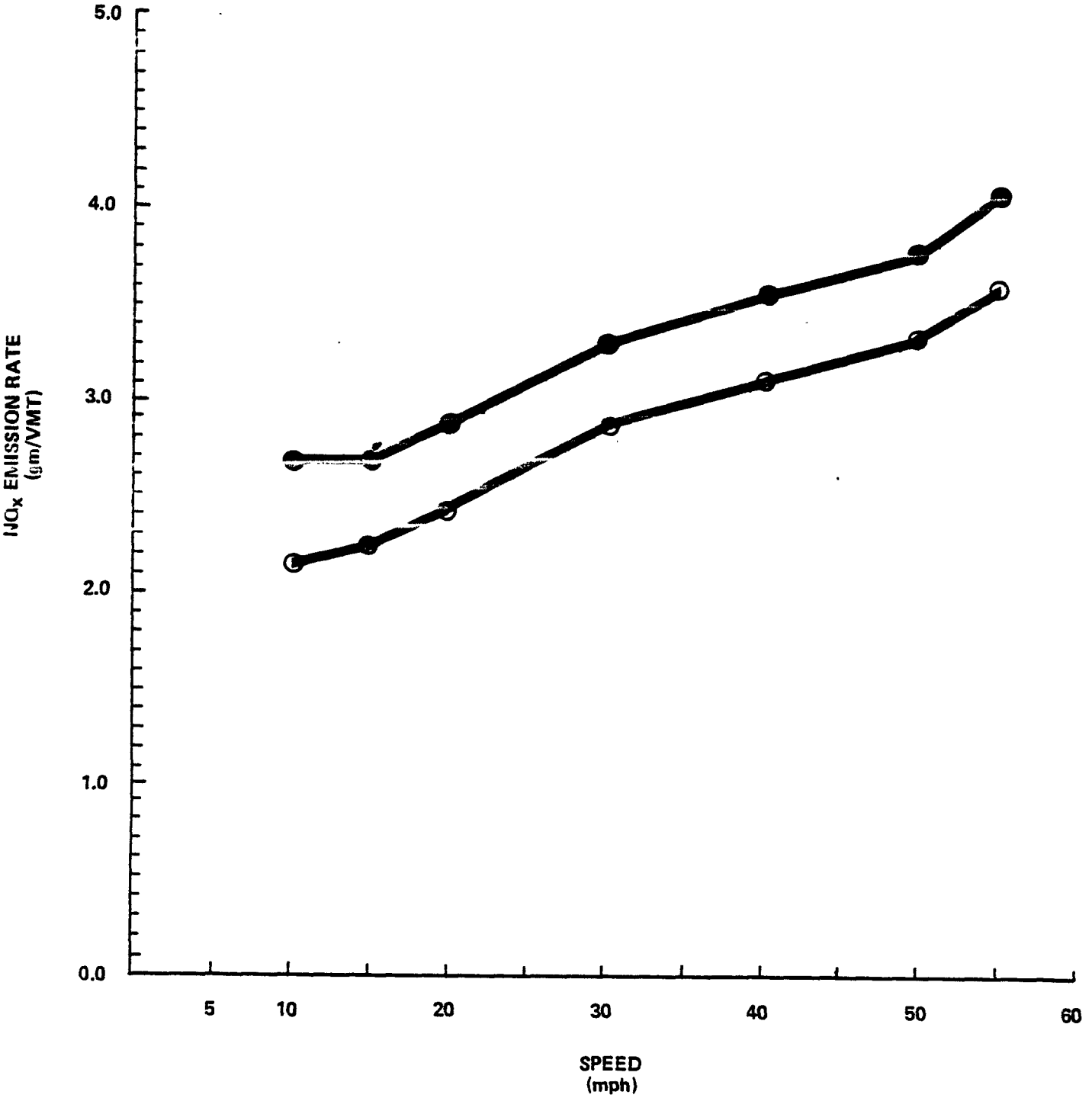


FIGURE 7

MOBILE 1
TOTAL EMISSION RATE RANGES
TRUCKS
NON-METHANE HC
gm/VMT

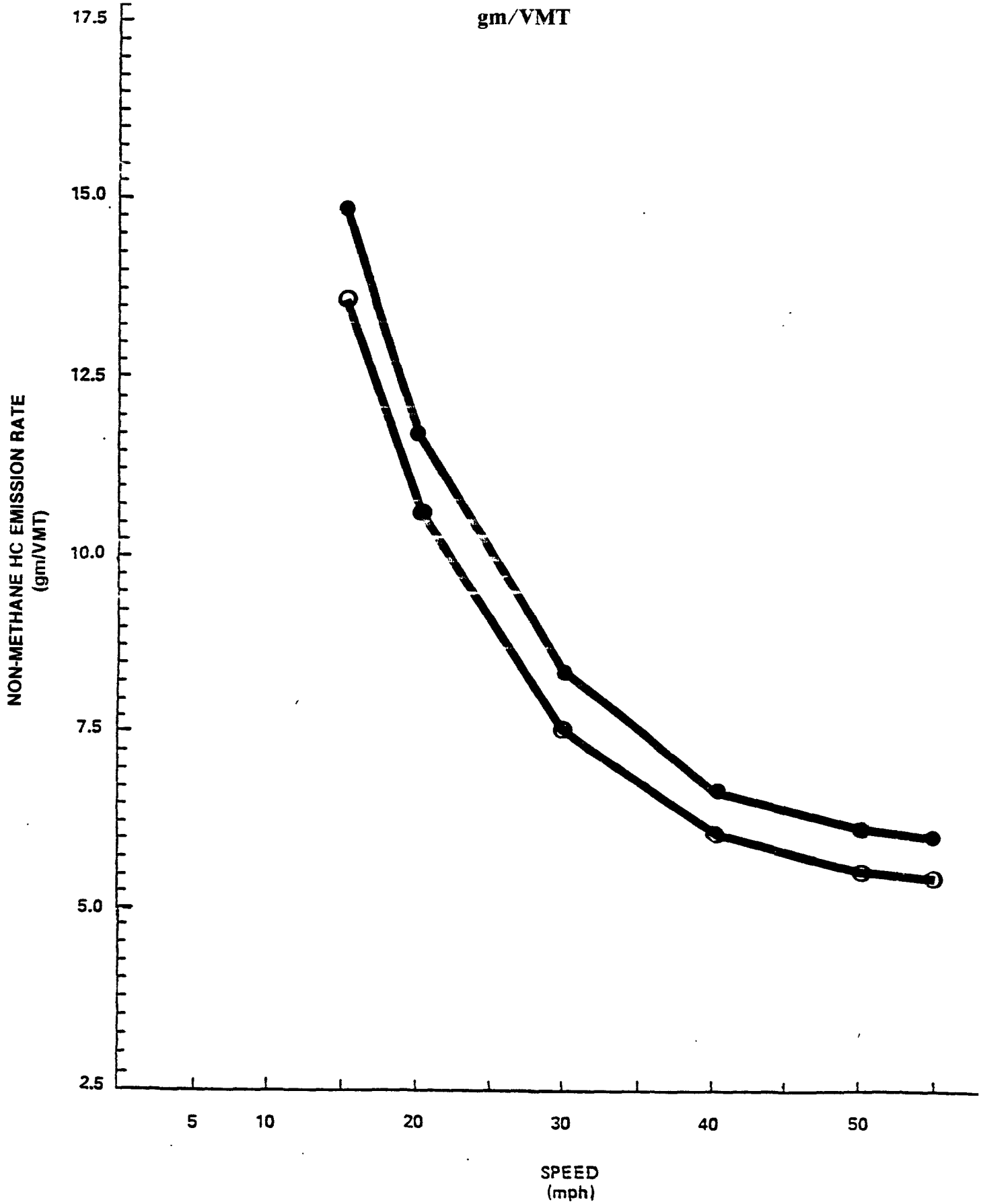


FIGURE 8

MOBILE 1
TOTAL EMISSION RATE RANGES
TRUCKS
NOx
gm/VMT

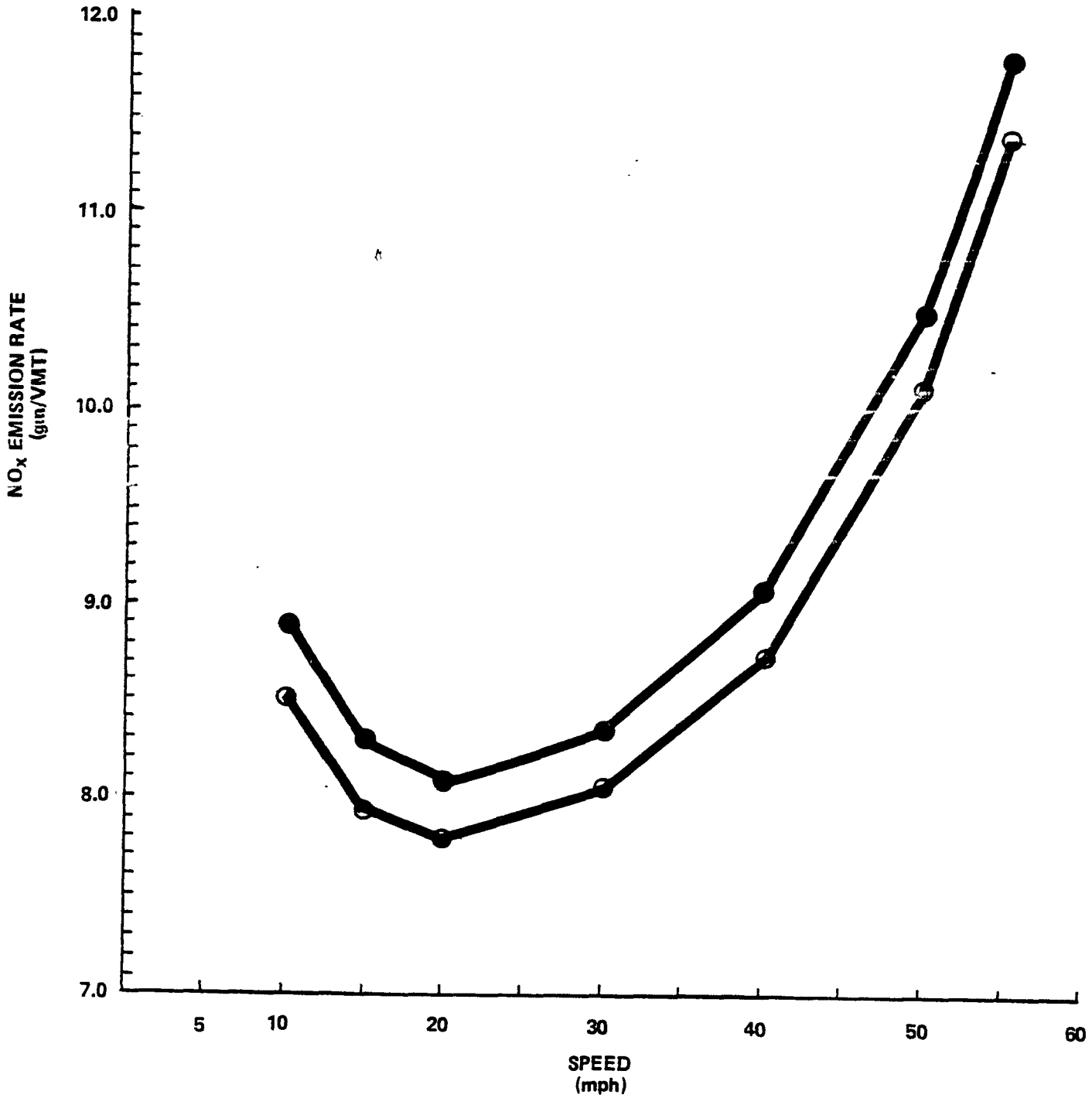


FIGURE 9

MOBILE 2
COMPOSITE FLEET EMISSION RANGES
NON-METHANE HC
gm/VMT

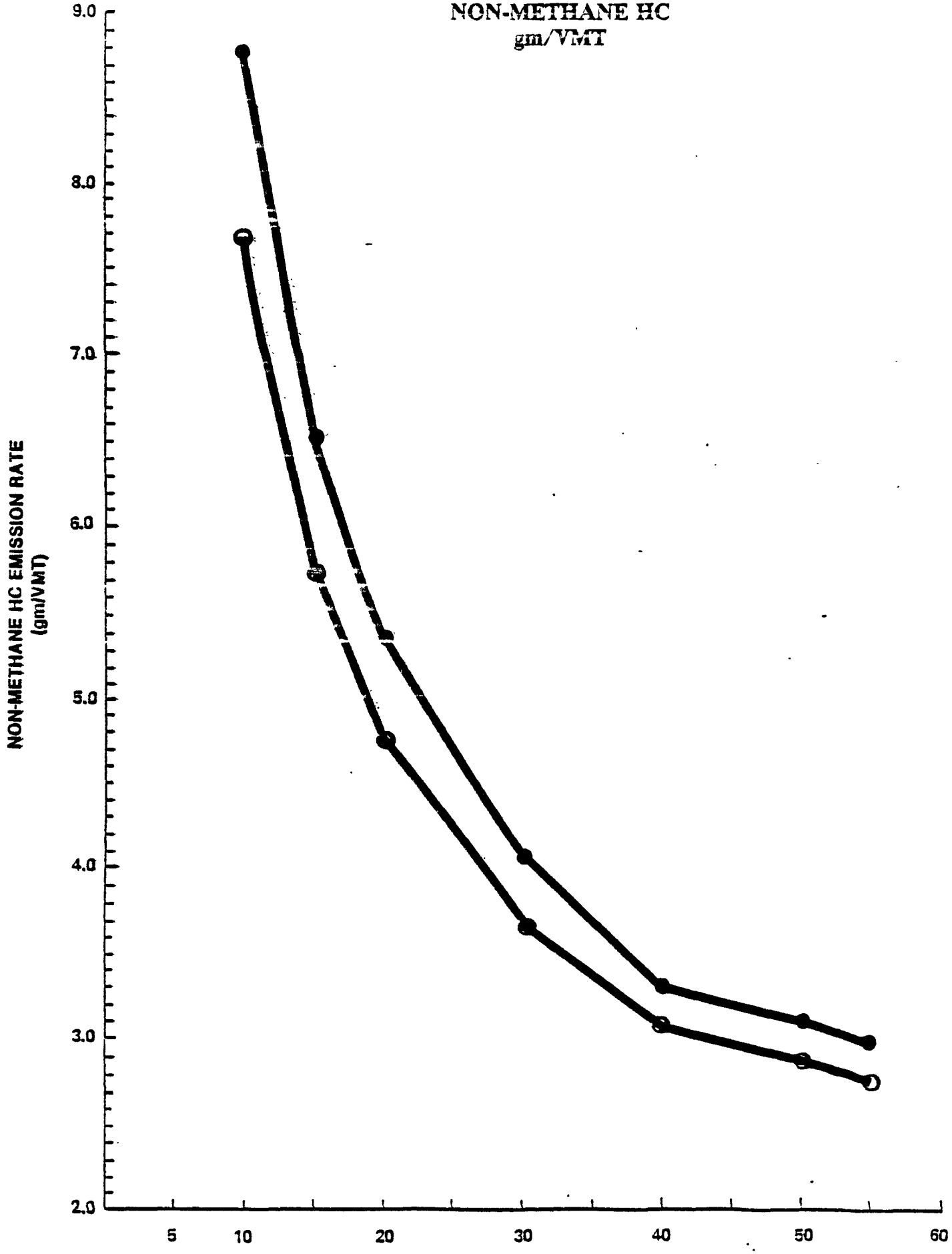


FIGURE 10

MOBILE 2
COMPOSITE FLEET EMISSION RANGES
NOx
gm/VMT

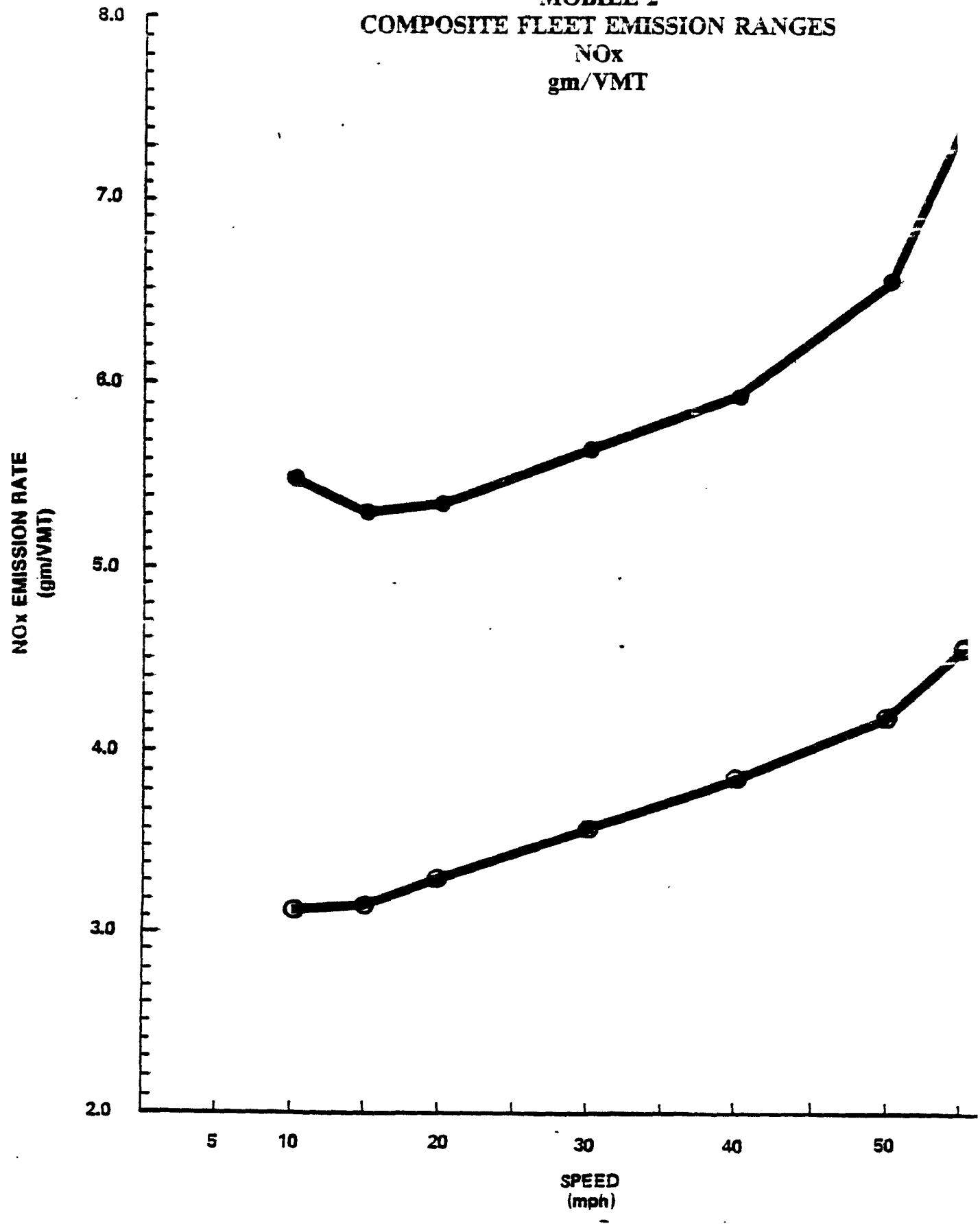


FIGURE 11

MOBILE 2
TOTAL EMISSION RATE RANGES
AUTOMOBILES
NON-METHANE HC
gm/VMT

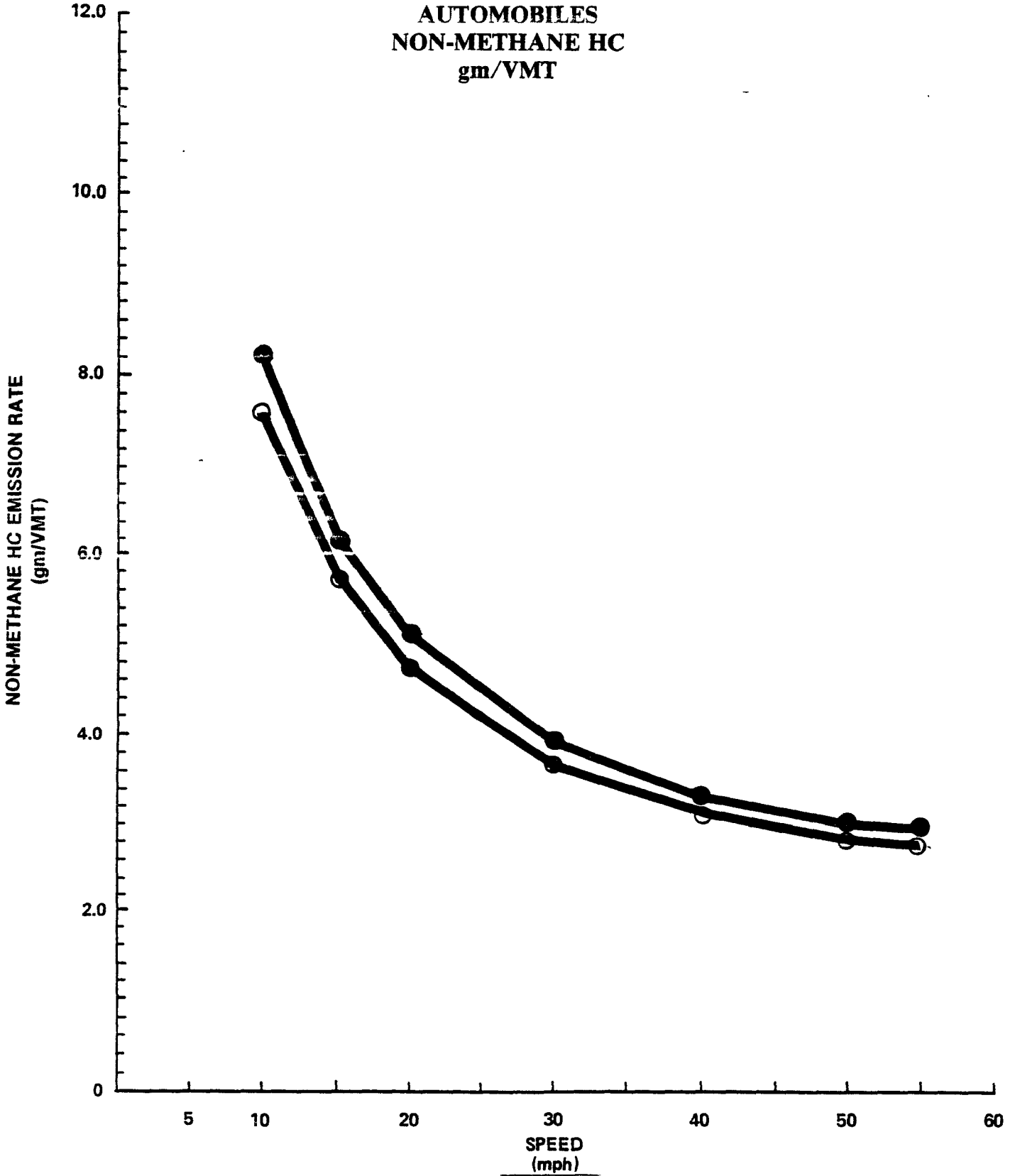


FIGURE 12

MOBILE 2
TOTAL EMISSION RATE RANGES
AUTOMOBILES
NOx
gm/VMT

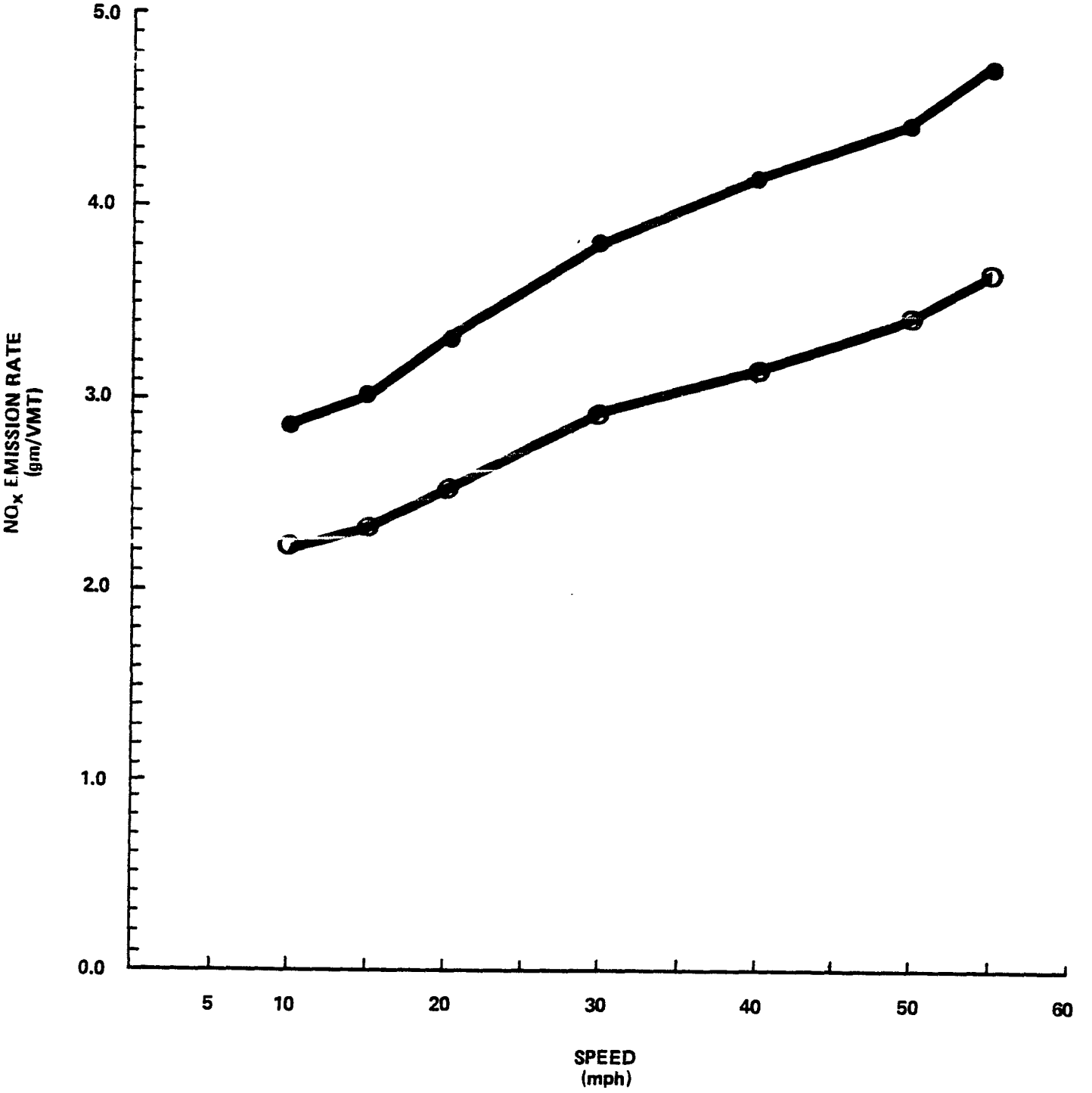


FIGURE 13

MOBILE 2
TOTAL EMISSION RATE RANGES
TRUCKS
NON-METHANE HC
gm/VMT

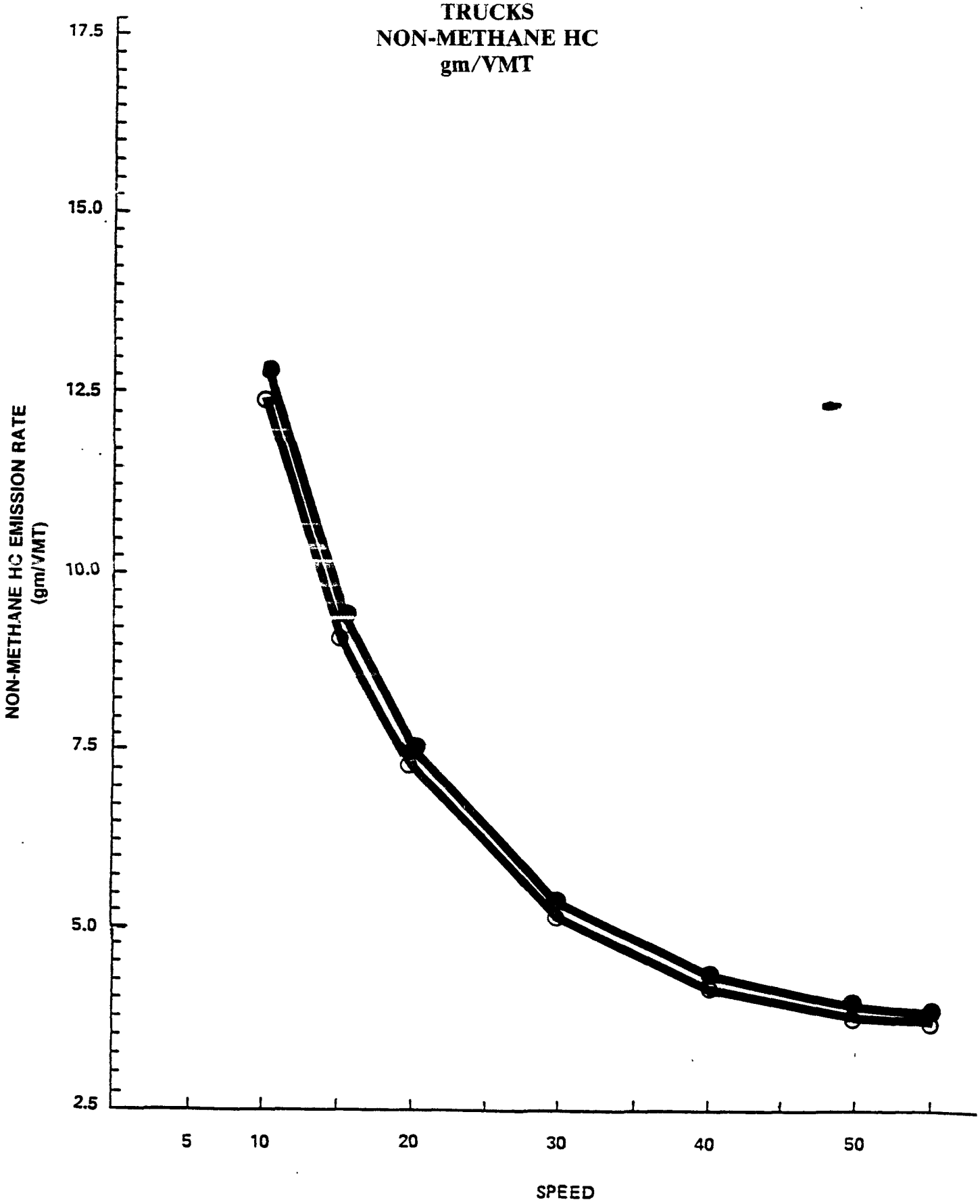
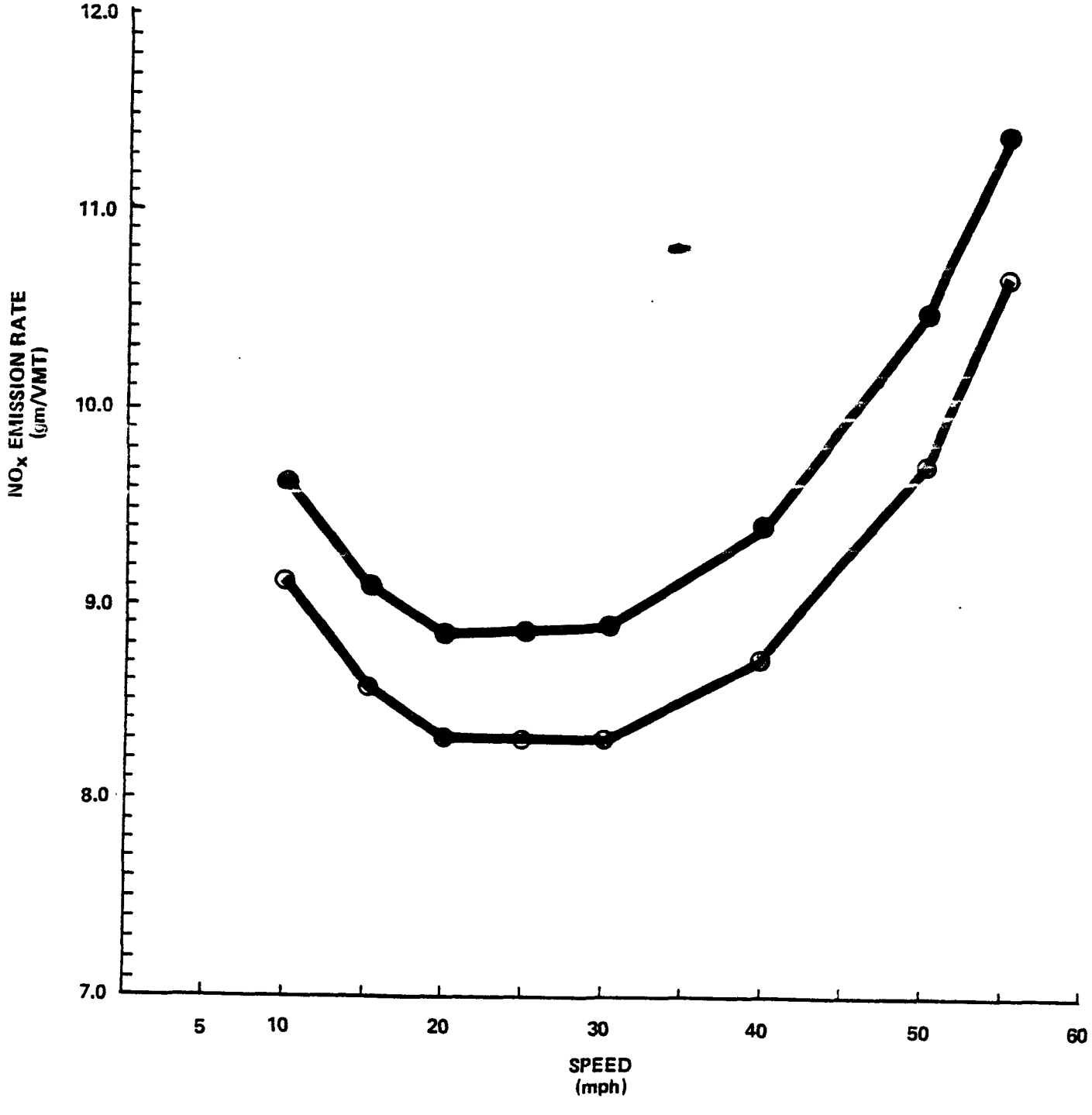


FIGURE 14

MOBILE 2
TOTAL EMISSION RATE RANGES
TRUCKS
NOx
gm/VMT



APPENDIX B

DOCUMENTATION OF REASONABLENESS CRITERIA

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DOCUMENTATION OF REASONABLENESS CRITERIA

The principal sources of information for developing the reasonableness criteria in Appendix A are included the following reports:

- USDOT. 1974 National Transportation Report, Urban Data Supplement. 1976.
- Characteristics of Urban Transportation Demand - A Handbook for Transportation Planners, Wilbur Smith and Associates for UMTA. UMTA-IT-06-0049-78-1, April, 1978.
- How to Prepare the Transportation Portion of Your State Air Quality Implementation Plan, USDOT/FHWA/EPA/ November, 1978.

Many of the tabulations in Appendix A were derived from the 1974 National Transportation Report. In most instances, the only adjustments made to these estimates were the rounding of published data and the dropping of selected data points which appeared to be unique or in error. There are several reasons for using this source of information: It provides consistent information for 1972 for urban areas throughout the nation; and it presents information that is unavailable in other sources. This reference includes forecasts for 1980 and 1990, but this information is based on planned transportation investments which may or may not have been implemented between 1972 and 1980.

Several updates were made to selected data items in this reference:

- In the case of VMT/capita, the 1972 estimates were updated to 1980 by multiplying by a factor of 1.225. This factor came from comparing national changes in total urban VMT and urban population between 1972 and 1979. This information was obtained from the Highway Statistics reports published by FHWA and from the Bureau of the Census.
- Average speed for the Interstate system in 1972 was lowered to reflect the 55 mph speed limit. The average operating speeds for each remaining functional classification were considered reasonable, as were the percentages of VMT for each functional highway classification.

Of the tables not derived primarily from the National Transportation Report, the cold start/hot start fractions presented the most difficulty. Because of the highly variable nature in which this parameter can be reported, it was decided that a single set of ranges for the entire urban area based on 24-hour conditions, was the criteria most readily available from all urban areas. The ranges were set up using the cold/hot/ stable fractions by time of day from the report, The Determination of Vehicular Cold and Hot Operating Fractions for Estimating Highway Emissions in combination with information on fraction of vehicle travel by time of day contained in the report, Characteristics of Urban Travel Demand. The combined tables provide the basis for the daily average of cold/hot/ stable fractions presented in Table 2.

The emission rate criteria in Figures 3 through 8 were estimated using MOBILE 1. MOBILE 2 was used for Figures 9 through 14. The assumptions used for each of the model runs are listed below.

- For Figures 3, 4, 9, and 10:

  Lower Curve - 80% LDV, 3.0% LDT1, 5.0% LDT2, 4.5% HDG, 7.5% HDD with 43% cold start (catalyst), 27% hot start catalyst, and 30% cold start (non-catalyst). Temperature 75° F, humidity 75 grains, no air conditioning, loading, or trailer correction factors were used.

  Upper Curve - 85% LDV, 4.5% LDT1, 5.5% LDT2, 1.5% HDG, 2.5% HDD, 1% MC with 12% cold start (catalyst), 7% hot start (catalyst), and 10% cold start (non-catalyst). Temperature 75° F, humidity 75 grains, no air conditioning, loading, or trailer correction factors were used.

- For Figures 5, 6, 11, and 12:

  Lower Curve - 99% LDV, 1% MC, Temperature 75° F., 43% cold start (catalyst), 27% hot start (catalyst), 30% cold start (non-catalyst), humidity 75 grains, no air conditioning, loading, or trailer correction factors were used.

  Upper Curve - 99% LDV, 1% MC, Temperature 75° F, 12% cold start (catalyst), 7% hot start (catalyst), 10% cold start (non-catalyst), humidity 75 grains, no air conditioning, loading, or trailer correction factors were used.

- For Figures 7, 8, 13, and 14:

  Lower Curve - 0% LDV, 30.2% LDT1, 30.2% LDT2, 23.5% HD, 16.1% HDD, Temperature 75° F, with 43% cold start (catalyst), 27% hot start (catalyst), 30% cold start (non-catalyst), humidity 75 grains, no air conditioning, loading, or trailer correction factors were used.

  Upper Curve - 0% LDV, 30.2% LDT1, 30.2% LDT2, 23.5% HDG, 16.1% HDD, Temperature 75° F with 12% cold start (catalyst), 7% hot start (catalyst), 10% cold start (non-catalyst), humidity 75 grains, no air conditioning, loading, or trailer correction, factors were used.

APPENDIX C

DEFINITIONS

APPENDIX C
DEFINITIONS

Vehicle Classifications

LDV: All automobiles.

LDT1: Trucks used chiefly for personal transportation which are powered by gasoline fueled, spark-ignited internal combustion engines, and have a gross vehicle weight (GVW) of 6000 lbs. or less.

LDT2: See LDT1, except that vehicles have a GVW between 6000 and 8500 lbs.

HDG: Trucks and buses having a GVW of over 8500 lbs., and are powered by gasoline-fueled, spark ignited internal combustion engines.

HDD: Trucks and buses having a GVW over 8500 lbs., and which are powered by diesel engines.

MC: Motorcycles.

Source: Mobile Source Emissions Factors, EPA, 1978, EPA-400/9-78-006

Highway Functional Classifications

Interstate: Any roadway that constitutes a part of The National System of Interstate and Defense Highways.

Principal Arterial: Streets and highways serving major metropolitan activity centers, the highest traffic volume corridors, the longest trip desires, and a high proportion of total urban area travel on a minimum of milleage.

Minor Arterial: Streets and highways interconnecting with and augmenting the urban principal arterial system, and providing service to trips of moderate length at a somewhat lower level of travel mobility.

Collector: Streets penetrating neighborhoods, collecting traffic from local streets in the neighborhoods, and channeling it into the arterial system.

Local: Streets not classified in a higher system, primarily providing direct access to abutting land, and access to higher systems.

Source: 1968 National Highway Functional Classification Study Manual, USDOT, April, 1969.

APPENDIX D

EXAMPLES OF COMPLETED WORKSHEETS

Reviewer - John Doe
Date - 10-17-80

METHODOLOGY REVIEW SHEET

1. Urban Area - Example City

2. What agency developed the base year HC and NOx emissions inventories for highway sources? (List agency name, address and telephone number.)

Example City Regional Planning Commission
1000 Downtown Drive
Example City, State 10000 Phone (101) 654-3210

3. a) For what base year have the emissions inventories been established? 1980

b) If 1980 is not the base year for the emission inventories, indicate why another year was used.

4. What type of procedure was used to estimate highway emissions? (Check one)

- [x] - Link-based procedure *
- [ ] - Trip-based procedure *
- [ ] - Hybrid procedure *
- [ ] - Other (Please explain below)

* Section II of this manual describes each of these procedures in more detail.

5. a) How were VMT and vehicle operating speeds estimated for use in developing the emissions inventories? (e.g. Are the estimates based on traffic counts and travel time surveys or are they based on estimates from the travel forecasting procedures used for urban transportation planning?)

VMT and speeds were developed using the Urban Transportation Planning models for this area.

b) Are there any elements of the travel estimation procedures that are questionable?

24-hour traffic assignments were made to estimate VMT & speeds. Little effort was made to account for the effects of peak and off-peak travel on speeds and the emission factors.

c) What year's data was used to calibrate the travel estimation procedures cited in Question 5a?

1963 travel survey data was used for calibration.

d) When were the procedures cited in question 5a last validated (i.e., checked to determine if they can reproduce observed traffic flows)?

Traffic assignment outputs for 1977 were compared with 1977 traffic counts at 6 screenlines and a CBD cordon line. All comparisons were within ±7%, while the overall comparison for all screenlines was within 1.5%.

6. Are estimates of "off-network" VMT (e.g., VMT on links normally not included in a computerized highway network) accounted for in the highway emissions inventories? If yes, briefly describe how the VMT and corresponding operating speeds estimates for each travel were determined.

Yes - off-network VMT is produced from intrazonal trip tables. Speeds are estimated by professional judgement.

7. a) What procedure was used to estimate mobile source emission factors? (Check one)

- [x] MOBILE 1
- [ ] MOBILE 2
- [ ] Other procedure (Enter name of procedure) _____

b) If "Other" was checked in question 7a, describe and assess the adequacy of the procedure.

_____

_____

_____

8. Based on the above, summarize and briefly discuss any major deficiencies in the travel and emissions estimation procedures used by this urban area.

Although travel models are based on old information, they were satisfactorily validated in 1977 and appear reasonable for developing the 1980 emission inventory.

WORKSHEET 1

TRAVEL DATA FOR REASONABLENESS ASSESSMENT

NAME OF URBAN AREA Example City

REGION OF COUNTY (SEE FIGURE 2) NMW (Northern Midwest)

VARIABLE	ESTIMATE FOR BASE YEAR VALUE	UNITS	SOURCE
1. Population	1,750	1,000's	Regional Land Use Plan from 1978 for Base Year 1977.
2. Average Daily VMT by Functional Class *	69	1,000's of vehicle miles	Transit Miles
a) Interstate	8716	(000)	- interstate
b) Principal Arterial	-	(000)	
c) Minor Arterial	14,146	(000)	- standard surface streets
d) Collectors	-	(000)	
e) Local	2373	(000)	- Collector & local Streets
f) Total	25,304	(000)	from: Regional Air Quality and Maintenance Plan, 1980
3. Average Daily VMT by Vehicle Class **		1,000's of vehicle miles	
a) LDV	21,667	(000)	-
b) LDT 1 (< 6000 lbs.)	1636	(000)	- } combined LDT1 & LDT2
c) LDT 2 (> 6000 lbs.)	-	(000)	-
d) HDG	1304	(000)	-
e) HDD	628	(000)	-
f) ~~MC~~ Transit	69	(000)	- Mass Transit Vehicles
g) Total	25,304	(000)	
OR			
h) Auto		(000)	Source: Regional Air Quality and Maintenance Plan, 1980
i) Truck		(000)	
j) Total		(000)	
4. Average Daily Operating Speeds (24 hrs.) by Functional Class *		in miles per hour	Same categories as in row 2
a) Interstate	50	mph	
b) Principal Arterial }	-	mph	
c) Minor Arterial }	40	mph	
d) Collector }	-	mph	
e) Local }	20	mph	
OR			Source: Regional Air Quality and Maintenance Plan, 1980
f) Average Daily Speed for the System (where a-e aren't available.)		mph	
5. Average Daily Trip Length	12.80	minutes	Regional Land Use Plan from 1978 for Base Year 1977.
6. Average Daily Vehicle Trips		in 1,000's	
a) Passenger Vehicles	N.A.	(000)	
b) Trucks		(000)	
7. Seasonal Adjustment Factor	N.A.		In 1977, all four seasons were used

* Functional classifications, see Appendix C.

** MOBILE 1 vehicle classifications, see Appendix C.

WORKSHEET 2a

EMISSION FACTOR INPUTS AND EMISSION INVENTORY OUTPUTS, REASONABLENESS ASSESSMENT

NAME OF CITY Example City

VARIABLE	ESTIMATE FOR BASE YEAR VALUE	UNITS	CRITERIA	FINDINGS
8. Average Daily Cold/ Hot Operating Fractions		Percent	See TABLE 2	Source: Regional Air Quality & Maintenance Plan, 1980 and Mobile Source Emissions Factors - E.P.A., 1978
a) Cold Mode Catalyst	21	%	43-27	
b) Hot Mode Catalyst	27	%	30-17	
c) Cold Mode Non-catalyst	21	%	27-18	
9. Meteorological Data			See Table 9	
a) Summertime Temperature	68	°F	69.7	
b) Summertime Humidity	72	Grains/lb.	Indicate Source U.S. Weather Service	- O.K.
10. Total Annual Highway Emissions				
a) HC	47,908	Tons	None	Source: Regional Air Quality and Maintenance Plan, 1980
b) NOx	47,668	Tons	None	

WORKSHEET 2b

VARIABLE 11: FRACTION OF VMT PER VEHICLE CLASSIFICATION BY MODEL YEAR

AGE	LDV		LDT 1		LDT 2		HDG		HDD		MC	
	B.Y.E.*	N.A.V.**	B.Y.E.	N.A.V.	B.Y.E.	N.A.V.	B.Y.E.	N.A.V.	B.Y.E.	N.A.V.	B.Y.E.	N.A.V.
1	.136 - H	.106		.093		.061		.061		.102		.107
2	.135 - L	.142		.136		.116		.116		.178		.286
3	.128 - L	.133		.126		.116		.122		.168		.216
4	.120 - L	.123		.129		.115		.124		.149		.140
5	.108	.108		.097		.090		.098		.101		.085
6	.096 - H	.092		.082		.081		.088		.081		.051
7	.080 - H	.077		.075		.075	N.A.V.	.079	N.A.V.	.067	N.A.V	.036
8	.064	.064	N.A.V.	.057		.062		.063		.046		.025
9	.049 - L	.050		.044		.050		.049		.031		.021
10	.034 - L	.035		.031		.042		.040		.021		.016
11	.020 - L	.023		.023		.033		.030		.016		.005
12	.008 - L	.016		.015		.022		.020		.009		.003
13	↑	.010		.018		.025		.021		.008		.008
14		.007		.016		.023		.019		.006		.000
15		.004		.014		.020		.016		.006		.000
16	.022	.003		.012		.018		.014		.004		.000
17		.002		.011		.016		.012		.003		.000
18		.002		.009		.014		.011		.002		.000
19	↓	.002		.008		.012		.010		.002		.000
20		.002		.007		.010		.009		.001		.000

Findings: Did not separate LDT into two classes and used LDT1 N.A.V. for the sum of all LDT.
Source: Regional Vehicle Registrations (Regional Air Quality & Maintenance Plan, 1980.)
Conclusion: Not Significantly Different.

* B.Y.E. = Base Year Estimates

** N.A.V. = National Averages Used as Default Values in Mobile1 .

WORKSHEET 2c

VARIABLE 12: VEHICLE EMISSION RATES BY FUNCTIONAL CLASS (GM/VMT)

HIGHWAY CLASSIFICATION	COMPOSITE EMISSIONS		TOTAL AUTO EMISSIONS		TOTAL TRUCK EMISSIONS	
	ESTIMATE	CRITERIA	ESTIMATE	CRITERIA	ESTIMATE	CRITERIA
		See Fig. 3 or 9 for HC See Fig. 4 or 10 for NOx		See Fig. 5 or 11 for HC See Fig. 6 or 12 for NOx		See Fig. 7 or 13 See Fig. 8 or 14
Speed 50 (MPH) INTERSTATE						
Non-Methane HC	3.59 gm/VMT	3.25 - 3.98 gm/VMT				
NOx	5.29 gm/VMT	4.21 - 6.02 gm/VMT				
Speed 40 (MPH) PRINCIPAL ARTERIAL						
Non-Methane HC	3.79 gm/VMT	3.42 - 4.29 gm/VMT				
NOx	4.59 gm/VMT	3.81 - 5.28 gm/VMT				
Speed ____ (MPH) MINOR ARTERIAL						
Non-Methane HC						
NOx						
Speed 30 (MPH) COLLECTOR						
Non-Methane HC	5.39 gm/VMT	5.04 - 6.65 gm/VMT				
NOx	3.89 gm/VMT	3.15 - 4.58 gm/VMT				
Speed ____ (MPH) LOCAL						
Non-Methane HC						
NOx						
Speed ____ (MPH) TOTAL						
Non-Methane HC		N.A.				
NOx						

Findings: Replaced "Principal Arterials" with "All Arterials"
Replaced "Collector" with "Locals and Collectors"
Findings: HC and NO_x emission Rates are O.K.

Directions: Enter the average daily operating speeds from rows 4a through 4e (in Worksheet 1) in the first column. If MOBILE 1 was used to generate emissions factors, use figures 3 through 8 in Appendix A to select appropriate reasonableness criteria. If MOBILE 2 was used, see Fig.'s 9 through 14 in Appendix A. Draw a vertical line, on the appropriate figures for HC and NOx at the average vehicle operating speed for each VMT stratification. The intersection of the vertical line with the two solid curves in each figure determines the reasonableness range for that VMT stratification. That range should then be placed in the appropriate column and row in the Table. For VMT stratifications by other functional classes, use this Table and method, but note the new column headings in the space marked "Findings". For an example of this procedure see Appendix D and Figures 3 and 4.

7. a) What procedure was used to estimate mobile source emission factors? (Check one)

- [x] MOBILE 1
- [ ] MOBILE 2
- [ ] Other procedure (Enter name of procedure) _____

b) If "Other" was checked in question 7a, describe and assess the adequacy of the procedure.

_____

_____

_____

8. Based on the above, summarize and briefly discuss any major deficiencies in the travel and emissions estimation procedures used by this urban area.

Although travel models are based on old information, they were satisfactorily validated in 1977 and appear reasonable for developing the 1980 emission inventory.

WORKSHEET 3

REASONABLENESS ASSESSMENT FOR TRAVEL DATA

VARIABLE	BASE YEAR REASONABLENESS MEASURES: MEASURE	COMPUTATION	CRITERIA	FINDINGS
13. Daily VMT/Capita	14.5 mi/per.	(2f÷1a)	See TABLE 3 12-17 mi/person	O.K.
14. Percent VMT by Functional Class			See TABLE 4 (Percent)	
a) Interstate	34.5 %	(2a÷2f)	18-23 %	- High
b) Principal Arterial	%	(2b÷2f)	%	
c) Minor Arterial	55.9 %	(2c÷2f)	42-63 % *	- O.K
d) Collector	%	(2d÷2f)	%	
e) Local	9.4 %	(2e÷2f)	19-29 % *	- Low
15. Percent VMT By Vehicle Class			(Percent)	
a) LDV	85.6 %	(3a÷3g)	78-89 %	- O.K, but high
b) LDT (< 6000 lbs.)	6.5 %	(3b÷3g)	5-12 %	- low, slightly
c) LDT (> 6000 lbs.)	%	(3c÷3g)	2.5-6 %	
d) HDG	5.2 %	(3d÷3g)	1.5-4.5 %	- high, slightly
e) HDD	2.5 %	(3e÷3g)	2.5-7.5 %	- O.K., but low
f) ~~MC~~ Transit	0.2 %	(3f÷3g)	~~0-1~~ %	
OR				
g) Auto	%	(3h÷3j)	78-89 %	
h) Truck	%	(3i ÷3j)	10-22 %	
16. Total VMT	1,000 mi/day 25,304	(3g or j)	See 2f, worksheet 1 1,000 mi/day 25,304	O.K.
17. Vehicle Operating Speed by Functional Class			See TABLE 5 (miles/hour)	
a) Interstate	50	(4a)	45-50 mph	Interstate and
b) Principal Arterial		(4b)	mph	Arterials are
c) Minor Arterial	40	(4c)	25-40 mph	O.K but slightly
d) Collector		(4d)	mph	
e) Local	20	(4e)	15-25 mph	high
OR				
f) Average Vehicle System Speed		(4f)	See TABLE 6 mph	
18. Average Daily Trip Length	12.80 min.	(5a)	See TABLE 7 12-14 (minutes)	O.K.
19. Vehicle Trips/Capita				
a) Passenger Vehicles	N/A Trip/per.	(6a÷1a)	1.8-2.4 Trips/per.	—
b) Trucks	N/A Trip/per.	(6b÷1a)	.27-.48 Trips/per.	
20. Seasonal Adjustment Factor	N/A ———	(7a)	See TABLE 8	—

* Note - Criteria for % VMT from Table 4 have been added together to represent combined functional classes.

Possibly a definition problem (?)

APPENDIX E

BLANK WORKSHEETS

Reviewer - _____

Date - _____

METHODOLOGY REVIEW SHEET

1. Urban Area - _____

2. What agency developed the base year HC and NOx emissions inventories for highway sources? (List agency name, address and telephone number.)

_____

_____

_____

3. a) For what base year have the emissions inventories been established? _____

b) If 1980 is <u>not</u> the base year for the emission inventories, indicate why another year was used.

_____

_____

_____

4. What type of procedure was used to estimate highway emissions? (Check one)

- ☐ - Link-based procedure *
- ☐ - Trip-based procedure *
- ☐ - Hybrid procedure *
- ☐ - Other (Please explain below)

_____

_____

_____

* Section II of this manual describes each of these procedures in more detail.

5. a) How were VMT and vehicle operating speeds estimated for use in developing the emissions inventories? (e.g. Are the estimates based on traffic counts and travel time surveys or are they based on estimates from the travel forecasting procedures used for urban transportation planning?)

b) Are there any elements of the travel estimation procedures that are questionable?

c) What year's data was used to calibrate the travel estimation procedures cited in Question 5a?

d) When were the procedures cited in question 5a last validated (i.e., checked to determine if they can reproduce observed traffic flows)?

6. Are estimates of "off-network" VMT (e.g., VMT on links normally not included in a computerized highway network) accounted for in the highway emissions inventories? If yes, briefly describe how the VMT and corresponding operating speeds estimates for each travel were determined.

7. a) What procedure was used to estimate mobile source emission factors? (Check one)

☐ MOBILE 1

☐ MOBILE 2

☐ Other procedure (Enter name of procedure) _____

b) If "Other" was checked in question 7a, describe and assess the adequacy of the procedure.

_____

_____

_____

8. Based on the above, summarize and briefly discuss any major deficiencies in the travel and emissions estimation procedures used by this urban area.

_____

_____

_____

WORKSHEET 1

TRAVEL DATA FOR REASONABLENESS ASSESSMENT

NAME OF URBAN AREA _____

REGION OF COUNTY (SEE FIGURE 2) _____

VARIABLE	ESTIMATE FOR BASE YEAR		SOURCE
	VALUE	UNITS	
1. Population		1,000's	
2. Average Daily VMT by Functional Class *		1,000's of vehicle miles	
a) Interstate		(000)	
b) Principal Arterial		(000)	
c) Minor Arterial		(000)	
d) Collectors		(000)	
e) Local		(000)	
f) Total		(000)	
3. Average Daily VMT by Vehicle Class **		1,000's of vehicle miles	
a) LDV		(000)	
b) LDT 1 (< 6000 lbs.)		(000)	
c) LDT 2 (> 6000 lbs.)		(000)	
d) HDG		(000)	
e) HDD		(000)	
f) MC		(000)	
g) Total		(000)	
OR			
h) Auto		(000)	
i) Truck		(000)	
j) Total		(000)	
4. Average Daily Operating Speeds (24 hrs.) by Functional Class *		in miles per hour	
a) Interstate		mph	
b) Principal Arterial		mph	
c) Minor Arterial		mph	
d) Collector		mph	
e) Local			
OR			
f) Average Daily Speed for the System (where a-e aren't available.)		mph	
5. Average Daily Trip Length		minutes	
6. Average Daily Vehicle Trips		in 1,000's	
a) Passenger Vehicles		(000)	
b) Trucks		(000)	
7. Seasonal Adjustment Factor			

* Functional classifications, see Appendix C.

** MOBILE 1 vehicle classifications, see Appendix C.

WORKSHEET 2a

EMISSION FACTOR INPUTS AND EMISSION INVENTORY OUTPUTS, REASONABLENESS ASSESSMENT

NAME OF CITY_____

VARIABLE	ESTIMATE FOR BASE YEAR VALUE	UNITS	CRITERIA	FINDINGS
8. Average Daily Cold/ Hot Operating Fractions		Percent	See Table 2	
a) Cold Mode Catalyst		%		
b) Hot Mode Catalyst		%		
c) Cold Mode Non-catalyst		%		
9. Meteorological Data			See Table 9	
a) Summertime Temperature		^{o}F		
b) Summertime Humidity		Grains/lb.	Indicate Source	
10. Total Annual Highway Emissions				
a) HC		Tons	None	
b) NO_x		Tons	None	

WORKSHEET 2b

VARIABLE 11: FRACTION OF VMT PER VEHICLE CLASSIFICATION BY MODEL YEAR

AGE	LDV		LDT 1		LDT 2		HDG		HDD		MC	
	B.Y.E. *	N.A.V. **	B.Y.E.	N.A.V.	B.Y.E.	N.A.V.	B.Y.E.	N.A.V.	B.Y.E.	N.A.V.	B.Y.E.	N.A.V.
1		.106		.093		.061		.061		.102		.107
2		.142		.136		.116		.116		.178		.286
3		.133		.126		.116		.122		.168		.216
4		.123		.129		.115		.124		.149		.140
5		.108		.097		.090		.098		.101		.085
6		.092		.082		.081		.088		.081		.051
7		.077		.075		.075		.079		.067		.036
8		.064		.057		.062		.063		.046		.025
9		.050		.044		.050		.049		.031		.021
10		.035		.031		.042		.040		.021		.016
11		.023		.023		.033		.030		.016		.005
12		.016		.015		.022		.020		.009		.003
13		.010		.018		.025		.021		.008		.008
14		.007		.016		.023		.019		.006		.000
15		.004		.014		.020		.016		.006		.000
16		.003		.012		.018		.014		.004		.000
17		.002		.011		.016		.012		.003		.000
18		.002		.009		.014		.011		.002		.000
19		.002		.008		.012		.010		.002		.000
20		.002		.007		.010		.009		.001		.000

Findings:

* B.Y.E. = Base Year Estimates

** N.A.V. = National Averages Used as Default Values in Mobile

WORKSHEET 2c

VARIABLE 12: VEHICLE EMISSION RATES BY FUNCTIONAL CLASS (GM/VMT)

HIGHWAY CLASSIFICATION	COMPOSITE EMISSIONS		TOTAL AUTO EMISSIONS		TOTAL TRUCK EMISSIONS	
	ESTIMATE	CRITERIA	ESTIMATE	CRITERIA	ESTIMATE	CRITERI
		See Fig. 3 or 9 for HC See Fig. 4 or 10 for NOx		See Fig. 5 or 11 for HC See Fig. 6 or 12 for NOx		See Fig. 7 or 13 See Fig. 8 or 14
Speed ____ (MPH) INTERSTATE						
Non-Methane HC						
NOx						
Speed ____ (MPH) PRINCIPAL ARTERIAL						
Non-Methane HC						
NOx						
Speed ____ (MPH) MINOR ARTERIAL						
Non-Methane HC						
NOx						
Speed ____ (MPH) COLLECTOR						
Non-Methane HC						
NOx						
Speed ____ (MPH) LOCAL						
Non-Methane HC						
NOx						
Speed ____ (MPH) TOTAL						
Non-Methane HC						
NOx						

Findings:

Directions: Enter the average daily operating speeds from rows 4a through 4e (in Worksheet 1) in the first column. If MOBILE 1 was used to compute emissions factors, use figures 3 through 8 in Appendix A to select appropriate reasonableness criteria. If MOBILE 2 was used, see Fig.'s 9 through 14 in Appendix A. Draw a vertical line, on the appropriate figures for HC and NOx at the average vehicle operating speed for each VMT stratification. The intersection of the vertical line with the two solid curves in each figure determines the reasonableness range for that VMT stratification. That range should then be placed in the appropriate column and row in the Table. For VMT stratification by other functional classes, use this Table and method, but note the new column headings in the space marked "Findings". For an example of this procedure see Appendix D and Figures 3 and 4.

WORKSHEET 3

REASONABLENESS ASSESSMENT FOR TRAVEL DATA

VARIABLE	BASE YEAR REASONABLENESS MEASURES		CRITERIA	FINDINGS
	MEASURE	COMPUTATION		
13. Daily VMT/Capita	mi/per.	(2f÷1a)	See TABLE 3 mi/ person	
14. Percent VMT by Functional Class			See TABLE 4 (Percent)	
a) Interstate	%	(2a÷2f)	%	
b) Principal Arterial	%	(2b÷2f)	%	
c) Minor Arterial	%	(2c÷2f)	%	
d) Collector	%	(2d÷2f)	%	
e) Local	%	(2e÷2f)	%	
15. Percent VMT By Vehicle Class			(Percent)	
a) LDV	%	(3a÷3g)	78-88 %	
b) LDT (< 6000 lbs.)	%	(3b÷3g)	5-12 %	
c) LDT (> 6000 lbs.)	%	(3c÷3g)	2.5-6 %	
d) HDG	%	(3d÷3g)	1.5-4.5 %	
e) HDD	%	(3e÷3g)	2.5-7.5 %	
f) MC	%	(3f÷3g)	0-1 %	
OR				
g) Auto	%	(3h÷3i)	78-89 %	
h) Truck	%	(3i ÷3i)	10-22 %	
16. Total VMT	1,000 mi/day	(3g or j)	See ∠T, worksheet 1 1,000 mi/day	
17. Vehicle Operating Speed by Functional Class			See TABLE 5 (miles/hour)	
a) Interstate		(4a)	mph	
b) Principal Arterial		(4b)	mph	
c) Minor Arterial		(4c)	mph	
d) Collector		(4d)	mph	
e) Local		(4e)	mph	
OR				
f) Average Vehicle System Speed		(4f)	See TABLE 6 mph	
18. Average Daily Trip Length	min.	(5a)	See TABLE 7 (minutes)	
19. Vehicle Trips/Capita				
a) Passenger Vehicles	Trip/per.	(6a÷1a)	1.8-2.4 Trips/per.	
b) Trucks	Trip/per.	(6b÷1a)	.27-.48 Trips/per.	
20. Seasonal Adjustment Factor	———	(7a)	See TABLE 8	

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-400/12-80-002		

4. TITLE AND SUBTITLE	5. REPORT DATE
Guidelines for Review of Highway Source Emission Inventories for 1982 State Implementation Plans	December, 1980
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
John F. DiRenzo and Mark Hallenbeck	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
Peat, Marwick, Mitchell & Co. 1990 K Street, N.W. Washington, D.C. 20006	11. CONTRACT/GRANT NO. 68-02-3506
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
Office of Transportation and Land Use Policy Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460	FINAL REPORT 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This manual presents procedures and data to assist EPA, state, and local agencies in assessing the adequacy of HC and NO_x highway source emission inventories for 1980, the base year of interest in preparing 1982 SIP submission. The procedures provide a basis for reviewing: (1) the reasonableness of travel and related inputs used to estimate HC and NO_x emissions and (2) the reasonableness of the emissions estimates themselves. The procedures are applicable to urban areas with a population greater than 200,000 people.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Quality Planning Urban Transportation Planning Emission Inventories		

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
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