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16. Abstract

The Environmental Protection Agency (EPA) highway vehicle emission factor model provides average in-use fleet emission factors for three pollutants [volatile organic compounds (VOC), carbon monoxide (CO), and oxides of nitrogen (NOx)], for gas and diesel vehicles for calendar years between 1970 and 2050, under various conditions affecting in-use emission levels as specified by the modeler.

EPA is now in the process of revising the MOBILE model. The latest version, MOBILE6, will differ significantly in structure and data requirements from the current versions of the model (MOBILE 5a and 5b). Some of the revisions will require fundamental changes in the traffic input needs and in the way they are provided to MOBILE6.

The rest of this report discusses the input requirements for MOBILE6, default values of inputs, if applicable, and the methodology used to arrive at these default values.

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Review of Input Requirements for Emission Factor Model MOBILE6

by

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1. BACKGROUND

The U.S. Environmental Protection Agency (EPA) has developed the MOBILE series of models for highway vehicle emissions. The latest version is the MOBILE6 model, which will become the required standard for air quality conformity and transportation control measure (TCM) effectiveness analysis. In this report, we will examine the changes in the inputs for MOBILE6. The changes for MOBILE6 are in the following areas:

- Emissions, fleet, and activity data:
  - Basic exhaust emissions: There have been changes to the basic exhaust emissions with updates to the in-use deterioration estimates for light-duty and heavy-duty cars and trucks. Also the basic exhaust emissions must conform to the new emission standards for light-duty and heavy-duty vehicles.
  - Speed and off-cycle effects for light-duty vehicles: For light-duty vehicles, facility-based speed corrections, the effects of the supplemental Federal Test Procedure (FTP) rule, and the effects of air-conditioning on the exhaust emissions have been included.
  - Heavy-duty emissions: For heavy-duty vehicles, the impact of new emission standards has been accounted for and the emissions are adjusted for excess of nitrogen oxides.
  - Effects of fuel composition: The effects of oxygenated fuels on the carbon monoxide (CO) emissions and the explicit effects of sulfur on exhaust emissions have been accounted for. The emissions of natural gas vehicles are modeled explicitly.
  - Changes to evaporative hydrocarbon emissions: Diurnals and resting loss emissions are based on new real-time and multi-day data. Liquid leaker emissions are added to hot-soak, diurnal, running, and resting losses. For hot soak emission calculation, new data have to be provided for fuel Reid Vapor Pressure less than 9.0 psi. A new method has been included for evaporative I/M calculations.
  - Fleet characterization: New estimates are used for national average mileage accumulation, vehicle registration (age) distribution, and vehicle class counts.
  - Vehicle activity: For MOBILE6, the following new activity data is specified: (1) new trip-length estimates, (2) engine start soak time distribution, (3) diurnal soak time distributions, (4) trip starts and trip ends, (5) vehicle miles traveled (VMT) by hour of day, facility, and speed.

- Structural changes: Running and start emissions are separated in MOBILE6. Start emissions are those that occur in the first hour of the trip. They depend on the soak duration prior to the trip, the environmental conditions prevailing during the trip start, and vehicle characteristics such as type, age, and mileage. Running emissions are those that occur during hot-stabilized operation. Aggregate running emissions depend on vehicle speeds; environmental conditions during the trip; the hour of day; distribution of vehicle characteristics such as age, mileage, and type; VMT mix; and the implementation of inspection/maintenance programs. In MOBILE6, calculation of emissions is carried out by the hour. The vehicle classification has been expanded with the inclusion of the following sub-classes: LDDV, LDGV, LDGT 1–4, LDDT 12, 34, HDGV 2b-8b, HDDV 2b-8b, MC, HDGB, HDDB-S, and HDDB-T (refer to Table 1 of Appendix I).
- Changes in the input and output formats: Control flags are eliminated in MOBILE6. There is more extensive use of user-supplied comments. External files are needed for registration distributions, in-use program descriptions, and local activity data.

2. COMPUTING EMISSION FACTORS

2.1 Introduction

MOBILE6 utilizes an input file that provides program control information and data describing the scenarios for which emission factors are to be estimated for calculating pollutant-specific emission factors. The input file is divided into three different sections, namely the Control section, the One-Time Data section, and the Scenario section.

The Control section manages the input, output, and execution of the program. The One-Time Data section allows users to input emission-related parameters that differ from the internal default values of MOBILE6. The values of these parameters are applied collectively to all scenarios each time the program is run. The Scenario section provides information on the individual scenarios for which emission factors are to be calculated. Each run of MOBILE6 can include many different scenarios, and each scenario can include different scenario parameters.

Because the Control section does not pertain to the traffic-related inputs, our discussion will be restricted to the One-Time Data and Scenario selection sections.

MOBILE6 includes default values for a wide range of parameters that affect emissions. These defaults are calculated to represent “national average” input data values. Substituting

default values with information related to local conditions will result in more precise estimates of local emissions. The following sub-sections discuss default values and input data required by the user for each of the inputs included in the One-Time Data and Scenario selection sections.

2.2 One-Time Data

The One-Time Data section includes information that is input only once in a given MOBILE6 input file. These inputs are used to alter MOBILE6 default values to reflect locality-specific data when such information is available to the user. Figure 1 shows the one-time data inputs and the corresponding command type. Each of these inputs is discussed in the following subsections.

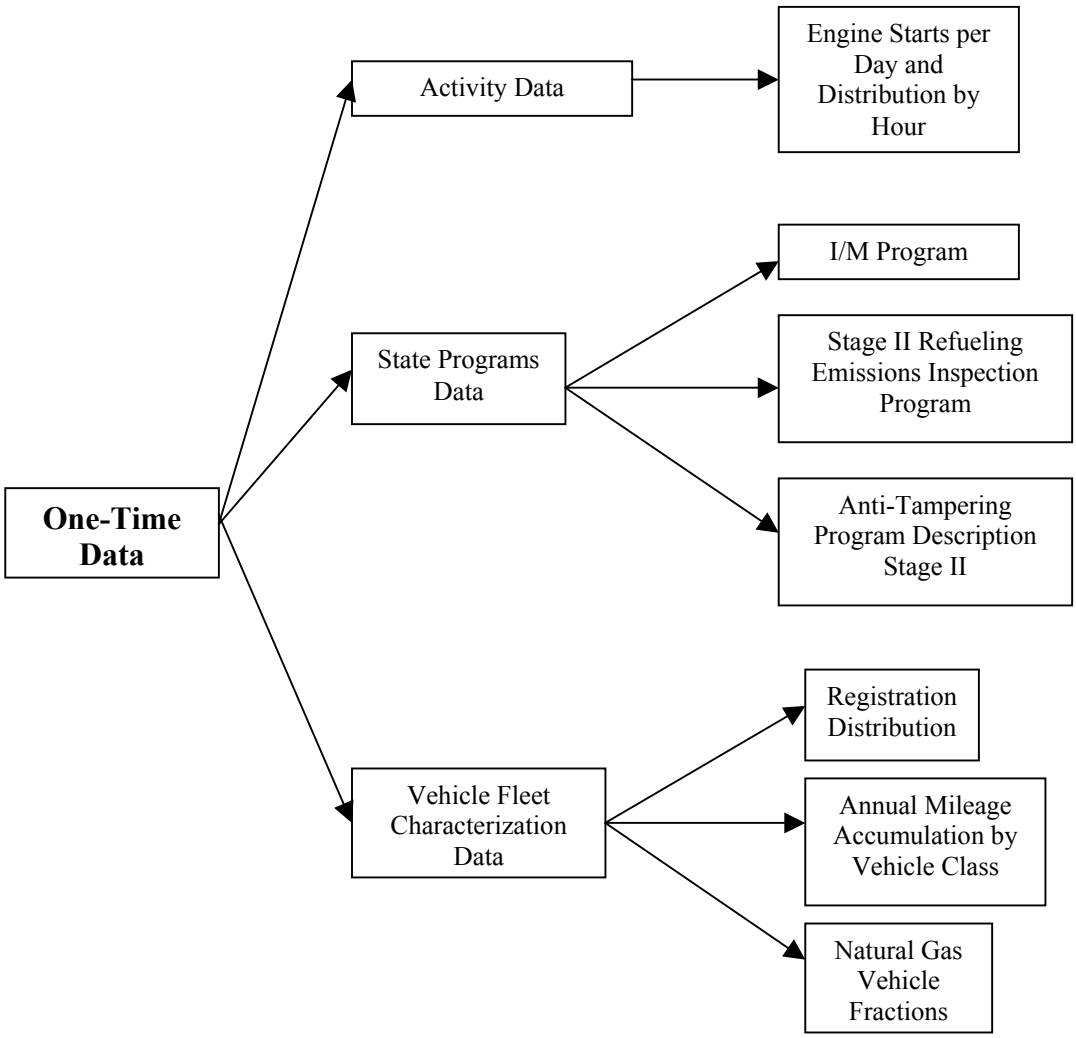

Figure 1. One-Time Data

2.2.1 Engine Starts per Day and Distribution by Hour

The number of starts per day affects engine exhaust start emission estimates for light-duty gasoline cars, diesel passenger cars, trucks, and motorcycles. It also affects the evaporative hot soak losses (which occur at trip ends) on all gasoline-fueled vehicles, including heavy-duty vehicles and buses. The number of starts per day is used to calculate the number of trips and trip ends per day. This command does not affect the emission estimates for heavy-duty, diesel-fueled vehicles and buses. MOBILE6 assigns a separate default value for the number of engine starts per day to each of the twenty-eight individual vehicle classes at each of twenty-five vehicle ages. These default values differ for weekdays and weekends, though the same default value is used for all ages within a vehicle class. The default values for engine weekday/weekend trips and starts

per day for different vehicle classes are given in Table 2.1 of Appendix II. They were developed based on instrumented vehicle studies conducted on 168 vehicles in the Baltimore and Spokane areas. Emission estimates for heavy-duty, diesel-fueled vehicles and buses are not affected by the number of starts per day within MOBILE6.

Input data required by user:

- Engine starts per day values for all vehicle classes affected by the Starts Per Day command (see Table 4 in Appendix I for affected vehicle classes) for the twenty-five vehicle ages included in each day type.

The distribution of engine starts by hour of day refers to the frequency distribution of starts across fourteen time periods of the day. These time periods are listed in Table 2.2 of Appendix II. The default values for distribution of starts by hour were developed from instrumented vehicle studies conducted on 168 vehicles in Baltimore and Spokane. These values are listed in Appendix II, Table 2.3.

Input data required by user:

- Average fraction of all engine starts that occur in each hour of a 24-hour day, for both weekdays and weekends.

2.2.2 I/M Program

The user can direct MOBILE6 to model an I/M program and define basic information about the program to be modeled using the I/M Program command. If the user chooses not to use this command, MOBILE6 assumes no I/M program is in place. There are several commands that can be used to define the I/M program, which are discussed later in this section.

Input data required by user:

- The number of I/M programs that will be used in the run.
- Calendar year that the program began (1960–2051).
- Calendar year that the program ended (1960–2051).
- Frequency of inspection (biennial or annual).
- I/M program type:
  - Test and Repair (computerized)
  - Test and Repair (manual)

    - Test Only
- I/M inspection type:
    - Exhaust
    - Evaporative

In order to specify the first and last model years that will be covered by the I/M program to be modeled, the user is required to use the I/M Model Years command. There is no default for this command; however, this command must be entered if the user wishes to model an I/M program.

Input data required by user:

- The first model year that is covered (1941–2050).
- The last model year that is covered (1941–2050).

The I/M Vehicles command identifies which vehicle types are included in the I/M program to be modeled. Again, there is no default value for this command, yet the value is required if the user is modeling exhaust or evaporative I/M.

Input data required by user:

- Which of the five light-duty vehicles are subject to an I/M inspection.
- Which of the eight heavy-duty vehicles are subject to an I/M inspection.
- Whether or not gasoline buses are subject to an I/M inspection.

The I/M Stringency command is required when an exhaust I/M program is being modeled. Using this command, the user is able to define the expected exhaust inspection failure rate for pre-1981 model year vehicles included in the I/M program being modeled. There is no default value for this command.

Input data required by user:

- The test failure rate expected in pre-1981 model year passenger cars or light trucks expressed as a percentage of tests administered.

The I/M Compliance command lets the user specify the percentage of vehicles in the fleet that complete the I/M program and receive either a certificate of compliance or a waiver. This command is required for an exhaust I/M and optional for an evaporative I/M. There is no default

value for the exhaust I/M, however, there is a default value of 85% for an evaporative I/M. If a compliance rate is entered for an exhaust I/M but not for an evaporative I/M, MOBILE6 uses the exhaust program compliance rate to compute evaporative benefits on the vehicles covered by both the exhaust and evaporative programs.

Input data required by user:

- The percentage of the fleet subjected to I/M that goes through the entire I/M process to receive a pass or a waiver (50–100%).

The I/M Waiver Rates command allows the user to specify the number of vehicles that fail an initial I/M test and receive a certificate of compliance after failing the retest. There is no default value for this command for exhaust I/M programs. The default value for the evaporative I/M programs is 5%.

Input data required by user:

- Waiver rate for the pre-1981 model year vehicles (0–50%).
- Waiver rate for 1981 and later model year vehicles (0–50%).

The I/M Exemption Age command allows the user to specify the age at which the vehicles become exempt from the I/M program that is being modeled. Exempted vehicles lose all potential I/M credit. The default value for this command is 25 years old; in other words, vehicles never become exempt from I/M due to age.

Input data required by user:

- I/M exemption age; ranging from 1–25 years, where 1 exempts the entire fleet from the I/M requirements and 25 exempts vehicles age 25 years and older.

The age at which vehicles first become subject to I/M testing is specified using the I/M Grace Period command. This input gives the user the ability to model programs that exempt the newest vehicles from the requirements. The default value of vehicle age for exemption given by MOBILE6 is 1 year.

Input data required by user:

- Age at which vehicles are first subject to mandatory I/M requirements, ranging from 1 to 25 years, where 1 exempts vehicles that are less than 1 year old and 25 exempts all but the oldest model-year vehicles.

The I/M Effectiveness command is used to enter separate effectiveness values for each of the three pollutants, hydrocarbons (HC), carbon monoxide (CO), and nitrogen oxides (NOx). This command is used as a correction factor that reduces the exhaust I/M credit for test and repair programs by the percentage input by the user. MOBILE6 uses a default value of 100% (full credit) to all I/M programs.

Input data required by user:

- I/M effectiveness values for HC, CO, and NOx.

2.2.3 Stage II Refueling Emissions Inspection Program

The Effects of Stage II on Refueling Emissions command permits the user to model the impact of refueling emissions required by a Stage II vapor recovery system. There is no default calculation of impact of a Stage II program.

Input data required by user:

- Calendar year (1989–2050).
- Number of phase-in years of the program (1–9 years).
- The percent efficiency for the light duty gasoline vehicles (LDGVs) and the light duty gasoline trucks (LDGTs) in the program (0–100%).
- The percent efficiency for the heavy duty gasoline vehicles (HDGVs) in the program (0–100%).

2.2.4 Anti-Tampering Program Description Stage II

The user has the option to model the impact of an anti-tampering program using the Anti-Tampering Programs command. MOBILE6 supplies no default values for this command.

Input data required by user:

- Calendar year that the program began (1960–2050).
- The earliest model year to be covered by the program (1960–2050).
- The final model year to be covered by the program (1960–2050).

- Knowledge of which vehicle class is included in the program; vehicles included are light-duty and heavy-duty gasoline vehicles, and gasoline buses.
- Frequency of inspection (annual or biennial).
- Compliance rate for the anti-tampering program (0–100%).
- Knowledge of which vehicle components will be inspected; components include air pump system disablement, catalyst removal, fuel inlet restrictor disablement, tailpipe lead deposit test, EGR disablement, evaporative system disablement, PCV system disablement, and missing gas cap.

2.2.5 Vehicle Registration Distribution

The Distribution of Vehicle Registration command allows the user to supply vehicle registration distributions by vehicle age for any of the sixteen composite (combined gas and diesel) vehicle types. A list of these vehicle types can be found in Appendix I, Table 2. Vehicle age involves a 25-year range, with vehicles 25 years and older grouped together.

In order to prepare reasonable default values, estimates of the number of vehicles of various ages in operation in the U.S. as of July 1, 1996, were made using the Polk database and information on transit bus registrations was taken from the Federal Transit Authority (FTA) database. Because the MOBILE6 model describes emission effects in future years as well as past years, exponential and Weibull curve fitting was used to fit curves through the registration data for each vehicle class and fuel type category in order to predict vehicle registration distributions for future years. Curve fit equations for registration distribution by age can be found in Appendix II, Table 2.4. Default values for the vehicle registration distribution are provided in Appendix II, Table 2.5.

Input data required by user:

- Vehicle registration data for each of the twenty-five vehicle ages for one or more of the sixteen composite vehicle types.
- Each composite vehicle type requires twenty-five age fractions, representing the fraction of vehicles of that age in that composite vehicle class in July.

2.2.6 Annual Mileage Accumulation by Vehicle Class

The Annual Mileage Accumulation Rates command allows the user to input the annual mileage accumulation rates by vehicle age for any of the twenty-eight individual vehicle types. A list of these vehicle types can be found in Appendix I, Table 1. As mentioned above, vehicle age involves a 25-year range, with vehicles 25 years and older grouped together.

Data were evaluated from numerous sources in order to calculate default values for annual mileage accumulation. Records were entered into a database, sorted into gross vehicle weight rating categories; plotted graphically; and the results were smoothed using linear, exponential, and best-fit curve analysis. Curve fit equations can be found in Appendix II, Table 2.6. These age-specific average annual mileage accumulation rates represent the 1996 calendar year and are used for all past, present, and future calendar-year default values, which are shown in Appendix II, Table 2.7.

Input data required by user:

- The total annual travel miles accumulated per vehicle of a given age for the twenty-eight vehicle categories.

2.2.7 Natural Gas Vehicle Fractions

The Natural Gas Vehicles Fraction command allows the user to give the percent of vehicle in the fleet that are certified to operate on either compressed or liquefied natural gas in each of the twenty-eight individual classes (Appendix I, Table 1) beginning with the 1994 model year. The default fraction of NGV vehicles in the fleet is equal to zero.

Input data required by user:

- Number of vehicles that are NGV for the twenty-eight individual classes for the years 1994–2050.

In addition to the above command, the user may also enter separate NGV emission factors for each of the twenty-eight vehicle types using the Alternate Emission Factors for Natural Gas Vehicles command. Emissions that are analyzed include HC, CO, and NOx.

Input data required by user:

- Zero-mile emission level of the normal emitters.
- Increase in emissions of the normal emitters per 10,000 miles.
- Average emission level of high emitters.

2.3 Scenario Selection

The Scenario data are used to assign values to those variables that specifically define each of the scenarios to be evaluated. Figure 2 shows the scenario inputs and the corresponding command type. Each of these inputs is discussed in the following subsections.

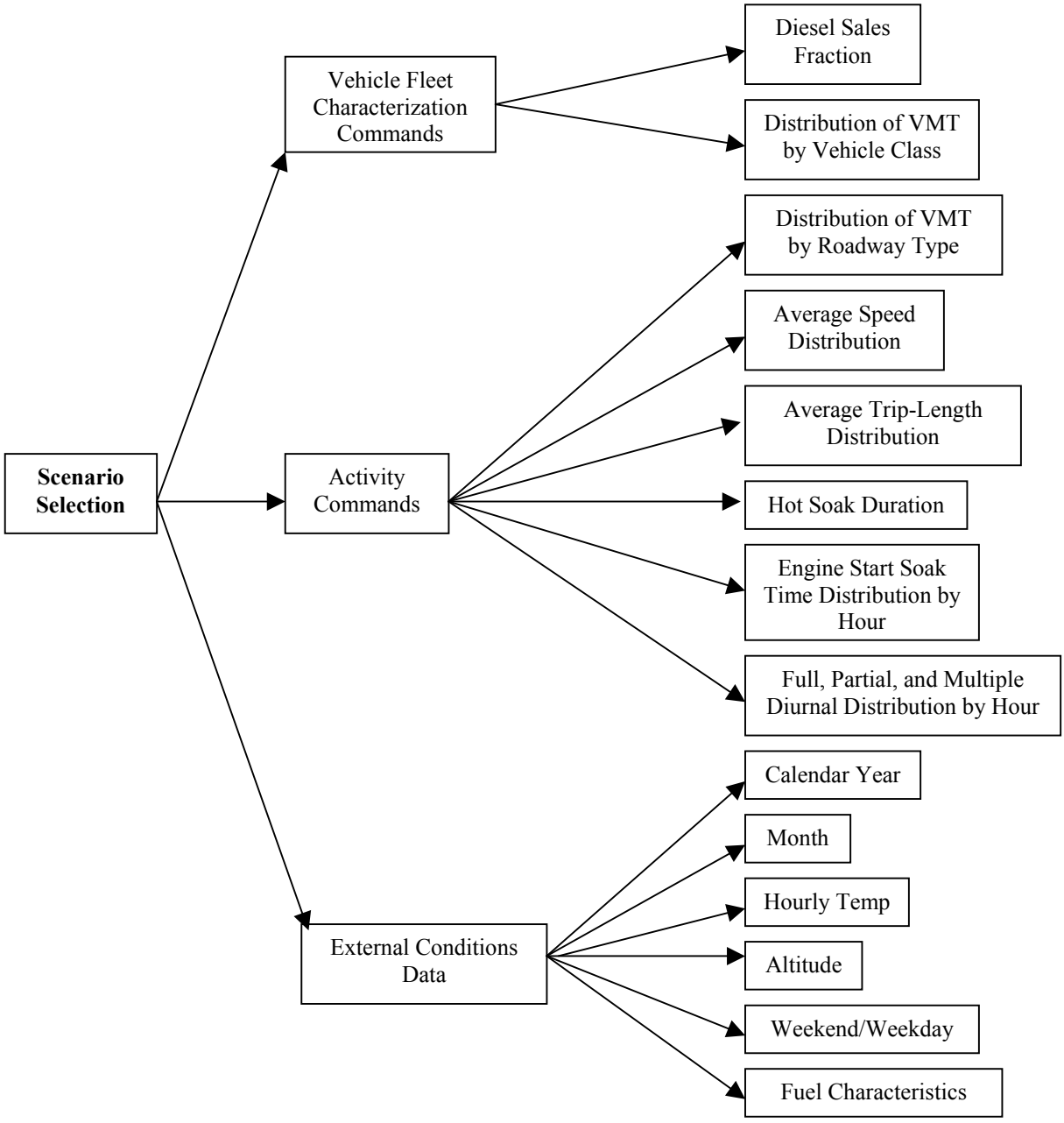

Figure 2. Scenario Selection

2.3.1 Diesel Sales Fractions

The user is able to supply locality-specific diesel fractions for fourteen of the sixteen composite vehicle categories (see Appendix I, Table 3) by vehicle age by using the Diesel Sales Fraction command. The two vehicles included are urban/transit buses and motorcycles, all of which are assumed to be diesel-fueled. The procedure to calculate default values began with taking fuel-specific vehicle counts as of July 1, 1996, by model year from the Arcadis report. Next, ratios of gasoline vehicles to diesel vehicles for each vehicle category and model years 1972 through 1996 were calculated. Default values for diesel sales fractions are located in Appendix III, Table 2.1a and b. Vehicle models from the calendar year 1971 and earlier were assumed to have the same diesel fraction as the 1972 model year. The vehicle models from the calendar year 1997 and later were assumed to have the same diesel fraction as the 1996 model year.

Input data required by user:

- Diesel fractions by age (1–25 years) of vehicle for each of the fourteen vehicle types to come up with 350 separate diesel fractions.

2.3.2 Distribution of Vehicle Miles Traveled by Vehicle Class

The Vehicle Miles Traveled (VMT) Fraction command permits the user to assign VMT to specific vehicle types. VMT mix supplied must consist of a set of sixteen fractional values, representing the fraction of total highway VMT accumulated by each of the sixteen combined vehicle types (see Appendix I, Table 2). For the default values within MOBILE6, the vehicle counts from 1982–2020 were collected from MOBILE5. Counts from 1982–2020 were used due to the fact that 1990 was the last year actual in-use vehicle data were collected. The counts obtained from calendar year 1982 were used for all years preceding 1982. Because MOBILE6 requires additional vehicle count estimates for 1991 and later calendar years, a method was developed to find vehicle counts (see Appendix III, Table 2.2a and b for default values for light-duty and heavy-duty vehicles). The formula used in this method is described in Equation 2.2.2.1:

Formula used:

$$VC_x = (VC_{x-1} + Sales_x) * (1 - SR_x) \qquad \text{(Eq. 2.2.2.1)}$$

where

VC_x : Total vehicle count for vehicle category

Sales: Number of new vehicles sold

SR: % of in-use fleet that is scrapped
X: Calendar year in question

Estimates of the Annual Rate of Scrappage (SR) were found from the 1996 World Vehicle Forecasts and Strategies document, which reports scrappage rates as "% parc" for the calendar years 1995, 2000, 2005, and 2010. After total vehicle counts were calculated, the light-duty vehicles and the heavy-duty vehicles were divided into the sixteen composite vehicle types. MOBILE6 then calculates the VMT mileage distribution from national average data, including the calendar year; vehicle population data for the sixteen composite vehicle classes; registration by age distribution data; diesel fractions; and mileage accumulation data.

Input data required by user:

- Calendar year of evaluation.
- Vehicle population data for the sixteen composite vehicle classes.
- Vehicle Registration by age distribution.
- Diesel fractions.
- Mileage accumulation data.

2.3.3 Distribution of Vehicle Miles Traveled by Roadway Type, Speed, and Hour

The VMT by Facility, Hour, and Speed commands are used to find the distribution of vehicle miles traveled by roadway type, by hour and by speed. Each of these commands is discussed below, followed by an explanation for the MOBILE6 default values.

The VMT by Facility command involves computing VMT on various roadway or facility types by vehicle class. The user may enter VMT distributions for each of the twenty-eight vehicle classes (see Appendix I, Table 1) across the four roadway types for each of 24 hours of the day. The four roadway types include freeway, arterial, local, and ramp.

Input data required by user:

- Fractional values for the four roadway types at each of the 24 hours of the day for a given vehicle class.
- The distributions for each hour must add up to one.
- Four roadway types include:

- Freeway,
- Arterial,
- Local, and
- Ramp.

If the VMT by Facility cannot be obtained or is not needed, the user is able to instead assign a fraction of VMT occurring at each hour of the day that is independent of facility type using the VMT by Hour command. Total VMT is allocated among the 24 hours of each day.

Input data required by user:

- Total VMT for the 24 hours of the day.

The Speed VMT command allows users to allocate VMT by average speed on freeways and arterial roads. The VMT distribution over fourteen pre-selected average speed ranges is used. MOBILE6 then calculates these distributions for each of the 24 hours of the day and for freeways and arterials.

Input data required by user:

- VMT distribution.
- Average speeds.

There are two methods by which the VMT mix by facility, class, and speed can be developed as follows.

Method 1: Using Traffic Count Data

Annual average daily traffic (AADT) counts are used to get the VMT distribution in the following manner:

1. Calculate the sum of counts in each functional vehicle class.
2. Determine the sample size in each functional class (the number of counters).
3. Determine the average volume by dividing the total count by sample size.
4. Determine the number of miles of facility type in each class. (This information is available from the Department of Transportation GIS databases.)

5. Calculate the VMT by class as average volume multiplied by the number of miles of facility.

To get the VMT distribution by facility type, the classification of roadways must be matched to the four functional classes in MOBILE6. Often ramp VMT information may not be available. In the absence of such information, the ramp VMT can be estimated as a fraction of the freeway VMT based upon estimates from a regional travel demand model.

From available hourly count data, the time of day distribution of VMT by facility type can be obtained. The effect of speed on emissions is significant only for freeways and arterials. To get the distribution of VMT by speed, estimates of speeds have to be taken from traffic count data. There are two methods for this purpose.

1) Highway Capacity Manual (HCM) procedure.
2) Volume/Capacity relationships from Bureau of Public Roads (BPR) curves.

The Assessment and Modeling Division, Office of Mobile Sources of the Environmental Protection Agency, recommends the use of the BPR method as being more practical for typical urban areas. The HCM method requires more facility-specific information than is typically available. Hence, only the BPR procedure is discussed below.

BPR procedure:

The standard BPR equation is: $s = s_f/(1 + a(v/c)^b)$

where:

s = predicted mean speed

s_f = free-flow speed

v = volume

c = practical capacity

a = 0.05 for signalized intersections

a = 0.20 for unsignalized intersections

b =10

Practical capacity is defined as 80% of the maximum capacity. Free-flow speed is the mean speed of vehicles when traffic volumes are so light that they have negligible effect on the speed and is estimated to be 1.15 times the speed at capacity. Relationships for free-flow speeds developed by Dowling et al. are as follows:

Uninterrupted facilities with posted speed limits > 50 mph:

Mean speed (mph) = 0.88*(posted speed limit in mph) + 14

Uninterrupted facilities with posted speed limits < 50 mph

Mean speed (mph) = 0.79*(posted speed limit in mph) + 12

Thus, the link speeds can be predicted using the BPR equation. The VMT within each functional class can be grouped by speed to get the distribution by speed for freeways. The use of the accuracy of the BPR method is lower when applied to arterials and local streets because of the complications caused by traffic controls such as signals and stop signs. To get the variations in speeds by time of day, the BPR equation should be applied after distributing the traffic volumes by time of day. Estimates of VMT for future years can be obtained by functional class and area type using travel demand models or based on past trends.

Method 2: Using Travel Demand Models (TDMs)

TDMs capture all trips within a region. Thus this method avoids the pitfalls of Method 1, namely, the inaccuracies introduced by extrapolation of traffic volumes from count data at a limited number of locations. However, TDMs do not provide as much detail on volume fluctuation by time of day, vehicle type, and speeds as traffic counts. TDMs use calculated speeds and route choices to minimize travel time while assigning traffic to a roadway network. It is not possible to describe hourly changes in speeds while using the TDMs for average daily travel assignments. Hence it may be preferable to calculate speeds externally using post-processing software, which uses the HCM procedures and BPR curves to calculate the hourly congested speeds. The procedure followed by the post-processing algorithms is as follows:

1. Distribute link-level volumes by hour of day by using user-provided or default temporal distributions.
2. Calculate hourly VMT by multiplying link distance by hourly volume.
3. Calculate the V/C ratio using either link-specific capacities or lookup tables.
4. Apply the BPR curve, using link-specific free flow speeds or lookup tables, to arrive at hourly congested speeds.

To develop VMT distributions for future years, the future year loaded network data are usually available with planners and hence the same procedure is repeated, this time with future year assignment.

The TDM procedure has some shortcomings. Intrazonal travel and trips on local roads are not assigned to the networks and must be addressed separately. Ramp travel may not be included in the TDMs or may be a part of the freeway volumes. For these, the user will have to rely on traffic counts. TDMs account only for the travel by individuals and not for freight movements. Freight travel has to be modeled separately.

The two methods described above were used to develop default distributions for MOBILE6. The default values are the same for every vehicle type. Vehicle activity estimates (derived from both traffic counts and travel demand models) were used to develop distributions of vehicle miles traveled by functional class, speed, and time of day for eight urban areas, namely Chicago, IL; New York, NY; Charlotte, NC; Houston, TX; Ada County, Id (Boise region); Baltimore, MD; Spokane, WA; and Los Angeles, CA. The distributions for these areas along with highway performance monitoring system VMT data (HPMS, 1995) were used to arrive at the national default VMT weighting. The area-specific results were used to develop national default distributions, based on the assumption that these cities can be used as prototypes for other urban areas (see Appendix III, Table 2.3 for default values).

2.3.4 Average Speed Distribution by Hour and Roadway Type

The Average Speed command permits the user to designate a single average speed to use for the total freeways and/or arterial/collectors for the entire 24 hours of the day. The user is able to enter a single value instead of distribution, as in the case of the Speed VMT command. The speed dependence of emission rates in MOBILE6 requires that either speed or level of service (LOS) further divide VMT for arterials and freeways. MOBILE6 uses national fleet data for the default distribution of VMT by average speed for freeways and arterial roadways (see Appendix III, Table 2.4 for default values).

Input data required by user:

- Average Speed Value ranging from 2.5 to 65 mph.
- The roadway scenario the user wants to model, choices include:
  - Non-Ramps, all VMT occurring on freeways, not including ramps,
  - Freeway, all VMT occurring on freeways, including ramps,
  - Arterial, all VMT occurring on arterial/collector roadways,

- Area wide, VMT occurring on all roadway types as determined by the VMT by Facility command.

2.3.5 Average Trip-Length Distribution

Trip-length activity estimates are used to calculate running loss emissions. Running loss emissions are evaporative emissions, i.e., emissions that have escaped from a vehicle while the engine is operating. The rate of running emissions is assumed to continually increase as a function of trip length until it reaches a plateau at a trip length of about 50 to 60 minutes. The 24 hour day was divided into fourteen different hourly groups. The hourly intervals are shown in Table 2.2 in Appendix II.

The basic methodology for developing default values for the trip-length activity estimates is described below:

1. In developing the trip-length activity estimates, the user must begin with trips per car per day. The default values for trips per car per day for cars and trucks are presented in Table 2.5 of Appendix III**.** These are average values obtained from the instrumented vehicle database. Similar values can be developed, as required, by the user.
2. A distribution of vehicle trips by hourly group based on VMT is required. Table 2.6a and Table 2.6b of Appendix III contains the default distributions of vehicle trips by hourly group. The distribution is VMT based rather than trip-count based. This is because the activity distribution for running losses is based on trip distance in miles. A distribution of running loss trip distance lengths has to be developed for each of the twenty-eight hourly group/weekday-weekend groups.
3. The vehicle trips in the database have to be categorized into a particular hourly/weekday-weekend group. A vehicle trip is classified as a weekday trip if it started on Monday through Friday. It is a weekend trip if it starts on a Saturday or Sunday. A vehicle trip is classified into a particular hourly group if any part of the trip duration is in a given hourly group. A given vehicle trip could be classified into one, two, or even three different hourly groups depending on the duration of the trip, and how many group interval boundaries it crosses.
4. After labeling each of the trips in the database using the method above, each trip is classified into one of six trip-duration categories based on trip duration in minutes (see

Table 2.7 in Appendix III for trip-duration categories). The duration in miles of each trip and trip phase is determined. In cases where the trip contained only one phase, the trip distance in miles is readily available. In cases where two phases were present, the mileage has to be split according to the length of the trip in time, assuming that the average speeds in both phases were equal.

5. After obtaining the mileage for each trip and trip phase, the mileages are summed for each hourly/weekday-weekend group and for each category within an hourly/weekday-weekend group. From the sums, percentages contributions were calculated for each category within a group. Tables 2.8a and 2.8b in Appendix III contain the default values of these percentages for weekdays and weekends.

   Input data required by user:

   - Trips/car per day for cars and trucks
   - Distribution of vehicle trips by hourly group based on VMT
   - Knowledge of whether trips occur during weekend or weekday
   - Trip length of vehicle trip (see Appendix III, Table 2.7 for trip duration categories)

2.3.6 Hot Soak Duration

Hot soak emissions occur when fuel vapors escape from a hot vehicle that has just been turned off. The emissions are highest immediately after the engine is shut down and decrease over time, reaching a baseline level in about an hour. Hot soak emissions are truncated if the engine is turned on again before the baseline has been reached (before an hour has elapsed). MOBILE6 assumes that hot soak durations range from 1 minute at minimum to a maximum of 60 minutes. The hot soak time distributions reflect the number of vehicles experiencing a hot soak of a given duration (1 to 60 minutes) at each hour of the day. MOBILE6 divides the day into fourteen time periods, one for each hour between 6 a.m. and 7 p.m., plus one for the hours from 7 p.m. through 5 a.m. the next day. MOBILE6 computes hot soak emissions for each minute of each hour, and weights these emissions by the fraction of vehicles experiencing a hot soak at that time.

The first parameters required for the calculation of the default hot soak activity parameters are the estimates for hot soaks per car per day. The starting point for this calculation is the trips per car per day default values, which are shown in Table 2.5 in Appendix III**.** Every hot soak corresponds to a trip. The default values of hot soaks per car per day (see Table 2.5, Appendix

III) were obtained from the trips per car per day values by ignoring the trips that were less than 4 minutes in length.

Table 2.9 in Appendix III contains the distribution of the vehicle hot soaks across fourteen time periods of the day. Separate estimates are provided for weekends and weekdays. The data, on which Table 3 was based, were obtained from an instrumented vehicle database.

Input data required by the user are:

- Hot soak activity values representing the fraction of vehicles experiencing a hot soak of each duration (1 to 60 minutes) at each of the fourteen time periods of the day (see Appendix III, Table 2.9 for fourteen time periods).

Hot Soak Length Distribution by Hourly Group

The MOBILE6 model will contain a cumulative soak length distribution for each of the fourteen hourly groups, and for both weekdays and weekends. As a result, there will be twenty-eight cumulative soak length distributions. These twenty-eight distributions are based on data from the instrumented vehicle study. To make the distributions smoother for use in the MOBILE6 model, a Weibull function fit was generated for each of the twenty-eight soak length distributions. Only the first 59 minutes of the cumulative distribution are fitted. Since the 60 minute (the last minute) contained all of the soaks that were 60 minutes or greater in length, it produces a discontinuous function that jumps up to 100%. The 60-minute point will be accounted for separately in the MOBILE6 model by coding the value of 100% for the 60-minute point.

The Weibull function is of the form

$$Y = b1 - b2 * \exp(-b3 * Soaklength^{b4}) \quad \text{(Eq. 2.2.6.1)}$$

where *b1, b2, b3,* and *b4* are regression coefficients, and soak length in minutes (0 to 59) is the independent variable. The variable *Y* is the cumulative distribution in percent.

The values of the regression coefficients (*b1, b2, b3,* and *b4*) for each of the twenty-eight hourly and weekday/weekend groups are given in Tables 2.10a and b in Appendix III.

2.3.7 Engine Start Soak Time Distribution by Hour

A vehicle is defined to be "soaking" if its engine is not running. Soak time is the time interval between when an engine is turned off and the next time it is started.

The MOBILE6 model contains a soak length distribution for each of the fourteen hourly groups for weekdays and weekends (refer to Table 2.1, Appendix II). Each of these distributions contains seventy values representing a range of soak durations varying from 0 to over 720 minutes. From the soak time data, the model computes the percentage of vehicles that have been soaking for a given amount of time prior to an engine start for each hour of the day. This, in turn, affects start emissions, which depend on the length of soak time. The *same* soak time distributions are applied to all vehicle classes and all vehicle ages. The default values for soak duration distribution on weekends and weekdays are available in Table 2.11a and b in Appendix III. The default values were developed from instrumented vehicle studies conducted on 168 vehicles in the Baltimore and Spokane areas.

Input data required by user:

- Values for each of the seventy soak durations for each of the 24 hours of the day for week and weekend days (3,360 values).
- The seventy values represent the percentage of soaks with a particular range of soak length occurring in a particular hour of the day (the fractions must add up to 1 for a given hour).
- The soak time intervals are:

Interval range	Time (minutes)
N = 1	0.01- 1
N = 2–30	>N-1, <=N
N = 31–45	>(2N-32), <=(2N-30)
N = 46–67	>(30N-1320), <=(30N-1290)
N = 68	>720
N = 69	0–0.01 (Restarts)
N = 70	0 (Stalls, not used)

N= Interval Number

2.3.8 Full, Partial, and Multiple Diurnal Distribution by Hour

Diurnal emissions are much like evaporative emissions excluding those that occur during vehicle running, starting, or hot soak operation. They generally occur over a period of several hours and have to be distributed across different hourly groups. In the MOBILE6 model framework, three types of diurnals are defined. The first type is the multi-day diurnal. This type occurs if a vehicle is operated, and then "soaks" (is parked) for 2 or more days, and experiences two or more cycles of sufficiently large thermal gradients during the multi-day soak period to raise fuel tank

temperatures past a threshold value. The second type is the full or 1-day diurnal. This type of diurnal starts prior to the beginning of the temperature rise (i.e., prior to 6 a.m.), and can last for up to 24 hours. The third type is the interrupted diurnal. This type is similar to the previous ones, except that the soak periods range from a minimum of 1 hour up to 24 hours, and they start later in the day (i.e., the vehicle is operated during the morning so that the early morning heat build, beginning at 6 a.m., is interrupted). The diurnals, which range from 25 to 48 hours, are a combination of a one-day diurnal and an interrupted diurnal or multi-day depending on when they start.

The procedure for obtaining default values for the diurnal distribution is described below: For a given hourly group interval, the number of vehicles that were experiencing a diurnal and the number of vehicles that were in running mode or in hot soak mode have to be determined. Diurnals can occur over several hours. Each vehicle can experience either one or zero diurnals in a given hour of a day. Because of this feature of diurnals, the concept of vehicle-days is used instead of trips. The first test day for each vehicle is omitted because the length of the soak prior to the installation of the instrumentation is not known. The database is organized into valid vehicle-days, and it is determined whether or not a diurnal occurred on each of the valid vehicle-days for each of the thirteen hourly groups. The soak duration prior to the beginning of the hourly group is ascertained. For each hour, the duration of the preceding soaks are grouped in twelve intervals. These intervals are shown in the first column of Table 2.12 in Appendix III. They range from a soak duration of 1 to 2 hours up to a multi-day soak of 72 hours or more. To apply the activity distribution to all soak lengths and to smooth the distribution curve, MOBILE6 will apply activity values using a distribution curve. The actual diurnal activity distribution parameters, which will be used in MOBILE6, are shown in Table 2.13 found in Appendix III. A set of four parameters (A, B, C, and D) is shown for each of the thirteen hourly groups. These parameters are the result of fitting Weibull equations (non-linear regression) to the diurnal activity results.

The Weibull function fit is of the form:

$$Y = A - B * \exp(-C * \text{Soak length}^{**}D) \qquad \text{(Eq. 2.2.8.1)}$$

where A, B, C, and D are regression coefficients (listed in Appendix III, Table 2.13), and soak length in hours (1 to 72+) is the independent variable. The variable Y is the cumulative distribution in percent.

The Weibull function fit is a cumulative distribution of the soaks, which are diurnals. It does not include the portion of the fleet that is in hot soak or running mode. In the MOBILE6 model, it is necessary to calculate the percentage of soaks in a given hourly group that are X hours in duration. Equation 2.2.8.2 can be used to transform the cumulative Weibull distribution into a non-cumulative distribution.

$$D(i) = Y(i) - Y(i-1) \quad \text{(Eq. 2.2.8.2)}$$

where $D(i)$ is the distribution for the interval from $t-1$ to t, Y is the Weibull function from Equation 2.2.8.1.

Diurnal emissions vary with the length of time a vehicle has been soaking; in other words, the length of time it has been parked. The diurnal ends with the start of a new trip. MOBILE6 assumes that diurnal soak times range from 1 hour at a minimum to a maximum of 72 hours. Diurnal soak time distributions represent the distribution of the length of time that vehicles have been soaking during each of the 24 hours for which emissions are to be calculated. However, the 7 hours from 11 p.m. through 6 a.m. are treated as having a common soak time distribution, reducing the number of required distributions that represent the day from twenty-four to eighteen. Since temperatures fall during the night, diurnal emissions will be calculated to be zero from 12 a.m. to 6 a.m., regardless of the soak time distribution. For each hour of the day, MOBILE6 computes emissions separately for the seventy-two different soak distributions and weighs them by the fraction of vehicles experiencing a diurnal of that duration.

Input data required by user:

- Values representing the fraction of vehicles that experience a diurnal of each duration (72) at each time period of the day (18) (1,296 values total).
- MOBILE6 assumes that diurnal soak times range from 1 hour at a minimum to a maximum of 72 hours.
- Diurnal emissions are calculated to be zero from 12 a.m. to 6 a.m., since temperatures fall during the night (hence, eighteen time periods in the day).
- Results in 1,296 values total.

2.3.9 Calendar Year

The Calendar Year command allows the user to specify a four-digit value for the calendar year for which the emission factors are to be calculated, known as the calendar year of evaluation. There is no default value for the calendar year.

Input data required by user:

- Calendar year between 1952 and 2050.

2.3.10 Month

Using the Month command, the user is required to specify either January 1 or July 1 as the date of calculation of the emission factors. January 1 is the default value.

The specified month will affect emission computations in the following ways:

a) Change in the composition of the fleet. (July will include an additional 6 months of fleet turnover).

b) Change in the way reformulated gasoline (RFG) effects are modeled. If January is selected, winter rules for RFG are applied, and if July is selected, summer rules for RFG are applied.

Input data required by user:

- Knowledge on which season's rules are applied for RFG effects.

2.3.11 Hourly Temperature

In the specification of temperatures the user has two options. The first option is to specify the daily minimum and maximum temperatures, as in previous versions of the MOBILE model. The second option is to specify the twenty-four hourly temperatures. There are no default values for this command. MOBILE6 uses the maximum and minimum daily temperatures to perform temperature corrections to exhaust HC, CO, and NO_x; diurnal, hot soak, running loss and resting loss portions of evaporative HC; and temperature of dispensed fuel to calculate refueling emissions.

Input data required by user:

- Daily minimum and maximum temperatures or twenty-four hourly temperatures.

2.3.12 Altitude

This command lets the user specify whether emissions are to be calculated for a low altitude region (approximately 500 feet above sea level) or a high altitude region (approximately 5,500 feet above sea level). The MOBILE6 default is low altitude.

Input data required by user:

- Which altitude region (high or low) the emissions are being calculated for.

2.3.13 Weekend/Weekday

Weekend activity patterns of vehicle owners are significantly different from weekday patterns. Using this command, the user is allowed to specify whether MOBILE6 should use weekday or weekend data in its computations. By default, MOBILE6 uses weekday data in its computations.

Input data required by user:

- Which days of the week the data are obtained from.

2.3.14 Fuel Characteristics

MOBILE6 allows the user to model the impact of various gasoline fuel parameters. The user can specify one of two Tier 2 sulfur phase-in schedules to model the impact of a reformulated gasoline program or to specify the sulfur content for gasoline after 1999. The user has the following options:

a. Conventional Gasoline East: This is the MOBILE6 default. It supplies post-1999 gasoline sulfur levels by year under the phase-in schedule prescribed by the Tier 2 rule for most states.
b. Reformulated Gasoline: This option should be used to model the effects of an RFG program. The option sets 1995-and-later gasoline sulfur content, oxygen content, and fuel volatility values for the MOBILE6 calculations. The exact fuel parameters modeled for RFG depend on the geographic region, the calendar year, and the season. The values used by MOBILE6 are listed in Tables 2.14a and 2.14b in Appendix III. The user can also specify the effective season for the RFG calculation.
c. Conventional Gasoline West: This option supplies post-1999 gasoline sulfur levels by year under the phase-in schedule prescribed by the Tier 2 rule for specific western

states (i.e., Alaska, Colorado, Idaho, Montana, New Mexico, North Dakota, Utah, and Wyoming) and bordering counties in other states.

d. User-supplied gasoline sulfur levels: This option allows the user to directly specify the average and maximum sulfur levels (in the range of 30 to 600 ppm) if these are known to differ from RFG or the conventional fuels programmed into the model. The default sulfur content is 300 ppm.

The user can also include the effect of oxygenated fuels. For this the user has to specify the following: ether blend market share, alcohol blend market share, average oxygen content of ether blend fuels, average oxygen content of alcohol blend fuels, and whether a RVP waiver has been granted to allow "splash-blending" of alcohol-based oxygenates.

The user is required to specify the fuel RVP between 6.5 psi and 15.2 psi, inclusive for the area to be modeled. There is no default value of fuel RVP.

Appendix I

Vehicle Classes

Table 1. List of Vehicle Classes in MOBILE6

Number	*Abbreviation*	*Description*
1	LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)
2	LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3,750 lbs. LVW)
3	LDGT2	Light-Duty Gasoline Trucks 2 (0-6,000 lbs. GVWR, 3,751-5750 lbs. LVW)
4	LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
5	LDGT4	Light-Duty Gasoline Trucks 4 (6,001-8500 lbs. GVWR, 3,751-5750 lbs. LVW)
6	HDGV2b	Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs. GVWR)
7	HDGV3	Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs. GVWR)
8	HDGV4	Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs. GVWR)
9	HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs. GVWR)
10	HDGV6	Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs. GVWR)
11	HDGV7	Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs. GVWR)
12	HDGV8a	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs. GVWR)
13	HDGV8b	Class 8b Heavy-Duty Gasoline Vehicles (>60,000 lbs. GVWR)
14	LDDV	Light-Duty Diesel Vehicles (Passenger Cars)
15	LDDT12	Light-Duty Diesel Trucks 1and 2 (0-6,000 lbs. GVWR)
16	HDDV2b	Class 2b Heavy-Duty Diesel Vehicles (8501-10,000 lbs. GVWR)
17	HDDV3	Class 3 Heavy-Duty Diesel Vehicles (10,001-14,000 lbs. GVWR)
18	HDDV4	Class 4 Heavy-Duty Diesel Vehicles (14,001-16,000 lbs. GVWR)
19	HDDV5	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs. GVWR)
20	HDDV6	Class 6 Heavy-Duty Diesel Vehicles (19,501-26,000 lbs. GVWR)
21	HDDV7	Class 7 Heavy-Duty Diesel Vehicles (26,001-33,000 lbs. GVWR)
22	HDDV8a	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)
23	HDDV8b	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs. GVWR)
24	MC	Motorcycles (Gasoline)
25	HDGB	Gasoline Buses (School, Transit and Urban)
26	HDDBT	Diesel Transit and Urban Buses
27	HDDBS	Diesel School Buses
28	LDDT34	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs. GVWR)

Source: U.S. EPA. Draft User's Guide to MOBILE6.0 Mobile Source Emission Factor Model, August 2001. http://www.epa.gov/otaq/models/mobile6/d01003.pdf.

Table 2. Composite Vehicle Classes

Number	Abbreviation	Description
1	LDV	Light-Duty Vehicles (Passenger Cars)
2	LDT1	Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3,750 lbs. LVW)
3	LDT2	Light-Duty Trucks 2 (0-6,000 lbs. GVWR, 3,751-5,750 lbs. LVW)
4	LDT3	Light-Duty Trucks 3 (6,001-8,500 lbs. GVWR, 0-5,750 lbs. ALVW*)
5	LDT4	Light-Duty Trucks 4 (6,001-8,500 lbs. GVWR, 5,751 lbs. and greater ALVW)
6	HDV2B	Class 2b Heavy-Duty Vehicles (8,501-10,000 lbs. GVWR)
7	HDV3	Class 3 Heavy-Duty Vehicles (10,001-14,000 lbs. GVWR)
8	HDV4	Class 4 Heavy-Duty Vehicles (14,001-16,000 lbs. GVWR)
9	HDV5	Class 5 Heavy-Duty Vehicles (16,001-19,500 lbs. GVWR)
10	HDV6	Class 6 Heavy-Duty Vehicles (19,501-26,000 lbs. GVWR)
11	HDV7	Class 7 Heavy-Duty Vehicles (26,001-33,000 lbs. GVWR)
12	HDV8A	Class 8a Heavy-Duty Vehicles (33,001-60,000 lbs. GVWR)
13	HDV8B	Class 8b Heavy-Duty Vehicles (>60,000 lbs. GVWR)
14	HDBS	School Buses
15	HDBT	Transit and Urban Buses
16	MC	Motorcycles (All)

* ALVW = Alternative Loaded Vehicle Weight: The adjusted loaded vehicle weight is the numerical average of the vehicle curb weight and the gross vehicle weight rating (GVWR)

Source: U.S. EPA. Draft User's Guide to MOBILE6.0 Mobile Source Emission Factor Model, August 2001. http://www.epa.gov/otaq/models/mobile6/d01003.pdf.

Table 3. Composite Vehicle Types for Diesel Sales Fractions

Number	Abbreviation	Description
1	LDV	Light-Duty Vehicles (Passenger Cars)
2	LDT1	Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
3	LDT2	Light-Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
4	LDT3	Light-Duty Trucks 3 (6,001-8,500 lbs. GVWR, 0-5750 lbs. ALVW)
5	LDT4	Light-Duty Trucks 4 (6,001-8,500 lbs. GVWR, 5751 lbs. and greater ALVW)
6	HDV2B	Class 2b Heavy-Duty Vehicles (8501-10,000 lbs. GVWR)
7	HDV3	Class 3 Heavy-Duty Vehicles (10,001-14,000 lbs. GVWR)
8	HDV4	Class 4 Heavy-Duty Vehicles (14,001-16,000 lbs. GVWR)
9	HDV5	Class 5 Heavy-Duty Vehicles (16,001-19,500 lbs. GVWR)
10	HDV6	Class 6 Heavy-Duty Vehicles (19,501-26,000 lbs. GVWR)
11	HDV7	Class 7 Heavy-Duty Vehicles (26,001-33,000 lbs. GVWR)
12	HDV8A	Class 8a Heavy-Duty Vehicles (33,001-60,000 lbs. GVWR)
13	HDV8B	Class 8b Heavy-Duty Vehicles (>60,000 lbs. GVWR)
14	HDBS	School Buses

Source: U.S. EPA. Draft User's Guide to MOBILE6.0 Mobile Source Emission Factor Model, August 2001. http://www.epa.gov/otaq/models/mobile6/d01003.pdf.

Table 4. Vehicle Classes Affected By the Starts Per Day command

Number	Abbreviation	Description
1	LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)
2	LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
3	LDGT2	Light-Duty Gasoline Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
4	LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVWR, 0-5750 lbs. ALVW)
5	LDGT4	Light-Duty Gasoline Trucks 4 (6,001-8,500 lbs. GVWR, 5751 lbs. and greater ALVW)
6	HDGV2B	Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs. GVWR)
7	HDGV3	Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs. GVWR)
8	HDGV4	Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs. GVWR)
9	HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs. GVWR)
10	HDGV6	Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs. GVWR)
11	HDGV7	Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs. GVWR)
12	HDGV8A	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs. GVWR)
13	HDGV8B	Class 8b Heavy-Duty Gasoline Vehicles (>60,000 lbs. GVWR)
14	LDDV	Light-Duty Diesel Vehicles (Passenger Cars)
15	LDDT12	Light-Duty Diesel Trucks 1 and 2 (0-6,000 lbs. GVWR)
24	MC	Motorcycles (Gasoline)
25	HDGB	Gasoline Buses (School, Transit and Urban)
28	LDDT34	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs. GVWR)

Source: U.S. EPA. Draft User's Guide to MOBILE6.0 Mobile Source Emission Factor Model, August 2001. http://www.epa.gov/otaq/models/mobile6/d01003.pdf.

Table 5. MOBILE6 Vehicle Classes Mapped to Typical Vehicle Classes

MOBILE6 class	Vehicle type
LDGV	Passenger cars
LDGT1	PUVs, SUVs
LDGT2	
LDGT3	
LDGT4	
HDGV2b	Trucks
HDGV3	
HDGV4	
HDGV5	
HDGV6	
HDGV7	
HDGV8a	
HDGV8b	
LDDV	Passenger cars
LDDT12	PUVs, SUVs
HDDV2b	Trucks
HDDV3	
HDDV4	
HDDV5	
HDDV6	
HDDV7	
HDDV8a	
HDDV8b	
MC	Motorcycles
HDGB	Buses
HDDBT	
HDDBS	
LDDT34	PUVs, SUVs

PUV: Pick-ups and vans, SUV: Sports utility vehicle.

Source: VMT Mix modeling for MOBILE source emissions forecasting: Formulation and Empirical Application, Chandra R. Bhat and Harikesh S. Nair, The University of Texas at Austin.

Appendix II

One-Time Data

Table 2.1 Default Values for Engine Starts per Day and Distribution by Hour

Vehicle Class	Weekday (trips/day)	Weekend (trips/day)
Light-duty passenger vehicles	7.28	5.41
Light trucks	8.06	5.68
Motorcycles	1.35	1.35
Heavy-duty gasoline vehicles and buses	6.88	6.88
Heavy-duty diesel vehicles and buses	6.65	6.65

Source: U.S. EPA. Draft User's Guide to MOBILE6.0 Mobile Source Emission Factor Model, August 2001. http://www.epa.gov/otaq/models/mobile6/d01003.pdf.

Table 2.2 Hourly Start Distributions

Nominal Name	Hourly Intervals	
	Hourly Range	Time
6	6–7	6 a.m. – 7 a.m.
7	7–8	7 a.m. – 8 a.m.
8	8–9	8 a.m. – 9 a.m.
9	9–10	9 a.m. – 10 a.m.
10	10–11	10 a.m. – 11 a.m.
11	11–12	11 a.m. – 12 p.m.
12	12–13	12 p.m. – 1 p.m.
13	13–14	1 p.m. – 2 p.m.
14	14–15	2 p.m. – 3 p.m.
15	15–16	3 p.m. – 4 p.m.
16	16–17	4 p.m. – 5 p.m.
17	17–18	5 p.m. – 6 p.m.
18	18–19	6 p.m. – 7 p.m.
24	19–24 and 24–5	7 p.m. – 6 a.m.

Source: U.S. EPA Assessment and Modeling Division report on "Soak Length Activity Factors for Start Emissions," February 1998. http://www.epa.gov/OMS/models/mobile6/m6flt003.pdf.

Table 2.3 Default Values for Distribution of Starts by Hour

Distribution of Starts by Hour (in percent)		
Hour	**Weekday**	**Weekend**
6	2.04	0.91
7	5.54	1.93
8	6.02	3.10
9	4.73	6.45
10	5.16	6.91
11	6.72	7.97
12	8.07	10.16
13	7.30	7.26
14	8.04	8.89
15	8.98	7.36
16	8.41	8.02
17	7.73	7.11
18	6.02	6.15
24	15.24	17.78

Source: U.S. EPA Assessment and Modeling Division report on "Soak Length Activity Factors for Start Emission," February 1998. http://www.epa.gov/OMS/models/mobile6/m6flt003.pdf.

Table 2.4 Curve Fit Equations for Registration Distribution by Age

Aggregate Vehicle Category	Equation	Vehicle Ages
Light-duty vehicle	$y = 0.92867417^{(-(age/16.10050554)\ exp\ (4.45489164)}$ $y = 112855609.5568(^{-0.2321*age}$	1-12 13-30
Light-duty truck 0-6,000 lbs	$y = 0.90942551^{(-(age/14.38211814)\ exp\ (3.04037069)}$ $y = 805298.7399^{(-0.0409*age)}$	1-18 19-30
Light-duty trucks 6,001-8,500 lbs	$y = 1305324.4^{(-0.070863*age)}$	1-30
Heavy-duty vehicles classes 2B-3	$y = 732326.5^{(-0.09455*age)}$	1-30
Heavy-duty vehicles classes 4-8	$y = 404143.88^{(-0.066843*age)}$	1-30
Heavy-duty school buses	$y = 38982^{(-0.068092*age)}$	1-30
Heavy-duty transit buses	$y = 0.73096392^{(-(age/17.16909475)\ exp\ (12.53214119)}$ $y = 24987.0776^{(-0.2000*age)}$	1-17 18-30

Source: U.S. EPA Assessment and Modeling Division report on "Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates and Projected Vehicle Counts for Use in MOBILE6," March 1999. http://www.epa.gov/OMS/models/mobile6/m6flt007.pdf.

Table 2.5 Default Values of Vehicle Registration Distribution by Age for Selected Vehicle Categories

Vehicle Age	LDV ALL	LDT 0 -6,000	LDT 6,001-8,500	HDV 2B-3 8,501-14,000	HDV 4-8B 14,001+	HD School Bus (All)	HD Transit. Bus (All)
1*	0.053	0.058	0.059	0.074	0.057	0.058	0.045
2	0.071	0.077	0.074	0.089	0.071	0.072	0.060
3	0.071	0.077	0.069	0.081	0.067	0.067	0.060
4	0.071	0.076	0.064	0.074	0.062	0.063	0.060
5	0.070	0.074	0.060	0.067	0.058	0.059	0.060
6	0.070	0.072	0.056	0.061	0.055	0.055	0.060
7	0.069	0.069	0.052	0.056	0.051	0.051	0.060
8	0.068	0.066	0.048	0.051	0.048	0.048	0.060
9	0.066	0.061	0.045	0.046	0.045	0.045	0.060
10	0.063	0.056	0.042	0.042	0.042	0.042	0.060
11	0.059	0.050	0.039	0.038	0.039	0.039	0.060
12	0.054	0.044	0.036	0.035	0.036	0.036	0.060
13	0.046	0.037	0.034	0.032	0.034	0.034	0.059
14	0.036	0.031	0.032	0.029	0.032	0.032	0.056
15	0.029	0.025	0.029	0.026	0.030	0.030	0.050
16	0.023	0.019	0.027	0.024	0.028	0.028	0.040
17	0.018	0.015	0.025	0.022	0.026	0.026	0.025
18	0.014	0.011	0.024	0.020	0.024	0.024	0.012
19	0.011	0.008	0.022	0.018	0.023	0.023	0.010
20	0.009	0.008	0.021	0.016	0.021	0.021	0.008
21	0.007	0.008	0.019	0.015	0.020	0.020	0.007
22	0.006	0.007	0.018	0.013	0.019	0.018	0.005
23	0.004	0.007	0.017	0.012	0.017	0.017	0.004
24	0.004	0.007	0.016	0.011	0.016	0.016	0.004
25	0.003	0.007	0.014	0.010	0.015	0.015	0.003
26	0.002	0.006	0.013	0.009	0.014	0.014	0.002
27	0.002	0.006	0.013	0.008	0.013	0.013	0.002
28	0.001	0.006	0.012	0.008	0.013	0.012	0.002
29	0.001	0.006	0.011	0.007	0.012	0.011	0.001
30	0.001	0.005	0.010	0.006	0.011	0.011	0.001
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Source: U.S. EPA Assessment and Modeling Division report on "Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates and Projected Vehicle Counts for Use in MOBILE6," March 1999. http://www.epa.gov/OMS/models/mobile6/m6flt007.pdf.

Table 2.6 Curve Fit Equations for Annual Mileage Accumulation

Vehicle Class	Equation
LDGV	$y = 15684\ e^{-0.0506x}$
LDDV	$y = 15684\ e^{-0.0506x}$
LDGT1	$y = 17.472x^2 - 1163.7x + 20642$
LDGT2	$y = 22905\ e^{-0.0712x}$
LDDT1	$y = 30028\ e^{-0.1041x}$
LDDT2	$y = 28231\ e^{-0.0808x}$
HDGV (2B - 3)	$y = 21250\ e^{-0.0618x}$
HDGV (4 – 8)	$y = 23243\ e^{-0.0829x}$
HDGSB	$y = 9939$
HDGTB	$y = 38654\ e^{-0.0958x}$
HDDV (2B)	$y = 29657\ e^{-0.0888x}$
HDDV (3)	$y = 37008\ e^{-0.1222x}$
HDDV (4 – 5)	$y = 32635\ e^{-0.0656x}$
HDDV (6 – 7)	$y = 44883\ e^{-0.0983x}$
HDDV (8A)	$y = 98554\ e^{-0.1153X}$
HDDV (8B)	$y = 137024\ e^{-0.0982x}$
HDDSB	$y = 9939$
HDDTB	$y = 46659\ e^{-0.0324x}$

Source: U.S. EPA Assessment and Modeling Division report on "Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates and Projected Vehicle Counts for Use in MOBILE6," March 1999. http://www.epa.gov/OMS/models/mobile6/m6flt007.pdf.

Table 2.7 Default Values for Annual Mileage Accumulation by Vehicle Type Developed from Curve Fitting

Vehicle Age	LDV		LDGT		LDDT		HDGV		HDGB	
	LDGV	LDDV	LDGT 0-6000	LDGT 6001-8500	LDDT 0-6000	LDDT 6001-8500	2B-3 8501-14000	4-8 >14000	S.BUS ANY WGT.	T.BUS ANY WGT.
1	14910	14910	19496	21331	27059	26040	19977	21394	(a)	35123
2	14174	14174	18384	19865	24384	24018	18779	19692		31914
3	13475	13475	17308	18500	21973	22154	17654	18125		28999
4	12810	12810	16267	17228	19801	20434	16596	16683		26350
5	12178	12178	15260	16044	17843	18848	15601	15356		23942
6	11577	11577	14289	14942	16079	17385	14666	14134		21755
7	11006	11006	13352	13915	14490	16036	13787	13010		19768
8	10463	10463	12451	12959	13057	14791	12961	11975		17962
9	9947	9947	11584	12068	11766	13643	12184	11022		16321
10	9456	9456	10752	11239	10603	12584	11454	10145		14830
11	8989	8989	9955	10466	9555	11607	10768	9338		13475
12	8546	8546	9194	9747	8610	10706	10122	8595		12244
13	8124	8124	8467	9077	7759	9875	9516	7911		11126
14	7723	7723	7775	8453	6992	9109	8946	7282		10109
15	7342	7342	7118	7872	6301	8402	8409	6703		9186
16	6980	6980	6496	7331	5678	7749	7905	6169		8347
17	6636	6636	5909	6827	5116	7148	7432	5679		7584
18	6308	6308	5356	6358	4610	6593	6986	5227		6891
19	5997	5997	4839	5921	4155	6081	6568	4811		6262
20	5701	5701	4357	5514	3744	5609	6174	4428		5690
21	5420	5420	3909	5135	3374	5174	5804	4076		5170
22	5152	5152	3497	4782	3040	4772	5456	3752		4698
23	4898	4898	3120	4454	2740	4402	5129	3453		4268
24	4656	4656	2777	4148	2469	4060	4822	3178		3879
25	4427	4427	2470	3863	2225	3745	4533	2926		3524
26	4208	4208	2197	3597	2005	3454	4261	2693		3202
27	4001	4001	1959	3350	1807	3186	4006	2479		2910
28	3803	3803	1756	3120	1628	2939	3766	2281		2644
29	3616	3616	1589	2905	1467	2711	3540	2100		2402
30	3437	3437	1456	2706	1322	2500	3328	1933		2183

Source: U.S. EPA Assessment and Modeling Division report on "Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates and Projected Vehicle Counts for Use in MOBILE6," March 1999. http://www.epa.gov/OMS/models/mobile6/m6flt007.pdf.

Table 2.7, continued

Vehicle Age	HDDV						HDDB	
	2B 8501-10000	3 10001-14000	4-5 14001-19500	6-7 19501-33000	8A 33001-60000	8B >60000	S.BUS ANY WGT.	T.BUS ANY WGT.
1	27137	32751	30563	40681	87821	124208	(a)	45171
2	24831	28984	28622	36872	78257	112590		43731
3	22721	25650	26805	33420	69735	102060		42337
4	20791	22699	25103	30291	62141	92514		40987
5	19024	20088	23509	27455	55374	83861		39681
6	17407	17778	22016	24885	49343	76017		38416
7	15928	15733	20618	22555	43970	68907		37191
8	14575	13923	19309	20443	39181	62462		36005
9	13336	12321	18083	18529	34915	56620		34857
10	12203	10904	16935	16795	31112	51324		33746
11	11166	9650	15860	15222	27724	46523		32670
12	10217	8540	14853	13797	24705	42172		31629
13	9349	7557	13910	12505	22015	38228		30620
14	8555	6688	13026	11335	19617	34652		29644
15	7828	5919	12199	10273	17481	31411		28699
16	7163	5238	11425	9312	15577	28473		27784
17	6554	4635	10699	8440	13881	25810		26898
18	5997	4102	10020	7650	12369	23396		26041
19	5488	3630	9384	6933	11022	21208		25211
20	5021	3213	8788	6284	9822	19224		24407
21	4595	2843	8230	5696	8752	17426		23629
22	4204	2516	7707	5163	7799	15796		22875
23	3847	2227	7218	4679	6950	14319		22146
24	3520	1971	6760	4241	6193	12979		21440
25	3221	1744	6331	3844	5518	11765		20757
26	2947	1543	5929	3484	4918	10665		20095
27	2697	1366	5552	3158	4382	9667		19454
28	2468	1209	5200	2862	3905	8763		18834
29	2258	1070	4869	2594	3480	7944		18234
30	2066	947	4560	2352	3101	7201		17652

Source: U.S. EPA Assessment and Modeling Division report on "Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates and Projected Vehicle Counts for Use in MOBILE6," March 1999. http://www.epa.gov/OMS/models/mobile6/m6flt007.pdf.

Appendix III

Scenario Selection

Table 2.1a Default Values of Gasoline/Diesel Fractions for Light-Duty Vehicle Classes

LIGHT-DUTY VEHICLE CLASSES						
MODEL YEAR	Gasoline Vehicles	Diesel Vehicles	Gasoline Trucks 1&2	Diesel Trucks 1&2	Gasoline Trucks 3&4	Diesel Trucks 3&4
1996 and later	99.91%	0.09%	100.00%	0.00%	98.74%	1.26%
1995	99.94%	0.06%	100.00%	0.00%	98.85%	1.15%
1994	99.99%	0.01%	100.00%	0.00%	98.89%	1.11%
1993	99.97%	0.03%	100.00%	0.00%	98.55%	1.45%
1992	99.94%	0.06%	100.00%	0.00%	98.85%	1.15%
1991	99.87%	0.13%	100.00%	0.00%	98.71%	1.29%
1990	99.96%	0.04%	100.00%	0.00%	99.04%	0.96%
1989	99.96%	0.04%	100.00%	0.00%	99.17%	0.83%
1988	99.99%	0.01%	100.00%	0.00%	99.28%	0.72%
1987	99.73%	0.27%	99.93%	0.07%	99.18%	0.82%
1986	99.68%	0.32%	99.67%	0.33%	98.76%	1.24%
1985	99.03%	0.97%	99.52%	0.48%	98.65%	1.35%
1984	98.38%	1.62%	98.80%	1.20%	98.31%	1.69%
1983	97.59%	2.41%	97.77%	2.23%	97.91%	2.09%
1982	94.90%	5.10%	93.44%	6.56%	97.44%	2.56%
1981	92.94%	7.06%	93.84%	6.16%	99.87%	0.13%
1980	96.10%	3.90%	95.61%	4.39%	99.94%	0.06%
1979	97.31%	2.69%	96.84%	3.16%	99.89%	0.11%
1978	98.86%	1.14%	97.41%	2.59%	99.99%	0.01%
1977	99.07%	0.93%	100.00%	0.00%	100.00%	0.00%
1976	98.63%	1.37%	98.13%	1.87%	100.00%	0.00%
1975	98.45%	1.55%	89.62%	10.38%	100.00%	0.00%
1974	99.33%	0.67%	88.30%	11.70%	99.99%	0.01%
1973	99.33%	0.67%	88.30%	11.70%	99.99%	0.01%
1972 and earlier	99.33%	0.67%	88.30%	11.70%	99.99%	0.01%

Source: U.S. EPA Assessment and Modeling Division report on "Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates and Projected Vehicle Counts for Use in MOBILE6," March 1999. http://www.epa.gov/OMS/models/mobile6/m6flt007.pdf.

Table 2.1b Gasoline/ Diesel Fractions for Heavy Duty Vehicle Classes

HEAVY-DUTY VEHICLE CATEGORIES						
MODEL YEAR	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel
	2B	2B	3	3	4	4
1996 and later	80.02%	19.98%	32.26%	67.74%	13.94%	86.06%
1995	74.22%	25.78%	22.85%	77.15%	15.27%	84.73%
1994	74.85%	25.15%	20.90%	79.10%	19.52%	80.48%
1993	67.37%	32.63%	18.95%	81.05%	16.69%	83.31%
1992	72.61%	27.84%	19.32%	80.68%	20.99%	79.01%
1991	70.37%	29.63%	17.20%	82.80%	26.84%	73.16%
1990	76.16%	23.84%	15.23%	84.77%	27.25%	72.55%
1989	79.42%	20.58%	20.60%	79.40%	28.42%	71.58%
1988	82.44%	17.56%	25.12%	74.88%	43.53%	56.47%
1987	80.42%	19.58%	22.11%	77.89%	68.22%	31.78%
1986	72.74%	27.26%	21.58%	78.42%	77.93%	22.07%
1985	72.57%	27.43%	38.55%	61.45%	80.32%	19.68%
1984	69.96%	30.04%	48.61%	51.39%	84.30%	15.70%
1983	70.82%	29.18%	49.68%	50.32%	92.62%	7.38%
1982	71.41%	28.59%	57.23%	42.77%	96.59%	3.41%
1981	98.62%	1.38%	99.21%	0.79%	95.86%	4.14%
1980	100.00%	0.00%	100.00%	0.00%	99.97%	0.03%
1979	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
1978	100.00%	0.00%	99.99%	0.01%	100.00%	0.00%
1977	100.00%	0.00%	99.97%	0.03%	100.00%	0.00%
1976	100.00%	0.00%	99.90%	0.10%	97.41%	2.59%
1975	100.00%	0.00%	99.72%	0.28%	99.22%	0.78%
1974	100.00%	0.00%	97.52%	2.48%	99.96%	0.04%
1973	100.00%	0.00%	0.00%	100.00%	99.10%	0.90%
1972 and earlier	100.00%	0.00%	0.00%	100.00%	98.88%	1.12%

Table 2.1b, continued

Gasoline/ Diesel Fractions for Heavy Duty Vehicle Classes

HEAVY-DUTY VEHICLE CATEGORIES						
MODEL YEAR	**Gasoline**	**Diesel**	**Gasoline**	**Diesel**	**Gasoline**	**Diesel**
	5	**5**	**6**	**6**	**7**	**7**
1996 and later	53.53%	46.47%	37.00%	63.00%	14.37%	85.63%
1995	56.16%	43.84%	39.22%	60.78%	15.57%	84.43%
1994	63.30%	36.70%	47.54%	52.46%	20.57%	79.43%
1993	58.75%	41.25%	42.33%	57.67%	17.34%	82.66%
1992	65.38%	34.62%	47.11%	52.89%	20.28%	79.72%
1991	72.39%	27.71%	42.12%	57.88%	17.21%	82.79%
1990	72.70%	27.30%	43.83%	56.17%	18.23%	81.77%
1989	73.84%	26.16%	54.63%	45.37%	25.60%	74.40%
1988	84.57%	15.43%	57.84%	42.16%	28.16%	71.84%
1987	93.85%	6.15%	52.66%	47.34%	24.12%	75.88%
1986	96.17%	3.83%	52.95%	47.05%	24.33%	75.67%
1985	96.67%	3.33%	54.75%	45.25%	25.69%	74.31%
1984	97.45%	2.55%	56.90%	43.10%	27.39%	72.61%
1983	98.89%	1.11%	64.31%	35.69%	33.98%	66.02%
1982	99.51%	0.49%	63.10%	36.90%	32.83%	67.17%
1981	99.40%	0.60%	55.87%	44.13%	26.56%	73.44%
1980	100.00%	0.00%	69.06%	30.94%	38.93%	61.07%
1979	100.00%	0.00%	83.21%	16.79%	58.60%	41.40%
1978	100.00%	0.00%	86.10%	13.90%	63.90%	36.10%
1977	100.00%	0.00%	91.92%	8.08%	76.47%	23.53%
1976	99.63%	0.37%	95.24%	4.76%	85.11%	14.89%
1975	99.89%	0.11%	96.35%	3.65%	88.30%	11.70%
1974	99.99%	0.01%	97.12%	2.88%	90.60%	9.40%
1973	99.87%	0.13%	97.26%	2.74%	91.03%	8.97%
1972 and earlier	99.84%	0.16%	97.03%	2.97%	90.34%	9.66%

Table 2.1b, continued

Gasoline/ Diesel Fractions for Heavy Duty Vehicle Classes

HEAVY-DUTY VEHICLE CATEGORIES				
MODEL YEAR	Gasoline	Diesel	Gasoline	Diesel
	8A	8A	8A	8B*
1996 and later	0.08%	99.92%	0.00%	100.00%
1995	0.11%	99.89%	0.00%	100.00%
1994	0.13%	99.87%	0.00%	100.00%
1993	0.11%	99.89%	0.00%	100.00%
1992	0.23%	99.77%	0.00%	100.00%
1991	0.16%	99.84%	0.00%	100.00%
1990	0.18%	99.82%	0.00%	100.00%
1989	0.21%	99.79%	0.00%	100.00%
1988	0.31%	99.69%	0.00%	100.00%
1987	0.22%	99.78%	0.00%	100.00%
1986	0.20%	99.80%	0.00%	100.00%
1985	0.21%	99.79%	0.00%	100.00%
1984	0.24%	99.76%	0.00%	100.00%
1983	0.31%	99.69%	0.00%	100.00%
1982	0.22%	99.78%	0.00%	100.00%
1981	0.18%	99.82%	0.00%	100.00%
1980	0.26%	99.74%	0.00%	100.00%
1979	0.35%	99.65%	0.00%	100.00%
1978	0.36%	99.64%	0.00%	100.00%
1977	0.51%	99.49%	0.00%	100.00%
1976	0.80%	99.20%	0.00%	100.00%
1975	0.64%	99.36%	0.00%	100.00%
1974	1.81%	98.19%	0.00%	100.00%
1973	1.88%	98.12%	0.00%	100.00%
1972 and earlier	2.80%	97.20%	97.03%	2.97%

Source: U.S. EPA Assessment and Modeling Division report on "Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates and Projected Vehicle Counts for Use in MOBILE6," March 1999. http://www.epa.gov/OMS/models/mobile6/m6flt007.pdf.

Table 2.2a Light-Duty Vehicle Class Vehicle Counts, Pre-1982 through 2050

	Calendar Year	Light-duty Vehicles	Light-duty Truck Class 1	Light-duty Truck Class 2	Light-duty Truck Class 3	Light-duty Truck Class 4	Light-duty Total
From MOBILE5 ➪	pre-1982	106,867,000	4,801,335	15,983,665	6,969,875	3,205,125	137,827,000
	1983	108,960,000	4,857,006	16,168,994	7,154,140	3,289,860	140,430,000
	1984	112,018,000	5,065,830	16,864,170	7,495,270	3,446,730	144,890,000
	1985	114,662,000	5,336,562	17,765,438	7,676,795	3,530,205	148,971,000
	1986	117,268,000	5,676,594	18,897,406	8,141,910	3,744,090	153,728,000
	1987	119,849,000	6,006,462	19,995,538	8,480,985	3,900,015	158,232,000
	1988	121,519,000	6,343,260	21,116,740	9,159,820	4,212,180	162,351,000
	1989	122,758,000	6,759,984	22,504,016	9,548,900	4,391,100	165,962,000
	1990	124,658,000	7,058,898	23,499,102	9,640,005	4,432,995	169,289,000
Interpolated ➪	*1991*	123,917,173	7,495,735	24,953,334	9,662,236	4,443,218	170,471,696
	1992	123,176,346	7,932,572	26,407,567	9,684,467	4,453,441	171,654,392
	1993	122,435,519	8,369,409	27,861,799	9,706,698	4,463,664	172,837,088
	1994	121,694,691	8,806,246	29,316,031	9,728,929	4,473,887	174,019,784
	1995	120,953,864	9,243,083	30,770,263	9,751,160	4,484,110	175,202,480
Arcadis Report ➪	1996	120,213,037	9,566,078	31,845,513	10,110,975	4,649,573	176,385,176
Calculated ➪	1997	118,773,800	10,414,527	34,670,004	11,007,753	5,061,960	179,928,044
	1998	117,096,045	11,280,465	37,552,716	11,923,017	5,482,847	183,335,089
	1999	115,193,551	12,162,938	40,490,475	12,855,757	5,911,772	186,614,492
	2000	113,163,114	13,070,784	43,512,698	13,815,316	6,353,028	189,914,940
	2001	112,067,320	13,799,291	45,937,900	14,585,319	6,707,118	193,096,949
	2002	110,950,294	14,512,453	48,312,019	15,339,104	7,053,749	196,167,619
	2003	109,439,432	15,274,865	50,850,090	16,144,943	7,424,317	199,133,647
	2004	107,898,603	16,025,634	53,349,406	16,938,478	7,789,227	202,001,349
	2005	105,955,155	16,685,013	55,544,480	17,635,416	8,109,717	203,929,782
	2006	103,575,222	17,410,842	57,960,767	18,402,589	8,462,504	205,811,924
	2007	101,040,538	18,155,682	60,440,343	19,189,856	8,824,532	207,650,951
	2008	98,431,413	18,906,365	62,939,370	19,983,299	9,189,400	209,449,847
	2009	96,043,330	19,613,047	65,291,919	20,730,235	9,532,882	211,211,414
	2010	93,587,131	20,228,884	67,342,044	21,381,152	9,832,208	212,371,419
	2011	91,290,697	20,817,379	69,301,145	22,003,168	10,118,245	213,530,633
	2012	89,345,016	21,346,077	71,061,181	22,561,981	10,375,217	214,689,471
	2013	87,503,888	21,856,971	72,761,950	23,101,976	10,623,537	215,848,322
	2014	85,917,827	22,324,492	74,318,331	23,596,128	10,850,774	217,007,553
	2015	84,384,402	22,695,902	75,554,755	23,988,694	11,031,297	217,655,051
	2016	82,971,891	23,052,159	76,740,738	24,365,244	11,204,455	218,334,488
	2017	81,805,681	23,371,618	77,804,216	24,702,900	11,359,728	219,044,142
	2018	80,793,310	23,669,750	78,796,699	25,018,014	11,504,634	219,782,406
	2019	79,950,083	23,943,693	79,708,656	25,307,561	11,637,783	220,547,776
	2020 - 2050	79,436,359	24,165,899	80,448,384	25,542,425	11,745,787	221,338,854

Source: U.S. EPA Assessment and Modeling Division report on "Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates and Projected Vehicle Counts for Use in MOBILE6," March 1999. http://www.epa.gov/OMS/models/mobile6/m6flt007.pdf.

Table 2.2b Heavy-Duty Vehicle Class Vehicle Counts, Pre-1982 through 2050

	Calendar Year	2B	3	4	5	6	7	8A	8B	School Bus	Transit Bus	Heavy-duty total
From MOBILE5 →	Pre-1982	3,025,472	267,759	198,250	176,578	551,683	581,388	298,804	689,099	209,625	28,301	6,027,000
	1983	3,350,257	296,503	219,576	195,534	610,907	643,800	330,880	763,074	232,128	31,339	6,674,000
	1984	3,650,445	323,071	239,251	213,054	665,645	701,486	360,528	831,447	252,927	34,147	7,272,000
	1985	4,056,552	359,012	265,867	236,756	739,697	779,525	400,636	923,944	281,065	37,946	8,081,000
	1986	4,200,622	371,762	275,310	245,164	765,968	807,210	414,865	956,758	291,047	39,294	8,368,000
	1987	4,498,300	398,107	294,819	262,538	820,248	864,414	444,264	1,024,559	311,672	42,078	8,961,000
	1988	4,714,656	417,255	308,999	275,165	859,700	905,989	465,632	1,073,838	326,663	44,102	9,392,000
	1989	5,018,358	444,133	328,904	292,891	915,079	964,350	495,627	1,143,011	347,705	46,943	9,997,000
	1990	5,173,471	457,861	339,070	301,944	943,363	994,158	510,946	1,178,340	358,453	48,394	10,306,000
	1991	5,306,653	469,648	347,799	309,717	967,648	1,019,750	524,099	1,208,675	367,680	49,640	10,571,310
Interpolated →	1992	5,439,835	481,435	356,528	317,490	991,933	1,045,343	537,253	1,239,009	376,908	50,886	10,836,620
	1993	5,573,017	493,222	365,257	325,263	1,016,219	1,070,936	550,406	1,269,343	386,136	52,132	11,101,930
	1994	5,706,199	505,008	373,985	333,036	1,040,504	1,096,529	563,560	1,299,677	395,364	53,377	11,367,239
	1995	5,839,381	516,795	382,714	340,809	1,064,789	1,122,122	576,713	1,330,012	404,591	54,623	11,632,54
	1996	5,972,563	528,582	391,443	348,582	1,089,074	1,147,715	589,867	1,360,346	413,819	55,869	11,897,859
Arcadis Report →	1997	6,234,738	551,785	408,626	363,883	1,136,881	1,198,095	615,760	1,420,060	431,984	58,321	12,420,134
Calculated →	1998	6,495,685	574,879	425,728	379,113	1,184,464	1,248,240	641,531	1,479,495	450,064	60,762	12,939,962
	1999	6,755,458	597,870	442,754	394,274	1,231,832	1,298,151	667,187	1,538,663	468,063	63,192	13,457,453
	2000	6,929,009	613,229	454,129	404,404	1,263,479	1,331,510	684,328	1,578,192	480,088	64,816	13,803,182
	2001	7,103,086	621,635	465,538	414,563	1,295,221	1,364,961	701,520	1,617,840	492,149	66,444	14,149,957
	2002	7,277,658	644,085	476,979	424,752	1,325,053	1,398,507	718,761	1,657,602	504,245	68,077	14,497,720

Table 2.2b, continued

Calendar Year	2B	3	4	5	6	7	8A	8B	School Bus	Transit Bus	Heavy-duty total
2003	7,452,698	659,576	488,451	434,968	1,358,971	1,432,144	736,049	1,697,470	516,373	69,715	14,846,415
2004	7,628,181	675,107	499,952	445,210	1,390,970	1,465,865	753,380	1,737,439	528,531	71,356	15,195,992
2005	7,729,717	684,093	506,607	451,136	1,409,485	1,485,377	763,408	1,760,566	535,566	72,306	15,398,261
2006	7,834,765	693,390	513,492	457,267	1,428,640	1,505,564	773,783	1,784,492	542,845	73,289	15,607,525
2007	7,943,097	702,978	520,592	463,590	1,448,394	1,526,381	784,482	1,809,166	550,351	74,302	15,823,332
2008	8,054,502	712,837	527,894	470,092	1,468,708	1,547,789	795,484	1,834,541	558,070	75,344	16,045,260
2009	8,168,782	722,951	535,383	476,761	1,489,547	1,569,750	806,771	1,860,570	565,988	76,413	16,272,915
2010	8,226,408	728,051	539,160	480,125	1,500,055	1,580,824	812,462	1,873,695	569,980	76,952	16,387,713
2011	8,289,920	733,672	543,323	483,832	1,511,636	1,593,028	818,735	1,888,161	574,381	77,546	16,514,234
2012	8,358,898	739,777	547,844	487,857	1,524,214	1,606,283	825,547	1,903,872	579,160	78,191	16,651,644
2013	8,432,953	746,331	552,697	492,180	1,537,717	1,620,514	832,861	1,920,739	584,291	78,884	16,799,168
2014	8,511,724	753,302	557,860	496,777	1,552,081	1,635,661	840,641	1,938,680	589,749	79,621	16,956,086
2015	8,553,232	756,976	560,580	499,199	1,559,650	1,643,628	844,740	1,948,134	592,625	80,009	17,038,774
2016	8,601,538	761,251	563,746	502,019	1,568,458	1,652,910	849,511	1,959,137	595,972	80,461	17,135,004
2017	8,656,127	766,082	567,324	505,205	1,578,412	1,663,400	854,903	1,971,570	599,754	80,972	17,243,750
2018	8,716,524	771,427	571,283	508,730	1,589,425	1,675,006	860,868	1,985,327	603,939	81,537	17,364,065
2019	8,782,288	777,247	575,593	512,568	1,601,417	1,687,644	867,363	2,000,305	608,495	82,152	17,495,073
2020–2050	8,853,014	783,507	580,228	516,696	1,614,314	1,701,235	874,348	2,016,414	613,396	82,814	17,635,965

Source: U.S. EPA Assessment and Modeling Division report on "Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates and Projected Vehicle Counts for Use in MOBILE6," March 1999. http://www.epa.gov/OMS/models/mobile6/m6flt007.pdf.

Table 2.3 Default Values of Hourly Distribution of VMT by Functional Class

Hour	Freeways	Arterials & Collectors	Locals
1	0.0135	0.0091	0.0098
2	0.0112	0.0070	0.0076
3	0.0108	0.0064	0.0068
4	0.0108	0.0063	0.0066
5	0.0130	0.0079	0.0081
6	0.0227	0.0162	0.0159
7	0.0652	0.0523	0.0509
8	0.0744	0.0739	0.0733
9	0.0648	0.0655	0.0679
10	0.0566	0.0549	0.0548
11	0.0546	0.0540	0.0526
12	0.0567	0.0595	0.0577
13	0.0576	0.0631	0.0614
14	0.0557	0.0580	0.0573
15	0.0584	0.0608	0.0603
16	0.0594	0.0662	0.0653
17	0.0750	0.0790	0.0804
18	0.0666	0.0764	0.0782
19	0.0432	0.0541	0.0542
20	0.0352	0.0411	0.0407
21	0.0296	0.0315	0.0313
22	0.0264	0.0263	0.0264
23	0.0216	0.0179	0.0187
24	0.0171	0.0126	0.0136

Source: U.S. EPA Assessment and Modeling Division report on "Development of Method for VMT Weighting by Facility Type," February 1999. http://www.epa.gov/OMS/models/mobile6/m6spd003.pdf.

Table 2.4 Default Values of Average Hourly Speed Distribution

Hour 1	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0000	0.0001	0.0000	0.0001
	2.5 - 7.5	0.0002	0.0000	0.0000	0.0001
	7.5 - 12.5	0.0010	0.0000	0.0007	0.0005
	12.5 - 17.5	0.0000	0.0000	0.0000	0.0000
	17.5 - 22.5	0.0011	0.0087	0.0042	0.0031
	22.5 - 27.5	0.0012	0.0502	0.2977	0.0149
	27.5 - 32.5	0.0140	0.3303	0.4230	0.1628
	32.5 - 37.5	0.0119	0.1054	0.0269	0.0502
	37.5 - 42.5	0.0240	0.3306	0.1414	0.1948
	42.5 - 47.5	0.0302	0.0699	0.0658	0.0456
	47.5 - 52.5	0.2422	0.0733	0.0396	0.1659
	52.5 - 57.5	0.1208	0.0100	0.0008	0.0682
	57.5 - 62.5	0.5271	0.0211	0.0000	0.2805
	62.5 - 67.5	0.0233	0.0002	0.0000	0.0117
	67.5 - 72.5	0.0031	0.0000	0.0000	0.0015
Hour 2	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0000	0.0001	0.0000	0.0001
	2.5 - 7.5	0.0013	0.0000	0.0000	0.0006
	7.5 - 12.5	0.0000	0.0000	0.0000	0.0000
	12.5 - 17.5	0.0000	0.0000	0.0000	0.0000
	17.5 - 22.5	0.0000	0.0082	0.0041	0.0023
	22.5 - 27.5	0.0010	0.0496	0.2945	0.0146
	27.5 - 32.5	0.0115	0.3302	0.4227	0.1613
	32.5 - 37.5	0.0097	0.1057	0.0265	0.0492
	37.5 - 42.5	0.0200	0.3293	0.1412	0.1922
	42.5 - 47.5	0.0241	0.0696	0.0679	0.0425
	47.5 - 52.5	0.2450	0.0757	0.0425	0.1686
	52.5 - 57.5	0.1285	0.0101	0.0007	0.0720
	57.5 - 62.5	0.5271	0.0211	0.0000	0.2805
	62.5 - 67.5	0.0287	0.0004	0.0000	0.0145
	67.5 - 72.5	0.0031	0.0000	0.0000	0.0015

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 4	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0000	0.0000	0.0000	0.0000
	2.5 - 7.5	0.0013	0.0000	0.0000	0.0006
	7.5 - 12.5	0.0000	0.0000	0.0000	0.0000
	12.5 - 17.5	0.0000	0.0000	0.0000	0.0000
	17.5 - 22.5	0.0000	0.0077	0.0039	0.0022
	22.5 - 27.5	0.0008	0.0489	0.2904	0.0143
	27.5 - 32.5	0.0107	0.3291	0.4214	0.1601
	32.5 - 37.5	0.0081	0.1060	0.0260	0.0484
	37.5 - 42.5	0.0170	0.3316	0.1410	0.1920
	42.5 - 47.5	0.0199	0.0692	0.0706	0.0402
	47.5 - 52.5	0.2451	0.0758	0.0462	0.1687
	52.5 - 57.5	0.1341	0.0101	0.0005	0.0748
	57.5 - 62.5	0.5271	0.0211	0.0000	0.2805
	62.5 - 67.5	0.0328	0.0005	0.0000	0.0165
	67.5 - 72.5	0.0031	0.0000	0.0000	0.0015
Hour 5	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0021	0.0000	0.0000	0.0010
	2.5 - 7.5	0.0003	0.0000	0.0000	0.0001
	7.5 - 12.5	0.0000	0.0000	0.0007	0.0000
	12.5 - 17.5	0.0010	0.0000	0.0000	0.0005
	17.5 - 22.5	0.0000	0.0082	0.0041	0.0024
	22.5 - 27.5	0.0010	0.0497	0.2950	0.0147
	27.5 - 32.5	0.0118	0.3286	0.4222	0.1607
	32.5 - 37.5	0.0100	0.1056	0.0266	0.0493
	37.5 - 42.5	0.0205	0.3311	0.1413	0.1934
	42.5 - 47.5	0.0224	0.0697	0.0675	0.0416
	47.5 - 52.5	0.2452	0.0756	0.0420	0.1686
	52.5 - 57.5	0.1274	0.0101	0.0007	0.0715
	57.5 - 62.5	0.5271	0.0211	0.0000	0.2805
	62.5 - 67.5	0.0280	0.0003	0.0000	0.0141
	67.5 - 72.5	0.0031	0.0000	0.0000	0.0015

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 6	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0031	0.0000	0.0000	0.0015
	2.5 - 7.5	0.0003	0.0000	0.0000	0.0001
	7.5 - 12.5	0.0000	0.0000	0.0000	0.0000
	12.5 - 17.5	0.0010	0.0000	0.0007	0.0005
	17.5 - 22.5	0.0001	0.0085	0.0041	0.0025
	22.5 - 27.5	0.0011	0.0502	0.2971	0.0149
	27.5 - 32.5	0.0134	0.3271	0.4229	0.1609
	32.5 - 37.5	0.0124	0.1054	0.0269	0.0504
	37.5 - 42.5	0.0240	0.3324	0.1414	0.1958
	42.5 - 47.5	0.0267	0.0699	0.0662	0.0438
	47.5 - 52.5	0.2404	0.0752	0.0401	0.1660
	52.5 - 57.5	0.1226	0.0100	0.0008	0.0691
	57.5 - 62.5	0.5271	0.0211	0.0000	0.2805
	62.5 - 67.5	0.0246	0.0002	0.0000	0.0124
	67.5 - 72.5	0.0031	0.0000	0.0000	0.0015

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 7	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0083	0.0004	0.0020	0.0044
	2.5 - 7.5	0.0272	0.0052	0.0007	0.0178
	7.5 - 12.5	0.0210	0.0061	0.0015	0.0152
	12.5 - 17.5	0.0224	0.0053	0.0046	0.0153
	17.5 - 22.5	0.0217	0.0158	0.0082	0.0184
	22.5 - 27.5	0.0381	0.0854	0.3114	0.0476
	27.5 - 32.5	0.0344	0.3210	0.4001	0.1763
	32.5 - 37.5	0.0536	0.1382	0.0345	0.0888
	37.5 - 42.5	0.0614	0.2804	0.1354	0.1820
	42.5 - 47.5	0.0700	0.0595	0.0654	0.0613
	47.5 - 52.5	0.2507	0.0628	0.0354	0.1618
	52.5 - 57.5	0.1150	0.0103	0.0009	0.0654
	57.5 - 62.5	0.2550	0.0095	0.0000	0.1351
	62.5 - 67.5	0.0200	0.0002	0.0000	0.0101
	67.5 - 72.5	0.0011	0.0000	0.0000	0.0006
Hour 8	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0260	0.0036	0.0086	0.0151
	2.5 - 7.5	0.0066	0.0029	0.0071	0.0047
	7.5 - 12.5	0.0076	0.0059	0.0042	0.0060
	12.5 - 17.5	0.0156	0.0234	0.0082	0.0152
	17.5 - 22.5	0.0282	0.0735	0.0415	0.0356
	22.5 - 27.5	0.0326	0.1114	0.3101	0.0486
	27.5 - 32.5	0.0344	0.2842	0.3870	0.1582
	32.5 - 37.5	0.0361	0.0950	0.0349	0.0645
	37.5 - 42.5	0.0360	0.2633	0.1205	0.1758
	42.5 - 47.5	0.0435	0.0396	0.0490	0.0441
	47.5 - 52.5	0.2453	0.0698	0.0280	0.1661
	52.5 - 57.5	0.1729	0.0107	0.0009	0.0950
	57.5 - 62.5	0.3023	0.0168	0.0000	0.1646
	62.5 - 67.5	0.0118	0.0000	0.0000	0.0059
	67.5 - 72.5	0.0011	0.0000	0.0000	0.0006

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 9	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0260	0.0033	0.0092	0.0149
	2.5 - 7.5	0.0033	0.0021	0.0055	0.0028
	7.5 - 12.5	0.0064	0.0032	0.0032	0.0047
	12.5 - 17.5	0.0057	0.0085	0.0034	0.0059
	17.5 - 22.5	0.0126	0.0436	0.0231	0.0191
	22.5 - 27.5	0.0281	0.1130	0.3207	0.0469
	27.5 - 32.5	0.0342	0.2914	0.3856	0.1581
	32.5 - 37.5	0.0349	0.1076	0.0367	0.0651
	37.5 - 42.5	0.0407	0.2835	0.1219	0.1875
	42.5 - 47.5	0.0369	0.0424	0.0584	0.0411
	47.5 - 52.5	0.2181	0.0719	0.0314	0.1537
	52.5 - 57.5	0.1066	0.0091	0.0008	0.0604
	57.5 - 62.5	0.4339	0.0205	0.0000	0.2333
	62.5 - 67.5	0.0098	0.0000	0.0000	0.0049
	67.5 - 72.5	0.0029	0.0000	0.0000	0.0015

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 10	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0145	0.0030	0.0053	0.0090
	2.5 - 7.5	0.0096	0.0015	0.0022	0.0057
	7.5 - 12.5	0.0021	0.0011	0.0040	0.0016
	12.5 - 17.5	0.0022	0.0015	0.0024	0.0017
	17.5 - 22.5	0.0041	0.0183	0.0113	0.0075
	22.5 - 27.5	0.0166	0.1001	0.3211	0.0373
	27.5 - 32.5	0.0232	0.2910	0.3891	0.1529
	32.5 - 37.5	0.0373	0.1246	0.0396	0.0711
	37.5 - 42.5	0.0418	0.3013	0.1218	0.1936
	42.5 - 47.5	0.0449	0.0535	0.0673	0.0482
	47.5 - 52.5	0.2248	0.0743	0.0353	0.1581
	52.5 - 57.5	0.1190	0.0094	0.0008	0.0668
	57.5 - 62.5	0.4422	0.0205	0.0000	0.2375
	62.5 - 67.5	0.0147	0.0000	0.0000	0.0074
	67.5 - 72.5	0.0029	0.0000	0.0000	0.0015
Hour 11	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0083	0.0030	0.0053	0.0059
	2.5 - 7.5	0.0086	0.0014	0.0009	0.0051
	7.5 - 12.5	0.0052	0.0005	0.0040	0.0029
	12.5 - 17.5	0.0032	0.0017	0.0011	0.0024
	17.5 - 22.5	0.0040	0.0181	0.0095	0.0075
	22.5 - 27.5	0.0163	0.1008	0.3193	0.0376
	27.5 - 32.5	0.0232	0.2898	0.3952	0.1523
	32.5 - 37.5	0.0364	0.1246	0.0396	0.0707
	37.5 - 42.5	0.0375	0.3015	0.1218	0.1914
	42.5 - 47.5	0.0420	0.0537	0.0673	0.0468
	47.5 - 52.5	0.2352	0.0751	0.0353	0.1637
	52.5 - 57.5	0.1170	0.0094	0.0008	0.0657
	57.5 - 62.5	0.4454	0.0205	0.0000	0.2391
	62.5 - 67.5	0.0148	0.0000	0.0000	0.0074
	67.5 - 72.5	0.0029	0.0000	0.0000	0.0015

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 12	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0073	0.0034	0.0046	0.0056
	2.5 - 7.5	0.0034	0.0017	0.0032	0.0026
	7.5 - 12.5	0.0042	0.0021	0.0032	0.0032
	12.5 - 17.5	0.0098	0.0049	0.0035	0.0067
	17.5 - 22.5	0.0121	0.0344	0.0188	0.0164
	22.5 - 27.5	0.0244	0.1091	0.3174	0.0440
	27.5 - 32.5	0.0289	0.2894	0.3973	0.1539
	32.5 - 37.5	0.0327	0.1125	0.0351	0.0654
	37.5 - 42.5	0.0401	0.2932	0.1205	0.1908
	42.5 - 47.5	0.0392	0.0460	0.0620	0.0433
	47.5 - 52.5	0.2294	0.0735	0.0335	0.1601
	52.5 - 57.5	0.1011	0.0093	0.0008	0.0577
	57.5 - 62.5	0.4538	0.0205	0.0000	0.2433
	62.5 - 67.5	0.0108	0.0000	0.0000	0.0054
	67.5 - 72.5	0.0029	0.0000	0.0000	0.0015

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 13	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0104	0.0040	0.0053	0.0075
	2.5 - 7.5	0.0023	0.0021	0.0041	0.0023
	7.5 - 12.5	0.0064	0.0027	0.0039	0.0045
	12.5 - 17.5	0.0087	0.0078	0.0054	0.0072
	17.5 - 22.5	0.0147	0.0427	0.0236	0.0200
	22.5 - 27.5	0.0281	0.1134	0.3176	0.0472
	27.5 - 32.5	0.0335	0.2857	0.3903	0.1546
	32.5 - 37.5	0.0328	0.1083	0.0369	0.0643
	37.5 - 42.5	0.0345	0.2886	0.1214	0.1867
	42.5 - 47.5	0.0354	0.0427	0.0581	0.0405
	47.5 - 52.5	0.2294	0.0724	0.0325	0.1596
	52.5 - 57.5	0.0964	0.0091	0.0008	0.0554
	57.5 - 62.5	0.4547	0.0205	0.0000	0.2438
	62.5 - 67.5	0.0099	0.0000	0.0000	0.0050
	67.5 - 72.5	0.0029	0.0000	0.0000	0.0015
Hour 14	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0083	0.0038	0.0073	0.0064
	2.5 - 7.5	0.0075	0.0025	0.0022	0.0052
	7.5 - 12.5	0.0052	0.0020	0.0041	0.0037
	12.5 - 17.5	0.0043	0.0022	0.0032	0.0031
	17.5 - 22.5	0.0054	0.0216	0.0117	0.0094
	22.5 - 27.5	0.0182	0.1034	0.3205	0.0395
	27.5 - 32.5	0.0257	0.2834	0.3900	0.1500
	32.5 - 37.5	0.0381	0.1243	0.0380	0.0715
	37.5 - 42.5	0.0380	0.3020	0.1206	0.1922
	42.5 - 47.5	0.0421	0.0515	0.0669	0.0463
	47.5 - 52.5	0.2258	0.0736	0.0348	0.1583
	52.5 - 57.5	0.1118	0.0094	0.0008	0.0632
	57.5 - 62.5	0.4512	0.0205	0.0000	0.2420
	62.5 - 67.5	0.0154	0.0000	0.0000	0.0077
	67.5 - 72.5	0.0029	0.0000	0.0000	0.0015

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 15	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0114	0.0041	0.0079	0.0081
	2.5 - 7.5	0.0065	0.0024	0.0038	0.0046
	7.5 - 12.5	0.0052	0.0020	0.0052	0.0038
	12.5 - 17.5	0.0023	0.0034	0.0024	0.0026
	17.5 - 22.5	0.0039	0.0249	0.0121	0.0096
	22.5 - 27.5	0.0206	0.1049	0.3213	0.0411
	27.5 - 32.5	0.0279	0.2844	0.3889	0.1513
	32.5 - 37.5	0.0358	0.1215	0.0369	0.0696
	37.5 - 42.5	0.0383	0.2986	0.1197	0.1910
	42.5 - 47.5	0.0517	0.0489	0.0666	0.0504
	47.5 - 52.5	0.2147	0.0751	0.0344	0.1535
	52.5 - 57.5	0.1151	0.0093	0.0008	0.0647
	57.5 - 62.5	0.4484	0.0205	0.0000	0.2406
	62.5 - 67.5	0.0154	0.0000	0.0000	0.0077
	67.5 - 72.5	0.0029	0.0000	0.0000	0.0015

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 16	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0156	0.0052	0.0079	0.0108
	2.5 - 7.5	0.0075	0.0027	0.0061	0.0053
	7.5 - 12.5	0.0034	0.0032	0.0045	0.0034
	12.5 - 17.5	0.0042	0.0085	0.0064	0.0050
	17.5 - 22.5	0.0081	0.0450	0.0284	0.0177
	22.5 - 27.5	0.0272	0.1151	0.3199	0.0475
	27.5 - 32.5	0.0324	0.2822	0.3766	0.1521
	32.5 - 37.5	0.0363	0.1024	0.0419	0.0621
	37.5 - 42.5	0.0315	0.2835	0.1213	0.1824
	42.5 - 47.5	0.0390	0.0419	0.0558	0.0420
	47.5 - 52.5	0.2124	0.0777	0.0301	0.1546
	52.5 - 57.5	0.0644	0.0096	0.0009	0.0398
	57.5 - 62.5	0.5000	0.0230	0.0000	0.2684
	62.5 - 67.5	0.0148	0.0000	0.0000	0.0074
	67.5 - 72.5	0.0033	0.0000	0.0000	0.0016
Hour 17	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0156	0.0049	0.0106	0.0107
	2.5 - 7.5	0.0411	0.0165	0.0050	0.0328
	7.5 - 12.5	0.0225	0.0087	0.0057	0.0162
	12.5 - 17.5	0.0199	0.0222	0.0107	0.0190
	17.5 - 22.5	0.0284	0.0652	0.0359	0.0354
	22.5 - 27.5	0.0316	0.1222	0.3135	0.0541
	27.5 - 32.5	0.0500	0.2809	0.3839	0.1637
	32.5 - 37.5	0.0488	0.0959	0.0395	0.0689
	37.5 - 42.5	0.0446	0.2557	0.1166	0.1714
	42.5 - 47.5	0.0555	0.0405	0.0507	0.0507
	47.5 - 52.5	0.2223	0.0651	0.0271	0.1497
	52.5 - 57.5	0.1092	0.0095	0.0009	0.0621
	57.5 - 62.5	0.2957	0.0125	0.0000	0.1579
	62.5 - 67.5	0.0144	0.0000	0.0000	0.0072
	67.5 - 72.5	0.0003	0.0000	0.0000	0.0002

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 18	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0187	0.0055	0.0112	0.0125
	2.5 - 7.5	0.0113	0.0071	0.0100	0.0103
	7.5 - 12.5	0.0046	0.0082	0.0036	0.0061
	12.5 - 17.5	0.0110	0.0219	0.0107	0.0128
	17.5 - 22.5	0.0183	0.0675	0.0396	0.0294
	22.5 - 27.5	0.0261	0.1169	0.3150	0.0481
	27.5 - 32.5	0.0488	0.2771	0.3786	0.1609
	32.5 - 37.5	0.0383	0.0915	0.0421	0.0612
	37.5 - 42.5	0.0314	0.2637	0.1138	0.1726
	42.5 - 47.5	0.0534	0.0394	0.0480	0.0489
	47.5 - 52.5	0.2235	0.0712	0.0265	0.1558
	52.5 - 57.5	0.1237	0.0106	0.0009	0.0702
	57.5 - 62.5	0.3736	0.0194	0.0000	0.2023
	62.5 - 67.5	0.0160	0.0000	0.0000	0.0080
	67.5 - 72.5	0.0014	0.0000	0.0000	0.0007

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 19	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0176	0.0043	0.0106	0.0113
	2.5 - 7.5	0.0064	0.0024	0.0050	0.0046
	7.5 - 12.5	0.0010	0.0016	0.0007	0.0013
	12.5 - 17.5	0.0024	0.0038	0.0046	0.0027
	17.5 - 22.5	0.0034	0.0255	0.0213	0.0095
	22.5 - 27.5	0.0155	0.1005	0.3165	0.0370
	27.5 - 32.5	0.0191	0.2849	0.3815	0.1460
	32.5 - 37.5	0.0315	0.1205	0.0433	0.0651
	37.5 - 42.5	0.0357	0.2996	0.1229	0.1919
	42.5 - 47.5	0.0515	0.0497	0.0616	0.0506
	47.5 - 52.5	0.2134	0.0761	0.0312	0.1540
	52.5 - 57.5	0.0674	0.0100	0.0009	0.0415
	57.5 - 62.5	0.5178	0.0211	0.0000	0.2758
	62.5 - 67.5	0.0141	0.0001	0.0000	0.0071
	67.5 - 72.5	0.0031	0.0000	0.0000	0.0015
Hour 20	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0135	0.0038	0.0099	0.0090
	2.5 - 7.5	0.0043	0.0021	0.0007	0.0034
	7.5 - 12.5	0.0031	0.0018	0.0025	0.0026
	12.5 - 17.5	0.0010	0.0014	0.0032	0.0013
	17.5 - 22.5	0.0012	0.0115	0.0080	0.0044
	22.5 - 27.5	0.0094	0.0734	0.3132	0.0263
	27.5 - 32.5	0.0177	0.2923	0.3929	0.1477
	32.5 - 37.5	0.0258	0.1219	0.0320	0.0622
	37.5 - 42.5	0.0264	0.3170	0.1385	0.1923
	42.5 - 47.5	0.0550	0.0641	0.0635	0.0564
	47.5 - 52.5	0.2060	0.0794	0.0349	0.1514
	52.5 - 57.5	0.0980	0.0100	0.0009	0.0567
	57.5 - 62.5	0.5209	0.0211	0.0000	0.2774
	62.5 - 67.5	0.0145	0.0001	0.0000	0.0073
	67.5 - 72.5	0.0031	0.0000	0.0000	0.0015

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 21	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0095	0.0037	0.0073	0.0068
	2.5 - 7.5	0.0031	0.0017	0.0026	0.0052
	7.5 - 12.5	0.0025	0.0012	0.0007	0.0017
	12.5 - 17.5	0.0007	0.0019	0.0000	0.0011
	17.5 - 22.5	0.0012	0.0103	0.0096	0.0038
	22.5 - 27.5	0.0069	0.0558	0.2999	0.0181
	27.5 - 32.5	0.0166	0.3040	0.4095	0.1517
	32.5 - 37.5	0.0216	0.1067	0.0273	0.0555
	37.5 - 42.5	0.0257	0.3309	0.1416	0.1986
	42.5 - 47.5	0.0476	0.0702	0.0638	0.0516
	47.5 - 52.5	0.2169	0.0824	0.0368	0.1551
	52.5 - 57.5	0.1048	0.0100	0.0009	0.0636
	57.5 - 62.5	0.5228	0.0211	0.0000	0.2784
	62.5 - 67.5	0.0171	0.0001	0.0000	0.0069
	67.5 - 72.5	0.0031	0.0000	0.0000	0.0015

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 22	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0054	0.0036	0.0079	0.0052
	2.5 - 7.5	0.0018	0.0018	0.0007	0.0042
	7.5 - 12.5	0.0018	0.0009	0.0020	0.0026
	12.5 - 17.5	0.0004	0.0012	0.0007	0.0022
	17.5 - 22.5	0.0011	0.0109	0.0063	0.0058
	22.5 - 27.5	0.0045	0.0530	0.3036	0.0174
	27.5 - 32.5	0.0155	0.3056	0.4085	0.1527
	32.5 - 37.5	0.0175	0.1064	0.0273	0.0534
	37.5 - 42.5	0.0250	0.3320	0.1416	0.2007
	42.5 - 47.5	0.0401	0.0707	0.0638	0.0494
	47.5 - 52.5	0.2277	0.0827	0.0368	0.1573
	52.5 - 57.5	0.1117	0.0100	0.0009	0.0616
	57.5 - 62.5	0.5246	0.0211	0.0000	0.2789
	62.5 - 67.5	0.0198	0.0001	0.0000	0.0070
	67.5 - 72.5	0.0031	0.0000	0.0000	0.0015
Hour 23	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0027	0.0034	0.0053	0.0056
	2.5 - 7.5	0.0010	0.0009	0.0020	0.0053
	7.5 - 12.5	0.0014	0.0007	0.0013	0.0015
	12.5 - 17.5	0.0002	0.0015	0.0013	0.0014
	17.5 - 22.5	0.0011	0.0104	0.0076	0.0039
	22.5 - 27.5	0.0028	0.0531	0.3019	0.0171
	27.5 - 32.5	0.0147	0.3065	0.4102	0.1547
	32.5 - 37.5	0.0147	0.1064	0.0273	0.0548
	37.5 - 42.5	0.0245	0.3325	0.1416	0.1999
	42.5 - 47.5	0.0352	0.0706	0.0638	0.0494
	47.5 - 52.5	0.2350	0.0829	0.0368	0.1573
	52.5 - 57.5	0.1162	0.0100	0.0009	0.0616
	57.5 - 62.5	0.5259	0.0211	0.0000	0.2789
	62.5 - 67.5	0.0215	0.0001	0.0000	0.0070
	67.5 - 72.5	0.0031	0.0000	0.0000	0.0015

Table 2.4, continued

Default Values of Average Hourly Speed Distribution

Hour 24	Speed (mph)	Freeways	Art/Col	Locals	Ramps
	0.0 - 2.5	0.0014	0.0030	0.0046	0.0059
	2.5 - 7.5	0.0006	0.0013	0.0020	0.0029
	7.5 - 12.5	0.0012	0.0016	0.0013	0.0020
	12.5 - 17.5	0.0001	0.0018	0.0007	0.0016
	17.5 - 22.5	0.0011	0.0103	0.0076	0.0034
	22.5 - 27.5	0.0020	0.0528	0.3002	0.0170
	27.5 - 32.5	0.0144	0.3057	0.4127	0.1532
	32.5 - 37.5	0.0133	0.1061	0.0273	0.0538
	37.5 - 42.5	0.0242	0.3327	0.1416	0.2014
	42.5 - 47.5	0.0327	0.0704	0.0641	0.0509
	47.5 - 52.5	0.2386	0.0831	0.0372	0.1566
	52.5 - 57.5	0.1185	0.0100	0.0009	0.0630
	57.5 - 62.5	0.5265	0.0211	0.0000	0.2789
	62.5 - 67.5	0.0224	0.0001	0.0000	0.0080
	67.5 - 72.5	0.0031	0.0000	0.0000	0.0015

Table 2.5 Default Values for Trips/Car-Day for Cars and Trucks

Trips per Car per Day			
Cars		**Trucks**	
Weekday	Weekend	Weekday	Weekend
7.28	5.41	8.06	5.68
Hot Soaks per Car per Day			
Cars		**Trucks**	
Weekday	Weekend	Weekday	Weekend
Reduction = 26.1%	Reduction = 28.6%	Reduction = 26.1%	Reduction = 28.6%
5.38	3.86	5.96	4.06

Source: U.S. EPA Assessment and Modeling Division report on "Soak Length Activity Factors for Start Emissions," February 1998. http://www.epa.gov/OMS/models/mobile6/m6flt003.pdf.

Table 2.6a Default Distributions of Vehicle Trips by Hourly Group

Daily Distribution of Weekday Trips by Hourly Group (in percent)		
Hour	**VMT Based**	**Trip Count Based**
6	3.67	1.983
7	7.29	5.461
8	8.18	5.872
9	4.75	4.744
10	4.59	5.217
11	5.40	6.757
12	6.10	8.237
13	7.05	7.352
14	7.97	8.069
15	8.14	9.015
16	8.94	8.603
17	8.19	7.779
18	6.28	6.025
24	13.45	14.887

Source: U.S. EPA Assessment and Modeling Division report on "Soak Length Activity Factors for Start Emissions," February 1998. http://www.epa.gov/OMS/models/mobile6/m6flt003.pdf.

Table 2.6b Default Distributions of Vehicle Trips by Hourly Group

Daily Distribution of Weekend Trips by Hourly Group (in percent)		
Hour	**VMT Based**	**Trip Count Based**
6	0.90	0.905
7	1.70	1.962
8	2.84	3.068
9	4.57	6.590
10	6.20	6.992
11	7.62	7.998
12	8.79	10.312
13	9.98	7.294
14	7.64	8.803
15	9.19	7.294
16	9.04	7.998
17	6.88	7.042
18	6.57	6.087
24	18.07	17.656

Source: U.S. EPA Assessment and Modeling Division report on "Soak Length Activity Factors for Start Emissions," February 1998. http://www.epa.gov/OMS/models/mobile6/m6flt003.pdf.

Table 2.7 Trip Duration Categories

Trip Duration Categories	
Category Number	Trip Duration Range (in Minutes)
1	0 - 10 minutes
2	11 - 20 minutes
3	21 - 30 minutes
4	31 - 40 minutes
5	41 - 50 minutes
6	51+ minutes

Source: U.S. EPA Assessment and Modeling Division report on "Soak length Activity Factors for Start Emissions," February 1998. http://www.epa.gov/OMS/models/mobile6/m6flt003.pdf.

Table 2.8a Default Values for Trip Length Distribution (weekday)

	Hour	0-10 Min	11-20 Min	21-30 Min	31-40 Min	41-50 Min	51+ Min
Weekday	6	14.89%	22.70%	29.44%	20.76%	12.22%	0.00%
Weekday	7	16.06%	31.05%	40.00%	9.13%	3.75%	0.00%
Weekday	8	14.56%	33.48%	18.37%	18.49%	3.01%	12.10%
Weekday	9	27.40%	32.71%	22.20%	4.75%	0.00%	12.94%
Weekday	10	28.47%	42.99%	17.06%	7.92%	3.56%	0.00%
Weekday	11	32.94%	32.78%	14.96%	7.53%	5.34%	6.47%
Weekday	12	33.41%	39.64%	15.19%	11.76%	0.00%	0.00%
Weekday	13	28.89%	46.80%	13.93%	9.27%	1.10%	0.00%
Weekday	14	27.08%	39.31%	18.29%	3.18%	1.38%	10.76%
Weekday	15	26.79%	41.84%	24.28%	3.90%	2.20%	0.99%
Weekday	16	24.91%	40.78%	18.79%	10.87%	1.76%	2.89%
Weekday	17	21.09%	34.84%	29.41%	9.23%	5.42%	0.00%
Weekday	18	26.80%	32.23%	25.10%	11.98%	3.05%	0.84%
Weekday	24	20.95%	37.26%	24.51%	7.52%	6.37%	3.38%

Table 2.8b Default Values for Trip Length Distribution (weekend)

Weekend	6	18.98%	60.63%	20.39%	0.00%	0.00%	0.00%
Weekend	7	26.89%	42.40%	30.71%	0.00%	0.00%	0.00%
Weekend	8	20.60%	41.68%	18.82%	0.00%	18.90%	0.00%
Weekend	9	29.83%	38.26%	23.09%	8.82%	0.00%	0.00%
Weekend	10	25.57%	42.08%	16.58%	15.77%	0.00%	0.00%
Weekend	11	27.61%	36.42%	13.25%	10.31%	3.38%	9.03%
Weekend	12	25.85%	35.51%	28.61%	3.54%	6.49%	0.00%
Weekend	13	18.37%	19.41%	22.48%	9.86%	4.32%	25.56%
Weekend	14	23.71%	39.19%	12.26%	14.93%	9.91%	0.00%
Weekend	15	21.16%	25.39%	25.46%	4.07%	0.00%	23.92%
Weekend	16	25.66%	25.90%	12.34%	6.60%	15.03%	14.48%
Weekend	17	24.31%	37.71%	27.30%	3.91%	0.00%	6.76%
Weekend	18	18.01%	38.43%	18.27%	20.83%	4.46%	0.00%
Weekend	24	15.69%	27.42%	15.74%	9.57%	2.58%	28.99%

Source: U.S. EPA Assessment and Modeling Division report on "Soak Length Activity Factors for Start Emissions," February 1998. http://www.epa.gov/OMS/models/mobile6/m6flt003.pdf.

Table 2.9 Daily Distribution of Hot Soaks across the Fourteen Time Periods of the Day

Hour	Weekday	Weekend
6	2.33	0.99
7	6.05	2.26
8	6.30	3.38
9	4.62	6.41
10	5.08	6.98
11	6.32	8.80
12	7.80	9.23
13	7.32	7.40
14	7.87	8.10
15	8.63	6.62
16	8.71	8.03
17	7.99	6.91
18	5.88	6.27
24	15.10	18.62

Source: U.S. EPA Assessment and Modeling Division report on "Hot Soak Emissions as a Function of Time," June 1998. http://www.epa.gov/OMS/models/mobile6/m6evp007.pdf

Table 2.10a Hot Soak Length Distribution for Weekdays

Hourly Group	Coefficient B1	Coefficient B2	Coefficient B3	Coefficient B4	R-squared Value
6	1143.5	20.261	-4.028	-0.001095	0.947
7	1749.6	24.655	-4.259	-0.001225	0.990
8	2483.7	29.051	-4.449	-0.000981	0.981
9	3212.9	32.712	-4.589	-0.001003	0.971
10	4010.7	36.230	-4.709	-0.000929	0.955
11	2985.7	31.546	-4.552	-0.001310	0.988
12	3208.4	32.605	-4.590	-0.001202	0.985
13	4042.0	36.357	-4.714	-0.009702	0.964
14	3066.0	31.957	-4.565	-0.001189	0.987
15	3207.6	32.627	-4.590	-0.001167	0.987
16	2957.4	31.546	-4.549	-0.001149	0.977
17	2435.8	28.726	-4.440	-0.001239	0.995
18	2096.7	26.827	-4.361	-0.001445	0.969
24	1906.5	25.712	-4.306	-0.000900	0.977

Source: U.S. EPA Assessment and Modeling Division report on "Hot Soak Emissions as a Function of Time," June 1998. http://www.epa.gov/OMS/models/mobile6/m6evp007.pdf

Table 2.10b Hot Soak Length Distribution for Weekends

Hourly Group	Coefficient B1	Coefficient B2	Coefficient B3	Coefficient B4	R-squared Value
6	51.25	5.911	-18.036	-0.0359	0.935
7	55.31	0.0000633	-13.695	-0.0325	0.924
8	2732.31	0.1819	-9.620	-0.000651	0.943
9	2208.97	0.1645	-9.507	-0.000750	0.978
10	2706.57	0.1784	-9.631	-0.000628	0.951
11	2432.70	0.1674	-9.591	-0.000862	0.945
12	1824.07	0.1564	-9.364	-0.000857	0.972
13	1930.61	0.1506	-9.464	-0.000904	0.950
14	2424.95	0.1761	-9.531	-0.000692	0.980
15	1921.98	0.1496	-9.464	-0.000861	0.922
16	2129.29	0.1602	-9.498	-0.000819	0.978
17	1292.06	0.1333	-9.183	-0.001161	0.969
18	178.02	0.0327	-8.586	-0.007661	0.957
24	520.28	0.0902	-8.653	-0.001729	0.991

Source: U.S. EPA Assessment and Modeling Division report on "Hot Soak Emissions as a Function of Time," June 1998. http://www.epa.gov/OMS/models/mobile6/m6evp007.pdf

Table 2.11a Hourly Soak Length Activity Percentages for Weekdays

time	six	seven	eight	nine	ten	eleven	twelve
0	1.55039	2.51397	2.86458	0.66890	1.54321	2.10280	1.71756
1	3.87597	2.51397	4.42708	4.68227	6.17284	1.86916	4.96183
2	3.10078	6.14525	4.16667	5.01672	6.17284	4.67290	5.53435
3	2.32558	3.35196	3.12500	5.35117	4.01235	4.90654	4.96183
4	1.55039	3.07263	2.34375	2.67559	4.01235	4.67290	4.77099
5	0.77519	0.55866	2.34375	2.00669	2.16049	3.27103	2.48092
6	0.77519	0.83799	3.38542	2.34114	3.39506	3.73832	3.81679
7	0.00000	1.11732	2.08333	1.00334	1.23457	3.27103	2.09924
8	1.55039	0.55866	1.30208	1.33779	0.61728	1.16822	2.09924
9	0.77519	0.27933	0.26042	0.66890	0.92593	3.03738	1.71756
10	0.77519	0.55866	2.60417	1.67224	1.85185	0.93458	0.95420
11	0.77519	0.27933	1.82292	2.00669	2.46914	1.86916	1.90840
12	0.00000	0.55866	1.30208	2.67559	1.23457	3.27103	1.90840
13	0.00000	0.55866	1.56250	1.00334	0.30864	0.93458	0.57252
14	0.00000	0.55866	1.04167	0.66890	1.23457	0.70093	1.14504
15	0.00000	0.55866	1.04167	1.00334	0.92593	1.16822	1.52672
16	0.00000	0.00000	0.52083	1.33779	0.61728	0.93458	0.95420
17	0.77519	0.27933	1.56250	1.00334	1.23457	1.40187	1.14504
18	0.00000	0.83799	1.04167	0.33445	1.23457	0.46729	0.76336
19	0.00000	0.00000	1.04167	1.00334	0.61728	0.70093	1.90840
20	0.00000	0.55866	1.30208	1.33779	1.54321	0.70093	1.33588
21	0.00000	0.83799	0.00000	0.33445	1.23457	1.16822	0.95420
22	0.00000	0.00000	0.78125	1.00334	0.61728	0.46729	0.57252
23	0.00000	0.00000	0.00000	0.00000	1.54321	1.40187	0.76336
24	0.00000	0.00000	0.78125	2.34114	0.61728	0.46729	0.57252
25	0.00000	0.00000	0.26042	1.00334	0.00000	0.46729	0.38168
26	0.00000	0.00000	0.52083	0.66890	0.92593	0.93458	1.14504
27	0.00000	0.00000	0.78125	0.33445	0.00000	0.46729	0.57252
28	0.00000	0.27933	0.26042	0.33445	0.00000	1.16822	0.19084
29	0.00000	0.27933	0.00000	0.33445	0.92593	0.23364	0.57252
30	0.00000	0.00000	0.26042	1.00334	0.30864	0.46729	0.38168
32	0.00000	0.00000	0.78125	1.33779	0.92593	1.63551	1.14504
34	0.77519	0.55866	0.78125	0.33445	0.61728	1.40187	2.09924
36	0.00000	0.00000	0.26042	0.00000	1.23457	1.16822	1.33588
38	0.00000	0.27933	1.04167	0.66890	0.30864	0.46729	0.57252
40	0.00000	0.00000	0.52083	1.00334	1.23457	1.40187	0.76336
42	0.00000	0.00000	0.00000	1.33779	0.92593	0.46729	1.14504
44	0.00000	0.27933	0.52083	0.66890	1.23457	1.40187	0.95420
46	0.00000	0.00000	0.00000	0.00000	0.61728	0.46729	0.95420
48	0.00000	0.55866	0.52083	2.00669	0.61728	0.93458	0.38168
50	0.00000	0.27933	0.78125	0.00000	1.85185	0.70093	0.38168
52	0.00000	0.27933	0.00000	0.33445	0.92593	0.46729	0.76336
54	0.00000	0.00000	0.00000	0.33445	0.61728	0.23364	1.52672
56	0.00000	0.27933	0.00000	0.33445	0.92593	0.70093	0.76336
58	0.00000	0.00000	0.26042	0.66890	0.30864	0.23364	1.33588
60	0.00000	0.00000	0.26042	0.00000	0.30864	0.00000	0.38168
90	0.00000	0.00000	1.30208	6.02007	7.40741	4.90654	5.15267
120	0.00000	0.27933	0.26042	4.01338	4.01235	4.90654	2.29008
150	0.00000	0.00000	0.26042	2.34114	1.85185	3.03738	1.90840
180	0.77519	0.00000	0.00000	0.00000	0.30864	3.03738	2.29008
210	0.00000	0.00000	0.00000	0.00000	0.92593	2.33645	1.71756
240	0.00000	0.27933	0.26042	0.33445	1.23457	2.80374	2.86260
270	0.00000	0.00000	0.00000	0.33445	0.30864	2.57009	3.62595
300	0.00000	0.27933	0.26042	0.00000	0.30864	0.00000	2.29008
330	0.00000	0.27933	0.00000	0.00000	0.61728	0.23364	0.38168
360	0.00000	0.27933	0.00000	0.00000	0.30864	0.00000	0.76336
390	0.00000	0.27933	0.00000	0.33445	0.30864	0.70093	0.00000
420	0.77519	0.55866	0.26042	0.00000	0.30864	0.23364	0.00000
450	0.77519	1.39665	0.26042	0.33445	0.00000	0.00000	0.38168
480	3.10078	1.11732	0.26042	0.00000	0.30864	0.23364	0.38168
510	5.42636	0.83799	0.00000	0.00000	0.00000	0.00000	0.00000
540	3.10078	1.11732	0.52083	0.66890	0.61728	0.00000	0.00000
570	2.32558	2.79330	1.82292	0.66890	0.61728	0.23364	0.00000
600	3.87597	1.67598	2.34375	0.66890	0.30864	0.00000	0.00000
630	1.55039	5.58659	0.78125	1.00334	0.61728	0.46729	0.38168
660	4.65116	3.63128	1.56250	0.66890	0.61728	0.46729	0.00000
690	4.65116	3.91061	1.56250	2.00669	1.23457	0.23364	0.19084
720	3.87597	3.35196	2.60417	0.33445	0.30864	0.00000	0.00000
720+	45.73643	42.73743	35.15625	24.08027	15.12346	8.87850	6.48855

Source: U.S. EPA Assessment and Modeling Division report on "Soak Length Activity Factors for Hourly Emissions," February 1998. http://www.epa.gov/OMS/models/mobile6/m6flt003.pdf

Table 2.11a, continued

time	thirteen	fourteen	fifteen	sixteen	seventeen	eighteen	twenty-four
0	2.15054	1.36452	1.39616	2.02578	2.61044	1.29870	1.75077
1	3.87097	4.87329	3.83944	4.41989	3.61446	3.37662	3.39856
2	4.94624	4.87329	5.93368	4.60405	6.02410	3.63636	3.70752
3	3.87097	4.67836	4.71204	4.41989	6.62651	3.89610	2.88363
4	4.08602	1.94932	3.49040	3.49908	3.61446	3.11688	2.26571
5	3.22581	4.67836	3.66492	4.05157	2.00803	3.37662	1.75077
6	3.22581	2.72904	4.01396	2.39411	2.20884	3.89610	1.54480
7	2.15054	3.11891	2.61780	1.84162	2.40964	2.33766	1.64779
8	2.58065	2.53411	2.61780	2.02578	1.80723	3.11688	0.72091
9	2.15054	2.33918	1.74520	2.02578	1.40562	0.25974	0.41195
10	1.29032	1.94932	2.44328	1.47330	1.00402	1.81818	0.72091
11	2.58065	1.75439	1.57068	2.20994	1.40562	1.03896	0.72091
12	1.93548	1.36452	1.57068	0.92081	1.00402	2.07792	0.72091
13	1.29032	1.75439	1.22164	1.28913	1.20482	1.55844	0.51493
14	1.50538	0.97466	0.69808	0.55249	1.00402	0.77922	0.92688
15	1.50538	0.38986	1.04712	1.47330	1.40562	1.29870	1.33883
16	0.86022	0.19493	1.04712	0.92081	0.80321	1.81818	0.61792
17	0.86022	1.36452	0.34904	0.36832	0.40161	1.03896	0.41195
18	1.07527	1.55945	1.22164	1.10497	0.80321	0.00000	1.13285
19	1.72043	0.38986	0.69808	1.10497	1.40562	1.03896	0.61792
20	0.21505	0.77973	1.04712	1.10497	0.60241	0.25974	1.02987
21	1.29032	0.38986	0.87260	0.92081	0.60241	0.77922	0.41195
22	2.15054	1.16959	1.04712	0.55249	0.40161	1.03896	0.72091
23	0.21505	0.77973	1.04712	0.73665	1.20482	1.29870	1.13285
24	1.50538	0.77973	0.69808	1.10497	1.20482	0.25974	0.82389
25	1.29032	0.58480	0.69808	0.55249	0.20080	0.25974	0.30896
26	0.86022	0.77973	0.17452	0.92081	0.80321	0.25974	0.30896
27	0.21505	1.16959	0.34904	0.73665	1.20482	0.77922	0.41195
28	1.07527	0.77973	0.52356	0.55249	0.80321	0.51948	0.41195
29	0.86022	0.19493	0.34904	0.36832	0.40161	1.55844	0.30896
30	0.64516	0.58480	0.52356	1.28913	0.20080	0.51948	0.61792
32	0.64516	1.36452	1.22164	1.10497	1.20482	0.51948	1.13285
34	1.72043	1.36452	0.69808	0.73665	1.60643	0.77922	0.82389
36	0.86022	1.75439	0.34904	1.28913	0.80321	0.77922	0.92688
38	1.07527	0.97466	1.22164	0.55249	0.80321	0.77922	0.51493
40	0.64516	0.97466	1.39616	0.92081	0.80321	0.77922	0.92688
42	1.07527	0.77973	0.52356	0.73665	1.00402	0.77922	0.20597
44	0.64516	0.58480	1.04712	0.36832	0.80321	1.29870	0.41195
46	1.07527	0.77973	1.22164	0.73665	0.40161	0.51948	0.72091
48	0.43011	1.75439	0.34904	0.73665	0.60241	0.51948	0.92688
50	0.64516	0.00000	0.17452	0.92081	0.60241	0.51948	0.30896
52	0.86022	0.58480	0.34904	0.92081	0.00000	1.03896	1.23584
54	0.43011	0.58480	0.52356	0.55249	1.00402	1.03896	0.92688
56	0.43011	0.97466	0.87260	1.28913	0.80321	0.77922	0.82389
58	0.86022	0.97466	0.52356	0.36832	0.20080	0.77922	0.82389
60	0.00000	0.38986	0.17452	0.18416	1.00402	0.51948	0.51493
90	6.45161	7.21248	5.58464	6.62983	5.42169	10.90909	8.44490
120	1.93548	4.67836	4.01396	4.78821	4.81928	4.41558	6.48816
150	3.01075	4.28850	2.44328	2.57827	2.20884	5.71429	5.87024
180	1.93548	2.33918	3.14136	1.84162	2.40964	4.67532	4.84037
210	1.72043	1.36452	1.22164	1.65746	2.20884	1.81818	3.29557
240	2.15054	1.36452	1.04712	3.13076	0.60241	1.03896	2.88363
270	1.07527	0.77973	0.69808	1.28913	2.40964	1.81818	1.64779
300	1.07527	0.97466	0.52356	1.28913	1.60643	1.03896	1.33883
330	1.07527	0.58480	0.52356	0.55249	0.60241	0.25974	2.16272
360	0.21505	0.19493	1.04712	0.36832	1.00402	0.51948	1.13285
390	1.07527	1.16959	1.91972	0.36832	0.20080	0.51948	0.92688
420	0.64516	0.97466	1.57068	0.00000	0.20080	0.00000	1.02987
450	0.21505	1.36452	0.87260	0.18416	0.00000	0.25974	0.72091
480	0.21505	0.19493	1.57068	1.65746	1.40562	0.00000	1.54480
510	0.43011	0.38986	1.39616	1.84162	2.61044	0.00000	1.95675
540	0.64516	0.77973	3.83944	4.78821	2.61044	0.25974	2.26571
570	0.00000	0.38986	1.91972	0.92081	3.21285	0.77922	0.92688
600	0.43011	0.00000	0.17452	0.36832	1.60643	3.11688	0.30896
630	0.00000	0.00000	0.34904	0.18416	1.40562	0.25974	0.61792
660	0.00000	0.19493	0.00000	0.36832	0.00000	0.51948	0.92688
690	0.00000	0.00000	0.00000	0.00000	0.00000	0.77922	0.61792
720	0.00000	0.00000	0.00000	0.18416	0.00000	0.00000	0.41195
720+	7.09677	4.09357	2.26876	2.02578	1.40562	1.55844	4.11946

Source: U.S. EPA Assessment and Modeling Division report on "Soak Length Activity Factors for Hourly Emissions," February 1998. http://www.epa.gov/OMS/models/mobile6/m6flt003.pdf

Table 2.11b Hourly Soak Length Activity Percentages for Weekdays

time	six	seven	eight	nine	ten	eleven	twelve
0	0.00000	0.05263	0.00000	0.03937	0.00000	0.02548	0.01500
1	0.11111	0.02632	0.03279	0.02362	0.05147	0.02548	0.05500
2	0.05556	0.07895	0.01639	0.05512	0.05147	0.01911	0.05500
3	0.16667	0.05263	0.03279	0.05512	0.05147	0.05096	0.03500
4	0.05556	0.00000	0.06557	0.00787	0.03676	0.02548	0.04000
5	0.00000	0.02632	0.03279	0.06299	0.02206	0.03822	0.04000
6	0.05556	0.00000	0.01639	0.00000	0.03676	0.00637	0.02500
7	0.00000	0.05263	0.01639	0.00787	0.01471	0.01911	0.04500
8	0.00000	0.00000	0.01639	0.01575	0.02941	0.01911	0.03500
9	0.00000	0.00000	0.03279	0.00787	0.02206	0.03185	0.01500
10	0.00000	0.00000	0.00000	0.00787	0.00000	0.00637	0.01500
11	0.00000	0.00000	0.00000	0.00787	0.00000	0.00637	0.03500
12	0.00000	0.00000	0.00000	0.02362	0.01471	0.02548	0.01500
13	0.00000	0.00000	0.00000	0.00787	0.01471	0.01274	0.00000
14	0.05556	0.00000	0.00000	0.00787	0.02206	0.01274	0.01500
15	0.00000	0.00000	0.00000	0.00000	0.01471	0.00000	0.01500
16	0.00000	0.00000	0.00000	0.01575	0.00000	0.00000	0.00500
17	0.00000	0.00000	0.01639	0.02362	0.00735	0.02548	0.01500
18	0.00000	0.00000	0.01639	0.00000	0.01471	0.00637	0.00500
19	0.00000	0.00000	0.01639	0.00787	0.00000	0.01274	0.01000
20	0.00000	0.00000	0.00000	0.00787	0.00735	0.00637	0.01500
21	0.00000	0.00000	0.00000	0.00000	0.00000	0.00637	0.01000
22	0.00000	0.00000	0.00000	0.02362	0.00000	0.01274	0.01000
23	0.00000	0.00000	0.00000	0.01575	0.00000	0.01274	0.00000
24	0.00000	0.00000	0.00000	0.00000	0.00000	0.00637	0.00000
25	0.00000	0.00000	0.03279	0.00000	0.00000	0.00637	0.01500
26	0.00000	0.00000	0.00000	0.00000	0.00735	0.00000	0.00500
27	0.00000	0.00000	0.01639	0.01575	0.01471	0.01274	0.00500
28	0.00000	0.00000	0.00000	0.00787	0.00000	0.00637	0.00500
29	0.00000	0.00000	0.00000	0.00000	0.00000	0.00637	0.00000
30	0.00000	0.00000	0.00000	0.00000	0.00735	0.02548	0.01000
32	0.00000	0.00000	0.00000	0.00787	0.02206	0.04459	0.00000
34	0.00000	0.00000	0.01639	0.00000	0.03676	0.00000	0.00500
36	0.00000	0.00000	0.01639	0.01575	0.00735	0.00637	0.00500
38	0.00000	0.00000	0.00000	0.00000	0.00000	0.00637	0.02500
40	0.00000	0.00000	0.00000	0.01575	0.02941	0.01274	0.00500
42	0.00000	0.00000	0.01639	0.00000	0.00000	0.00637	0.00000
44	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.02000
46	0.00000	0.00000	0.00000	0.00787	0.00000	0.00000	0.01500
48	0.00000	0.00000	0.01639	0.00000	0.00000	0.01911	0.00000
50	0.00000	0.00000	0.00000	0.00787	0.00735	0.01274	0.00000
52	0.00000	0.00000	0.00000	0.00000	0.02206	0.01274	0.00000
54	0.00000	0.00000	0.00000	0.00000	0.00735	0.00637	0.02000
56	0.00000	0.00000	0.00000	0.00000	0.00735	0.00000	0.00500
58	0.00000	0.00000	0.01639	0.00787	0.00000	0.00000	0.01000
60	0.00000	0.00000	0.00000	0.00787	0.00735	0.00637	0.00500
90	0.00000	0.00000	0.03279	0.03150	0.04412	0.08917	0.04000
120	0.00000	0.00000	0.00000	0.02362	0.00735	0.01911	0.03500
150	0.00000	0.00000	0.00000	0.00787	0.00735	0.02548	0.02500
180	0.00000	0.00000	0.00000	0.00000	0.02206	0.00000	0.02500
210	0.00000	0.00000	0.00000	0.00000	0.00000	0.00637	0.01000
240	0.00000	0.00000	0.00000	0.01575	0.00000	0.01274	0.00500
270	0.00000	0.00000	0.00000	0.00000	0.00735	0.00000	0.00000
300	0.00000	0.02632	0.00000	0.00000	0.00000	0.00000	0.00500
330	0.00000	0.02632	0.00000	0.00000	0.00000	0.00637	0.01000
360	0.05556	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
390	0.05556	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
420	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
450	0.05556	0.02632	0.01639	0.01575	0.00000	0.00000	0.00000
480	0.00000	0.02632	0.00000	0.00787	0.00000	0.00000	0.00000
510	0.05556	0.02632	0.00000	0.00787	0.01471	0.00000	0.00500
540	0.05556	0.05263	0.01639	0.01575	0.00735	0.00000	0.00000
570	0.00000	0.00000	0.04918	0.02362	0.00735	0.00637	0.00500
600	0.00000	0.02632	0.01639	0.00787	0.00735	0.00637	0.00000
630	0.00000	0.00000	0.01639	0.03150	0.00735	0.01274	0.00500
660	0.00000	0.05263	0.03279	0.00000	0.00000	0.00637	0.00000
690	0.00000	0.00000	0.00000	0.00787	0.00000	0.00000	0.00500
720	0.00000	0.02632	0.03279	0.00787	0.01471	0.00000	0.00000
>720	0.22222	0.42105	0.34426	0.27559	0.26471	0.20382	0.14500

Source: U.S. EPA Assessment and Modeling Division report on "Soak Length Activity Factors for Hourly Emissions," February 1998. http://www.epa.gov/OMS/models/mobile6/m6flt003.pdf

Table 2.11b, continued

time	thirteen	fourteen	fifteen	sixteen	seventeen	eighteen	twenty-four
0	0.00699	0.03429	0.01379	0.00704	0.00758	0.02542	0.01172
1	0.04196	0.06286	0.06207	0.04225	0.02273	0.04237	0.04297
2	0.05594	0.04571	0.04828	0.03521	0.03788	0.05085	0.05469
3	0.04196	0.02857	0.06207	0.04225	0.04545	0.03390	0.04688
4	0.04196	0.05143	0.02759	0.04225	0.03030	0.02542	0.05078
5	0.01399	0.02286	0.03448	0.04225	0.01515	0.00847	0.03125
6	0.03497	0.01143	0.02069	0.02817	0.01515	0.00000	0.02734
7	0.02098	0.02857	0.01379	0.03521	0.03030	0.03390	0.02344
8	0.00699	0.02857	0.04138	0.02817	0.00758	0.01695	0.00391
9	0.00699	0.01714	0.03448	0.02817	0.03030	0.01695	0.01563
10	0.01399	0.02286	0.00690	0.01408	0.01515	0.01695	0.01172
11	0.02797	0.00000	0.01379	0.00704	0.00758	0.01695	0.01953
12	0.01399	0.01143	0.00000	0.00704	0.00000	0.03390	0.00000
13	0.02797	0.00571	0.00690	0.02113	0.00758	0.00000	0.00000
14	0.00000	0.00000	0.00000	0.01408	0.04545	0.00847	0.00000
15	0.00699	0.01714	0.00000	0.00000	0.03030	0.00847	0.00000
16	0.00699	0.01143	0.02069	0.00000	0.00758	0.00000	0.01563
17	0.01399	0.00571	0.01379	0.00704	0.03030	0.01695	0.00391
18	0.01399	0.00571	0.01379	0.00704	0.00758	0.00000	0.00781
19	0.00699	0.03429	0.00000	0.02817	0.00758	0.01695	0.00391
20	0.00699	0.01143	0.00690	0.01408	0.00758	0.00847	0.00391
21	0.00000	0.01143	0.01379	0.00000	0.01515	0.00000	0.00781
22	0.01399	0.00000	0.00000	0.00704	0.03030	0.01695	0.00000
23	0.00699	0.00571	0.00690	0.01408	0.00758	0.00000	0.00391
24	0.00000	0.01143	0.02069	0.01408	0.00758	0.00847	0.00781
25	0.00000	0.00571	0.00000	0.02113	0.00000	0.00000	0.00391
26	0.00000	0.01143	0.00690	0.00000	0.00000	0.00000	0.00000
27	0.01399	0.00571	0.00000	0.00704	0.00000	0.00000	0.00000
28	0.01399	0.00571	0.00690	0.01408	0.00000	0.00847	0.00000
29	0.01399	0.00571	0.00690	0.00000	0.00000	0.00000	0.00781
30	0.01399	0.00000	0.00000	0.00704	0.00000	0.00847	0.00000
32	0.00000	0.01143	0.00690	0.02113	0.01515	0.01695	0.00781
34	0.02098	0.01714	0.00690	0.00704	0.00758	0.00847	0.00000
36	0.02098	0.01143	0.00690	0.00000	0.00000	0.00847	0.00000
38	0.01399	0.00000	0.02759	0.00704	0.00000	0.00000	0.00391
40	0.00000	0.00000	0.00690	0.04225	0.02273	0.00000	0.01172
42	0.01399	0.01714	0.02069	0.01408	0.02273	0.00000	0.00391
44	0.01399	0.00000	0.00690	0.00000	0.01515	0.02542	0.00391
46	0.01399	0.00571	0.00690	0.02817	0.00758	0.01695	0.00391
48	0.01399	0.01143	0.02759	0.00000	0.00000	0.00000	0.00781
50	0.01399	0.00571	0.00690	0.00000	0.02273	0.00000	0.00391
52	0.00699	0.01714	0.00690	0.00000	0.00758	0.00847	0.01563
54	0.01399	0.00000	0.01379	0.02113	0.01515	0.00000	0.00391
56	0.00000	0.01714	0.00690	0.00000	0.00000	0.02542	0.00000
58	0.00000	0.00571	0.01379	0.02113	0.00000	0.00000	0.00391
60	0.01399	0.00000	0.00000	0.00000	0.01515	0.00000	0.00391
90	0.06294	0.08000	0.04138	0.09155	0.09091	0.09322	0.08984
120	0.04895	0.04571	0.04828	0.04225	0.06818	0.11864	0.05469
150	0.01399	0.04000	0.04138	0.02817	0.03030	0.05932	0.05469
180	0.03497	0.02286	0.03448	0.05634	0.03030	0.01695	0.06250
210	0.02098	0.00000	0.01379	0.00000	0.00000	0.05085	0.05078
240	0.00699	0.02857	0.02759	0.02113	0.01515	0.01695	0.02734
270	0.00699	0.00000	0.00690	0.02113	0.01515	0.03390	0.03125
300	0.00699	0.01143	0.01379	0.01408	0.01515	0.01695	0.04688
330	0.00699	0.00571	0.00000	0.00704	0.04545	0.00847	0.00391
360	0.00699	0.00000	0.00000	0.00000	0.03030	0.00000	0.00781
390	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.01563
420	0.00000	0.00000	0.00000	0.00000	0.01515	0.00847	0.02344
450	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
480	0.00000	0.01143	0.00690	0.01408	0.00000	0.00000	0.00391
510	0.00000	0.00571	0.00690	0.00704	0.00000	0.02542	0.01953
540	0.00000	0.00000	0.00690	0.00000	0.00758	0.00000	0.00391
570	0.00000	0.00571	0.00000	0.00000	0.00758	0.00847	0.00391
600	0.00000	0.00000	0.00000	0.00000	0.00758	0.00000	0.00781
630	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00781
660	0.00000	0.00000	0.00690	0.00000	0.00000	0.00847	0.00000
690	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00391
720	0.00699	0.00571	0.00000	0.00000	0.00000	0.00000	0.00000
>720	0.12587	0.09714	0.07586	0.00000	0.00000	0.00000	0.00000

Source: U.S. EPA Assessment and Modeling Division report on "Soak Length Activity Factors for Hourly Emissions," February 1998. http://www.epa.gov/OMS/models/mobile6/m6flt003.pdf

Table 2.12 Default Values of Diurnal Soak Time Distribution by Time Period

			Diurnal Activity Parameters by Hourly Group										
SOAK Hrs	6 - 7 AM	7 - 8 AM	8 - 9 AM	9 - 10 AM	10 - 11 AM	11 - 12 AM	12 - 1 PM	1 - 2 PM	2 - 3 PM	3 - 4 PM	4 - 5 PM	5 - 6 PM	6 - 7 PM
1 to 2	1.27%	2.23%	5.25%	12.97%	14.88%	8.99%	7.48%	7.80%	11.14%	8.99%	10.18%	11.93%	13.84%
2 to 3	0.72%	1.27%	2.15%	5.09%	12.09%	13.13%	6.92%	5.41%	5.73%	8.75%	6.44%	8.27%	9.71%
3 to 4	1.27%	0.64%	1.19%	1.91%	4.93%	10.10%	11.30%	5.57%	4.30%	4.85%	6.52%	4.85%	7.08%
4 to 5	3.02%	0.95%	0.64%	1.11%	1.67%	4.77%	7.80%	10.26%	5.09%	3.98%	4.14%	5.33%	4.38%
5 to 6	3.50%	2.86%	0.95%	0.56%	0.95%	1.43%	4.30%	7.40%	9.39%	3.82%	3.58%	3.34%	4.85%
6 to 7	4.85%	2.94%	2.70%	0.72%	0.40%	0.80%	1.27%	3.90%	6.76%	8.19%	3.74%	3.34%	3.34%
7 to 8	5.81%	3.98%	2.63%	2.55%	0.56%	0.40%	0.64%	1.11%	3.26%	4.93%	6.05%	3.10%	3.10%
8 to 23	61.02%	47.81%	36.20%	29.04%	23.71%	17.90%	13.37%	9.63%	7.40%	5.89%	6.60%	7.40%	7.72%
24 to 47	4.93%	4.06%	3.26%	2.39%	2.07%	1.91%	1.27%	1.27%	0.95%	1.03%	0.72%	0.48%	0.48%
48 to 71	0.88%	0.72%	0.64%	0.56%	0.48%	0.48%	0.48%	0.40%	0.32%	0.24%	0.24%	0.16%	0.16%
72+	0.48%	0.32%	0.32%	0.16%	0.08%	0.08%	0.08%	0.08%	0.08%	0.08%	0.08%	0.08%	0.08%
running / hot soak	12.25%	32.22%	44.07%	42.96%	38.19%	40.02%	45.11%	47.18%	45.58%	49.24%	51.71%	51.71%	45.27%
TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Source: U.S. EPA Assessment and Modeling Division report on "Modeling Hourly Diurnal Emissions and Interrupted Diurnal Emissions based on Real-Time Data," May 1998. http://www.epa.gov/OMS/models/mobile6/m6evp002.pdf

Table 2.13 Weibull Distribution Coefficients for Diurnal Activities

Hourly Group	Coefficient A	Coefficient B	Coefficient C	Coefficient D	Regression R^2 Value
6 - 7	0.8502	.8427	0.001616	2.6440	0.995
7 - 8	0.6559	0.6342	0.001473	2.5928	0.996
8 - 9	0.5418	0.4793	0.001880	2.4486	0.995
9 - 10	0.5525	0.3867	0.002715	2.2846	0.994
10 - 11	0.5987	0.3971	0.038477	1.3344	0.973
11 - 12	0.5950	0.8389	0.5479	0.5086	0.974
12 - 13	0.5313	0.9246	0.6797	0.4943	0.981
13 - 14	0.4995	0.6927	0.4367	0.6834	0.979
14 - 15	0.5039	0.5180	0.2147	1.0038	0.976
15 - 16	0.4630	0.4793	0.2227	1.0182	0.981
16 - 17	0.4361	0.3870	0.1233	1.3237	0.989
17 - 18	0.4400	0.3881	0.1723	1.1886	0.996
18 +	0.5025	0.4509	0.1967	1.1494	0.998

Source: U.S. EPA Assessment and Modeling Division report on "Modeling Hourly Diurnal Emissions and Interrupted Diurnal Emissions Based on Real-Time Data," May 1998. http://www.epa.gov/OMS/models/mobile6/m6evp002.pdf

Table 2.14a

Reformulated Gasoline Parameters—Summer (1)						
Year (2)	RVP (pounds per square inch, or psi)		Oxygenated Fuels		Sulfur Content (ppm)	
	North	South	Ether Oxygen Content (% by weight)	Ether Market Share (%)	Average	Max
1995-1999	8.0	7.1	2.1	100	300	N/A
2000	6.7	6.7	2.1	100	150	1000
2001	6.7	6.7	2.1	100	149	1000
2002	6.7	6.7	2.1	100	129	1000
2003	6.8	6.8	2.1	100	120	1000
2004	6.8	6.8	2.1	100	120	303
2005	6.8	6.8	2.1	100	90	303
2006	6.8	6.8	2.1	100	30	87
2007	6.8	6.8	2.1	100	30	87
2008	6.8	6.8	2.1	100	30	80

Source: U.S. EPA. Draft User's Guide to MOBILE6.0 Mobile Source Emission Factor Model, August 2001. http://www.epa.gov/otaq/models/mobile6/d01003.pdf.

Table 2.14b

Reformulated Gasoline Parameters—Winter (1)							
Year (2)	RVP (psi)	Oxygenated Fuels (3)				Sulfur Content (ppm) (4)	
	North or South	Ether Oxygen Content (% by weight)	Ether Market Share (%)	Ethanol Oxygen Content (% by weight)	Ethanol Market Share	Average	Max
1995-1999	as set by user	1.5	70	3.5	30	300 (5)	N/A
2000		1.5	70	3.5	30	300	1000
2001		1.5	70	3.5	30	299	1000
2002		1.5	70	3.5	30	279	1000
2003		1.5	70	3.5	30	259	1000
2004		1.5	70	3.5	30	121	303
2005		1.5	70	3.5	30	92	303
2006		1.5	70	3.5	30	33	87
2007		1.5	70	3.5	30	33	87
2008		1.5	70	3.5	30	30	80

Source: U.S. EPA. Draft User's Guide to MOBILE6.0 Mobile Source Emission Factor Model, August 2001. http://www.epa.gov/otaq/models/mobile6/d01003.pdf.

Appendix IV

State of the Practice in Forecasting Traffic Inputs

State of the Practice in Vehicle Miles Travel (VMT) Mix Determination

The MOBILE5 model currently used by metropolitan planning organizations (MPOs) requires vehicle miles travel (VMT) split by eight vehicle classes. The vehicle classes are based on size and weight of the vehicles, and the type of fuel being used. The eight vehicle classes are shown in the table below:

MOBILE5 Vehicle Classes

Vehicle class	Description
LDGV	Light-duty gasoline vehicle
LDGT1	Light-duty gasoline truck, type 1
LDGV2	Light-duty gasoline truck, type 2
HDGV	Heavy-duty gasoline vehicle
LDDV	Light-duty diesel vehicle
LDDT	Light-duty diesel truck
HDDV	Heavy-duty diesel vehicle
MC	Motorcycle

The practice among many MPOs is to accept the aggregate default values computed by MOBILE5 and to apply this mix to all the network links. The default VMT mix was developed from national data.

Some MPOs adopt another approach. They use the 24-hour local vehicle classification counts (instead of the MOBILE5 default values) to determine VMT mix, followed by the application of factors to convert vehicle types in traffic counts to the eight MOBILE5 categories. This approach is recommended by the EPA since the MOBILE5 default values may not reflect the local VMT mix accurately. In this approach, the VMT is stratified by the functional classification of the roadway to account for variation across roadway types.

There are some problems associated with the procedures described above. The vehicle counts collected by metropolitan agencies typically classify vehicles into vehicle types that are different from the eight vehicle classification scheme for MOBILE5. Appropriate conversion factors based on MOBILE5 national defaults have to be applied to convert them into MOBILE vehicle classes. In the context of the new MOBILE6 model, the conversion of vehicle classes assumes greater significance since the number of vehicle classes has been expanded to twenty-

eight in the new model. Another problem is that vehicle counts are typically available for higher roadway classes (such as interstates and major arterials), and there is insufficient data to get the VMT variations for lower roadway classes (such as minor arterials, collectors, and local roads). Also, these procedures apply aggregate values across links in the road network in a region. It has been documented that there is substantial variation in the VMT mix across different regions and across links of the same roadway class within a region.

State of the Practice in Determining the Soak-Time Distribution of Trips for Mobile Source Emissions Forecasting

The soak time of vehicle trip starts is defined as the duration of time in which the vehicle's engine is not operating that precedes a successful vehicle start. The distribution of the soak duration over time is an important input for the emissions forecasting model since the start emissions are dependent on the soak durations. There has been a significant change from MOBILE5 to MOBILE6 with respect to soak time distribution. MOBILE5 uses the concept of mode fractions, which requires the classification of vehicle miles traveled into three operating modes: cold-transient, hot-transient, and hot-stabilized. The transient mode of operation consists of all operations before 505 seconds after the start of the trip. Transient trips are further classified into cold transient and hot transient depending on whether the start mode was a cold start or a hot start. Hot starts are those that occur less than 1 hour after the end of the preceding trip. In MOBILE6 the "start" emissions are separated from the "running" emissions (emissions that occur while the vehicle is being driven). In order to calculate the start emissions, the hot vehicle starts (ranging from 1 minute to 12 hours) into seventy time bins and assigning an emissions effect to each of the bins. From the distribution of soak times, the proportion of soaks that fall into each time bin is obtained. The emission value of an average vehicle start is calculated as the sum of the product of the start emission effects associated with each time bin and the corresponding soak-length activity proportion. The product of this average vehicle start emissions with the number of starts per day gives the start emission level.

The practice in most U.S. MPOs is to accept the default start and operating fraction values developed by the EPA through its Federal Test Procedure (FTP). These are national default values and often may not accurately reflect local conditions. A few studies have attempted to develop locally estimated start mode fractions. These have involved the use of field data obtained by direct on-road measurement of engine conditions or analysis of origin-

destination data from travel surveys to get aggregate measures of start modes. With the adoption of the new MOBILE6 model more disaggregate soak time distributions will have to be developed in place of the mode fractions.

State of the Practice in Vehicle Registration Distribution

Vehicle registration distribution refers to the split up of the registered vehicles in the region among different types, and ages. The methodology suggested by the EPA to develop this distribution involves the use of average growth rates for projecting estimates of the number of new vehicle registrations and average survival rates for estimating the number of older vehicles that will be registered in each future year.

The aim is to estimate the new vehicle registrations for the model year for each county. Registration data for each year is collected county wise. Scrappage rates for the current year are used to get the estimates for past years for which the registration data is unavailable. From the registration data of past years, the growth rate of new vehicle registrations is developed. The average growth rate is used to estimate the number of vehicles in the model year. El Paso MPO adopted a slightly different approach in estimating the number of new vehicle registrations (Benson, Dresser, and Bell, 1994). The data input data used by it included population data for current years and population estimates for future years. The vehicle registration data for past years is analyzed to determine what fraction of the change from year to year could be attributed to new vehicle registration and what fraction to addition or scrapping of older vehicles. A regression analysis was performed on the percentage that could be attributed to new vehicles as a function of population change for each county. The results of this analysis were applied to the predicted population change in each county to get the percentage of new vehicle registrations (by vehicle type) for each county for the target year. Also a regression analysis was performed between the growth in new vehicle registrations and the population change over a span of time. The growth rate due to new vehicle registration and the scrappage rates were applied to estimate the number of vehicles of each type that would be registered in each county in the target year. Linear regressions were performed between total vehicles registered and county populations. The coefficients obtained were applied to population estimates for future years to obtain the expected number of vehicle registered for the target year. The percentage of those vehicles that would be new was estimated using the coefficients of the earlier regression. The estimates from this

procedure and the results from the earlier procedure relating the change in new vehicle registration and population change the final projections were made. For automobiles (LDV), motorcycles (MC), and light duty gas trucks type one (LDGT1), the larger of the two estimates of new vehicle registrations was used. For light duty gas trucks type two (LDGT2), heavy-duty gas trucks (HDGV), and heavy-duty diesel trucks (HDDV), the two estimates were averaged. The older vehicles were distributed in the same proportion as those that survived from the previous year.

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