

**USER'S GUIDE**  
**to**  
**MOBILE5**  
**(MOBILE SOURCE EMISSION FACTOR MODEL)**

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## ABSTRACT

This document is the USER'S GUIDE to MOBILE5. MOBILE5 is a computer program that estimates hydrocarbon (HC), carbon monoxide (CO), and oxides of nitrogen (NO<sub>x</sub>) emission factors for gasoline-fueled and diesel highway motor vehicles. The program uses the calculation procedures presented in Compilation of Air Pollutant Emission Factors - Volume II: Highway Mobile Sources (AP-42, Fourth Edition, September 1985; Supplement A to AP-42 Volume II, January 1991).

MOBILE5 calculates emission factors for eight individual vehicle types in two regions (low- and high-altitude) of the country. MOBILE5 emission factor estimates depend on various conditions such as ambient temperatures, average travel speed, operating modes, fuel volatility, and mileage accrual rates. Many of the variables affecting vehicle emissions can be specified by the user. MOBILE5 will estimate emission factors for any calendar year between 1960 and 2020, inclusive. The 25 most recent model years are considered to be in operation in each calendar year. MOBILE5 supercedes MOBILE4.1, and is to be used by the States in the preparation of the highway mobile source portion of the 1990 base year emission inventories required by the Clean Air Act Amendments of 1990. Compared to MOBILE4.1, MOBILE5 incorporates several new options, calculating methodologies, emission factor estimates, emission control regulations, and internal program designs.

The MOBILE5 program was initially released December 4, 1992, and a Federal Register notice of its availability was published February 9, 1993 (58 FR 7780). Several Final Rulemakings (FRMs) affecting vehicles and fuels, and hence emission levels, were approved in late 1992 and early 1993. The finalization of these rules, and the detection of several errors in the MOBILE5 code, led OMS to update and correct MOBILE5. This updated version, MOBILE5a, was released on March 26, 1993, and its availability announced in the Federal Register on May 20, 1993 (58 FR 29409). This document generally refers to "MOBILE5" in the main text. All such references in this document should be construed as referring to the most recent version of MOBILE5, which at the time of this writing is MOBILE5a (26-March-93) as noted above.

The source code and compiled (executable) code for MOBILE5 for the IBM PC and clones or for Apple Macintosh computers, this User's Guide, all existing MOBILE5 Information Sheets (see Chapter 6), and example input and output files are available electronically via modem connection through the EPA Technology Transfer Network (TTN) computer Bulletin Board System (BBS). See Chapter 4, section 4.2, for details on accessing MOBILE5 and related documentation using the TTN BBS.

Requests for hard copies of the MOBILE5 program diskette or tape, or for paper copies of this User's Guide, should be directed to:

National Technical Information Service (NTIS)  
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Questions concerning MOBILE5 or this User's Guide should be directed to:

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## Chapter 1

### TECHNICAL REVISIONS IN MOBILE5

#### 1.0 INTRODUCTION

MOBILE5 is an integrated set of FORTRAN routines for use in the analysis of the air pollution impact of gasoline-fueled and diesel-powered highway mobile sources. The program provides the user with a flexible analytical tool that can be applied to a wide variety of air quality modeling and planning functions. MOBILE5 updates and supersedes the previous version of the emission factor model (MOBILE4.1, November 1991), and should be used for all new analyses requiring estimates of highway vehicle emissions. In particular, MOBILE5 is to be used in the preparation of all projection year emission inventories required by the Clean Air Act Amendments of 1990 for non-California areas (excepting that the use of MOBILE4.1 was permitted for carbon monoxide (CO) nonattainment areas due to the shorter deadlines, relative to ozone nonattainment areas, imposed by the 1990 Clean Air Act Amendments).

MOBILE5 calculates emission factors for gasoline-fueled light-duty vehicles (LDGVs), light-duty trucks (LDGTs), heavy-duty vehicles (HDGVs), and motorcycles, and for diesel light-duty vehicles (LDDVs), light-duty trucks (LDDTs), and heavy-duty vehicles (HDDVs). MOBILE5 also contains provisions for modeling the impact on emission factors of oxygenated fuels (i.e., gasoline/alcohol and gasoline/ether blends) and of participation in the reformulated gasoline (RFG) program under the 1990 Clean Air Act Amendments.

This chapter briefly explains most of the major differences between MOBILE4.1 and MOBILE5. Many of these revisions are transparent to the user, in that no changes are required to the input data files and the physical appearance of the output is unchanged. Other revisions to the model provide the user with previously unavailable options or require that additional input data be supplied. Throughout Chapters 2 and 3, note is made of those changes that affect preparation of the input data files and/or result in differences in the formats of the emission factor reports produced.

Many of the revisions that have been made to the model since the release of MOBILE4.1 will have an impact on the emission factor calculations for any calendar year after 1990. As described in the User's Guide to MOBILE4.1, EPA's intent for that version of the model was to include all revisions and updates of use in making the 1990 base year

emission factors (and thus mobile source emission inventories) as accurate as was possible at that time. Many of the new requirements placed on vehicles and fuels by the Clean Air Act Amendments of 1990 were not included in MOBILE4.1, but did not have any effect on 1990 emission factors. These new requirements have been included in MOBILE5.

A second goal in developing MOBILE4.1 was to account for all factors affecting emission factors calculated for calendar year 1990, so that these emission factors would be the same when estimated using MOBILE4.1 or MOBILE5. In the end, this was not possible, therefore base year (1990) emission inventories prepared using MOBILE5 will not be identical to those constructed using MOBILE4.1.

Instructions on how to use MOBILE5 are contained in Chapters 2 thru 4 of this document. Chapter 2, "MOBILE5 Inputs," covers all of the possible input data requirements of the model. A brief explanation of FORTRAN format specifications and their interpretation is also provided for use in preparing MOBILE5 input files. Where applicable, Chapter 2 also contains guidance on determining appropriate values for input data, particularly those that are (or can be) specific to the area being modeled. Chapter 2 as presented herein is the essentially the same document as the draft Chapter 2 that was released with MOBILE5a (March 26, 1993) and that has been available on the EPA Technology Transfer Network (TTN) computer bulletin board system (BBS). Revisions that have been made to Chapter 2 since then include the addition of Appendix 2B, which discusses modeling of the California low emission vehicle (LEV) program and SIP emission credits based on implementation of that program, and otherwise are mostly corrections of typographical errors and cross-references. The information content of Chapter 2 as presented here is the same, with the exception of the added Appendix 2B and related information in the sections on I/M and LEVs, as the Chapter 2 that was released earlier and that has been available on the EPA's TTN BBS.

Chapter 3, "MOBILE5 Outputs," documents all of the possible outputs from the model. In addition to discussing the six choices of output format (numerical, descriptive, by model year, spreadsheet), this includes a listing of all diagnostic messages (errors and warnings) generated by the model and discussion of the prompting messages. Chapter 4 has been extensively revised; whereas for past versions of the model, this chapter focused primarily on the implementation and execution of MOBILE in a mainframe (timesharing) computer environment, this Chapter 4 is focused on the details of installing and using MOBILE5 on desktop computers, particularly IBM PCs and clones. Thus Chapter 4 now details the memory requirements for the program and how the program is most efficiently installed and executed. Chapter 5, "MOBILE5 Examples," has been expanded to include a listing and description of all of the input/output example files that are included on the

diskettes and electronic files distributed by EPA. The most interesting and useful of these examples are reproduced in Chapter 5.

There is also a Chapter 6, "MOBILE5 Information Sheets," which provides the user with a place to save all such Information Sheets that are released by EPA before the next major revision to the model. As of this writing, three such "Information Sheets" have been developed and released by EPA. These three are included in this User's Guide.

This User's Guide is applicable to MOBILE5 (December 4, 1992) as well as to MOBILE5a (March 26, 1993). MOBILE5a is a corrected release of MOBILE5, as detailed in the Federal Register notice of its availability (58 FR 29409). At the time of release of this User's Guide, EPA is planning to release a further refinement of this model (to be called MOBILE5b) later in 1994. MOBILE5b will account for regulatory developments since the release of MOBILE5a (e.g., the final rules for Phase 2 reformulated gasoline and for onboard vapor recovery systems). This User's Guide will also be applicable to MOBILE5b; current plans are to release any necessary changes or additions to the User's Guide in the form of an MOBILE5 Information Sheet (see Chapter 6). This User's Guide is a self-contained, "stand-alone" document. Earlier versions of the User's Guide are not required in order to understand and operate MOBILE5.

The rest of this chapter consists of a listing and brief discussion of all of the major revisions that have been made since the release of MOBILE4.1. These are arranged by subject area, with separate sections for those revisions primarily affecting exhaust emissions, evaporative emissions (including running and resting losses), inspection and maintenance (I/M) programs, fuels and fuel composition, and fleet characterization data and other miscellaneous revisions.

## **1.1 REVISIONS TO EXHAUST EMISSION FACTORS**

### **1.1.1 Revised Basic Emission Rate Equations for Model Year 1981 and Later Light-Duty Gas Vehicles and Light-Duty Gas Trucks**

As in previous revisions and updates to the emission factor model, EPA has revised the basic emission rate equations on the basis of new data. These equations, which describe emissions from properly maintained non-tampered vehicles as a function of odometer mileage, are based primarily on data collected as part of EPA's Emission Factor Testing Program (EFP). The revisions included in MOBILE5 are based on additional emission factor program data from the laboratory-based EFP, in combination with EFP data collected at an inspection and maintenance (I/M) program lane in Hammond, IN.

A major advantage of the Hammond data collection effort was the far larger number of vehicles that could be tested. Traditional laboratory-based EFP is limited, by resources and other constraints, to testing approximately 300 vehicles annually. By contrast, EPA was able to obtain emission data from almost 8000 vehicles over two years at the Hammond I/M lane. In addition, recruitment of vehicles for testing at the Hammond I/M lane was not subject to some of the sources of potential sample bias encountered in the standard emission factor testing program, in that all vehicles in the area are required to have an I/M test biennially (once every two years) in order to renew their registrations. Thus, vehicles with owners that may be unwilling to lend their vehicles to EPA for emission factor testing in a laboratory could still be tested and included in EPA's emission factor data base. Another advantage of EFP data collection at an I/M lane is the ability to focus testing on vehicles that are both older and of high mileage. In the laboratory-based EFP, much of the data collected on high-mileage vehicles (e.g., over 50,000 miles) is from vehicles that are relatively new, but have accumulated mileage at a much greater than average rate. The Hammond program provided substantially more data from vehicles that have high odometer mileage accumulated at more typical rates.

The Hammond I/M program is a test-only program, meaning that all vehicles subject to the testing requirement must appear at a central, State-operated testing facility. In cooperation with the State of Indiana, EPA took over operation of one of the lanes at an inspection station in Hammond. Every vehicle that passed through that lane was tested on a chassis dynamometer over the IM240 cycle, a four-minute transient driving cycle. Testing over this cycle, combined with the use of a constant volume sampler and other analytical equipment, allowed emission rates in grams per mile (g/mi) for hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO<sub>x</sub>) to be determined for each of the tested vehicles.

EPA also recruited vehicles that passed through the EPA-operated I/M lane for more complete laboratory testing. Of the approximately 8000 vehicles for which IM240 results were obtained at the lane over the period 1991-1992, EPA also obtained complete laboratory test results over the Federal Test Procedure (FTP) from about 400 vehicles. The IM240 scores and laboratory FTP scores for these vehicles were then used to derive a correlation between IM240 scores and basic emission rates. This correlation, in turn, was used to predict laboratory FTP emission rates from the IM240 emission rates for the larger sample. Analysis of the resulting database provided EPA with revised estimates for the basic emission rate (BER) equations for 1981 and later model year light-duty vehicles.

The results of this analysis were incorporated into MOBILE5. Two major aspects of the revised BERs merit specific mention: The overall emission levels for all three pollutants, for all emission control technology categories represented, are higher than the levels used in

MOBILE4.1, and nearly all of the observed increase is the result of higher in-use deterioration rates (rather than changes in the zero-mile levels). Each BER consists of a zero-mile level (which can be thought of as the y-intercept of the equation describing emission levels as a function of odometer mileage), and one or two deterioration rates, expressed in terms of grams-per-mile per 10,000 miles (which can be thought of as the slope(s) of the equation). There are separate BERs for each vehicle type/model year group/emission control technology category/pollutant combination. The zero-mile levels determined for MOBILE5, using the IM240 data discussed above in combination with data collected in the laboratory-based emission factor test program, were in most cases not significantly different from the estimates made for MOBILE4.1. However, the rates of increase in emissions with increasing odometer mileage (i.e., the deterioration rates) were found to be greater than had been estimated for MOBILE4.1. The net effect of this change is to increase estimated average emissions of all three pollutants from light-duty vehicles, for all model years 1981 and later.

EPA is continuing to collect emission factor data through its traditional recruitment program. In 1992, EPA also began data collection at an I/M lane in Phoenix, AZ, which will provide not only more emission data on in-use vehicles, but from a climatically and geographically different area of the country. These data will continue to be added to the emission factor data base, and should allow EPA to further improve the accuracy of the BERs in future revisions to the model.

### **1.1.2 Changes in Federal Exhaust Emission Standards**

The Clean Air Act Amendments of 1990 included numerous changes to the emission standards applicable to new light-duty vehicles and light-duty trucks. The first of these revisions, chronologically, are referred to as the Federal Tier 1 emission standards, and are set to be phased in over the mid to late 1990s. As discussed in the User's Guide to MOBILE4.1, EPA did not include all of the Federal Tier 1 tailpipe emission standards in that version of the model, due to time constraints and the necessity at that time of providing an emission factor model that could be used to develop base year (1990) emission factors and inventories. The Federal Tier 1 and cold-temperature exhaust carbon monoxide (CO) standards were included in MOBILE4.1 to provide CO nonattainment areas the ability to model emission factors and inventories through the mid 1990s, since CO nonattainment areas had a more stringent schedule imposed by the Act for the submission to EPA of projected inventories and attainment demonstrations than did ozone nonattainment areas.

In MOBILE5, the remaining Federal Tier 1 emission standards have been incorporated. These include new standards for exhaust hydrocarbons and oxides of nitrogen for both light-duty vehicles and light-duty trucks. All of the Tier 1 emission standards are

phased in beginning with model year (MY) 1994 vehicles. The Federal Tier 1 standards for light-duty vehicles and light-duty trucks include the exhausts emission standards for non-methane hydrocarbons (NMHC), CO, and oxides of nitrogen (NO<sub>x</sub>) specified in section 202(g) of the Act, and the intermediate in-use emission standards specified in section 207(c) of the Act. All of these have been taken into account in developing MOBILE5. The effect of the new emission standards is modeled by taking BER equations for vehicles meeting the new standards, developed from data on existing vehicles meeting existing emission standards with such changes as are required to correspond to the new standards, weighted together with BERs for vehicles built to comply with existing standards, with the weightings relative to the proportion of each case in the new car fleet for each model year in the phase-in period.

The phase-in schedules specified in sections 202(g) and 207(c), taken together, result in a five-year phase-in, with at least 40 percent of model year (MY) 1994 vehicles meeting the intermediate §207(c) standards, 80 percent of MY 1995 vehicles meeting the §207(c) standards, all MY 1996 vehicles meeting the §207(c) standards and at least 40 percent of them meeting the final Tier 1 §202(g) standards, 80 percent of MY 1997 vehicles meeting the §202(g) standards, and all 1998 and later MY vehicles meeting the §202(g) standards.

It is assumed in MOBILE5 that the new Tier 1 emission standards (both the intermediate §207(c) standards and the final §202(g) standards) will impact the level of emissions from "normal" emitting vehicles, but will not impact emission rates from "high" or "super" emitters, nor the rates at which vehicles become high or super emitters. Thus the impact of the new standards is not as large as the reduction in the numerical values of the standards (i.e., replacing the 0.41 g/mi HC emission standard by a 0.25 g/mi standard reduces emissions, but by less than the 40 percent reduction in the level of the standard). New inspection and maintenance (I/M) program emission reduction credits have also been developed for use in modeling emissions from vehicles meeting the Tier 1 emission standards (see section 1.3).

While not generally considered to be part of the "Tier 1" emission standards, the new 4.0 gram per brake horsepower-hour (g/bhp-hr) standard for exhaust NO<sub>x</sub> emissions from heavy-duty engines has also been incorporated into MOBILE5. This standard is applicable to model years 1998 and later, and represents a reduction from the current 5.0 g/bhp-hr NO<sub>x</sub> standard that took effect beginning in the 1991 model year.

### **1.1.3 Revisions to Light-Duty Truck Exhaust Emission Factors**

The basic emission rate equations for LDGTs have been revised to incorporate two deterioration rates (rate of increase in emissions as a function of increasing mileage). As was



done for LDGVs earlier, there are now separate deterioration rates for mileage accumulated up to 50,000 miles and for mileage accumulated in excess of 50,000 miles. The second deterioration rate is greater than the first, and reflects the pattern observed in the emission data, where emissions increase at a higher rate after 50,000 miles than is true in the 0-50,000 mile range. The use of two deterioration rates more accurately captures the emissions performance of older, high-mileage vehicles than does a single linear equation.

Light-duty trucks are inherently similar to light-duty vehicles in terms of size, weight, typical usage, and emission standards. In the MOBILE model, the relative lack of light-duty gasoline truck (LDGT) emission factor data has resulted in EPA basing the emission rate equations for LDGTs on those for LDGVs, mapping according to common emission standards and control technologies. For MOBILE5, the changes in the passenger car basic emission rates (discussed in section 1.1.1) are reflected in the basic emission rates for light-duty trucks. The effects of the Federal Tier 1 emission standards on in-use emissions from LDGTs are also based on the emission estimates developed for passenger cars meeting similar standards.

#### **1.1.4 California Low-Emitting Vehicle (LEV) Program**

Under the Clean Air Act Amendments of 1990, States have been provided the opportunity to adopt the motor vehicle control program and regulations promulgated by the State of California for vehicles sold in that state. California historically has suffered more severe air pollution problems, much of them due to highway vehicles, than has the rest of the nation. For this reason, Congress has allowed California to establish its own regulations requiring lower emissions (greater emission reductions) than are required of vehicles certified to Federal standards.

In order to address the continuing severe air quality problems of Los Angeles and other urban areas in California, California has adopted regulations which go beyond the Federal Tier 1 emission standards. These regulations are collectively referred to in this document as the "California Low-Emitting Vehicle Program," or "LEV program," and include further reductions in motor vehicle emissions in phases. A specific label is associated with each of the levels of standards included in these regulations: transitional low-emitting vehicles (TLEVs), low-emitting vehicles (LEVs), ultra low-emitting vehicles (ULEVs), and zero-emitting vehicles (ZEVs). The emission standards and model years associated with each of these emission categories for passenger cars under the California program are summarized in Table 1.1-1 on the next page.

With the exception of the ZEVs, there are no specific sales fraction mandates associated with each of these levels of standards. Rather, there is a "sales-weighted" set of emission standards that must be met, on average, in each model year beginning with 1994. The percentages shown in the Table 1.1-1, used as weighting factors for each of the associated standards levels, yield the sales-weighted average emission level that must be attained by each manufacturer's California sales in each model year beginning in 1994. In modeling compliance with the California LEV program, MOBILE5 assumes that these fractions represent the mix of vehicles in each model year.

The summary in Table 1.1-1 is applicable to light-duty gas vehicles (LDGVs) only. There are similar provisions for four separate categories of LDGTs, with slightly different standard levels and sales fractions. On the basis of recent sales, EPA weighted these fractions together to estimate, for example, the fractions of LDGT1s (which EPA defines as those LDGTs up to 6000 lb gross vehicle weight, or GVW) that are represented by California's subcategories, which are referred to as "LDGT1-light" and "LDGT1-heavy". "LDGT1-light" vehicles are less than 6000 lb GVW and less than 3750 lb loaded vehicle weight (LVW), while "LDGT1-heavy" vehicles are less than 6000 lb GVW but over 3750 lb LVW, up to 5750 lb LVW. Similarly, where EPA defines LDGT2s to be those LDGTs that are 6001-8500 lb GVW, under the California regulations this category is subdivided into those trucks that are between 3751-5750 lb test weight (TW) and those between 5751-8500 lb TW, which are referred to as "LDGT2-light" and "LDGT2-heavy", respectively. California also labels such vehicles "medium-duty vehicles," which has no direct analog in EPA's regulatory classification scheme. The complete terms of the California LEV program, including the various standards applicable to different "types" of LDGTs, are beyond the scope of this document.

MOBILE5 includes the ability to model the effects of an area opting in to the California LEV program, as detailed above. The user of MOBILE5 can simply indicate that the California program is to be assumed, in which case no additional input information is required, or can indicate that the program is being adopted but under a different timetable than that adopted by California and summarized above. The latter option requires the user to specify the initial model year, as discussed in section 2.3.7, but does not permit the user to change the rate at which the program requirements are phased in.

Table 1.1-1

Emission Standards for Light-Duty  
Vehicles Under the California LEV Program

<u>Emission Level</u>	<u>Standards (g/mi) [NMOG/CO/NOx]</u>	<u>Assumed Rate of Compliance</u>
TLEV (intermediate)	0.188/3.4/0.40	10 % in MY 1994 15 % in MY 1995
TLEV	0.125/3.4/0.40	20 % in MY 1996
LEV (intermediate)	0.100/3.4/0.30	25 % in MY 1997 48 % in MY 1998
LEV	0.075/3.4/0.20	73 % in MY 1999 96 % in MY 2000 90 % in MY 2001
ULEV (intermediate)	0.058/2.6/0.30	2 % in MY 1997 2 % in MY 1998
ULEV	0.040/1.7/0.20	2 % in MY 1999-2000 5 % in MY 2001 10 % in MY 2002 15 % in MY 2003+
ZEV	0.0/0.0/0.0	2 % in MY 1998-2000* 5 % in MY 2001-2002* 10 % in MY 2003+*

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\* Market shares specifically mandated under the California regulations.

When the California LEV program is to be assumed in the emission factor calculations, the user must also indicate what type of inspection and maintenance (I/M) program requirements will be applicable for such vehicles. The benefits associated with adoption of the LEV program are strongly dependent on the I/M program associated with such vehicles: If there is no I/M program, or only a very weak I/M program, in place to monitor the performance of LEVs in use and force the repair of individual vehicles not meeting the standards, then the difference between

the exhaust emission factors for LEVs and for Tier 1 vehicles under the same inspection regime will be limited to the difference in the zero-mile emission levels (i.e., there is assumed to be no difference in the in-use deterioration factors). On the other hand, a stringent I/M program in conjunction with certain other requirements (see section 1.3.6 and Appendix 2B) is expected to keep LEVs in compliance with their certification standards, on average, over the useful life of the vehicles (i.e., over 100,000 miles accumulated mileage). The choice of what I/M program is assumed to be applicable to LEVs under the assumption that the California program is adopted is selected by the user through the value assigned to REGION in the Scenario data (see section 2.3.1), or, if the user is changing the start year for this program, on the LEV Program Parameter Record (see section 2.3.7).

For additional information on the modeling of California-standard LEVs in MOBILE5, and the relation of the I/M program chosen to the benefits (emission reductions) attributable to LEVs, see Appendix 2B: "Emission Reduction Credits for California Low Emission Vehicles (LEVs)."

### **1.1.5 Revised Speed Correction Factors for LDGVs and LDGTs**

The average speed of the Federal Test Procedure (FTP) driving cycle is 19.6 miles per hour (mph) [31.5 kilometers per hour (km/hr)]. All of the basic emission rate (BER) equations describing emissions as a function of accumulated mileage are based on this 19.6 mph average trip speed. To model emission factors at average trip speeds other than 19.6 mph, the MOBILE5 uses speed correction factors to adjust "19.6 mph emission factors" to other average speeds. There are different speed correction factors, by pollutant, for each vehicle type and model year/emission control technology combination.

The range of average speed for which MOBILE5 contains speed correction factors is 2.5 to 65 mph (4.0 to 105 km/hr). Input of speeds outside of this range generate warning messages to the user, and the minimum (or maximum) available speed is used in the emission factor calculations. The speed correction factors are divided into three ranges of average speeds: "low speeds," consisting of speeds from the minimum 2.5 mph to 19.6 mph; "mid-range speeds," from 19.6 mph to about 48 mph (77 km/hr); and "high speeds," from 48 mph to the maximum of 65 mph. The general shape of the curves describing HC and CO emissions as functions of average trip speed exhibits high g/mi emissions at very low speeds, with emission rates dropping rapidly as average speed increases up to 19.6 mph, then emissions dropping more slowly as average trip speed increases from 19.6 to 48 mph, no change in emissions in the range 48 to 55 mph (88 km/hr), and finally emissions rising again as average speed increases from 55 to 65 mph.

The speed correction factors for light-duty gas vehicles (LDGVs) are derived from analysis of emission data taken from tests over driving cycles of different average speeds, while the speed correction factors for light-duty gas trucks (LDGTs) are based on those developed for

LDGVs, with appropriate adjustments for differing emission control technologies by model year. There are not sufficient data available for the development of speed correction factors for LDGTs to be based on testing of LDGTs over various speed cycles, however this is not considered to be a significant source of uncertainty since LDGTs are inherently similar to LDGVs in terms of weight, duty cycles, and emission control equipment used. Thus revision of the LDGV speed correction factors also involves revision of the LDGT factors.

For MOBILE5, all accumulated speed cycle emission data for the "mid-range" of speeds was reanalyzed. Little new data on emissions at "low" speeds (under 19.6 mph) were available for analysis at this time, hence the revisions were limited to the "mid-range" and "high" average speeds (19.6 to 48, and 48 to 65, mph). This included all data that were considered in the analysis for MOBILE4.1, and all new data obtained since completion of the MOBILE4.1 analysis. The forms of the speed correction factors considered were the same as those investigated for MOBILE4.1, and the same forms of speed correction factor equations were chosen as continuing to represent the best fit to the data. Thus the basic nature of the speed corrections are unchanged, although the values for the equation coefficients are different, and hence the actual correction factor assigned to a given average speed is also different.

These revised speed correction factors for 1981 and later model year LDGVs also resulted in revisions to the speed correction factors applicable for LDGTs, which are based on mapping the LDGV speed corrections to LDGTs on the basis of similar emission standards and control technologies. The net effect of the revisions is to "flatten the curve" for HC and CO emissions as a function of speed: Emissions still continue to decrease as average trip speed increases from 19.6 to 48 mph, however the rate of decrease is less than that modeled in MOBILE4.1. MOBILE5 HC and CO emission factors are higher than the corresponding MOBILE4.1 emission factors for all average trip speeds, due to the revised basic emission rate equations discussed above; but emissions at average trip speeds between 20 and 48 mph, relative to emissions at 19.6 mph, are greater in MOBILE5 than was the case in MOBILE4.1.

In the case of NO<sub>x</sub> emissions, the revised speed correction factors also have the effect of making MOBILE5 NO<sub>x</sub> emission factors for a given average trip speed, relative to the emission factor at 19.6 mph, higher than the corresponding MOBILE4.1 emission factors. The shape of the curve describing NO<sub>x</sub> as a function of average speed is different in MOBILE5 as well. MOBILE4.1 modeled NO<sub>x</sub> emission factors for LDGVs as decreasing with increasing average trip speed over the range from 2.5 to 48 mph (although the change is much less pronounced than for HC and CO emission factors), then increasing with further increases in average speed from 48 to 65 mph. The new speed correction factor analysis in MOBILE5 resulted in NO<sub>x</sub> emission factors that have a minimum at an average speed of 19.6 mph. From 19.6 to 48 mph, where MOBILE4.1 modeled LDGV NO<sub>x</sub> emission factors as slightly decreasing, MOBILE5 models them as slightly increasing. Both MOBILE4.1 and MOBILE5 model NO<sub>x</sub> emission factors as increasing more sharply with increased average trip speed from 48 to 65 mph.

### **1.1.6 Idle Emission Factors**

MOBILE4.1 and earlier versions of the model allowed the user to select, as an option, the calculation and output of idle emission factors, distinct from the exhaust or evaporative emission factors. The idle emission factors were expressed in terms of grams per minute (g/min) in MOBILE3 and earlier versions, or in grams per hour (g/hr) in MOBILE4 and 4.1, and were based on limited test data measuring emission rates at idle. Until MOBILE4.1, the idle emission factors produced by the model were for standard test conditions (stabilized operating mode, 75°F, 9.0 psi RVP fuel), regardless of the conditions specified by the modeler and used for the other emission estimates. After the release of MOBILE4.1, an algorithm was developed for adjusting idle emission rates for variations in operating mode, temperature, and fuel volatility, by using the impact of these variables on very low speed (i.e., 2.5 mph) exhaust emissions. This methodology was published in a memo for those using MOBILE4, and was coded into the MOBILE4.1 program.

The option for calculating and printing idle emission factors has been disabled in MOBILE5. There are no idle emission estimates available directly from MOBILE5, regardless of the value assigned to the IDLFLG in the Control data section. This action stems from EPA's inability, in the time available and in the absence of relevant data, to develop algorithms that would account for the effects on idle emissions of the new control programs mandated under the Clean Air Act Amendments of 1990 (e.g., Tier 1 emission standards, reformulated gasoline) and for the effects of other variables (temperature, fuel RVP, operating mode) in a logical and consistent way. EPA has released an "Information Sheet" (see Chapter 6) dealing with the issue of idle emission factors and MOBILE5, in which the exhaust emission factors at the minimum average trip speed or 2.5 mph form the basis for an estimate of idle emission factors in grams per hour. EPA will continue to collect data and to work to develop a more satisfactory approach to estimating idle emission factors.

## **1.2 REVISIONS TO EVAPORATIVE EMISSION FACTORS**

### **1.2.1 Effects of New Evaporative Emission Test Procedure**

In addition to the Federal Tier 1 exhaust emission standards, the Clean Air Act Amendments of 1990 direct EPA to develop and require a new test procedure for the measurement and control of evaporative emissions. The current test procedure involves a one-hour simulation of a diurnal heating event (60-84°F). Light-duty vehicles and trucks must not emit more than 2.0 grams of evaporative hydrocarbons during the test. Running losses and resting losses are not specifically addressed by the current test procedure, although resting

losses are being measured during the time the vehicle is in the evaporative sealed housing for evaporative determination (SHED).

A number of inadequacies of this test procedure in simulating real-world, real-time evaporative emissions have been noted. Primary concerns include the lack of measurement of running loss emissions, and the inaccuracy of a forced one-hour heat build (achieved by heating of the vehicle fuel tank) in simulating the emissions generated and released to the atmosphere in real-time diurnal temperature increase situations. The current procedure also does nothing to ensure that the capacity of a vehicle's evaporative emission control system is sufficient to control (prevent the release of) vapor generated during "multiple diurnal" events, where the vehicle is not driven for two or more consecutive days and hence experiences multiple diurnal heat builds without any opportunity for the carbon canister to be purged of trapped vapor.

The Clean Air Act Amendments directed EPA to establish and promulgate a revised evaporative emission test procedure addressing such concerns. Features of the new test procedure include "real-time" diurnal testing over three days and a more realistic (summer) temperature range of 72 to 96°F (22 to 36°C). Measurement of running loss emissions is also part of the new test procedure, so the new evaporative emission test procedure will effectively be a combined diurnal/hot soak/running loss/resting loss measurement and control program.

Modeling of the effects of the new evaporative emission test procedure on average in-use evaporative emission rates in MOBILE5 (December 4, 1992) was based on the terms of the proposal, including the start year (model year 1995) and phase-in schedule (10% in MY 1995, 30% in MY 1996, 50% in MY 1997, and 100% in MY 1998 and beyond). The revised evaporative test procedure was finalized in March 1993 (58 FR 16002, March 24, 1993), and provides for the requirement to begin with the 1996 MY and proceed by the following phase-in schedule: 20% in MY 1996, 40% in MY 1997, 90% in MY 1998, and 100% in MY 1999 and beyond. The provisions of the final rule are accurately reflected in MOBILE5a (March 26, 1993). See section 2.2.4.2 for additional information.

### **1.2.2 New Pass/Fail Rates and Associated Emission Levels for Functional Purge and Pressure Tests**

The MOBILE models have accounted for tampering with various emission control components, based on the results of analyzing data obtained in tampering surveys conducted by EPA in different parts of the country, for a number of years. These rates are periodically updated on the basis of new survey data, and the types of tampering modeled include "evaporative control system disablement" and "missing gas caps," both of which can result in very high levels of evaporative emissions (including running losses). However, these tampering surveys do not detect all types of problems with evaporative control systems. Visual inspections can detect and force correction of obvious problems, such as missing canisters and disconnected vapor hoses,

but cannot detect problems such as holes in hoses (which is as bad, in terms of emission control, as a disconnected hose), or problems with canister purging (if the canister is not properly and frequently purged of accumulated vapor, even an intact system with no missing or disconnected parts will be unable to control evaporative emissions).

As part of the IM240 lane testing program in Hammond, IN (see section 1.1.1), EPA has also been performing functional testing of in-use vehicles' evaporative emission control systems. These functional tests, referred to as "pressure tests" and "purge tests," allow major malfunctioning evaporative emission control systems to be detected, including those that would readily pass simpler visual inspections. In addition to obtaining data on the rates at which in-use vehicles pass or fail one or both of these functional tests, EPA has performed laboratory evaporative emissions tests on both passing and failing vehicles, providing in-use emission rate data for vehicles that pass both tests and those that fail one or both of these tests.

The results of this analysis were incorporated in the MOBILE4.1 model in 1991. The net effect was to increase the evaporative emission factors, since the pressure/purge test pass/fail rates indicated a much more widespread problem with in-use evaporative emission control systems than reflected in the more traditional tampering survey results and that emissions from vehicles failing one or both of these tests are higher than the emissions previously associated with tampered vehicles.

With the addition of test results from approximately 4000 vehicles to the Hammond data base since the MOBILE4.1 analysis, EPA has revisited the pass/fail rates and the emissions levels associated with vehicles in both conditions. The results of this reanalysis are included in MOBILE5, and show that fewer vehicles failed one or both of these tests than was observed in the data used in MOBILE4.1. The emission rates associated with "passing" and "failing" vehicles were virtually the same as those observed in the MOBILE4.1 data. The net effect of these changes is to slightly decrease the average in-use evaporative emission factors (hot soak, diurnal, running losses) for light-duty gas vehicles and trucks, relative to those estimated by MOBILE4.1.

### **1.2.3 Updated Hot Soak and Diurnal Emission Rates**

MOBILE5 includes updated emission rate estimates for both hot soak (trip-end) and diurnal evaporative emissions. This update was based on the increased number of vehicle tests available for analysis and inclusion in the model, and on a more realistic method of estimating diurnal emissions.

Hot soak emissions, also referred to as trip-end emissions, are those evaporative emissions generated when a vehicle completes a trip. Under such conditions, the vehicle's engine, fuel tank, and the fuel are all heated to normal operating temperatures. When the engine



is turned off, fuel in the carburetor (if applicable), the fuel lines, and the fuel tank is hotter than the ambient temperature, and evaporative emissions are generated until the vehicle/engine/fuel tank and fuel have cooled to the ambient temperature. With the engine off, these emissions cannot be purged from the canister. Diurnal emissions are those evaporative emissions generated from a vehicle that is not driven during a period of rising ambient temperature. For example, if a vehicle is driven to work in the morning and then is not driven again until the end of the work day, then after the vehicle/engine/fuel system have cooled to ambient temperature (and hot soak emissions are no longer being generated), the increasing temperature over the remainder of the day will result in vapor generation, and (in the absence of adequate control mechanisms) diurnal evaporative emissions.

The evaporative emissions testing performed in conjunction with the Federal Test Procedure (FTP), pending revisions to this procedure as discussed above, consists of a simulated one-hour diurnal heat build before the exhaust emission (dynamometer) test, and a one-hour hot soak immediately following the exhaust test. The associated nominal test temperatures are 82°F (28°C) for the hot soak test, and a heat build of 60-84°F (16-29°C) for the diurnal test. EPA has collected data on these emission rates from more, and more recent, vehicles since the release of MOBILE4.1, and these data are reflected in the MOBILE5 emission rates. In addition, the diurnal emission rate data base has been enhanced by the collection of data from 8-hour simulated diurnal heat builds, which more accurately represent the heating that occurs in the real-world diurnal emission situations. The new diurnal emission data reflect increased emissions, primarily as a result of this longer, more realistic diurnal testing and measurement.

#### **1.2.4 Updated Running Loss Emission Estimates**

Running loss emissions in MOBILE5 have been updated in two significant ways since the release of MOBILE4.1. First, as is true for the other categories of emissions, EPA has considerably more data available, including data on newer vehicles. The inclusion of the newer data did not have a major impact on the running loss emission estimates. Second, and of greater impact on the running loss emission factors calculated by the model, EPA has detected and corrected an error in the trip length fractions used to weight running loss emission estimates from trips of different lengths (time duration).

As discussed in section 2.3.13, the running loss emission estimates produced by MOBILE5 are based on the results of running loss emission measurements over trips of different lengths (duration in time, not distance traveled). As a vehicle is driven longer, the vehicle engine/fuel system and the fuel increase in temperature, resulting in vapor generation. Up to an hour or so, the longer the trip lasts, the higher these temperatures, the greater the vapor generation, and hence the higher the running loss emissions. This is particularly true at low average speeds, as might be encountered in congested urban traffic, since some vehicles' canister purge logic will not purge the carbon canister of accumulated vapor under such conditions,

resulting in canister capacity being reached and additional vapor generation being released as running loss emissions.

EPA's running loss test procedure involves the measurement of running loss emissions approximately every 10 minutes over the course of one hour. The measurements are cumulative, meaning that the emission measurement at each 10-minute interval (10 min, 20 min, etc.) include all emissions from the start of the trip (0 min) to that point. An emission factor for each 10-minute period, for each of three average trip speeds, is then determined on a grams per mile basis. The three average trip speeds are 7.1 mph (11 km/hr), representing highly congested urban traffic; 19.6 mph (31.5 km/hr), the FTP average speed, representing more typical traffic in urban areas; and 48.6 mph (78.2 km/hr), representing relatively free-flowing traffic including limited access highways. Six running loss emission measurements are associated with each of these average trip speeds: for trips that total 10 minutes or less, for trips of 11-20 min, 21-30 min, 31-40 min, 41-50 min, and finally for trips of 51+ min. Weighting factors, representing the fraction of total VMT accumulated by vehicles during trips of each of these time bands, are used to weight these emission factors to derive the overall running loss emission factor. The error detected and corrected in MOBILE5 involved using *trip* fractions rather than *VMT* fractions, resulting in overestimates of the fraction of VMT accumulated in trips of shorter duration (which have the lowest running loss emissions). Correction of this error increased the running loss emission factor calculated for any average speed, as the longer the duration of driving, the greater the generation and release of running loss emissions.

## **1.3 INSPECTION AND MAINTENANCE PROGRAMS**

### **1.3.1 Ability to Model Two Different I/M Programs**

The MOBILE4.1 model (and all previous versions of the MOBILE model) allowed the user to indicate the presence of an Inspection and Maintenance (I/M) program and required the user to specify a single set of parameters describing the scope and stringency of the program. These parameters included the program start date, model year and vehicle type coverage, and inspection test type for model year (MY) 1981 and newer vehicles. I/M program designs have become more complex as changes to the Clean Air Act have mandated more stringent I/M programs. Most I/M programs, even the most complex, can be modeled by carefully performing a series of MOBILE model runs and summing the partial benefits from each run. This approach can become difficult when multiple scenarios are necessary, such as analysis for an Urban Airshed Model, because of all of the hand calculations that are necessary.

For MOBILE5, an option for a second I/M Descriptive Record was added to the One-Time Data section of the model to reduce the number of cases where multiple MOBILE runs would be necessary to determine the proper I/M benefits. The user is required to enter two I/M Descriptive Records whenever the IMFLAG in the Control section of the input data is set to 3

or 5 (see section 2.1.9). This second I/M Descriptive Record (see section 2.2.5) is identical to the first, containing all of the same program parameters and using the same format. MOBILE5 reads both I/M records and merges the information contained in them to determine the overall I/M program design intended by the user. When using the option to enter two I/M Program Descriptive Records, there are several considerations to bear in mind when describing the I/M programs.

First is the fact that all of the parameters on both records are considered together. Any parameter set on either record will cause the model to act in a manner consistent with that descriptive input. For example, if one record shows only passenger cars are covered by the I/M program, but the second shows both cars and light-duty trucks are covered, then the model will include both cars and trucks in at least some of the program benefit calculations.

Second, the second I/M Program Descriptive Record always takes precedence over the first whenever there is a conflict. The MOBILE5 model calculates emissions for each model year separately. If both the first and second records claim that a model year is covered by the program described, only the program described in the second record will be used to determine emission reductions for that model year. The information on the first record will be ignored whenever there is a conflict. This feature can be useful in some situations. For example, if the first record indicates an idle test is used for all model years for all vehicle types and the second record indicates use of the IM240 test procedure for 1986 and newer passenger cars, the idle test will be used for all 1986 and newer trucks as well as for pre-1986 passenger cars and trucks. The second I/M descriptive record only supersedes the test type for the 1986 and newer passenger cars.

Finally, the two I/M descriptive records should not be used to show changes in the I/M program over time. The I/M program start date effects the amount of benefits each model year vehicle gets in any particular calendar year. If the I/M program start date is different in the second I/M program descriptive record, the second I/M program start date will be used to determine benefits for any model years included in the I/M program description.

For example, an existing I/M program which started in 1984 begins using the IM240 test procedure for 1986 and newer vehicles starting in calendar year 1995. If the user sets the I/M program start date for the second I/M descriptive record, which describes the IM240 portion of the program, to 1995, it would appear that a series of calendar year evaluations from 1990 through 1996 would show the change in the program description starting in 1995. However, since the second I/M program descriptive record effectively changes the start date for the 1986 through 1995 model year vehicles, the benefits for those vehicles will not be correct in 1996. In cases like this two separate MOBILE5 runs, one describing the program in effect in the 1990 through 1994 calendar years and the second describing the program after 1995, will be necessary. In the second runs, the I/M program starting date for both I/M descriptive records would be 1984, reflecting the date on which the vehicles were first inspected.

### **1.3.2 Expanded User Input for Short Test Transient Test (IM240)**

Later versions of the MOBILE4.1 model included the ability to model the use of the new IM240 test procedure (see Appendix 2A, section 2A.1.10) using an expanded I/M program description record. This only allowed the input of the oldest model year coverage parameter; all other parameters were taken from the other portions of the I/M program description.

MOBILE5 has capability to model two entirely separate I/M program descriptions using two I/M program descriptive records (see above and section 2.2.5). Each record has the ability to indicate the IM240 test procedure as a test type. This will allow a separate I/M program description record for the model years covered by the IM240 procedure including all of the parameters now available in the model. However, since the IM240 test procedure has no default set of emission cutpoints, any I/M program descriptive record which specifies the IM240 test procedure must enter the emission cutpoints to be used (see section 1.3.5).

### **1.3.3 Expanded User Input for Evaporative Pressure and Purge Tests**

Later versions of the MOBILE4.1 model included the ability to model the use of functional tests of the evaporative emission control systems, referred to as "purge" and "pressure" checks (see Appendix 2A, sections 2A.1.16 and 17). The pressure and purge checks were accessed using an expanded I/M program description record. This only allowed the input of the oldest model year coverage parameter for each check; all other parameters were taken from the other portions of the I/M program description.

MOBILE5 has a separate program descriptive record for both the pressure and the purge check (see sections 2.2.6.3.2 and 2.2.6.3.3). Each descriptive record contains similar program parameters to an Anti-Tampering program (ATP) descriptive record, allowing the parameters for each functional check to be controlled independently.

### **1.3.4 Revisions to I/M Program Emission Credits**

MOBILE5 has separate data files (TECH12.D and IMDATA.D) which contain the emission benefit credits for I/M programs. The credits in these files have been updated from MOBILE4.1 to reflect changes in the basic emission rates, changes in the estimate of emissions identified by each I/M program test type and changes in the estimate of emission reductions from the repair of vehicles. All of these changes reflect the addition of new testing data not originally used in the release of the MOBILE4.1 model.

### **1.3.5 I/M Program Emission Testing Cutpoints**

Each I/M program descriptive record in MOBILE5 has been expanded to include the option for the user to specify the emission testing cutpoints for hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NOx) emissions to be used when modeling the I/M program. These are the emission levels which I/M programs will use to determine vehicles passing or failing the tailpipe emission test used by the program. If a vehicle's measured emissions exceed the corresponding cutpoint level for that pollutant, the vehicle is considered failing and subject to a repair requirement. In MOBILE5, these cutpoint levels are used in combination with the tailpipe inspection test type as a method to specify the set of I/M credits to be used to estimate the emission reductions for the I/M program. However, only certain combinations of cutpoints and test type have been included in the I/M credits available with MOBILE5. The available sets of cutpoints (those sets of cutpoints for which MOBILE5 can calculate appropriate emission credits without additional input) are summarized in Table 1.3-1. Other combinations of cutpoints are possible, but the associated emission reduction credits must be calculated and added to the I/M data file before MOBILE5 can use them.

The cutpoint combinations are only used directly to determine the I/M benefit credits for the 1981 through 1993 model year passenger cars (LDGV) covered by the I/M program description. Passenger cars with model years older than 1981 always use the stringency input of the I/M program descriptive record to determine I/M benefit credits (see section 2A.1.3). These benefits do not directly depend on the cutpoints or the test type indicated on the I/M program descriptive record. I/M credits for heavy-duty gasoline-fueled vehicles (HDGV) do not depend on test type, cutpoints, or stringency.

The I/M program credits for other vehicle classes, such as light-duty trucks (LDGT1 and LDGT2), and 1994 and later model year passenger cars (Tier 1) are determined based on the assumption that the I/M program design is attempting to maintain equivalent stringency between different vehicle groups based on their emission standards. The benefits for these other vehicle groups are determined from adjusting the credits for the 1981 through 1993 passenger cars to reflect the differences in their emission standards and vehicle emission performance. As a result, MOBILE5 only requires the input of one set of cutpoints for the 1981 through 1993 model year passenger cars, and the credits for all of the other groups are determined from this input. Since there is no explicit input for the cutpoints for these other groups, there is no easy method to change the effect of this assumption using MOBILE5. If it is necessary to know explicitly what the cutpoints for the other groups would be for a given MOBILE5 cutpoint combination, the user should contact the Office of Mobile Sources.

This same method was used to apply I/M credits to the case when California standards are chosen using the REGION flag on the Scenario Record (see section 2.3.1), but without the maximum I/M program option (see section 1.3.6, below, and Appendix 2B). MOBILE5 uses the same assumption of equivalent stringency to determine the emission reduction credits for vehicles certified to the California LEV program standards as was used for light-duty trucks and Tier 1 vehicles.

Table 1.3-1

MOBILE5 Inspection and Maintenance Program  
Available Cutpoint Combinations (Annual and Biennial)

<u>HC</u>	<u>CO</u>	<u>NOx</u>	<u>Test Procedure (Option)</u>
(ppm)	(%)	(N/A)	(units)
220.	1.20	999.	Idle Test (1)
220.	1.20	999.	2500/Idle Test (2)
220.	1.20	999.	Loaded/Idle Test (3)*
(g/mi)	(g/mi)	(g/mi)	(units)
0.40	8.00	1.80	ASM Test (3)*
0.80	15.0	999.	IM240 Test (4)
0.80	20.0	999.	IM240 Test (4)
0.80	15.0	1.50	IM240 Test (4)
0.80	20.0	1.50	IM240 Test (4)
0.80	15.0	2.00	IM240 Test (4)
0.80	20.0	2.00	IM240 Test (4)
0.80	15.0	2.50	IM240 Test (4)
0.80	20.0	2.50	IM240 Test (4)
0.80	15.0	3.00	IM240 Test (4)
0.80	20.0	3.00	IM240 Test (4)
0.60	10.0	999.	IM240 Test (4)
0.60	12.0	999.	IM240 Test (4)
0.60	15.0	999.	IM240 Test (4)
0.60	20.0	999.	IM240 Test (4)
0.60	10.0	1.50	IM240 Test (4)
0.60	12.0	1.50	IM240 Test (4)
0.60	15.0	1.50	IM240 Test (4)
0.60	20.0	1.50	IM240 Test (4)
0.60	10.0	2.00	IM240 Test (4)
0.60	12.0	2.00	IM240 Test (4)
0.60	15.0	2.00	IM240 Test (4)
0.60	20.0	2.00	IM240 Test (4)
0.60	10.0	2.50	IM240 Test (4)
0.60	12.0	2.50	IM240 Test (4)
0.60	15.0	2.50	IM240 Test (4)
0.60	20.0	2.50	IM240 Test (4)
0.60	10.0	3.00	IM240 Test (4)
0.60	12.0	3.00	IM240 Test (4)
0.60	15.0	3.00	IM240 Test (4)
0.60	20.0	3.00	IM240 Test (4)

1.00	20.0	2.00	IM240 Test (4)*
1.20	20.0	999.	IM240 Test (4)
1.20	20.0	1.50	IM240 Test (4)
1.20	20.0	2.00	IM240 Test (4)
1.20	20.0	2.50	IM240 Test (4)
1.20	20.0	3.00	IM240 Test (4)

---

\* New credits. All other credits identical as released with MOBILE5a (March 26, 1993).

### **1.3.6 I/M Programs for Tier 1 Vehicles and for LEVs**

Appendix 2B of this User's Guide provides guidance on inspection and maintenance (I/M) programs that are designed to keep California low emission program vehicles (LEVs), on average, in compliance with their exhaust emission certification standards up to the end of their useful life. Such a program also assumes that all high-emitting vehicles are eliminated, so that rate of increase in emissions (deterioration rates) does not increase after 50,000 miles. To attempt to make vehicles cleaner than this would require that vehicles be capable of being repaired to emission levels lower than their design standard.

MOBILE5 also has the capability to model the benefits of such a program for 1994 and newer vehicles meeting Federal Tier 1 standards, using the IMFLAG (see section 2.1.9). However, EPA has not yet issued guidance on the program requirements necessary to achieve these benefits for Tier 1 vehicles. States interested in this option should consult with EPA for assistance. Comparable I/M benefits can also be chosen for vehicles under California LEV program standards using the REGION flag (see section 2.3.1). These two options may be used independently or in combination. Indicating that I/M programs meeting the criteria outlined in Appendix 2B are to be assumed will cause MOBILE5 to ignore all other user-input I/M program and anti-tampering program parameters for those vehicles covered by this I/M program. Instead, certain assumptions consistent with the discussion provided in Appendix 2B will be applied to the emission rates for those vehicles. There are no other user inputs to control the model year coverage or other parameters related to the this I/M concept.

The user is strongly encouraged to read the relevant sections of this User's Guide (section 2.2.5 on I/M programs, section 2.3.1 on the REGION variable, and section 2.3.7 on LEV program vehicles), and the discussion in Appendix 2B, closely.

## **1.4 FUELS AND FUEL PARAMETERS**

### **1.4.1 Revision of Basic Emission Rates to Reflect Industry-Average Fuel Composition**

In addition to the revisions to the basic emission rate equations that were made on the basis of the IM240 data and analysis (see section 1.1.1), EPA has also revised the basic emission rate equations to account for the difference between industry average commercial fuel and the fuel(s) used for laboratory testing. MOBILE5, like the last several versions of the model, explicitly accounts for fuel volatility as measured by Reid vapor pressure (RVP). However, there are other aspects of fuel composition that affect emission levels.

EPA's standard test fuel has a number of specific characteristics. On the basis of fuel surveys and other data, the average commercially marketed gasoline in the U.S. differs from this standard test fuel in a number of parameters. These differences in fuel composition result in differences in emissions of all three regulated gaseous pollutants. MOBILE5, in addition to and



completely distinct from the ability of the modeler to specify RVP, includes a correction to account for the differences between EPA test fuel and average commercial fuel. This adjustment is handled in the program code, and is not controllable by the user. When programs that would affect fuel properties affecting emissions are specified (e.g., reformulated gasoline), MOBILE5 makes the necessary adjustments starting from emissions under current industry-average fuel emission levels.

The industry-average fuel adjustment results in emission increases (relative to corresponding MOBILE4.1 estimates) of about 13.6% for hydrocarbons, 8% for carbon monoxide, and 13.8% for oxides of nitrogen. Note that these increases are for the industry-average fuel adjustment only, and are in addition to the increases in the BERs that resulted from the IM240-based analysis discussed earlier.

#### **1.4.2 Reformulated Gasoline**

Among the control programs required by the 1990 Clean Air Act Amendments is reformulated gasoline (RFG). RFG is required under the Act in the nine most severe ozone nonattainment areas (Los Angeles, Chicago, Houston, Milwaukee, New York City, Baltimore, Philadelphia, San Diego, and Greater Connecticut). Other areas of the country have the ability to "opt-in" to the RFG program, and as of this writing a number of other areas have done so.

There are two levels, or phases, of RFG specified in section 211(k). The first of these requires, among other things, that emissions of volatile organic compounds (VOC) from "baseline vehicles" shall be reduced at least 15 percent when such vehicles are operated on RFG, relative to emissions when operated on standard fuels. Other requirements include that NO<sub>x</sub> emissions must be no greater on RFG than on standard gasoline, that benzene content be limited to a maximum of 1.0 percent, and so on. Phase II RFG, which is required beginning in 2000, must result in a 25 percent reduction in VOC emissions. Much of the detail of the RFG requirements is left to the Administrator to be implemented by regulation.

As part of the rulemaking process to establish RFG requirements, EPA has been working with concerned parties in the development of models to be used in determining the effects of various possible formulations of gasoline that could serve to meet the RFG requirements. The "simple model" has been used in the early Notice of Proposed Rulemaking and associated analyses, while development efforts more recently have been focused on the "complex model," in which more variables will be explicitly accounted for and more data will underlie the estimates. The effects of Phase I and Phase II RFG have been modeled in MOBILE5 using a "simple model" approach. Non-exhaust emission reductions are determined solely from the specified reductions in fuel volatility (as measured by Reid vapor pressure (RVP)). Exhaust emission reductions are based on the effects of the oxygen content of the fuel, which are then further adjusted to match current estimates for exhaust emission effects. The effects of RFG in MOBILE5a are based on the estimates found in the February 26, 1993 proposal (58 FR 11722). The 15-percent (for Phase 1) and 25-percent (for Phase 2) emission reductions specified in the

Act are based on the emission performance of a certain vehicle/emission control technology combination as of model year 1990, and thus will not be observed *per se* in any MOBILE5 emission factor runs (that is, in no case should the modeler expect to find that the emission factors produced in two MOBILE5 runs, identical except that one includes and one does not include RFG, will show exactly a 15% or a 25% reduction in the in-use emission factor as a result of RFG). When more detailed estimates are available, revisions and updates to the modeling of RFG effects on emissions will be incorporated into later versions of the MOBILE model.

Assuming RFG in a MOBILE5 emission factor run is simply a matter of setting a "switch" to "turn on" the feature (see section 2.2.16). The effects of RFG differ by season, with rules aimed more toward the reduction of ozone precursors (e.g., volatility restrictions) in the summertime, and more toward a reduction in CO emissions (e.g., minimum oxygen content requirements) in the winter. The effects of RFG in MOBILE5 depend on which season is to be assumed and what fuel volatility class applies. The model determines the season (summer or winter) for RFG modeling by the value of the new "month" input variable (see sections 1.5.2 and 2.3.6); if the month is "1" (January), then the winter RFG rules are applied, and if the month is "7" (July), the summer RFG rules are assumed. The fuel volatility class, which is not the same thing as the ASTM Class variable used in earlier MOBILE models, is discussed in section 2.2.10.

### **1.4.3 Oxygenated Fuel Impacts on HC Emissions**

MOBILE4.1 included for the first time provisions for modeling the impact on emissions of oxygenated fuels. Such fuels, whether alcohol/gasoline blends such as gasohol (10% ethanol in gasoline) or ether/gasoline blends (such as MTBE or ETBE), reduce emissions by incorporating oxygen into the fuel itself, improving combustion. The largest impact of oxygenated fuels is seen on carbon monoxide (CO) emissions. Due to the need for CO nonattainment areas to complete analyses including attainment demonstrations, MOBILE4.1 included the effects of oxygenated fuels only on CO emissions.

In MOBILE5, EPA has included the impact of oxygenated fuels on VOC emissions. There has been no revision in how oxygenated fuels are modeled using MOBILE (no changes to flags or other required input data). The effects of oxygenate content in gasoline on NOx emissions is both very slight and inconsistent (small increases for some vehicles, small decreases for others), and so while these effects are included in the model, the net effect on NOx emission factors of RFG is negligible. In other words, specifying oxygenated fuels will reduce CO emissions, as in MOBILE4.1, will reduce VOC emissions to a lesser extent (new in MOBILE5), and will have no effect on NOx emission factors.

## **1.5 MISCELLANEOUS REVISIONS**

### **1.5.1 Updated Registration Distributions by Age and Annual Mileage Accumulation Rates**

Two of the main descriptors of the in-use vehicle fleet are the registration distributions by age and the annual mileage accumulation rates by age. Registration distributions by age, for each of the vehicle types in the model, are a set of 25 fractional values ( $0.0 \leq$  each individual fraction  $\leq 1.0$ ) that sum to 1.0 and define what fraction of all vehicles of a given type are of a given age. Annual mileage accumulation rates by age, again specific for each vehicle type, are the average miles driven by a vehicle of a given type during each year that it is on the road. Both registration distributions by age and annual mileage accumulation rates by age are taken into account in calculating travel fractions, which (again, for each vehicle type) are a set of fractions that describe what fraction of all vehicle miles traveled accounted for by a given vehicle type are accumulated by vehicles of each age. Travel fractions in turn are used as the weighting factors in estimating an emission factor for all LDGVs (or other vehicle type) on the basis of the emission factors calculated for LDGVs (or other vehicles) of each specific age.

The default registration distributions by age that were included in MOBILE4.1 were representative of the entire U.S. vehicle population as of 1990. These distributions are unchanged in MOBILE5 for light-duty vehicles, but have been updated on the basis of more recent data for light- and heavy-duty trucks. Reflecting what has been observed elsewhere, the revised distributions indicate that the average age of vehicles of each of these types (LDGT1, LDGT2, LDDT, HDGV, and HDDV) has increased relative to the estimates used in MOBILE4.1. EPA has also updated the annual mileage accumulation rates, and the new rates reflect higher mileage accumulation by all vehicles and for all ages. Taken together, these changes show a fleet that is older and drives more miles than has previously been estimated, both factors leading to increased emission factor estimates.

As noted in Chapter 2 (section 2.2.3), modelers are generally encouraged to develop and use registration distributions by age that are specific to the area being modeled. At the least, such distributions should be relatively easy to develop on a State-specific basis, and using such locality-specific data will enhance the accuracy of the modeled emission factors. The discussion in Chapter 2 indicates that few if any users are likely to be capable of developing area-specific annual mileage accumulation rates by age. While this has been true historically, there are some areas for which such data could be developed, either now or in the near future, on the basis of recorded odometer mileage data collected as part of I/M programs. In order to develop such data, an I/M program would have to have been in operation and recording odometer mileage from all vehicles tested for at least two complete cycles of inspections (two calendar years for annual programs, or four calendar years for biennial programs). Areas with operating programs that record odometer miles should consider the development of annual mileage accumulation

rates from that data for use in MOBILE modeling. Further assistance in this area is available by contacting OMS.

### **1.5.2 July 1 Month of Evaluation Option**

All previous versions of the MOBILE model have estimated emission factors as of January 1 of the calendar year of evaluation (selected by the modeler). Although the modeler could estimate emission factors for summertime conditions (high temperatures and low fuel volatility, for example), the fleet composition (registration distributions and mileage accumulations) were estimated on the basis of January 1 of the specified year. This did not pose significant difficulties for most applications of the emission factors, but has become more critical (particularly for ozone nonattainment areas) in recent years. EPA has provided guidance in the past that the way to estimate summer emission factors (that is, July 1 rather than January 1) is to interpolate two sets of MOBILE-produced emission factors. For example, the modeler seeking to estimate July 1, 1990 emission factors using MOBILE4.1 would run the model for calendar years 1990 and 1991, holding all other variables constant, then take the average of the two sets of emission factors. This linear interpolation can also be used to estimate fleet composition and its effects on emissions for other months of the year.

MOBILE5 has added the option for the user to specify "month" as part of the input data (see section 2.3.6). The available choices are "1" which specifies January 1 (no change from earlier models), and "7" which specifies July 1. This option is provided as a convenience for modelers focused on ozone precursor emissions, and is also used in the calculation of the effects of reformulated gasoline (see sections 1.4.2 and 2.2.16). The results of estimating emission factors using a July 1 evaluation date should be identical to those obtained using the older method of interpolating between consecutive calendar year MOBILE5 runs evaluated on January 1, with the exception of areas (modeling runs) specifying reformulated gasoline (see section 2.2.16).

## Chapter 2

### MOBILE5 INPUTS

#### 2.0 INTRODUCTION

The reader is encouraged to refer to the examples in Chapter 5 when reading this chapter. These examples provide illustrations of the use of MOBILE5 options and data input requirements. However, reference to the examples in Chapter 5 cannot substitute for a thorough reading of this chapter.

MOBILE5 utilizes an input file that provides program control information and the data describing the scenarios for which emission factors are to be estimated. The input information consists of three distinct sections: the Control section, the One-time Data section, and the Scenario section.

The Control section is the portion of the input file that controls the input, output, and execution of the program. For example, the Control section indicates whether MOBILE5 will require the user to supply additional input data, or analyze a scenario that includes an inspection and maintenance program, or output the emission factors in a format suitable for visual inspection or in a format suitable as input to another program.

Some parameters used in the emission factor calculations have internal values built into MOBILE5. The One-time Data section is the portion of the input that allows the user to define parameter values different from those internal to MOBILE5, which will be used in the calculations for all of the scenarios within a given run. For example, in the One-time Data section the user can specify alternate annual mileage accumulation rates or registration distributions by age for each vehicle type. In addition, the One-time Data section allows the user to specify further control program parameters, such as description(s) of inspection and maintenance program(s). Information supplied in the One-time Data section is specified once and applied to all scenarios.

The Scenario section is the portion of the MOBILE5 input that details the individual scenarios for which emission factors are to be calculated. For example, in the Scenario section the user specifies the calendar year of evaluation and the average speed(s) to be assumed. Each MOBILE5 run can include many scenarios, and each scenario can have different scenario parameters.

In a few cases, the placement of data in either the One-time Data section or the Scenario section is determined by the setting assigned to a flag in the Control section of the input. In these cases, discussion of the variable(s) involved is provided once (usually in the One-time Data section), and then is referenced in the other section.

The Control section specifies values for variables termed flags. In section 2.1 each flag is named, and the range of possible settings for that flag and the resulting action is noted. In the One-time Data and Scenario sections (sections 2.2 and 2.3 respectively), the following general format is used. (Depending on the variable being discussed, not every item noted below is included for every variable.)

**Description:** A brief description of what the variable means, and how it is used by MOBILE5.

**Options:** A summary of choices available to the MOBILE5 user.

**Use in MOBILE5:** A description of the value(s) used in MOBILE5 for the variable(s) if the user does not input locality-specific information, where applicable, and discussion of how the information is used in the emission factor calculations.

**Required Information:** A specific description of exactly what information is required of the user, where applicable, including format specifications.

**Changes Since MOBILE4.1:** A statement summarizing exactly what changes have been made in the variable since MOBILE4.1. Not every variable has been revised. For those that have changed, this section highlights exactly what is different in MOBILE5 relative to MOBILE4.1 (options, format requirements, or use within the model). These sections are particularly important in finding and understanding the new options that are available in MOBILE5 (e.g., California LEV program, reformulated gasoline). In order to maintain compatibility between MOBILE4.1 and MOBILE5 input files to the maximum extent feasible, new options in MOBILE5 are generally accessed through either the addition of new values for existing flags, or by optional additional flags that appear at the end of distinct records (lines) in the input file. As was done in the introduction of new options for MOBILE4.1 (such as the oxygenated fuels program), these new optional values are located and interpreted in such a way that if they are missing, the program interprets the value as "not applicable to this case". This allows MOBILE4.1 input files to be used to run MOBILE5, although not every option available in MOBILE5 can be accessed using an old MOBILE4.1 input file.

**Guidance:** Where applicable, EPA's recommendations and suggestions with respect to the determination of user-supplied values for the variable(s) under discussion. Many users of MOBILE5 will be involved in developing (or recasting) base-year (1990) emission inventories as part of the State Implementation Plan (SIP) process. In many cases, there is no single correct answer or recommendation that will be the best answer for all areas. For those using MOBILE5 to estimate highway mobile source base-year emission inventories in response to the requirements of the Clean Air Act Amendments of 1990, it is important that the guidance provided in the emission inventory preparation guidance (see below) be followed, and that EPA Regional Office personnel be kept involved in decisions concerning questionable or controversial assumptions and steps in the modeling.

There are also two appendixes to this chapter. Appendix 2A discusses the terminology used to describe inspection and maintenance (I/M) programs and anti-tampering programs (ATPs) Appendix 2B, which was not included in previous distribution of this chapter, reproduces a memorandum from the Office of Mobile Sources to EPA Regional Office Air Division Directors that details the guidance for obtaining emission credits for State Implementation Plans (SIPs) based on adoption of the California low emission vehicle (LEV) program. The issuance of the guidance provided in Appendix 2B has led to revisions in the following sections of this chapter, relative to the version distributed with the release of MOBILE5a and previously available through the TTN BBS:

- o 2.2.5 Inspection and Maintenance Programs
- o 2.2.6 Anti-Tampering Programs
- o 2.3.1 REGION (variable on scenario record)
- o 2.3.7 LEV Program Parameter Record

With the exception of the changes resulting from issuance of this guidance, there have been no substantive changes to Chapter 2 of this User's Guide since its initial release.

Guidance on the determination of appropriate values for temperatures and fuel volatility (RVP) appears in the revised emission inventory guidance ("Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources," EPA-450/4-81-026d (revised), July 1992).

Questions about this document, and suggestions as to how the MOBILE5 User's Guide may be made clearer and more useful, should be addressed to:

MOBILE5 User's Guide -- Comments  
 Air Quality Analysis Branch  
 2565 Plymouth Road  
 Ann Arbor, MI 48105

The remainder of Chapter 2 is structured as it was in the User's Guide to MOBILE4.1. For the most part, the same section numbers correspond to the same inputs and discussions as in the previous User's Guide. Where applicable, new subsections have been added to clearly indicate changes relative to MOBILE4.1.

### 2.0.1 How to Read FORTRAN Format Specifications

The descriptors used in the remainder of Chapter 2 to define and describe the input field specifications are FORTRAN format specifications. Following is a brief key for interpretation. Additional detail can be found in any FORTRAN manual.

<u>Descriptor</u>	<u>Definition and Interpretation</u>
<b>'Iw'</b>	The next <b>w</b> characters (columns; includes blank spaces) will be read in as an integer value. Leading blanks are ignored, but trailing blanks are read as zeroes; thus, integer input values should be "right-justified" within the input field (i.e., if a value of "2" is to be entered in a field specified as I2, the two columns should be filled in "blank,2", not "2,blank" which will be interpreted as "20").
<b>'Fw.d'</b>	The next <b>w</b> characters will be read in as a floating-point real number, where <b>d</b> is the number of digits to the right of (following) the decimal point. If the field contains an explicit decimal point, the value will be read as specified and the implied point specified by <b>d</b> in the descriptor will be overridden. The decimal point, if present, is considered a character in the overall field width, <b>w</b> .
<b>'Aw'</b>	The next <b>w</b> characters will be interpreted and stored as alphanumeric (i.e., labels, text; any keyboard character can be entered).
<b>'wX'</b>	The next <b>w</b> characters will be ignored; they are not read by MOBILE5.
<b>'/'</b>	The field separator, used to indicate the end of one record (line of input). Input after the '/' will be read from the next record.

## 2.1 CONTROL SECTION

The first portion of the input stream for a MOBILE5 run consists primarily of a series of flag settings. These flags control the format (and in some cases the content) of the remainder of the input stream, influence the execution of the program, and determine the content and format of the program's output. Each flag is named, defined, and its possible values listed, along with the effect of each setting. Tables 2.1-1 and 2.1-2 summarize the information on Control flags.

### 2.1.1 PROMPT

#### 2.1.1.1 Description

This flag determines whether the user will be prompted for the remainder of the input stream, and the arrangement of the remaining Control section input.

#### 2.1.1.2 Values/Actions

This flag can be set to 1, 2, 3, or 4:

	<u>Value</u>	<u>Action</u>
1		No prompting; after PROJID record (section 2.1.3), vertical format (one value per line/record) used for remainder of input
2		MOBILE5 prompts for each input; vertical format
3		No prompting; after PROJID record, horizontal format (all values on one line/record) used for remainder of input
4		MOBILE5 prompts for each input; horizontal format

In general, EPA recommends that the input data for a MOBILE5 run be provided in a line file rather than entered interactively. Particularly when the user is supplying optional input data to replace values contained in the model, such as registration distributions by age, it is very difficult to interactively enter the large quantity of data required without error; providing the data in a separate file, which can be printed and examined, facilitates the process of detecting and correcting input errors. The use of this flag has largely been superseded by the use of a program driver routine in MOBILE5, but it is retained to maintain compatibility with MOBILE4.1 input files.

#### 2.1.1.3 Changes Since MOBILE4.1

There have been no changes to the PROMPT flag since MOBILE4.1. Users of MOBILE4.1 will note that a prompting message for the value of this flag has been added to the dialogue, after the prompts for output file name.

### 2.1.2 IOUNEW

#### 2.1.2.1 Description

The IOUNEW flag allows reassignment of output unit device numbers. There are three different types of program output (prompting messages, diagnostic messages, and the emission factor reports). This flag is only useful when the mainframe computer version of MOBILE5 (available on 9-track magnetic tape) is being operated. The desktop computer versions of MOBILE5 (for IBM PC machines and clones, or for Apple Macintosh computers) does not permit reassignment of I/O devices in this way.



### 2.1.2.2 Values/Actions

The three types of program output are formatted reports (emission factor results), diagnostic messages (error and warning messages), and prompting messages (such as are issued if the value of the PROMPT flag is 2 or 4). Single integer values representing other I/O device numbers may be assigned for any or all of these, in the order listed. If no device reassignments are desired, these fields may be left blank. Users of the desktop computer versions of MOBILE5 should never attempt to reassign the input devices. See Chapter 4 for additional information.

Any of the values 1 through 9 are technically allowed by MOBILE5 for assignment of any of the three possible output units. However, the values of 3 and 4 are reserved as input device codes in MOBILE5 for reading I/M credit files, and thus may not be assigned by the user for any IOUNEW field. If an illegal or missing IOUNEW value is encountered, MOBILE5 will revert to the default value. The user is cautioned that IOUNEW values considered valid by MOBILE5 may not be appropriate for a given computer system, and should thus be changed in the source code before the program is compiled. The default values used in the mainframe version of MOBILE5 are:

IOUREP = 7  
 IOUERR = 7  
 IOUASK = 6

### 2.1.2.3 Changes Since MOBILE4.1

There have been no revisions to IOUNEW since the release of MOBILE4.1.

## 2.1.3 **PROJID**

### 2.1.3.1 Description

MOBILE5 provides an 80-character alphanumeric field for the user to input a descriptive title for the MOBILE5 run.

### 2.1.3.2 Values/Action

The project title is an 80-column blank record. The user may use up to 80 characters for the title. The character string does not have to be left-justified. Whatever title is input by the user is echoed as the heading of the formatted reports section of the program output. If no title is desired, a blank record must be entered at this point in the input file.

### 2.1.3.3 Changes Since MOBILE4.1

There have been no revisions to this record, or how it is input to or used by the model, since the release of MOBILE4.1.

## 2.1.4 **TAMFLG**

### 2.1.4.1 Description

This flag provides the option of supplying tampering rates that differ from those included in the MOBILE5 code.

#### 2.1.4.2 Values/Action

This flag can be set to 1 or 2:

	<u>Value</u>	<u>Action</u>
	1	Use MOBILE5 default tampering rates
2		User supplies tampering rates for eight categories of tampering, for each of the four vehicle types affected by tampering (LDGV, LDGT1, LDGT2, HDGV)

The user-supplied tampering rate data, required if TAMFLG = 2, are placed in the One-time Data section. Section 2.2.1 discusses tampering rates as program input.

#### 2.1.4.3 Changes Since MOBILE5

There have been no revisions to TAMFLG since the release of MOBILE4.1.

### 2.1.5 SPDFLG

#### 2.1.5.1 Description

Exhaust and running loss emissions vary considerably with speed, and MOBILE5 requires that vehicle average speed be specified in the program input. This flag provides the option of specifying one speed for all eight vehicle types, or of specifying different speeds for each vehicle type. In both cases, the average speed(s) is(are) indicated on the Scenario data record. In addition, in MOBILE5 there are two values of SPDFLG that can be used to indicate that the user wishes to supply data on the distribution of trips by length (of time) for use in the estimation of running loss emission factors.

#### 2.1.5.2 Values/Action

This flag can be set to 1, 2, 3, or 4:

	<u>Value</u>	<u>Action</u>
	1	User supplies one value of average speed for all vehicle types
	2	User supplies eight values of average speed, one for each vehicle type
	3	User supplies one value of average speed for all vehicle types, <u>and</u> a set of trip length distribution records for use in calculating running loss emission factors for each scenario, in the Scenario data section
	4	User supplies one value of average speed for all vehicle types, <u>and</u> a single set of trip length distribution records for use in calculating running loss emission factors for all scenarios, in the One-time Data section

If the value of SPDFLG is 3 or 4, only a single speed input for all eight vehicle classes can be used (equivalent to SPDFLG = 1), and the user must supply information on the fraction of VMT that is accumulated in trips of different lengths. The alternate locality-specific VMT fractions by trip length may be placed in the One-time Data section, in which case those values will be used in all scenarios of the run (SPDFLG = 4), or in the Scenario section, in which case a separate set of values will be used for each scenario of the run (SPDFLG = 3). Sections 2.3.3 and 2.3.13 discuss speed and VMT fractions by trip length, respectively, as program input.

### 2.1.5.3 Changes Since MOBILE4.1

There have been no revisions to SPDFLG since the release of MOBILE4.1.

## 2.1.6 VMFLAG

### 2.1.6.1 Description

The setting of VMFLAG determines the vehicle miles traveled (VMT) mix (fraction of total VMT accumulated by vehicles of each of the eight types) that will be used in MOBILE5 to estimate the composite emission factor for a given scenario.

### 2.1.6.2 Values/Action

This flag can be set to 1, 2, or 3:

<u>Value</u>	<u>Action</u>
1	Use MOBILE5 VMT mix
2	User supplies a different VMT mix for each scenario
3	User supplies a single VMT mix for all scenarios

If VMFLAG = 2, the VMT mix input data are placed in the Scenario section. If VMFLAG = 3, the VMT mix input data are placed in the One-time Data section. Section 2.2.2 discusses VMT mix as input.

### 2.1.6.3 Changes Since MOBILE4.1

There have been no revisions to VMFLAG since the release of MOBILE4.1.

## 2.1.7 MYMRFG

### 2.1.7.1 Description

This flag controls the use of annual mileage accumulation rates by age and registration distributions by age. These parameters define the composition and travel characteristics of the fleet, and so affect the resulting emission factors.

### 2.1.7.2 Values/Action

This flag can be set to 1, 2, 3, or 4:

<u>Value</u>	<u>Action</u>
1	Use MOBILE5 (national average) annual mileage accumulation rates and registration distributions by age
2	User supplies annual mileage accumulation rates by age; use MOBILE5 registration distributions by age
3	User supplies registration distributions by age; use MOBILE5 annual mileage accumulation rates by age
4	User supplies both annual mileage accumulation rates and registration distributions by age

The input data required if MYMRFG = 2, 3, or 4 are placed in the One-time Data section. Section 2.2.3 discusses the input and use of annual mileage accumulation rates and registration distributions.

#### 2.1.7.3 Changes Since MOBILE4.1

There have been no revisions to MYMRFG since the release of MOBILE4.1.

### 2.1.8 NEWFLG

#### 2.1.8.1 Description

This flag provides the option of modifying the basic exhaust emission rates by model year. In MOBILE5, this flag also provides the user with several options for calculating projected (future year) emission factors. Additional information on these new options, which specify how the implementation of a new evaporative emission test procedure for gasoline-fueled vehicles is modeled and whether or not the new exhaust emission standards under the 1990 Clean Air Act Amendments are to be assumed in the modeling, is provided in section 2.2.4.2.

#### 2.1.8.2 Values/Action

This flag can be set to 1, 2, 3, 4, 5, or 6:

	<u>Value</u>	<u>Action</u>
	1	MOBILE5 basic exhaust emission rates are used
	2	User supplies one or more modifications to the MOBILE5 basic exhaust emission rates in the One-time Data section
	3	MOBILE5 basic exhaust emission rates are used, and user supplies information about the new evaporative emissions test procedure in the One-time Data section
	4	User supplies one or more modifications to the MOBILE5 basic exhaust emission rates, and information about the new evaporative emissions test procedure, in the One-time Data section
	5	MOBILE5 basic exhaust emission rates are used, and all new Clean Air Act requirements are disabled
	6	User supplies one or more modifications to the MOBILE5 basic exhaust emission rates in the One-time data section, and all new Clean Air Act requirements are disabled

The user-supplied modifications to the basic emission rates (required if NEWFLG = 2, 4, or 6) are placed in the One-time Data section. Section 2.2.4 discusses basic exhaust emission rates and their modification by the user. Additional information on user modification of the details of the new evaporative emission test procedure, and on the disabling of all new Clean Air Act requirements, is provided in section 2.2.4.2.

#### 2.1.8.3 Changes Since MOBILE4.1

Four new possible values (3, 4, 5, 6) of NEWFLG have been added in MOBILE5. In cases where NEWFLG = 1 or 2, this flag is unchanged in meaning or use since release of MOBILE4.1. The new features of specifying aspects of the new evaporative emission test procedure for gasoline-fueled vehicles and disabling all new Clean Air Act requirements are discussed in section 2.2.4.2.

## 2.1.9 **IMFLAG**

### 2.1.9.1 Description

This flag allows the option of having MOBILE5 include the emission benefits of operating (or planned) inspection and maintenance (I/M) program(s) on the emission factors.

### 2.1.9.2 Values/Action

This flag can be set to 1, 2, 3, 4, or 5:

<u>Value</u>	<u>Action</u>
1	No I/M program is assumed to be operating
2	User specifies a single I/M program and MOBILE5 models its impact on emissions
3	User specifies two I/M programs and MOBILE5 models their impact on emissions
4	User specifies a single I/M program (same as IMFLAG = 2), and beginning in 1994, emission credits based on assuming a specific I/M program (as discussed below) for Tier 1 vehicles override the user-specified program for LDGVs and LDGTs
5	User specifies two I/M programs (same as IMFLAG = 3), and beginning in 1994, emission credits based on assuming a specific I/M program (as discussed below) for Tier 1 vehicles override the user-specified programs for LDGVs and LDGTs

Values of 4 or 5 are used to control the exhaust emission estimates for Tier 1 vehicles (the effect of setting this flag to 4 or 5 on Tier 1 vehicle emissions is the same, so the choice between 4 and 5 depends on the intended I/M program for older cars). Values of 4 or 5 may be used for IMFLAG if the I/M program applied to Tier 1 vehicles meets the criteria discussed in section 1.3.6 and Appendix 2B for I/M testing of vehicles under the California low emission vehicle (LEV) program.

If values of 4 or 5 are used, this specific I/M program overrides the exhaust portion of any I/M program specified in the One-time Data section for model years that contain Tier 1 LDGVs and LDGTs. However, in order to receive credit for the evaporative emissions benefits of functional pressure and purge tests of the evaporative emission control system, these tests still must be specified in the One-time Data section (see sections 2.1.11 and 2.2.6).

The data specifying I/M program(s), required if IMFLAG = 2, 3, 4, or 5, are placed in the One-time Data section. Section 2.2.5 and Appendixes 2A and 2B discuss the specification of I/M program parameters and their use in MOBILE5.

### 2.1.9.3 Changes Since MOBILE4.1

The handling of complex I/M program designs, such as the addition of a transient I/M test (like the IM240), is now performed through the use of additional values for the IMFLAG. In MOBILE4.1, an IM240 transient I/M program was handled by the appending of additional values to the end of the I/M program descriptive record; this feature has been extensively revised, as noted here and in section 2.2.5.

## 2.1.10 **ALHFLG**

### 2.1.10.1 Description

This flag provides the ability to have MOBILE5 adjust some exhaust emission factors to account for certain conditions: air conditioning (A/C) usage, extra loading, trailer towing, and humidity. These additional

corrections apply only to exhaust emission factors (HC, CO, and NO<sub>x</sub>), and only to the light-duty gasoline-fueled vehicle types (LDGVs, LDGT1s, and LDGT2s), with the exception that the humidity correction affects only NO<sub>x</sub> emission factors and is also applied to motorcycle emissions.

#### 2.1.10.2 Values/Action

This flag can be set to 1, 2, or 3:

<u>Value</u>	<u>Action</u>
1	Do not apply these additional correction factors (no additional inputs required)
2	Apply one or more additional correction factors; six (6) additional input values required
3	Apply one or more additional correction factors; ten (10) additional input values required

The additional data required if ALHFLG = 2 or 3 are placed in the Scenario data section. The specific inputs required when ALHFLG = 2 or 3 are discussed in section 2.3.10.

#### 2.1.10.3 Changes Since MOBILE4.1

There have been no revisions to ALHFLG since the release of MOBILE4.1.

### 2.1.11 ATPFLG

#### 2.1.11.1 Description

This flag allows for the benefits of an operating anti-tampering program (ATP) to be included in the emission factor calculations. In MOBILE5, this flag is also used to indicate the use of functional purge and/or pressure tests of the evaporative emission control system as part of a periodic vehicle inspection/maintenance program.

#### 2.1.11.2 Values/Action

This flag can be set to 1, 2, 3, 4, 5, 6, 7, or 8:

<u>Value</u>	<u>Action</u>
1	No ATP is assumed
2	User specifies an ATP, and MOBILE5 accounts for its impact on emissions
3	User specifies functional pressure check of the evaporative emission control system and MOBILE5 accounts for its impact on emissions
4	User specifies functional purge check of the evaporative emission control system and MOBILE5 accounts for its impact on emissions
5	User specifies an ATP, and functional pressure check of the evaporative emission control system; and MOBILE5 accounts for their impact on emissions
6	User specifies an ATP, and functional purge check of the evaporative emission control system; and MOBILE5 accounts for their impact on emissions
7	User specifies functional pressure and purge checks of the evaporative emission control system, and MOBILE5 accounts for their impact on emissions
8	User specifies an ATP, and functional pressure and purge checks of the evaporative emission control system, and MOBILE5 accounts for their impact on emissions

The data specifying the characteristics of the ATP to be modeled (required when ATPFLG = 2, 5, 6, or 8), are placed in the One-time Data section. The data specifying the characteristics of the functional pressure check (required if ATPFLG = 3, 5, 7, or 8), or of the functional purge check (required if ATPFLG = 4, 6, 7, or 8), are also placed in the One-time Data section. Section 2.2.6.3.1 and Appendix 2A discuss user specification of ATPs. Sections 2.2.6.3.2 and 2.2.6.3.3 discusses user specification of functional pressure and purge checks of evaporative emission control systems.

### 2.1.11.3 Changes Since MOBILE4.1

This flag has been revised since the release of MOBILE4.1 to allow six additional values (3, 4, 5, 6, 7, 8). For ATPFLG = 1 or 2, this flag and the associated data input requirements (ATP descriptive record) are the same as in MOBILE4.1. The six additional possible values of ATPFLG allow for any combination of ATP, functional evaporative emission control system pressure check, and functional evaporative emission control system purge check to be specified. The pressure and/or purge checks were modeled by MOBILE4.1 based on the values of the last two (optional) flags on the I/M program descriptive record ; in MOBILE5, these functional evaporative emission control system checks are modeled based on the value of ATPFLG, and additional input information is required in the One-time Data section (section 2.2.6).

## 2.1.12 RLFLAG

### 2.1.12.1 Description

This flag controls whether and how MOBILE5 models refueling emissions (also referred to as Stage II emissions) from gasoline-fueled vehicles.

### 2.1.12.2 Values/Action

This flag can be set to 1, 2, 3, 4, or 5:

<u>Value</u>	<u>Action</u>
1	Use uncontrolled refueling emission rates for all gasoline-fueled vehicles and all model years
2	Model the impact of a Stage II ("at-the-pump") vapor recovery system (VRS) requirement on refueling emissions
3	Model the impact of an onboard VRS requirement on refueling emissions
4	Model the impact of both Stage II and onboard VRS requirements on refueling emissions
5	Zero-out refueling emissions completely (in this case, refueling emissions must be accounted for in the stationary source portion of SIP emission inventories)

The data describing the characteristics of either or both vapor recovery systems (required if RLFLAG = 2, 3, or 4) are placed in the One-time Data section. Refueling emissions and their modeling in MOBILE4.1 are discussed in section 2.2.7.

### 2.1.12.3 Changes Since MOBILE4.1

There have been no revisions to this flag since the release of MOBILE4.1.

### 2.1.13 LOCFLG

#### 2.1.13.1 Description

This flag controls the input by the user of the local area parameter (LAP) record. This record contains seven to ten fields: scenario name, fuel volatility class, minimum and maximum daily temperatures, "period 1" RVP, "period 2" RVP, "period 2" RVP start year, and optional values for OXYFLG, DSFLAG, and RFGFLG. The fuel volatility class, a version of which was a required part of the LAP record for MOBILE4 but not required in MOBILE4.1, is again a mandatory input for MOBILE5. It is required only for modeling of the effects of reformulated gasoline (RFG) on emissions. RFGFLG is a new flag in MOBILE5, indicating whether or not the use of reformulated gasoline is to be assumed in the modeling.

However, the format of the remainder of the LAP record is unchanged, so that a MOBILE4 or MOBILE4.1 LAP record will function as MOBILE5 input. The three optional "flag" values (OXYFLG, DSFLAG, and RFGFLG) are used to indicate whether the user is inputting data on an oxygenated fuels program, alternate diesel sales fractions by model year, and specifying the use of reformulated gasoline, respectively. These flags follow the "period 2" RVP start year, and in each case if missing are interpreted by MOBILE5 as indicating that none of these three types of data are included. Thus, a LAP record from a MOBILE4 or MOBILE4.1 input file will work in MOBILE5, although MOBILE5 has options that cannot be accessed by an unchanged MOBILE4/4.1 LAP record.

#### 2.1.13.2 Values/Action

This flag can be set to 1 or 2:

<u>Value</u>	<u>Action</u>
1	User enters a different LAP record for each scenario of the MOBILE5 run
2	User enters one LAP record to apply to all scenarios of the MOBILE5 run

If LOCFLG = 1, the LAP records are placed in the Scenario data section, with one LAP record required for each scenario being evaluated. If LOCFLG = 2, the single LAP record to be applied to all scenarios being evaluated is placed in the One-time Data section. The content of the LAP record is discussed in section 2.2.8, and the individual variables comprising the LAP record are discussed in sections 2.2.9 through 2.2.16. Table 2.2-10 provides a summary of and specifications for the LAP record in the MOBILE5 input stream.

#### 2.1.13.3 Changes Since MOBILE4.1

There have been no revisions to LOCFLG since the release of MOBILE4.1. Revisions to the content of the LAP record are discussed in sections 2.2.8 through 2.2.16.

### 2.1.14 TEMFLG

#### 2.1.14.1 Description

This flag controls the determination of temperatures to be used in the correction of the exhaust emission factors (HC, CO, and NO<sub>x</sub>), the hot soak and diurnal components of the evaporative HC emission factors, and the running loss and resting loss HC emission factors. All of these emissions are dependent on temperature.



#### 2.1.14.2 Values/Action

This flag can be set to 1 or 2:

<u>Value</u>	<u>Action</u>
1	MOBILE5 will determine the temperatures to be used in correcting emission factors on the basis of the input values of minimum and maximum daily temperature. The input value of ambient temperature will <u>not</u> be used in calculating temperature corrections to emissions if TEMFLG = 1; it will be overridden by specific values calculated individually for exhaust HC, CO, and NOx, hot soak evaporative HC, running loss HC, and resting loss HC.
2	The input value of ambient temperature will be used in calculating the temperature corrections to all exhaust emissions, hot soak evaporative emissions, and running and resting loss emissions. The input values of minimum and maximum daily temperature will still be used to calculate diurnal evaporative emissions.

If TEMFLG = 1, the temperatures used to correct exhaust, hot soak evaporative, and running loss and resting loss emissions are determined in a way that accounts for both the variation in emission levels with daily variation in temperature, and the distribution of travel (vehicle miles traveled (VMT)) over the course of a day. Thus the use of TEMFLG = 1 is generally recommended for daily emission inventory preparation and SIP-related modeling by the States.

For those areas modeling emission factors on an hourly basis, whether required for input to other air quality models (such as Urban Airshed) or for some other purpose, the use of TEMFLG = 2 will be more appropriate. When TEMFLG = 2, the input value of ambient temperature should be selected to represent conditions in the short time period (e.g., one hour) being modeled. This temperature will then be used to correct exhaust, hot soak evaporative, and running loss and resting loss emission factors. The input minimum and maximum temperatures are used only to calculate diurnal evaporative emissions when TEMFLG = 2.

The input of minimum/maximum temperatures is discussed in section 2.2.11. The input of ambient temperature is discussed in section 2.3.4. Additional guidance on the determination of appropriate values for use as temperature input to MOBILE5 when the model is being used for SIP-related emission inventory development and attainment planning is provided in "Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources," EPA-450/4-81-026d (revised), July 1992.

#### 2.1.14.3 Changes Since MOBILE4.1

There have been no revisions to TEMFLG since the release of MOBILE4.1.

Table 2.1-1 summarizes the flags controlling the input requirements and execution of MOBILE5.

### 2.1.15 OUTFMT

#### 2.1.15.1 Description

This flag controls the format structure of the formatted output report. Different formats are appropriate depending on the intended use of the MOBILE5 output.

### 2.1.15.2 Values/Action

This flag can be set to 1, 2, 3, 4, 5, or 6:

<u>Value</u>	<u>Action</u>
1	222-column numerical format
2	140-column numerical format
3	112-column descriptive format
4	80-column descriptive format
5	By-Model Year output (table of emission factors for vehicles of each model year provided, along with standard 112-column descriptive format)
6	"Spreadsheet" output format

The numerical formats (OUTFMT = 1 or 2) are generally used when the MOBILE5 output file is to be used as input for another program (e.g., air quality simulations). The descriptive formats (OUTFMT = 3 or 4) contain all of the same information, with more complete labels and headings for ease of visual inspection. The by model year output option (OUTFMT = 5) starts with the 112-column descriptive output report produced when OUTFMT = 3, then provides additional tables containing emission factors by individual model year. If the by model year option is selected, the user must supply an additional line of input specifying exactly what information is to be included in the output. This additional record, called the by model year inclusion vector, is discussed in section 2.2.18. The spreadsheet format (OUTFMT = 6) is new in MOBILE5, and provides the user with output in a form that facilitates transfer of the emission factors to a spreadsheet program [e.g., Excel, Lotus 1-2-3 (version 3.0 or higher)] for further manipulation. The output is written in a comma-separated variable (CSV) format, with text indicated by quotation marks. Illustrative examples of output formats 4 and 5 are shown in Chapter 5 (MOBILE5 Examples). Examples of output formats 1, 2, and 3 are included on the MOBILE5 diskette (see section 5.1, "MOBILE5 Examples Index"). All possible output formats are described in Chapter 3.

If the by model year option is selected, additional input must be provided in the form of one additional record in the One-Time Data section. This additional record tells MOBILE5 which vehicle types the by-model year output is desired for, and is described in section 2.2.18 and Table 2.2-11.

### 2.1.15.3 Changes Since MOBILE4.1

The first five options for output format are exactly as they were in MOBILE4.1. The last option (OUTFMT = 6) provides the user the ability to obtain the formatted emission factors report in the form of a "spreadsheet." This option is intended to facilitate transfer of the output into a spreadsheet program for additional manipulation, and is described in section 3.3.1.

## 2.1.16 PRTFLG

### 2.1.16.1 Description

This flag determines which pollutants will have emission factor calculations performed, and thus will be included in the program output. This feature enables the user to avoid the time and expense of calculating all emission factors when the results for only one of the pollutants are all that is necessary for some applications.

### 2.1.16.2 Values/Action

This flag can be set to 1, 2, 3, or 4:

<u>Value</u>	<u>Action</u>
1	Calculate and print HC (hydrocarbon) emission factors only
2	Calculate and print CO (carbon monoxide) emission factors only
3	Calculate and print NOx (oxides of nitrogen) emission factors only
4	Calculate and output emission factors for all three pollutants

### 2.1.16.3 Changes Since MOBILE4.1

There have been no revisions to this flag since the release of MOBILE4.1. However, the program code has been modified so that if only CO (PRTFLG = 2) or only NOx (PRTFLG = 3) emission factors are requested, the subroutines that deal only with HC emissions (such as the calculation of evaporative, running loss, resting loss, and refueling emissions) will be bypassed in execution. This should result in shorter execution times for CO-only and NOx-only emission factor runs, relative to MOBILE4.1.

## 2.1.17 IDLFLG

### 2.1.17.1 Description

This flag controls the calculation and output of idle emission factors (emissions at idle in terms of mass pollutant per unit time (g/hr) for each pollutant).

### 2.1.17.2 Values/Action

This flag can be set to 1 or 2:

<u>Value</u>	<u>Action</u>
1	No idle emission factors calculated or printed (exhaust and evaporative emission factors only)
2	Idle emission factors calculated and printed (in addition to exhaust and evaporative emission factors)

### 2.1.17.3 Changes Since MOBILE4.1

Due to the complexity of modeling idle emissions, particularly with respect to the interactions with many of the new features of MOBILE5 (e.g., Tier 1 vehicles, LEV program, reformulated gasoline), this feature has been temporarily disabled in MOBILE5 (and MOBILE5a). This flag should be set to "1" when running MOBILE5/5a. Modelers requiring idle emission factors specifically should consult "MOBILE5 Information Sheet #2" (July 30, 1993), which is available through EPA's Technology Transfer Network (TTN) computer bulletin board system (see sections 4.2 and 6.0).

## 2.1.18 NMHFLG

### 2.1.18.1 Description

This flag determines which of five possible options for the hydrocarbon emissions factors will be used in the calculations: total hydrocarbons, including methane (THC); non-methane hydrocarbons, defined as THC minus methane (NMHC); volatile organic compounds, defined as NMHC minus ethane corrected for aldehydes (VOC); total organic gases, defined as THC corrected for aldehydes (TOG); or non-methane organic gases,

defined as NMHC corrected for non-hydrocarbon reactive compounds, i.e., formaldehyde and acetaldehyde (NMOG). These are summarized below:

<u>Option</u>	<u>Compounds included in the emission factors</u>			
	<u>FID HC</u>	<u>Methane</u>	<u>Ethane</u>	<u>Aldehydes</u>
THC	Yes	Yes	Yes	No
NMHC	Yes	No	Yes	No
VOC	Yes	No	No	Yes
TOG	Yes	Yes	Yes	Yes
NMOG	Yes	No	Yes	Yes

In the table above, "FID HC" refers to the hydrocarbon emissions as measured by the flame ionization detector (FID) used in testing. The FID detects a portion (but not all) of the aldehydes emitted by the vehicle. Thus the first two options above (THC and NMHC) actually account for a portion of aldehyde emissions; the other options include a correction for that portion of aldehyde emissions not registered by the FID. This is not a change or revision to the model; total HC and NMHC emission factors produced by all previous versions of the MOBILE model included the portion of aldehyde emissions measured by the FID.

#### 2.1.18.2 Values/Action

This flag can be set to 1, 2, 3, 4, or 5:

<u>Value</u>	<u>Action</u>
1	Total hydrocarbon (THC) emission factors
2	Non-methane hydrocarbon (NMHC) emission factors
3	Volatile organic compound (VOC) emission factors
4	Total organic gases (TOG) emission factors
5	Non-methane organic gasses (NMOG) emission factors

For guidance on the most appropriate choice for the preparation of base year emission inventories, see "Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources," EPA-450/4-81-026d (revised), July 1992. The use of the VOC option for hydrocarbon emission factors is normally used by air quality modelers and in SIP-related applications of MOBILE5.

#### 2.1.18.3 Changes Since MOBILE4.1

There have been no revisions to this flag since the release of MOBILE4.1.

### 2.1.19 HCFLAG

#### 2.1.19.1 Description

This flag determines whether the HC emission factors displayed in the output will include only the sum of all components of HC emissions (whichever composition option for these emissions is selected using NMHFLG) or will also include the various component emission factors (exhaust, evaporative, refueling, running loss, resting loss, and total HC emissions). This flag also allows the user to select an expanded printout of the various components of "evaporative" (non-tailpipe) HC emissions.

### 2.1.19.2 Values/Action

This flag can be set to 1, 2, or 3:

<u>Value</u>	<u>Action</u>
1	No component emission factor output (print only the emission factor for the sum of all HC components in grams per mile)
2	Print sum and component (exhaust, evaporative, refueling, running loss, and resting loss HC) emission factors in grams per mile
3	Print sum and component (exhaust, evaporative, refueling, running loss, and resting loss HC) emission factors in grams per mile, and a detailed evaporative emission factor breakdown in grams. The emission factor for the sum of all HC components will <u>not</u> include refueling emissions (it will be the sum of exhaust, evaporative, running loss, and resting loss emissions)

When the detailed evaporative emission breakdown is requested (HCFLAG = 3), the units of the component emission factors are: grams per vehicle per event (trip end) for hot soak evaporative emissions, grams per vehicle per day (period of rising ambient temperature without trips) for diurnal evaporative emissions, grams per gallon of fuel dispensed for refueling emissions, and grams per vehicle per hour for resting losses. Running loss emission factors, which are only expressed in grams per mile, are not repeated in the expanded evaporative emission portion of the output.

### 2.1.19.3 Changes Since MOBILE4.1

There have been no revisions to this flag since the release of MOBILE4.1.

Table 2.1-2 summarizes the flags controlling the output of MOBILE5.

## 2.1.20 Inter-Flag Dependencies

### 2.1.20.1 Description

There are cases where the value assigned to one flag in the Control section either determines the value that must be assigned to another flag, or precludes the use of one or more possible values for another flag. Certain combinations of flag settings also impose requirements on other inputs in either the One-time Data or Scenario sections. While careful consideration of the input file prepared for a MOBILE5 run makes such situations clear, a short listing is provided here for the convenience of the user.

### 2.1.20.2 List of Inter-Flag Dependencies

- 2.1.20.2.1 If TAMFLG = 2 (user-supplied tampering rates) and IMFLAG = 1 (no I/M program assumed), supply only one set of alternate tampering rates (non-I/M rates).
- 2.1.20.2.2 If TAMFLG = 2 and IMFLAG = 2, 3, 4, or 5 (specify and model I/M program(s)), two sets of alternate tampering rates must be supplied (non-I/M and I/M rates).
- 2.1.20.2.3 If the user has elected to input alternate diesel sales fractions by model year for LDVs and LDTs, then LOCFLG = 1 (a separate LAP record to be entered for each scenario) is mandatory.
- 2.1.20.2.4 If the user has set PRTFLG = 2 or 3 (CO emission factors only or NOx emission factors only), then the values assigned to NMHFLG and HCFLAG will have no effect.
- 2.1.20.2.5 If the user has set NEWFLG = 2, 4, or 6 (user supplies alternate basic emission rate equations), then idle emissions will not be calculated regardless of the value of IDLFLG.
- 2.1.20.2.6 If the user has set HCFLAG = 3 (include expanded evaporative emission factor output table), then the output formats 3 or 5 must also be selected. If HCFLAG = 3 and OUTFMT = 1, 2, 4, or 6, a warning message will be issued and the expanded evaporative emission factor table will not be included in the output.
- 2.1.20.2.7 If the user has set DSFLAG = 2 (user supplies alternate diesel sales fractions for light-duty vehicles and light-duty trucks by model year), then LOCFLG = 1 (separate local area parameter record for each scenario) must also be selected. See section 2.2.10.
- 2.1.20.2.8 If the user has selected OUTFMT = 5 (requesting by model year output), then the month of evaluation must be January (month = 1 on required scenario record, section 2.3.6). By model year output is not available for July 1 evaluation dates.

This concludes the Control data section.

## 2.2 ONE-TIME DATA SECTION

As suggested by its name, the One-Time Data section contains information which is input only once in a given MOBILE5 input file. This input information is used to alter MOBILE5 internal data to reflect alternate (i.e., locality-specific) data when such information is available for use. For example, a user can incorporate annual mileage accumulation rates and/or registration distributions by age that are specific to the area of concern. These records are all optional, their use being dictated by the values of some of the flags in the Control section. Thus, it is possible to run MOBILE5 without any "one-time data" being included in the input. If any of these records are included in the input, they follow immediately after the Control section and appear in the order in which they are listed below.

It is possible for the user to include comments or other descriptive information outside of the required MOBILE5 input parameters, in order to aid in documenting and interpreting MOBILE5 input files. This is illustrated in the example input files included in Chapter 5 and on the program diskette. Such comments on the Local Area Parameter input record must not begin before (to the left of) column 53. Comments on scenario section input records must not begin until at least 15 columns after (to the right of) the last input variable. These restrictions are necessary to avoid generating error messages that will occur as a result of internal diagnostic checks that use these spaces.

One-time Data must be included in the input whenever one or more of the following MOBILE5 options are selected:

1. The user supplies alternate tampering rates (TAMFLG = 2).
2. The user supplies one alternate VMT mix to be applied to all emission factor calculations (VMFLAG = 3).
3. The user supplies alternate annual mileage accumulation rates and/or registration distributions by age (MYMRFG = 2, 3, or 4).
4. The user modifies the basic exhaust emission rates used in the emission factor calculations (NEWFLG = 2, 4, or 6).
5. The user modifies the start year and/or the phase-in period for the new evaporative emission test procedure (NEWFLG = 3 or 4).
6. The user includes the effects of one (or two) inspection/maintenance program(s) in the emission factor calculations (IMFLAG = 2, 3, 4, or 5).
7. The user includes the effects of an anti-tampering program in the emission factor calculations (ATPFLG = 2, 5, 6, or 8).
8. The user includes the effects of functional pressure and/or purge checks of the evaporative emission control system in the emission factor calculations (ATPFLG = 3, 4, 5, 6, 7, or 8).
9. The user includes the effects of Stage II and/or onboard vapor recovery systems on refueling emissions in the emission factor calculations (RLFLAG = 2, 3, or 4).
10. The user applies the same local area parameter (LAP) record input values to all scenarios in the MOBILE5 run (LOCFLG = 2).

11. The user supplies one alternate set of trip length distributions to be used in the calculation of running loss emissions for all scenarios (SPDFLG = 4).

Data in the One-time Data section are listed in the same order as the associated flags in the Control data section. The ordering of data in the One-time Data section is summarized in Table 2.4-1 at the end of this chapter.

## 2.2.1 **TAMPERING RATES**

### 2.2.1.1 Description

MOBILE5 calculates tampering rates as a piecewise linear function of accumulated mileage for each gasoline-fueled vehicle type (LDGV, LDGT1, LDGT2, and HDGV) and for eight types of tampering [air pump disablement, catalyst removal, overall misfueling, fuel inlet restrictor disablement, exhaust gas recirculation (EGR) system disablement, evaporative control system disablement, positive crankcase ventilation (PCV) system disablement, and missing gas caps]. These rates are combined with the corresponding fractions of vehicles equipped with the given control technology and the emissions impact rates to obtain the tampering offsets (the increase in emissions that results from the given type of tampering at the given rate). These offsets are later added to the non-tampered emission factors.

### 2.2.1.2 Options

MOBILE5 uses tampering rates based on OMS analysis of multi-city tampering survey results, if no alternate (e.g., locality-specific) rates are supplied as input (TAMFLG = 1). The use of the rates included in MOBILE5 is recommended for most situations.

MOBILE5 provides the user the option of specifying alternate tampering rates as part of the program input (by setting TAMFLG = 2). EPA has determined through its tampering surveys that tampering rates are lower in areas with operating inspection and maintenance (I/M) programs than in areas without such programs. Thus, if TAMFLG = 2 and IMFLAG = 1, the user must supply one set of alternate tampering rates (representing the rates for an area where no I/M program is in effect). If TAMFLG = 2 and IMFLAG = 2, 3, 4, or 5, the user must supply two sets of alternate tampering rates (representing both the non-I/M and I/M cases). The non-I/M rates are used to account for tampering that occurs before the I/M program is in operation.

Before approving the use of alternate tampering rates in the development of base-year highway vehicle emission factors and mobile source emission inventories for State Implementation Plans (SIPs), EPA must review and approve of the tampering survey(s) on which such rates are based.

### 2.2.1.3 MOBILE5 Tampering Rates

MOBILE5 uses three or six rate equations for each type of tampering stored within the model, for each of the vehicle types subject to tampering (one each for pre-1981 model year vehicles, for 1981-83 model year vehicles, and for 1984 and later model year vehicles; for either the non-I/M case only, or for both the non-I/M and I/M cases). These rate equations are based on OMS analysis of national tampering survey data.

### 2.2.1.4 Required Information

The following information is required for input of alternate tampering rates: For each combination of vehicle model year group (pre-1981, 1981-83, 1984 and later model year), tampering type, and non-I/M or I/M case, the user must supply a zero-mile level (ZML) and deterioration rate (DR; the rate of increase in the tampering rate per 10,000 miles accumulated mileage). This deterioration rate defines the increase in tampering over the first 50,000 accumulated miles. MOBILE5 adjusts these deterioration rates internally to account for the rate of increase



in tampering at mileages greater than 50,000 mi. All tampering rates are assumed to stop increasing after 130,000 accumulated miles. All input values must be in fractional units.

The order of the tampering types within each record is:

- 1) air pump disablement
- 2) catalyst removal
- 3) fuel inlet restrictor disablement
- 4) overall misfueling
- 5) EGR system disablement
- 6) evaporative control system disablement
- 7) PCV system disablement
- 8) missing gas caps.

A complete set of alternate tampering rate input data for the non-I/M case consists of a total of 24 records, and a complete set of inputs for both the non-I/M and I/M cases consists of 48 records. There are six records for each of the four gasoline-fueled vehicle types for each case (non-I/M, I/M). The six records required for each vehicle type are listed below. Each record listed occurs four times (once each for LDGVs, LDGT1s, LDGT2s, and HDGVs, in that order). Table 2.2-1 summarizes the complete alternate tampering rate input for both cases.

<u>Non-I/M Case Records</u>	<u>Non-I/M and I/M Records</u>	<u>Description</u>	<u>Format</u>
(1-4)	(1-4)	ZML for pre-1981 MY vehicles	(non-I/M) 8F8.4
(5-8)	(5-8)	ZML for 1981-83 MY vehicles	(non-I/M) 8F8.4
(9-12)	(9-12)	ZML for 1984+ MY vehicles	(non-I/M) 8F8.4
	(13-16)	ZML for pre-1981 MY vehicles	(I/M) 8F8.4
	(17-20)	ZML for 1981-83 MY vehicles	(I/M) 8F8.4
	(21-24)	ZML for 1984+ MY vehicles	(I/M) 8F8.4
(13-16)	(25-28)	DR for pre-1981 MY vehicles	(non-I/M) 8F8.4
(17-20)	(29-32)	DR for 1981-83 MY vehicles	(non-I/M) 8F8.4
(21-24)	(33-36)	DR for 1984+ MY vehicles	(non-I/M) 8F8.4
	(37-40)	DR for pre-1981 MY vehicles	(I/M) 8F8.4
	(41-44)	DR for 1981-83 MY vehicles	(I/M) 8F8.4
	(45-48)	DR for 1984+ MY vehicles	(I/M) 8F8.4

#### 2.2.1.5 Changes Since MOBILE4.1

The input of alternate tampering rates has not been revised since the release of MOBILE4.1.

#### 2.2.1.6 Guidance

The tampering rates built into MOBILE5 are the rates that should be used in all Clean Air Act (CAA) mandated development of mobile source emission inventories, including the base and projection year inventories required to be submitted as part of SIPs. Use of any other tampering rates in such work must be based on actual surveys of in-use tampering, and the surveys must be approved in advance by EPA. For guidance regarding EPA approval of local tampering surveys, contact the Office of Mobile Sources' Field Operations and Support Division (202/233-9000). For guidance on analysis of the data collected in a local tampering survey, contact OMS' Emission Planning and Strategies Division (313/668-4325).

## 2.2.2 VEHICLE MILES TRAVELED MIX by vehicle type

### 2.2.2.1 Description

The vehicle miles traveled (VMT) mix specifies the fraction of total highway VMT that is accumulated by each of the eight vehicle types. The VMT mix is used in MOBILE5 only to calculate the composite (all vehicle, or fleetwide) emission factor for a given scenario on the basis of the eight vehicle class-specific emission factors.

### 2.2.2.2 Options

The user can choose between the use of the MOBILE5 national VMT mix (VMFLAG = 1), the input of one alternate VMT mix (in One-time Data) for use in all scenarios of a given MOBILE5 run (VMFLAG = 3), or the input of a different alternate VMT mix (in Scenario data) for each scenario (VMFLAG = 2).

For SIP highway vehicle emission inventory development, EPA generally expects States to develop and use their own specific estimates of VMT by vehicle type. In such cases, VMT fractions based on those estimates of VMT by vehicle type should be calculated and used here as input. A VMT mix used as input should reflect the year for which emission factors are being calculated.

### 2.2.2.3 MOBILE5 VMT Mix

MOBILE5 calculates a typical urban area VMT mix based on national data characterizing registration distributions and annual mileage accumulation rates by age for each vehicle type, diesel sales fractions by model year (for LDVs and LDTs only), total HDDV registrations and annual mileage accumulations by weight class, the fraction of travel by each vehicle type that is typical of urban areas, and total vehicle counts (fleet size) by vehicle type. Considering the dependence of the calculated VMT mix on the annual mileage accumulation rates and registration distributions by age, the use of the MOBILE5 VMT mix is generally recommended in cases where the focus is on direct comparison of national or area-wide emission factors under different assumptions.

As noted above, for SIP highway vehicle emission inventory development, EPA expects that States will generally develop and apply their own estimates of VMT by vehicle type for specific highway facility types, sub-zones, times of day, and so on. The use of an alternate VMT mix can result in minor inconsistencies; for example, assumptions that are used in the emission factor calculations concerning the gas/diesel LDV sales fractions are not altered through the use of different VMT fractions for LDGVs and LDDVs. In part for this reason, MOBILE5 has the added capability for the user to also supply an alternate set of gas/diesel LDV and LDT sales fractions by model year, as discussed in section 2.3.12.

However, such inconsistencies will not significantly affect emission inventory construction unless the inventory is based only on the fleetwide composite emission factor and total mobile source VMT. Inventory construction based on vehicle-type-specific emission factors and VMT estimates, as EPA expects of States for SIP-related inventory development, will not use the composite fleetwide emission factor.

### 2.2.2.4 Required Information

Each VMT mix supplied as input must consist of a set of eight fractional values, representing the fraction of total highway VMT accumulated by each of the eight vehicle types. All values must be between zero and one ( $0.0 \leq \text{VMT fraction for any vehicle type} \leq 1.0$ ), and the eight values must sum to 1.0 (MOBILE5 produces an error message and does not execute the run if these constraints are not met).

The format of the VMT mix record(s) is **8F4.3**. The values correspond to the eight vehicle types in this order: LDGV, LDGT1, LDGT2, HDGV, LDDV, LDDT, HDDV, and MC. An example of a VMT mix record specifying that 65% of all VMT is accumulated by LDGVs and that each of the other seven vehicle types

accounts for 5% of all VMT is shown below. Note that this format does not include leading zeroes or blanks between the individual values.

.650.050.050.050.050.050.050

#### 2.2.2.5 Changes Since MOBILE4.1

There have been no revisions to how an alternate VMT mix is supplied to the program as input data since the release of MOBILE4.1.

#### 2.2.2.6 Guidance

States are generally required to develop estimates of VMT by vehicle type for use in construction of highway vehicle emission inventories for CAA-mandated and SIP-related purposes. Given such estimates of VMT by vehicle type, and thus of total highway VMT, it is straightforward to calculate a VMT mix and that mix should be used as input in MOBILE5 runs. Techniques for calculating estimated VMT by vehicle type (and thus, total VMT and the VMT mix fractions) from available data sources are described in Chapter 6 of the report "Techniques for Estimating MOBILE2 Variables."

### **2.2.3. ANNUAL MILEAGE ACCUMULATION RATES and/or REGISTRATION DISTRIBUTIONS by vehicle type and age**

#### 2.2.3.1 Description

MOBILE5's emission factor calculations rely in part on travel fractions for vehicles of each given age and type, which in turn are based on estimates of the average annual mileage accumulation by age (first year to 25th-and-greater years of operation) for each of the eight vehicle types, and the registration distribution by age (age 0-1 to age 24-25+) for each vehicle type, except motorcycles, for which annual mileage accumulation rates and registration distributions are only provided for the first to 12th-and-later years of operation (ages 0-1 to 11-12+).

#### 2.2.3.2 Options

MOBILE5 uses national average annual mileage accumulation rates and registration distributions by age, and has provisions allowing the input of alternate data for either or both of these. The use of the annual mileage accumulation rates by age included in MOBILE5 is strongly recommended. Users may develop registration distributions by age on the basis of locality-specific data, and States are strongly encouraged to do so in developing highway vehicle emission inventories for SIP purposes.

#### 2.2.3.3 MOBILE5 Mileage Accumulation Rates and Registration Distributions

If the user does not provide alternate mileage accumulation rates and/or registration distributions by age, MOBILE5 uses national average values.

This information is used for all calendar years evaluated. The annual mileage accumulation rates are based on analyses of information developed over a long period of time, and the registration distributions are based on analysis of calendar year 1990 registration data. Due to the importance of this information in characterizing the in-use fleet, the need to avoid basing such information on data collected over a short period of time (thereby increasing the risk of reflecting atypical or cyclical use or sale patterns), and the inherent difficulty of developing accurate locality-specific data describing annual mileage accumulation rates by age, the use of the MOBILE5 annual mileage accumulation rates by age is recommended. The use of locality-specific data to derive

registration distributions by age is more appropriate for some applications, particularly those cases where such data reflect significant differences from the national average.

If local annual mileage accumulation rates or registration distributions are used, they normally should not change across calendar years. In particular, EPA will not accept modeling for SIPs that includes assumptions that the vehicle fleet will be newer (have a lower average age) in the future than is reflected in the registration distributions used for the base year emission factors and inventory development. Modeling that assumes no further aging of the fleet from the current characterization will be accepted by EPA for SIP purposes.

#### 2.2.3.4 Required Information

These records are required if MYMRFG is set to 2, 3, or 4 (section 2.1.7).

To use locality-specific annual mileage accumulation rates by age, a total of 200 input values are required: the estimated annual mileage accumulated by vehicles of each of the eight types for each of 25 ages (except 12 ages for motorcycles; use ".00000" as the annual mileage accumulation rate for motorcycles of ages 13 through 25). These values are input as miles divided by 100,000 (e.g., 12,637 miles is input as 0.12637).

To use locality-specific registration distributions by age, again a total of 200 input values are required. For each vehicle type, a set of 25 values (except 12 values for motorcycles; use ".000" as the registration distribution fraction for motorcycles of ages 13 through 25) are required to represent the fraction of all vehicles of the given type that are of a given age. These registration distributions should be based on July 1 of the year being modeled; MOBILE5 will use these distributions directly if July 1 emission factors are requested, or will convert them to January 1 distributions if January 1 emission factors are requested. (The choice of January 1 or July 1 emission factors is new in MOBILE5, and is discussed in section 2.3.6).

The sum of the registration distribution values for a given vehicle type must equal 1.0; if they do not, MOBILE5 normalizes the input values so that the sum for each vehicle type is equal to 1.0, and a warning message is issued for each occurrence. Any individual value in the registration distribution must be between zero and one. The same registration distribution by age must be entered for LDGVs and LDDVs, and for LDGT1s and LDDTs. MOBILE5 uses an internal function to separate these pairs of vehicle types into distinct gas and diesel distributions, based on diesel sales fractions by model year. The registration distributions entered for LDGVs and LDDVs, and for LDGT1s and LDDTs, should therefore be a combined gasoline and diesel distribution. (For information on user input of alternate diesel sales fractions by model year, see section 2.3.12.) If this constraint is not met, one or more error messages will be issued and the MOBILE5 run will not be executed.

In addition, in the case where the user supplies both annual mileage accumulation rates by age and registration distributions by age, the two sets of values must not contain internal inconsistencies. In other words, the annual mileage accumulation rate corresponding to any vehicle type/age combination accounting for a non-zero fraction of registrations must be positive (i.e., if vehicles of a certain type and age exist in the fleet, then they must accumulate some mileage), and the registration fraction corresponding to any vehicle type/age combination that has a non-zero mileage accumulation rate must be positive (i.e., if vehicles of a certain type and age are assumed to accumulate some mileage, then such vehicles must exist in the fleet). If these constraints are not met, MOBILE5 will generate one or more error messages and the run will not be executed.

The annual mileage accumulation rates are entered as 24 records, in sets of three records per vehicle type. The format of these records is (**10F7.5/**, **10F7.5/**, **5F7.5/**), repeated eight times. Registration distributions by age are also entered as 24 records, in sets of three records per vehicle type, format (**10F5.3/**, **10F5.3/**, **5F5.3/**). If both annual mileage accumulation rates and registration distributions are being supplied, the annual mileage accumulation rates precede the registration distributions [24 records, format

(10F7.5/, 10F7.5/, 5F7.5/) repeated eight times, followed by 24 records, format (10F5.3/, 10F5.3/, 5F5.3/) repeated eight times].

In both cases, the 24 records represent three records per vehicle type for each of eight vehicle types in this order: LDGV, LDGT1, LDGT2, HDGV, LDDV, LDDT, HDDV, and MC. Each of the three records per vehicle type contains the annual mileage accumulation rate by age, or the registration distribution by age, as follows:

First record -	age 1, age 2, age 3, . . . , age 10
Second record -	age 11, age 12, age 13, . . . , age 20
Third record -	age 21, age 22, age 23, age 24, age 25.

Table 2.2-2 summarizes the input of alternate annual mileage accumulation rates, and Table 2.2-3 summarizes the input of alternate registration distributions by age. An example of one set of annual mileage accumulation rates and one set of registration distributions, in this case displaying the values that are contained in the MOBILE5 code for light-duty gas vehicles, is shown below. Note that the format of this input allows either a leading zero or a separating blank between entries, but not both. The example shown uses separating blanks between entries, including a blank space before the first entry on each line.

```
.13118 .12408 .11737 .11103 .10503 .09935 .09398 .08889 .08409 .07954
.07524 .07117 .06733 .06369 .06024 .05698 .05390 .05099 .04823 .04562
.04316 .04082 .03862 .03653 .03455
<annual mileage accumulation rates for the other seven vehicle types
  must also be provided, following the LDGV annual mileage accumulation
  rates and preceding the registration distributions by age>
.049 .079 .083 .082 .084 .081 .077 .056 .050 .051
.050 .054 .047 .037 .024 .019 .014 .015 .011 .008
.006 .005 .004 .003 .010
<registration distributions by age for the other seven vehicle types
  must also be provided, following the LDGV distributions>
```

In the example above, LDGVs of age 1 constitute 4.9% of all LDGVs and average 13,118 miles annually, LDGVs of age 2 constitute 7.9% of the fleet and average 12,408 miles annually, and so on, with LDGVs of ages 25+ constituting 1.0% of the fleet and averaging 3455 miles annually.

#### 2.2.3.5 Changes Since MOBILE4.1

The input of alternate annual mileage accumulation rates and registration distributions by age has not been revised since the release of MOBILE4.1.

#### 2.2.3.6 Guidance

For most users in most applications, the use of the default annual mileage accumulation rates by age included in MOBILE5 is recommended. Most local sources of mileage accumulation rate by age data are subject to sampling bias or data entry errors, and the use of such data should be approached with caution. In the development of highway vehicle emission inventories for SIPs, States should obtain prior approval of alternate mileage accumulation rates and their derivation from the appropriate EPA Regional Office before using such rates in their modeling.

The use of locality-specific data to derive registration distributions by age is more appropriate for many applications, particularly those cases where such data reflect significant differences from the national average. In many situations, registration distributions by age may be developed from data available through State motor vehicle registration records. EPA encourages and recommends the use of actual locality-specific calendar year

1990 registration distributions by age in the development of SIP emission inventories. One exception to this would be areas having relatively few local HDDV registrations, but significant interstate trucking activity within the local area. Such areas may want to retain and use the MOBILE5 national registration distributions. EPA will issue additional guidance on how locality-specific calendar year 1990 registration distributions by age may be adjusted to reflect future years at a later date.

If local annual mileage accumulation rates or registration distributions are used, they normally should not change across calendar years. In particular, EPA will not accept SIP-related modeling that includes assumptions that the vehicle fleet will be newer (have a lower average age) in the future than is reflected in the registration distributions used for the base year emission factor modeling and inventory development. The use of registration distributions that indicates that the vehicle fleet is newer than that reflected in the MOBILE5 distributions will only be accepted if the area supplies adequate documentation to support this assumption. Modeling that assumes no further aging of the fleet from the current (base year) characterization will be accepted by EPA for SIP inventory purposes.

Methods for estimating the annual mileage accumulation rates by age and the registration distributions by vehicle type and age are presented in Chapters 2 and 3, respectively, of the report "Techniques for Estimating MOBILE2 Variables."

## **2.2.4 BASIC EMISSION RATES; NEW EVAPORATIVE EMISSIONS TEST PROCEDURE; DISABLING NEW CLEAN AIR ACT REQUIREMENTS**

### **2.2.4.1 Basic Emission Rates**

#### **2.2.4.1.1 Description**

The basic emission rates (BERs) in MOBILE5 are expressed in the form of linear equations, consisting of a zero-mile level (ZML), or y-intercept, and one or two deterioration rates (DR), or slopes (increase in emissions per 10,000 miles accumulated mileage). Basic emission rates entered by the user, for all vehicle types except heavy-duty vehicles (HDGV, HDDV), are in units of grams per mile (g/mi) for the ZMLs and g/mi per 10,000 miles (g/mi-10K mi) for the DRs. For HDGVs and HDDVs, the units are grams per brake horsepower-hour (g/BHP-hr) for the ZML and grams per brake horsepower-hour per 10,000 miles [(g/BHP-hr)-10K mi] for the DR. There are different BER equations in MOBILE5 for each vehicle type/pollutant/model year group, with the model year groups defined on the basis of applicable emission standards and emission control technologies used.

For light-duty gas vehicles (LDGVs) and for model years 1991 and later (MY 1991+) light-duty trucks (LDGTs), there are two deterioration rates in each BER equation. In each such BER equation, there one DR is applicable to mileage accumulated between zero and 50,000 miles, and a second (higher) DR is applicable to mileage accumulated beyond 50,000 miles. This feature is applicable only to LDGVs and MY 1991+ LDGTs.

#### **2.2.4.1.2 Options**

MOBILE5 provides the capability to input alternate BER equations (by setting NEWFLG = 2, 4, or 6). However, the BERs in MOBILE5 accurately reflect all promulgated emission standards as of August 1992, and no changes to these equations are warranted for use in developing emission factors or inventories for SIP purposes. The option of alternate BERs is intended for use only in the situation where new or revised emission standards are promulgated by EPA after release of MOBILE5.

#### **2.2.4.1.3 MOBILE5 Basic Emission Rates**

The BER equations in MOBILE5 are based on the applicable Federal emission standards and the emission control technologies characterizing the fleet in various model years (for example, different types of catalytic converters exhibit different rates of deterioration). These equations are applicable for all non-California areas, both low- and high-altitude, and should not be altered by the user without EPA guidance. Since the size of any I/M credits (emission reductions due to inspection and maintenance programs) are dependent on these basic emission rates, entering alternate BER equations may render any I/M credit calculations used with the new emission rates inappropriate, unless alternate I/M credits derived from the new BER equations are also utilized.

#### 2.2.4.1.4 Required Information

If alternate BER equations are to be used, the information that must be supplied includes: the number of alternate BER equations that are to be entered, the region (low- or high- altitude) to which the alternate BERs apply, the vehicle type(s) affected, the first and last model years for which the alternate equations apply, the ZML (g/mi), and the DR (g/mi per 10K mi). If the vehicle type affected is HDGV or HDDV, units of g/BHP-hr must be used for the ZML and units of (g/BHP-hr)/10K mi must be used for the DR, since MOBILE5 will convert g/BHP-hr rates to g/mi rates internally.

If the vehicle type affected is LDGVs or MY 1991+ LDGTs, two deterioration rates must be supplied. The first is used to calculate emissions deterioration through 50,000 accumulated miles, and the second (higher) rate is applied to accumulated mileage beyond 50,000 mi.

The new BER input consists of a set of N+1 records, where N is the number of new BERs (records) that follow the first record. The maximum number of new BERs permitted in a MOBILE5 run is 100. In addition, for each combination of region/vehicle type/pollutant, no more than 12 new BERs are permitted.

The first required record is the total number of new BER equations to be read, entered in **I3**/format. The following BER input records each specify the region, vehicle type, pollutant, model year coverage, zero-mile emission level, and deterioration rate(s). The format of these records is **(3(I1,1X), 2(I2,1X), 2(F6.3,1X), F6.3)**. The example below shows the input of a single alternate BER for low-altitude LDGT2 NO<sub>x</sub> emissions, applicable to model years 1981 through 1983:

```
001
1 3 3 81 83 01.120 00.070 00.070
```

Table 2.2-4 summarizes the format specifications, allowable ranges, and codes for these records.

#### 2.2.4.1.5 Changes Since MOBILE4.1

There have been no revisions to the content or format of user input alternate BERs since the release of MOBILE4.1.

#### 2.2.4.1.6 Guidance

No need exists for modification of the BERs in MOBILE5 in order to develop emission factors for any pollutant for any calendar year for SIP purposes. If the use of alternate BER equations in MOBILE5 is being contemplated, the Office of Mobile Sources (Air Quality Analysis Branch, 313/668-4325) should be contacted for additional guidance.

### 2.2.4.2 **New Evaporative Emissions Test Procedure; Disabling Clean Air Act Requirements**

There are two optional features that are new to MOBILE5 and are accessed through setting the value of NEWFLG, which also controls the input of alternate basic emission rate equations as discussed above. Since these new features are accessed through the value assigned to NEWFLG (and since any associated One-time Data appears after any alternate BER equations and before any I/M program descriptive records), these new features are discussed here.

#### 2.2.4.2.1 New Evaporative Emissions Test Procedure

At the time that MOBILE5 was being prepared a revised and more stringent evaporative emissions test procedure, as required by the 1990 Clean Air Act Amendments, had been proposed but had not yet been finalized. The new evaporative emissions test procedure was modeled by MOBILE5 on the basis of the proposal, which includes a four-year phase-in of the new requirements beginning in the 1995 model year. The phase-in schedule assumed in MOBILE5 is 10% in model year (MY) 1995 (i.e., 10% of vehicles built in MY 1995 must comply with the new test procedure), 30% in MY 1996, 50% in MY 1997, and 100% in MY 1998 and beyond. Since the start year, the phase-in schedule, or both were subject to change in the final rulemaking, MOBILE5 includes provisions for the user to override the start year and phase-in schedule with alternate information. This permits the impact of the new evaporative emissions test procedure to be accurately modeled using MOBILE5 if these parameters of the new procedure differed between the proposed and final rules.

**NOTE:** The revised evaporative emissions test procedure was finalized in February 1993. The start year (first model year of applicability) was delayed one year from the proposal, to the 1996 model year (MY). The phase-in schedule was also revised. The revised phase-in schedule included in the final rule assumes 20% compliance in MY 1996, 40% in MY 1997, 90% in MY 1998, and 100% in MY 1999 and beyond. This schedule is included in MOBILE5a (March 26, 1993). Users of MOBILE5 (December 4, 1992) should enter the final rule start year (MY 1996) and the phase-in schedule (10% in MY96, 40% in MY97, 90% in MY98, 100% in MY99+) as part of the input, following the instructions provided below. Users of MOBILE5a do not need to be concerned with altering the terms of the new evaporative emissions test procedure.

The user accesses this option by setting NEWFLG = 3 or 4 (section 2.1.8), depending on whether or not alternate BER equations are also being supplied by the user. To alter the modeling of the effects of the new evaporative emissions test procedure, the user must supply the start year (which must be MY 1995 or later) and the phase-in schedule (the phase-in period, which must be 1 to 4 years, and the percent of new vehicles that must comply with the new procedure in each model year of the phase-in period). This information must appear in the One-time data section, immediately following any alternate BERs (if used), and immediately preceding any I/M program descriptive records (if used).

This information consists of two to five records (lines) of input, and is summarized in Table 2.2-5. The first record is the number of years in the phase-in period, which also tells MOBILE5 how many additional records (lines) of input on the new evaporative emissions test procedure will follow. The format of this record is **I1/**. The second and subsequent records (lines) give the model year(s) and percentage compliance for each model year in the phase-in period. The format of each of these records is **I2,F5.0/**. An example, reflecting the start year (1996) and phase-in schedule (10% in MY 1996, 40% in MY 1997, 90% in MY 1998, and 100% in MY 1999) included in the final rule, is shown below:

```
4
96 10.0
97 40.0
98 90.0
99 100.
```

#### 2.2.4.2.2 Disabling New Clean Air Act Requirements



MOBILE5 has been updated to include all new vehicle and fuel requirements mandated by the 1990 Amendments to the Clean Air Act. These include Tier 1 tailpipe exhaust emission standards and the new evaporative emissions test procedure. For some modeling purposes, emission factors for future years in the absence of the requirements imposed by the 1990 CAA amendments may be needed. By setting NEWFLG = 5 or 6 (depending on whether or not alternate BER equations are also being used), the user can "disable" the effects of the Tier 1 tailpipe exhaust emission standards, the cold CO exhaust emission standards, the 4.0 g/bhp-hr NOx standard for heavy-duty vehicles starting in model year 1998, and the new evaporative emissions test procedure. Emission factors calculated with the new CAA requirements disabled will still include fleet turnover effects, and will still be based on the other information specified by the user. The use of this option does not require that any additional information be supplied in the One-time Data section.

## **2.2.5 INSPECTION AND MAINTENANCE PROGRAMS**

### 2.2.5.1 Description

Many areas of the country have implemented inspection and maintenance (I/M) programs as a means of further reducing mobile source air pollution. MOBILE5 has the capability of modeling the impact of one or two I/M programs on the calculated emission factors, based on user specification of certain parameters describing the program(s) to be modeled.

### 2.2.5.2 Options

The user has the option of assuming that no I/M program is in effect for any year (IMFLAG = 1), of modeling the effects of a single I/M program, or of modeling the effects of two I/M programs. The addition of the ability to model two I/M programs provides the ability to model situations such as a conventional program for some model years' vehicles and an enhanced I/M program (i.e., the IM240) for later model years' vehicles.

Standard low-altitude area emission reduction credits for conventional programs and standard high-altitude area emission credits are included as separate files on the MOBILE5 diskettes and tapes. These files must be available if I/M program options are to be used. See Chapter 4 for more details. The model is also capable of accepting alternate credit matrices developed by EPA as input data.

### 2.2.5.3 Required Information

If IMFLAG = 2, 3, 4, or 5, all of the following I/M program parameters must be specified by the user in the order shown. If two I/M programs are specified, then two I/M descriptive records must be included, each containing the information shown.

- Program start year (calendar year that program begins)
- Stringency level (percent)
- First (earliest) and last (latest) model years of vehicles subject to the requirements of the program
- Waiver rates (percent of failed vehicles; one rate for pre-model year 1981 vehicles and one rate for 1981 and later model year vehicles)
- Compliance rate (percent)
- Program type (inspection only; inspection and repair (computerized); or inspection and repair (manual))

- Frequency of inspection (annual or biennial)
- Whether or not each of four gasoline-fueled vehicle types (LDGV, LDGT1, LDGT2, HDGV) are covered
- Test type (idle, 2500/idle, loaded/idle, or transient test)
- Whether or not the user is specifying non-default cutpoints
- Whether or not the user is specifying alternate I/M credit files for each of two technology groups (Tech I-II and Tech IV+)
- Cutpoints for HC, CO, and NOx, for model year 1981 thru 1993 passenger cars (LDGVs)

The format of this record is:

**4(I2,1X),2(F2.0,1X),F3.0,1X,2(I1,1X),4I1,1X,4I1,3(1X,F4.2)**

The I/M program descriptive record(s) required if IMFLAG = 2 or 3 are summarized in Table 2.2-6, including the codes and allowable values for each field of the record. Appendix 2A provides more information on I/M programs and terminology. Appendix 2B discusses the modeling of I/M programs applicable to California low emission vehicle (LEV) program vehicles.

#### 2.2.5.4 Changes Since MOBILE4.1

The I/M program descriptive record has been revised since the release of MOBILE4.1 to provide the user with the option of specifying two I/M programs, the option of providing cutpoints to be used in the calculation of emission reduction credits attributable to the I/M program(s), and to specify the alternate I/M credit file name(s) as part of the MOBILE5 input file.

In the list above, there are no revisions to the first eight items specified [through and including specifying which of the four gasoline-fueled vehicle types are subject to the requirements of the program(s)]. "Test type" has been expanded to include a fourth test type, transient I/M testing (such as the IM240). The next integer input after test type specifies whether cutpoints are being supplied by the user (later in the descriptive record); this flag may be set to 1 only if the standard cutpoints are to be assumed for the idle, 2500/idle, or loaded idle tests, and should be set to 2 if the user is specifying alternate cutpoints. The user must specify the cutpoints to be used if the transient IM240 test procedure is chosen. The option to assume standard cutpoints was offered to allow compatibility with old MOBILE4.1 input files. Users are encouraged to always specify the cutpoints to be used for all I/M test types. See Appendix 2A for a discussion of how to select I/M cutpoints for MOBILE5.

The next two integers indicate whether or not the user is supplying alternate I/M credit file names as input to the model. As in MOBILE4.1, the first integer applies to Tech I-II vehicles and the second to Tech IV+ vehicles, with "1" indicating use of the default credits and "2" indicating that an alternate credit file is to be used, for each technology group. The use of alternate I/M credit files can only be indicated in the first I/M program descriptive record. These flags will be ignored in the second descriptive record.

MOBILE5 now always reads all I/M credits from a separate data file supplied with the model. This data file contains a standard set of all low- and high-altitude emission reduction credits for all test types. These credits are accessed by MOBILE5 using default file names. High-altitude areas now do not normally need to set the flags to read alternate credits, since default high-altitude area I/M credits are contained in the default I/M credit file.

Entry of the I/M test cutpoints follow the last four integer inputs discussed (test type, supply alternate cutpoints, supply alternate credit file for Tech I-II vehicles, supply alternate credit file for Tech IV+ vehicles). The

default cutpoints included in MOBILE5 are 220 for HC, 1.2 for CO, and 999. for NOx (in the default case, NOx emissions have no cutpoint assigned and are not tested). These cutpoints only apply to idle, 2500/idle, and loaded idle tests procedures. If the user specifies the transient IM240 test procedure, then the user must specify the cutpoints to be used. If cutpoints are to be supplied, they follow in **F4.2** format, separated by single blank spaces. This format allows any four-digit number to be entered, provided that one of the four digits is a decimal point. For example: 0.80, .400, 999., and 20.0 are all valid entries for cutpoint values. (See section 2.0.1 for a description of FORTRAN format specifications.)

In previous versions of the model, when the user specified that alternate credit file(s) are to be read for Tech I-II and/or Tech IV+ vehicles, that credit file had to be called M4IMC and was required to be available in the local directory. Normally, MOBILE5 always reads I/M credits from two files named **TECH12.D** and **IMDATA.D**. However, if the user wishes to supply alternate file names and sets the appropriate flags in the first I/M program descriptive record, the alternate credit file names immediately follow the I/M program descriptive record(s) in the input file. If there are two I/M programs specified, the credit file names follow the second I/M descriptive record. This option can also be used to access the standard I/M credit files when they are stored in a location in the computer other than the current (active) directory. This is accomplished by specifying a path, such as **C:\DATA\IMDATA.D**, to the default file names to indicate where the I/M credit files are stored. The flags calling for alternate I/M credit file names can only be set using the first I/M program descriptive record. Setting these flags in the second I/M program descriptive record will have no effect, since the model ignores these inputs. These revisions are illustrated in the example below, which includes all of the options available to the user:

```
89 20 84 20 00 00 100 2 1 2222 1122
96 20 86 20 00 00 100 1 2 2111 4211 0.80 15.0 2.00
C:\DATA\TECH12.D
C:\DATA\IMDATA.D
```

The first I/M program (first line above) starts in 1989 (89), has a stringency level of 20% (20), 1984 model year is the first model year tested (84), 2020 is the latest model year tested (20), the waiver rate for pre-1981 vehicles is 0% (00), the waiver rate for 1981 and later vehicles is 0% (00), the compliance rate is 100% (100), the program type is test and repair (computerized) (2), the frequency of inspections is annual (1), all gasoline-fueled vehicle types (LDGV, LDGT1, LDGT2, HDGV) are subject to inspection (2222), the test type is idle test (the first 1 in 1122), alternate cutpoints are not supplied (the second 1 in 1122), an alternate credit file for Tech I-II vehicles is supplied (the first 2 in 1122), and an alternate credit file for Tech IV+ vehicles is supplied (the second 2 in 1122).

The second I/M program (second line above) starts in 1996 (96), has a stringency level of 20% (20), 1986 is the first model year tested (86), 2020 is the latest model year tested (20), the waiver rates are 0% for both pre-1981 and 1981-and-later vehicles (00 00), the compliance rate is 100% (100), the program type is centralized (1), the inspection frequency is biennial (2), only LDGVs (of the four gasoline-fueled vehicle types) are subject to inspection (2111), the test type is transient test (the 4 in 4211), and alternate cutpoints are supplied (the 2 in 4211). The flags to indicate alternate credit files for Tech I-II or Tech IV+ vehicles (the 11 in 4211) do not have any effect when set in the second I/M program descriptive record. Only the first I/M program descriptive record can call for alternative I/M credit file names. The values of the cutpoints to be assumed then follow: 0.80 for HC, 15.0 for CO, and 2.0 for NOx.

The next two lines are the file names of the alternate credit files to be read by the program, with the first (TECH12.D) applying to Tech I-II vehicles and the second (IMDATA.D) to Tech IV+ vehicles. The entry also indicates that the files are currently being stored in the DATA directory on drive C:\ of the computer.

#### 2.2.5.5 Guidance

Additional information on the modeling of I/M program benefits in MOBILE5 is provided in Appendixes 2A and 2B to this chapter. As detailed in Appendix 2B, if the modeler is including the California LEV program and assuming that an I/M program meeting the criteria discussed in detail in Appendix 2B for such vehicles, the cutpoints (0.6/10/1.2) should **not** be entered as part of the I/M program descriptive record. The cutpoints entered on the I/M descriptive record are applicable to pre-Tier 1 vehicles (model years 1981-1993 for LDGVs). The cutpoints for Federal Tier 1 vehicles and for California LEV program vehicles are determined by the model on the basis of (i) the cutpoints entered for MY 1981-93 vehicles and (ii) the values assigned to the REGION variable on the Scenario data record (see sections 2.3.1) and the I/M program variable on the LEV program record (see section 2.3.7). Modelers including the California LEV program in the emission factor calculations should read Appendix 2B closely.

For cases where the emission reduction credit matrices included with MOBILE5 (shown in Table 1.3-1 in Chapter 1) are inappropriate for the I/M program(s) being modeled, contact the Office of Mobile Sources (313/668-4325) to obtain the required credit matrices.

## **2.2.6 ANTI-TAMPERING PROGRAMS**

### 2.2.6.1 Description

Some areas of the country have implemented anti-tampering programs (ATPs) to reduce the frequency and resulting emission impact of emission control tampering (e.g., misfueling, removal or disablement of catalytic converters). MOBILE5 allows the user to include the effects of such a program on the calculated emission factors.

### 2.2.6.2 Options

You can choose to model the effects of an ATP on the emission factors, or to assume that no ATP is in effect. The information required of the user if the effects of an ATP on the emission factors is to be modeled is discussed below. MOBILE5 contains a subroutine that will generate the applicable emission factor credit matrices based on the information that is provided on the characteristics of the ATP.

In addition, the modeling of the effects of requiring functional pressure or purge tests of the vehicle evaporative emission control system are now accessed through the values of ATPFLG. The user has the ability to model any combination of conventional anti-tampering programs, functional pressure tests of evaporative emission control systems, and functional purge tests of evaporative emission control systems. (These features were accessed in MOBILE4.1 by appending additional information to the I/M program descriptive record, in the same way that transient (IM240) I/M tests were modeled.)

### 2.2.6.3 Required Information

#### 2.2.6.3.1 ATP Information

The following must be specified by the user in order to have MOBILE5 model the effects of an ATP, in the order shown:

- Start year (calendar year in which the program begins)
- First (earliest) and last (most recent) model years of vehicles subject to the requirements of the program
- Whether or not each of four possible vehicle types (LDGV, LDGT1, LDGT2, HDGV) are covered by the program

- Program type (inspection only or inspection and repair)
- Frequency of inspection (annual or biennial)
- Compliance rate (percent)
- Inspections performed (air system, catalyst, fuel inlet restrictor, tailpipe lead deposit test, EGR system, evaporative system, PCV, gas cap)

The format of this record is:

**3(I2,1X),4I1,1X,2I1,1X,F4.0,1X,8I1**

The ATP descriptive input record, required if ATPFLG = 2, 5, 6, or 8, is summarized in Table 2.2-7, including the variable names, codes, and allowable values for each field of the record. See Appendix 2A for more information on anti-tampering programs and terminology.

#### 2.2.6.3.2 Functional Pressure Test Information

The following must be specified by the user in order to have MOBILE5 model the effects of a functional pressure test of vehicle evaporative emission control systems, in the order shown:

- Start year (calendar year in which the program begins)
- First (earliest) and last (most recent) model years of vehicles subject to the program
- Whether or not each of four gasoline-fueled vehicle types (LDGV, LDGT1, LDGT2, HDGV) are covered by the program
- Program type (inspection only or inspection and repair)
- Frequency of inspection (annual or biennial)
- Compliance rate (percent)

The format of this record is:

**3(I2,1X),4I1,1X,2I1,1X,F4.0**

Note that the format of this record and the information it contains is exactly like the ATP descriptive record, except that the final inclusion vector (eight integer values representing inspections performed) is not required.

The functional pressure test input record (required if ATPFLG = 3, 5, 7, or 8), including the variable names, codes, and allowable values for each field of the record, is summarized in Table 2.2-8. See Appendix 2A for more information.

#### 2.2.6.3.3 Functional Purge Test Information

-

The following must be specified by the user in order to have MOBILE5 model the effects of a functional purge test of vehicle evaporative emission control systems, in the order shown:

- Start year (calendar year in which the program begins)
- First (earliest) and last (most recent) model years of vehicles subject to the program
- Whether or not each of four gasoline-fueled vehicle types (LDGV, LDGT1, LDGT2, HDGV) are covered by the program
- Program type (inspection only or inspection and repair)
- Frequency of inspection (annual or biennial)
- Compliance rate (percent)

The format of this record is:

**3(I2,1X),4I1,1X,2I1,1X,F4.0**

Note that the format of this record and the information it contains is exactly like the ATP descriptive record, except that the final inclusion vector (inspections performed, eight integer values) is not required.

The functional purge test input record (required if ATPFLG = 4, 6, 7, or 8), including the variable names, codes, and allowable values for each field of the record, is summarized in Table 2.2-8. See Appendix 2A for more information.

#### 2.2.6.3.4 Order of Input Records

These records, if used, appear in the One-time Data section. They appear in the location reserved for the ATP descriptive record in MOBILE4.1 (immediately after any I/M program descriptive records, if used, and immediately preceding any refueling vapor recovery system input records, if used). The order is ATP record (if used) first, followed by functional pressure test record (if used), followed by functional purge test record (if used).

#### 2.2.6.4 Changes Since MOBILE4.1

There have been no revisions to the information required to model the effect on emissions of an ATP, or to the format requirements of that data, since the release of MOBILE4.1. The functional pressure and/or purge tests of vehicle evaporative emission control systems are now modeled using one or two additional input records, as described above, rather than by adding additional information to the I/M program descriptive record as was done in MOBILE4.1.

#### 2.2.6.5 Guidance

MOBILE5 will only model an ATP with an evaporative system inspection (sixth in the list of inspections performed) and provide appropriate emission credits if a gas cap inspection (last in the list of inspections performed) is also included. If the user indicates that an evaporative system inspection is performed, but that a gas cap inspection is not performed, an error message will be issued and execution of the run will stop. The converse is not true: It is allowable to have a gas cap inspection without having an evaporative system inspection. Refer to the descriptions provided in Appendix 2A before choosing ATP parameters.

Additional information on ATP programs is provided in Appendix 2A. Enhanced I/M programs, including I/M programs for Federal Tier 1 and/or California LEV program vehicles meeting the criteria in Appendix 2B, must include the functional pressure and purge tests of the evaporative emission control system. (See Appendix 2B for additional information.) Further guidance on developing the information required to model the emissions impact of an ATP can be obtained by contacting the Office of Mobile Sources, Emission Control Strategies Branch (313/668-4374).

## **2.2.7 REFUELING EMISSIONS**

### **2.2.7.1 Description**

The refueling of gasoline-fueled vehicles results in the displacement of fuel vapor from the vehicle fuel tank to the atmosphere. There are two basic approaches to the control of vehicle refueling emissions, generally referred to as "Stage II" (at the pump) and "onboard" (on the vehicle) vapor recovery systems (VRS). MOBILE5 has the ability to model uncontrolled levels of refueling emissions (i.e., assuming no requirements for Stage II or onboard VRS systems), as well the impacts of the implementation of either or both types of VRS.

### **2.2.7.2 Options**

There are five approaches available in MOBILE5 for the modeling of vehicle refueling emissions, depending on the value assigned to RLFLAG (section 2.1.12):

<u>Value</u>	<u>Action</u>
1	Model uncontrolled refueling emissions for all gasoline-fueled vehicle types
2	Model refueling emissions assuming a Stage II VRS requirement
3	Model refueling emissions assuming an onboard VRS requirement
4	Model refueling emissions assuming both Stage II and onboard VRS requirements
5	No refueling emission factors calculated by MOBILE5 (refueling emissions must be accounted for elsewhere in the inventory for SIP purposes)

There are no additional input requirements for the first or last approaches. To include the effects of either or both VRS requirements on refueling emissions, additional information must be provided by the user as detailed below.

### **2.2.7.3 Refueling Emissions in MOBILE5**

The uncontrolled refueling emission factors in MOBILE5 are based on vehicle test results which were used to develop a regression equation expressing refueling emissions as a function of fuel RVP, temperature of dispensed fuel, and difference in temperatures of dispensed and residual tank fuel. Each of these values is supplied by the model user, either directly (fuel RVP) or indirectly (the temperature of the dispensed fuel is estimated as a function of the input minimum and maximum temperatures, while the "delta T" temperature term is in turn a function of the dispensed temperature). This equation yields refueling EFs in terms of grams of vapor emitted per gallon of fuel dispensed (g/gal). To this value an estimate of spillage losses is added, also in g/gal. Combining this total g/gal emission factor with vehicle fuel economy data (mi/gal) yields refueling emission factors in grams per mile (g/mi).

If you wish to model the effect of a Stage II VRS requirement on these emissions, its in-use control efficiencies (for LDGVs and LDGTs, and for HDGVs) must be entered as input. There are no national average values for Stage II efficiency in MOBILE5. In modeling an onboard VRS requirement, MOBILE5 assumes a 96 percent reduction in refueling emissions from uncontrolled levels from onboard-equipped vehicles.

#### 2.2.7.4 Required Information

To model the effect of a Stage II VRS requirement, four inputs must be provided: the start year (calendar year in which the requirement takes effect), the phase-in period (number of years for Stage II VRS installation to be completed), and the system efficiency (in percent) at controlling refueling emissions from light-duty vehicles and trucks, and from heavy-duty vehicles.

The format of the Stage II VRS descriptive record is:

**I2,1X,I1,2(1X,F3.0)**

For example, the record below is for a Stage II VRS system requirement that takes effect in 1995, allows 3 years for full implementation, and reduces refueling emissions from LDGVs and LDGTs by 90% and from HDGVs by 80%:

95 3 90. 80.

Modeling the effect of an onboard VRS requirement requires the user to provide only the starting model year and which of the four possible vehicle types (LDGV, LDGT1, LDGT2, HDGV) are subject to the requirement. On January 22, 1993, the U. S. Court of Appeals for the District of Columbia Circuit decided that the Clean Air Act does not provide for EPA discretion in determining whether onboard VRS requirements are to be issued, and that such a requirement must be promulgated. After this requirement has been finalized, the effects of onboard VRS will need to be included in SIP emission factor and inventory development.

The format of the onboard VRS descriptive record is:

**I2,1X,4I1**

For example, the record below is for an onboard VRS requirement that applies to LDGVs, LDGT1s, and LDGT2s, but not to HDGVs, and begins in the 1998 model year:

98 2221

All of the above information must be supplied if both VRS requirements are assumed. If both records are to be supplied, the Stage II record precedes the onboard record. Table 2.2-9 summarizes both of these records, including the variable names, codes, and allowable values for each field.

#### 2.2.7.5 Changes Since MOBILE4.1

There have been no revisions to the information required to model the effects of either type of VRS on refueling emissions, or to the format requirements of that information, since the release of MOBILE4.1.

#### 2.2.7.6 Guidance

EPA recommends that States and others use MOBILE5 to model refueling emissions for highway vehicle emission inventory development. The refueling emission factors can be calculated in grams per gallon of dispensed fuel (g/gal) or in grams per mile (g/mi). (The g/gal emission factor is calculated and output when the expanded evaporative emission factor output (HCFLAG=3) is selected; see section 2.1.19.) The preferred approach is to calculate g/gal refueling emission factors using MOBILE5, reflecting Stage II VRS requirements as applicable, then multiplying the g/gal emission factor by total gasoline sales. This is the most accurate method of estimating the contribution of refueling emissions to the inventory, particularly for areas with good data on gasoline sales (e.g., through tax records). This method also accounts for refueling emissions generated when gasoline is purchased in



an area, but consumed largely outside of the area, and does not include refueling emissions for through traffic that does not refuel in the area. When good data on gasoline sales is not available, the use of the g/mi refueling emission factor is more convenient and, while also more approximate, acceptable for SIP inventory development.

The overall effectiveness of Stage II VRS at controlling refueling emissions depends on a number of factors, including the baseline efficiency of the system used, the portion of total area gasoline consumption handled by service stations exempt from Stage II requirements, and the frequency and stringency of enforcement programs. In general, the effectiveness of Stage II VRS at controlling refueling emissions will be greater for light-duty vehicles and trucks than for heavy-duty vehicles, since HDGVs are more likely to be refueled at locations (such as private refueling depots) that will be exempted from Stage II requirements. For assistance in developing such information, contact EPA's Office of Air Quality Planning and Standards (919/541-5397).

Considering the January 1993 court decision requiring that an onboard VRS requirement be promulgated by EPA, many areas will have to model refueling emissions assuming both Stage II and onboard control systems. Stage II reduces refueling emissions from all gasoline-fueled vehicles, while onboard systems require a number of years for fleet turnover to result in most vehicles refueling emissions being controlled. MOBILE5 can model both requirements simultaneously; where Stage II is in place and onboard-equipped vehicles begin to enter the fleet, the control is dominated by onboard, which is generally more effective than Stage II.

If the user does not model refueling emissions using MOBILE5 (RLFLAG = 5), then these emissions must be accounted for in the stationary source portion of the inventory in the development of the base and projected emission inventories for SIPs. EPA recommends that States and others use MOBILE5 to model refueling emissions for highway vehicle emission inventory development.

## **2.2.8 LOCAL AREA PARAMETER RECORD**

### 2.2.8.1 Description

The local area parameter (LAP) record consists of seven, eight, nine, or ten locality-specific input variables. This record must be included at least once in every MOBILE5 run.

### 2.2.8.2 Options

The modeler can use one LAP record for all scenarios (LOCFLG = 2) or a different LAP record for each scenario (LOCFLG = 1). With the possible exception of the scenario name (section 2.2.9), the same LAP generally would be used for all scenarios (e.g., different evaluation years) for the same locality.

### 2.2.8.3 Content of the LAP

The following variables comprise the LAP record:

- 1) Scenario name
- 2) Fuel volatility class
- 3) Minimum daily temperature
- 4) Maximum daily temperature
- 5) "Period 1" RVP
- 6) "Period 2" RVP
- 7) "Period 2" RVP start year
- 8) \* OXYFLG
- 9) \* DSFLAG
- 10) \* RFGFLG

The last three variables, indicated by asterisks, are optional. Each variable is discussed in sections 2.2.9 through 2.2.16 below. Table 2.2-10 summarizes the LAP record, including the content, variable name, codes, and allowable values for each field of the record.

The format of the LAP record is:

**4A4,1X,A1,2F5.0,2F5.1,1X,I2,3(1X,I1)**

For example, the LAP record below is for an fuel volatility class "B" area with minimum and maximum temperatures of 68°F (20°C) and 77°F (25°C), "period 1" RVP of 10.5 psi, "period 2" RVP of 9.0 psi (starting in 1992), no oxygenated fuels program, no locality-specific diesel sales fractions being supplied as input, and no reformulated gasoline effects to be included in the emission factors:

Example LAP rcrd C 68. 77. 10.5 9.0 92 1 1 1

It is possible for the user to include comments or other descriptive information outside of the required MOBILE5 input parameters, in order to aid in documenting and interpreting MOBILE5 input files. This is illustrated in the example input files included in Chapter 5 and on the program diskette. Such comments on the Local Area Parameter input record must not begin before (to the left of) column 53. This restriction is necessary to avoid generating error messages that will occur as a result of internal diagnostic checks that use these spaces.

#### 2.2.8.4 Changes Since MOBILE4.1

There have been two revisions to the LAP record since the release of MOBILE4.1. First is the addition of the "fuel volatility class" variable. This variable is only used in the emission factor calculations if the effects of reformulated gasoline on emission factors is to be modeled (RFGFLG = 2, see below). Although this variable is in the same position as the "ASTM Class" variable used in MOBILE4, it is not the same variable. See section 2.2.10. The second change is the addition of a third optional flag value at the end of the LAP record. This flag, RFGFLG, is used to indicate whether the user wishes to model the effects of reformulated gasoline on the emission factors. The three optional flags are discussed in sections 2.2.14, 2.2.15, and 2.2.16.

### 2.2.9 SCENARIO NAME

#### 2.2.9.1 Description

A field of 16 character spaces is available for entering an identifying label for each scenario within a run. This label is echoed as part of the output. Nothing about the scenario name and its use has been revised since the release of MOBILE4.1.

#### 2.2.9.2 Guidance

If no scenario name is desired, a blank field must be entered here. This field is typically used to define the most important characteristics distinguishing the scenario from others within the same MOBILE5 run (e.g., calendar year of evaluation, with or without an operating I/M program, average speed assumed).

### 2.2.10 FUEL VOLATILITY CLASS

#### 2.2.10.1 Description

This variable represents the gasoline volatility class assigned to a given area for a given month under EPA's final (Phase 2) volatility control regulations (55 FR 23658, June 11, 1990). It is not the same as the ASTM Class, which was used in MOBILE4 as a surrogate for actual fuel volatility level (RVP) in certain calculations (refueling emissions), and was not used in MOBILE4.1. However, in order to minimize the need for reformatting of input data files prepared for use with MOBILE4, the space on the LAP record that contained the ASTM Class was retained in MOBILE4.1, but could be left blank. In MOBILE5, this space continues to be used, and a value of fuel volatility class must be provided if the effects of reformulated gasoline on the emission factors is to be modeled (that is, if RFGFLG = 2 on the LAP record - see section 2.2.16).

Since the release of MOBILE4/4.1, EPA has issued regulations controlling summertime fuel volatility and detailing the requirements for reformulated gasoline. The fuel volatility class to be entered here should be determined by reference to the Final Rulemaking (FRM) for "Volatility Regulations for Gasoline and Alcohol Blends Sold in Calendar Years 1992 and Beyond," 55 FR 23658, June 11, 1990. That rule divided the nation into two "VOC Control Regions," each of which has certain specifications for reformulated gasoline. The appropriate EPA Regional Office should also be able to provide the correct fuel volatility class code for a given state or region. The impact of the value entered for fuel volatility class on the calculated emission factors is discussed under Reformulated Gasoline (section 2.2.16). If reformulated gasoline is not being assumed in the emission factor calculations, then the value entered here will have no effect on the emission factors produced by MOBILE5.

#### 2.2.10.2 Options

If the effect of reformulated gasoline on emissions is to be modeled, then a valid fuel volatility class value (single capital letter: A, B, C, D, or E) must be specified. Areas that are defined as part of "VOC Control Region 1" in the FRM referenced above should use B (entering A will give the same result), while those areas defined in the FRM as being part of "VOC Control Region 2" should use C (entering D or E will give the same result) -- MOBILE5 will correctly interpret any of these five letters in modeling the effects of reformulated gasoline. This is discussed in section 2.2.16. If reformulated gasoline is not being assumed in the modeling, then either a valid value for fuel volatility class, or a blank space, must still appear in order to maintain the positions of the remaining variables on the LAP record.

### 2.2.11 MINIMUM and MAXIMUM DAILY TEMPERATURE

#### 2.2.11.1 Description

The minimum and maximum daily temperatures are used directly in MOBILE5 in the calculation of the diurnal portion of evaporative HC emissions, and in estimating the temperature of dispensed fuel for use in the calculation of refueling emissions. The temperatures used in calculating the temperature corrections to exhaust HC, CO, and NO<sub>x</sub> emissions, the hot soak portion of evaporative emissions, and resting loss and running loss HC emissions are calculated by MOBILE5 on the basis of the minimum and maximum temperatures input here, unless overridden by the user.

#### 2.2.11.2 Options

The user must input values for the minimum and maximum ambient temperatures. The minimum temperature must be between 0●F and 100●F (-18● to 38●C), and the maximum temperature must be between 10●F and 120●F (-12● to 49●C), inclusive. The maximum temperature must be greater than or equal to the minimum temperature.

#### 2.2.11.3 Use in MOBILE5

Diurnal emissions in MOBILE5 are adjusted for the minimum and maximum temperatures provided as input, based on evaporative emission testing over a number of temperature ranges. The basic exhaust emission rates for HC, CO, and NOx are based on the nominal standard test temperature of 75°F (24°C). MOBILE5 calculates a temperature for each pollutant representing average emissions over the course of the day (based on the input minimum and maximum daily temperatures, a representative curve of temperature as a function of time of day, and the typical distribution of travel over the course of the day), and adjusts the exhaust emission factors for temperature effects accordingly.

Hot soak emissions at FTP conditions are based on a temperature of 82°F (28°C). MOBILE5 can calculate a temperature for the hot soak emissions, based on the minimum and maximum temperatures input here, and adjust the basic hot soak emission rates for temperature effects accordingly. Resting loss and running loss HC emissions are also dependent on temperature. As in the cases of exhaust and hot soak emissions, MOBILE5 can calculate appropriate average temperatures for use in estimating resting loss and running loss emissions, weighted to account for differing emission levels at different temperatures in the range of the minimum and maximum daily temperatures and the variation in travel frequency over the course of the day.

The model should be operated in this mode if the desired result is total daily emissions (emission factors representing entire days). The algorithm used in MOBILE5 to determine temperatures for correction of the above types of emissions on the basis of the input minimum and maximum temperatures takes into account both the typical 24-hour diurnal temperature profile for a day having the specified minimum and maximum, and the typical distribution of travel over the course of 24 hours. Thus the emission factors calculated in this way are appropriately weighted for both trips and emissions at different temperatures, resulting in factors that can be multiplied by daily vehicle miles traveled (VMT) when total daily emissions are the desired result.

The input value of ambient temperature can also be used to determine the temperature corrections for exhaust HC, CO, and NOx emissions, hot soak evaporative emissions, dispensed fuel temperature in the refueling emissions calculations, and resting loss and running loss emissions, through the use of the control flag TEMFLG (section 2.1.14). This is not recommended unless the modeling of a short time period, such as an hour, is being performed. Refueling emissions should always be modeled using the "full day" approach, not with hourly temperatures. Diurnal emissions can only be modeled by the "full day" approach, as the algorithm used is inaccurate over the very small temperature rises (1 to 5 F) typical of a single hour.

If the input minimum temperature is less than 25°F (-4°C), or the calculated hot soak temperature is less than 40°F (4°C), evaporative emission factors will not be calculated. EPA does not have sufficient data to estimate evaporative emissions at low temperatures, and there is evidence that such emissions approach zero when temperatures are sufficiently low. The MOBILE5 output will include a warning message noting the lack of evaporative emission factor calculations if either of these temperature conditions occur. If the calculated running loss temperature is less than or equal to 40°F (4°C), no running loss emission factors will be calculated for similar reasons. Refueling emissions will be calculated for any valid input temperatures. Finally, if the calculated exhaust emission correction temperature is less than or equal to 45°F (7°C), the exhaust emission factors will not be corrected for the effects of fuel volatility (RVP).

#### 2.2.11.4 Required Information

Minimum and maximum daily temperatures (°F).

#### 2.2.11.5 Changes Since MOBILE4.1

There have been no revisions to the temperature input data requirements since the release of MOBILE4.1.

#### 2.2.11.6 Guidance

The temperatures to be used here depend on the intended application of the results. Restrictions on these temperatures are: the minimum daily and the ambient temperatures must be between 0°F (-18°C) and 100°F (38°C), the maximum daily temperature must be between 10°F (-12°C) and 110°F (43°C), the maximum daily temperature must be greater than or equal to the minimum daily temperature, and the ambient temperature must be between the minimum and maximum daily temperatures (minimum ≤ ambient ≤ maximum). Guidance on the determination of appropriate temperatures for use in development of emission inventories for nonattainment areas appears in "Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources," EPA-450/4-81-026d (revised), 1992.

## **2.2.12 "PERIOD 1" RVP**

### **2.2.12.1 Description**

Evaporative and refueling emissions (and exhaust emissions, to a lesser extent) vary with fuel volatility. EPA's vehicle certification program and much of its emission factor testing use gasoline with volatility [as measured by Reid vapor pressure (RVP)] of 9.0 psi. MOBILE5 adjusts the emission factors to account for the effects of fuel with other than 9.0 psi RVP.

The value to be used for "period 1" RVP is the average in-use RVP of gasoline in the area to be modeled in the time before a volatility control program takes effect, or the years preceding a change in the controlled RVP level (such as occurred in most areas in 1992, when EPA's Phase I volatility control program was superseded by Phase II volatility control limits). The major function of having two RVP values as input, "period 1" and "period 2", is to allow the user to define a step change in fuel volatility as of a specific calendar year.

### **2.2.12.2 Options**

The value used for "period 1" RVP can be anywhere between 7.0 psi and 15.2 psi inclusive. However, for accurate and meaningful results, the guidance provided below should be followed.

### **2.2.12.3 Use in MOBILE5**

The "period 1" RVP is used in MOBILE5, for calendar years of evaluation prior to the user-specified "period 2" start year, to account for the effects of fuel volatility on emissions. Thus, the use of the appropriate value of RVP allows the construction of more accurate emission factors and a more accurate emission inventory. If the calendar year of evaluation is the same or later than the specified "period 2" start year, then the "period 1" RVP input is ignored (in the sense that it will not have any impact on the emission factors for the evaluation year).

### **2.2.12.4 Required Information**

A value of RVP (in psi) representing the prevailing average fuel volatility for the geographic area of interest, either in the absence of volatility control requirements or before more stringent control requirements takes effect.

### **2.2.12.5 Changes Since MOBILE4.1**

There have been no revisions since the release of MOBILE4.1 to the definition or input requirements for this variable.

### **2.2.12.6 Guidance**

As with the temperature inputs discussed above, the intended use of the MOBILE5 run determines the season for which the average RVP should be ascertained. For ozone-related (summer season) modeling, use summer (July) RVP. For CO (winter season) modeling, use winter (January) RVP. Note that MOBILE5 does not model effects of RVP on exhaust emissions at temperatures of less than 45°F (7°C), and that no effects of fuel volatility greater than an RVP of 11.7 psi are modeled. If modeling of emission factors is being performed on a month-by-month basis, the value of RVP appropriate to each of the specific months being modeled should be used. It is not correct to average RVP values from different months or seasons together (since the effect of RVP on emissions is non-linear), or to use RVP from a season other than that used to determine the temperatures used in the emission factor modeling.

Further guidance on the determination of the appropriate values to use as input for fuel RVP is provided in "Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources," EPA-450/4-81-026d (revised), 1992.

### **2.2.13 "PERIOD 2" RVP and "PERIOD 2" START YEAR**

#### 2.2.13.1 Description

EPA has issued rules requiring that fuel RVP during the ozone season be limited to 10.5 psi RVP in most parts of the country (roughly corresponding to ASTM Class C areas) during the summer ozone-season months in 1989-91 (Phase I volatility control), and to 9.0 psi RVP during the summer ozone-season months in 1992 and later (Phase II control), with generally proportional reductions in summer fuel maximum RVP in other States (roughly corresponding to ASTM Class A and B areas). MOBILE5 provides the ability to model the effects of an RVP control program, or a step-function change in RVP for any other reason, through specification of the "Period 2" RVP limit and the calendar year in which the requirement is effective.

#### 2.2.13.2 Options

The user must input values for the "period 2" RVP and "period 2" start year. The RVP value can be between 6.5 and 15.2 psi inclusive. The earliest allowable "period 2" start year is 1989.

#### 2.2.13.3 Required Information

The RVP level to be assumed for "period 2" and the first calendar year in which this RVP level is effective.

#### 2.2.13.4 Changes Since MOBILE4.1

There have been no revisions in the input or formatting of these two variables since the release of MOBILE4.1.

#### 2.2.13.5 Guidance

To model the effects of the Federal volatility control program issued by EPA, in which volatility is limited in the summer months (May through September), see the relevant Federal Register notices (54 FR 11868, March 22, 1989 for Phase I control and 55 FR 23658, June 11, 1990 for Phase II control), or contact your EPA Regional Office to determine the applicable RVP limits for a specific State and month. The interim (Phase I) controls were in effect during 1989, 1990 and 1991, and the final (Phase II) controls took effect beginning in the summer of 1992.

EPA will accept the use of the Federal RVP limits for a given area as the fuel RVP for the highway vehicle emission factors and inventory. However, greater accuracy is possible by using the results of local fuel survey RVP

measurements, or by adjusting the regulated RVP limit to reflect the degree to which typical fuel RVP fall below the limits effective for areas and months with fuel survey data. For areas without fuel survey data, typical commercial fuel subject to an RVP limit of 9.0 psi can be assumed to have 8.7 psi RVP. For RVP limits of 7.8 psi or lower, no "margin of safety" should be assumed, since the cost of creating a safety margin at these lower volatility levels is greater. The margin can be estimated through interpolation for RVP limits between 7.8 and 9.0 psi. It is not correct to use the actual RVP limit in the base year and then to include a safety margin in modeling the projection years.

The effects of local (State, regional) fuel volatility control programs, which may be more stringent and/or take effect sooner than Federal controls, can be modeled by appropriate selection of values for "period 2" RVP and start year. To model the effect of a fuel volatility control program, use the proposed RVP limit as the value of "period 2" RVP, and the year in which the program takes effect as the "period 2" start year.

If no changes in fuel volatility are to be assumed, then the value of "period 1" RVP should be used for "period 2" RVP as well. In this case, with no change in RVP between "period 1" and "period 2," the period 2 start year should be set at 2020 (20).

## **2.2.14 OXYFLG**

### **2.2.14.1 Description**

There are three optional flag settings that appear as the last three variables of the LAP record. The first of these is OXYFLG, a flag that tells MOBILE5 whether or not the user intends to model the impact of oxygenated fuels on emissions. If this flag is missing, MOBILE5 will interpret its value as "1", assume no oxygenated fuels, and will not expect to see additional oxygenated fuel input data.

### **2.2.14.2 Options**

This flag has two possible values, 1 and 2. If OXYFLG = 2, then the user must supply an additional input record containing data on the average oxygen content of two types of oxygenated fuels (gasoline/alcohol and gasoline/ether blends), the market penetration of each type of oxygenated fuel, and whether or not an RVP waiver, or allowance, (+1.0 psi) for alcohol-based oxygenated fuels is in effect in the area being modeled. See section 2.3.11 for information on the placement and content of this record.

If OXYFLG = 1, then the model assumes that no oxygenated fuel information will be included in the remainder of the input data file, and no effects of fuel oxygen content on emissions will be modeled. If this flag is missing, it will be interpreted as "1" by MOBILE5, and no oxygenated fuels program will be assumed in the modeling.

### **2.2.14.3 Required Information**

No information is required; as noted above, if this flag is not present at the end of the LAP record (following the "period 2" RVP start year), it is interpreted as being set to 1. If the effects of an oxygenated fuels program on exhaust emissions are to be included in the modeling, this flag must be present and set to 2.

### **2.2.14.4 Use in MOBILE5**

The use of oxygenates in gasoline, whether in the form of alcohols or ethers, can affect both exhaust and evaporative emissions. MOBILE5 incorporates the effects of fuel oxygen content, as specified by the modeler, on emissions. If an RVP waiver is in effect for alcohol-based oxygenated fuels, such that the volatility limit for such

fuels is higher than that for straight gasoline, then this "RVP boost" will also result in slight changes in exhaust HC, CO, and NO<sub>x</sub> emission factors relative to the case where no waiver is in effect.

#### 2.2.14.5 Changes Since MOBILE4.1

The location and values of the OXYFLG are unchanged since the release of MOBILE4.1. The effects of oxygenate content on exhaust emission factors and on the composition of evaporative emissions is modeled by MOBILE5 (only the effects on exhaust CO emissions were modeled in MOBILE4.1).

#### 2.2.14.6 Guidance

If oxygenated fuels are known to have two percent or greater market penetration in the area being modeled, then this should be reflected in the highway vehicle emission factors and emission inventories prepared by States (or local or regional entities) for SIPs in response to the requirements of the 1990 CAA amendments. If reformulated gasoline is also being assumed in the modeling, then some of the user inputs detailing the oxygenated fuels program may be overridden by reformulated gasoline assumptions, particularly in the summer season. Additional information on the modeling of reformulated gasoline effects on emissions, and the interaction of oxygenated fuels programs and reformulated gasoline assumptions in the modeling, is provided in section 2.2.16.

### 2.2.15 DSFLAG

#### 2.2.15.1 Description

The second optional flag at the end of the LAP record is DSFLAG, which instructs MOBILE5 as to whether the user is supplying alternate diesel sales fractions by model year for LDVs and LDTs. As in the case of OXYFLG, if this flag is missing it will be interpreted as having a value of "1," and the model will not expect to find alternate diesel sales fractions as part of the model input data.

#### 2.2.15.2 Options

This flag has two possible values, 1 and 2. If DSFLAG = 2, then the user must supply 50 diesel sales fractions (25 each for LDVs and LDTs, for model years from the calendar year of evaluation to 25+ model years ago) for each scenario of the run. The placement of these fractions, format requirements, and additional information appear in section 2.3.12.

**NOTE:** If the user wishes to supply alternate diesel sales fractions by model year for LDVs and LDTs, then the entire LAP record must appear in the Scenario data section for each scenario of the run. In other words, if DSFLAG = 2 is selected, LOCFLG = 1 must be selected. The reasons for this are discussed in section 2.3.12. If the input file violates this condition by including DSFLAG = 2 on the LAP record, but contains only one LAP record for all scenarios, an error message will be produced and the run will not be executed.

#### 2.2.15.3 Required Information

No information is required; as noted above, if this flag is not present at the end of the LAP record (following the "period 2" RVP start year and the value of OXYFLG), it will be interpreted as being set to 1. If alternate diesel sales fractions by model year for LDVs and LDTs are to be included in the modeling, this flag must be present and set to 2, and the entire LAP record must appear in the Scenario data section.

#### 2.2.15.4 Use in MOBILE5



MOBILE5, like earlier versions of the model, uses a single set of registration distributions by age and annual mileage accumulation rates to describe all LDVs (gasoline and diesel vehicles combined), and another such set to describe all LDTs. The use of model-year-specific diesel sales fractions allows MOBILE5 to internally split the LDVs and LDTs into gas and diesel sub-categories, which have distinctly different emission rates and behaviors.

#### 2.2.15.5 Changes Since MOBILE4.1

There have been no changes to the user input of alternate diesel sales fractions by model year since the release of MOBILE4.1.

#### 2.2.15.6 Guidance

Sales of diesel powered light-duty vehicles and trucks underwent a surge in the late 1970s and early 1980s, peaking at 5.9 percent of LDV sales nationwide in the 1981 model year, and at 9.3 percent of LDT sales nationwide in the 1982 model year. Since then diesel sales have fallen precipitously, to virtually zero for LDVs (less than 0.05 percent of all LDV sales in model years 1988 through 1990) and to about 0.2 percent of LDTs since the 1988 model year.

To assist those areas having access to vehicle registration data that distinguishes between gas and diesel LDVs and LDTs, provisions exist in MOBILE5 to allow the user to input alternate (locality-specific) diesel sales fractions by model year. These data must be supplied for every calendar year of evaluation: Since they apply to vehicles of ages 1, 2, 3, ..., to 25+, different sets of fractions are required for each calendar year for which emission factors are to be modeled.

The input of alternate diesel sales fractions is discussed in section 2.3.12. Areas having the necessary information for development of these sales fractions by model year are encouraged to incorporate their own diesel sales fractions by model year for use in the construction of the base year inventories. EPA will accept the use of the built-in national average diesel sales fractions in modeling emission factors for use in constructing the mobile source portion of the base and projection year emission inventories developed for SIP purposes.

### **2.2.16 REFORMULATED GASOLINE**

#### 2.2.16.1 Description

The third and last optional flag at the end of the LAP record is RFGFLG, which instructs MOBILE5 as to whether the user is modeling the impact of reformulate gasoline (RFG) on the emission factors. As in the case of OXYFLG and DSLFLG, if this flag is missing it will be interpreted as having a value of "1" and no reformulated gasoline effects will be included in the modeling.

The effects of RFG on the calculated emission factors in MOBILE5a are based on the "simple model" developed for the RFG rulemaking supporting analyses. When the final rules for RFG have been promulgated and the "complex model" for estimating the emissions impacts has been completed, future MOBILE models will be updated to correspond to the provisions of the final rule and "complex" model. In MOBILE5, the principal RFG effects are based on fuel volatility (RVP) reductions and oxygen content. Another effect representing the impact of other fuel parameters (e.g., sulfur content) is also applied to the exhaust emission factors.

When the user specifies that RFG is to be assumed in the emission factor calculations, both Phase 1 and Phase 2 RFG are modeled, starting in calendar years 1995 and 2000 respectively. The volatility limits are 8.0 and 7.1 psi RVP under Phase 1, and 7.5 and 6.8 psi RVP under Phase 2, for fuel volatility classes A/B and C/D/E respectively. The user specifying RFG must specify the fuel volatility class (see section 2.2.10), which is used to

determine the RVP level for both Phase 1 and 2 RFG. The minimum oxygen content (2.1%) is the same for all areas. The effects of other fuel parameters on emissions is greater under Phase 2 RFG. The user is encouraged to consult the final rulemakings for fuel volatility controls and for RFG for additional information.

#### 2.2.16.2 Options

If the effects of reformulated gasoline on emissions are to be included in the modeling, this flag must be set equal to 2. If reformulated gasoline is not to be assumed in the modeling, this flag can be set to 1 or left blank (which will be interpreted by MOBILE5 as being set to 1).

#### 2.2.16.3 Required Information

The modeling of the effects of reformulated gasoline on emissions is handled entirely within MOBILE5. No additional input data (beyond entering the correct fuel volatility class on the LAP record as described in section 2.2.10) is required when RFGFLG = 2.

#### 2.2.16.4 Changes Since MOBILE4.1

This flag is new in MOBILE5.

#### 2.2.16.5 Guidance

Those areas required to be supplied with reformulated gasoline under the 1990 amendments to the Clean Air Act should account for this in projection year emission factor modeling by setting RFGFLG = 2. The effects of reformulated gasoline on emissions is a function of season -- the effects are different in summer and winter. The season assumed is controlled by the selected month of evaluation (January = winter season, July = summer season), which can be specified by the MOBILE5 user in the Scenario section of the input data (see section 2.3.6).

In summer (July) emission factor scenarios, the user input RVP and assumed mix of alcohol and ether blends is not important, since the RVP and oxygen content of reformulated gasoline are regulated. When RFG is modeled and the season is summer (July emission factors), the user-supplied RVPs and oxygenated fuel data are overridden by the provisions of the RFG rules. In winter (January emission factor) scenarios, however, RVP is not regulated. The user-specified RVP is used in winter (January), but is increased based on the assumed market share of alcohol blends, which are assumed to receive an RVP waiver (i.e., to be permitted to have RVP that exceeds by up to 1.0 psi that specified by the user for straight gasoline). In winter (January) emission factor scenarios, the default MOBILE5 market share assumed for alcohol blends and the assumption of an RVP waiver for such blends that is used in modeling the effects of reformulated gasoline can be overridden by the user through use of the OXYFLG on the LAP record and the input of an oxygenated fuels descriptive record. The average oxygen content input by the user for reformulated gasoline areas in this situation must be at least 2.1% and have a net 100% market share.

### **2.2.17 TRIP LENGTH DISTRIBUTION RECORD**

The trip length distribution record, required if SPDFLG = 3 or 4 (see section 2.1.5), is discussed in section 2.3.13. This record must appear in the One-time Data section if SPDFLG = 4 (one set of trip length distributions applied for all scenarios in the MOBILE5 run), or, in the Scenario section if SPDFLG = 3 (a different trip length distribution record is applied for each scenario within the MOBILE5 run). The information provided in section 2.3.13 applies in both cases. This record is not required if SPDFLG = 1 or 2.

### **2.2.18 BY MODEL YEAR INCLUSION VECTOR**

### 2.2.18.1 Description

If the user chooses to have MOBILE5 provide additional output tables showing the relative contribution of vehicles of each model year to the average fleet emission factor, for each vehicle type, then an additional input record that tells MOBILE5 which vehicle types the additional output is requested for and what additional information is requested must appear in the One-Time Data section of the input. This option is selected by setting the value of OUTFMT to 5 (see section 2.1.15). This record is essentially a string of "yes/no" flags, as described below. If used, it appears as the last input record in the One-Time Data section.

### 2.2.18.2 Options

If the "by model year" option has been selected, then the modeler must specify for which vehicle types the additional output information is desired. (Since running MOBILE5 in the "by model year" mode slows program execution and increases the output file size dramatically, it is suggested that the modeler carefully consider the need for the information provided before electing this option, and only select only those vehicle types and pollutants for which the model year-specific information is desired.)

The user also has the option of selecting two kinds of "by model year" output: One consisting only of the model year-specific emission factors, and one which also provides model year-specific I/M credits (assuming that an I/M program has been included in the modeling).

### 2.2.18.3 Required Information

If by model year output is requested, then the last record in the One-Time Data section consists of ten integer flags, each having a value of "1" or "2." The first eight instruct MOBILE5 whether by model year emission factor output is to be included in the output (2) or not (1) for each vehicle type, in this order: LDGV, LDGT1, LDGT2, HDGV, LDDV, LDDT, HDDV, and MC. The last flag instructs MOBILE5 whether the by model year output for I/M program effects is desired, coded such that 1 = "No" and 2 = "Yes."

The format of this record is:

**8I1,1X,I1**

An example is shown below:

22211111 2

In this example, by model year emission factors and I/M credit information are requested for light-duty gas vehicles and both classes of light-duty gas trucks; no by model year information is requested for the other five vehicle types.

### 2.2.18.4 Changes Since MOBILE4.1

The by model year option in MOBILE5 has been revised to eliminate the option for tables summarizing tampering rates and offsets on a model year-specific basis. However, using a MOBILE4.1 input file containing a value for the eliminated flag will not affect the running of MOBILE5.

### 2.2.18.5 Guidance

This option is provided for special modeling purposes. There is no need for this option to be exercised in the development of mobile source emission factors and inventories. Due to the increased computations and output required to exercise this option, selecting it results in a dramatic increase in the time necessary to execute

MOBILE5 runs and in the size of the output files produced. The contents of the additional by model year output are described in detail in section 3.3.5, and are illustrated by an example in Chapter 5. Modelers with a need for such information, and desiring further information than is provided in this section, are advised to contact EPA for assistance.

This concludes the One-time Data section.

### **2.3 SCENARIO SECTION**

The Scenario data follow the One-time Data in the MOBILE5 input stream, and are used to assign values to those variables that specifically define each of the scenarios to be evaluated. It consists of one to ten records (depending on the values assigned to the flags in the Control section, to the optional flags OXYFLG and DSFLAG on the LAP record, and to the "region" variable on the scenario descriptive record).

The user can calculate emissions for one or more scenarios. Each scenario is associated with one group of Scenario section records. Each MOBILE5 run must contain at least one scenario record. The program terminates execution upon detecting an end-of-file condition.

The first record, consisting of those variables discussed in sections 2.3.1 through 2.3.6, must be included for every scenario of every MOBILE5 run. The second possible record, required only if the value assigned to "region" on the first scenario record is 4, specifies information on the California low emission vehicle (LEV) program for the area being modeled. The third possible record, required only if LOCFLG = 1, consists of local area parameters to be applied for this scenario only (see sections 2.1.13 and 2.2.8 through 2.2.16). The fourth possible record, required only if the user has elected to model the effects on exhaust emissions of an oxygenated fuel program by setting OXYFLG = 2 on the LAP record, consists of the oxygenated fuels descriptive record (see section 2.3.11). The fifth through seventh possible records, required only if the user has chosen to input diesel sales fraction data for LDVs and LDTs by setting DSFLAG = 2 on the LAP record, contain the alternate diesel sales fractions (see section 2.3.12). The eighth possible record, required only if VMFLAG = 3, consists of the VMT mix to be applied for this scenario only (see sections 2.1.6 and 2.2.2). The ninth possible record, required if SPDFLG = 3, consists of the alternate trip length distribution records to be applied for this scenario only (see section 2.3.13). The tenth and last possible record, required only if ALHFLG = 2 or 3, consists of either six or ten additional input values used to correct certain exhaust emission factors (see sections 2.1.10 and 2.3.10).

The first scenario record, called the scenario descriptive record, is mandatory for all MOBILE5 runs. It contains the following information:

1)	Region (1, 2, 3, or 4)	See section 2.3.1
2)	Calendar year of evaluation	See section 2.3.2
3)	Average speed(s)	See section 2.3.3
4)	Ambient temperature	See section 2.3.4
5)	Operating mode fractions	See section 2.3.5
6)	Month of evaluation	See section 2.3.6

The standard format for this record, when only one value of average speed is specified and is applied to all eight vehicle types (SPDFLG = 1, 3, or 4), is:

**I1,1X,I2,5(1X,F4.1),2X,I1**

The alternate format, used when different average speeds are specified for each of the eight vehicle types (SPDFLG = 2), is:

**I1,1X,I2,12(1X,F4.1),2X,I1**

It is possible for the user to include comments or other descriptive information outside of the required MOBILE5 input parameters, in order to aid in documenting and interpreting MOBILE5 input files. This is illustrated in the example input files included in Chapter 5 and on the program diskette. Such comments on the Local Area Parameter input record must not begin before (to the left of) column 53. Comments on scenario section input records must not begin until at least 15 columns after (to the right of) the last input variable. These restrictions are necessary to avoid generating error messages that will occur as a result of internal diagnostic checks that use these spaces.

Table 2.3-1 summarizes the Scenario section input record(s), including the variable names, codes, and allowable values for each field.

### 2.3.1 REGION

#### 2.3.1.1 Description

The first specification required in the first record of the Scenario data section is the region for which emission factors are to be calculated.

#### 2.3.1.2 Options

MOBILE5 provides four options for region: low-altitude (value of 1) and high-altitude (value of 2) are the same as in MOBILE4.1. Low-altitude emission factors are based on conditions representative of approximately 500 feet above mean sea level (+500 ft MSL), and high-altitude factors are based on conditions representative of approximately +5500 ft MSL. When high-altitude region emission factors are requested by setting REGION = 2, MOBILE5 also includes vehicles that were built to meet specific high-altitude area emission standards. Values of 3 or 4 are used to indicate that the California LEV program is to be included in the modeling, and are applicable for low-altitude areas only.

MOBILE5 does not calculate California emission factors. Two additional options have been added to the REGION input variable, both dealing with the California Air Resources Board's vehicle program in which the introduction of transitional low emission vehicles (TLEVs), low emission vehicles (LEVs), ultra low emission vehicles (ULEVs), and zero emission vehicles (ZEVs) is required beginning in the late 1990s. Both of these new options are applicable to low-altitude areas only. The options for REGION are summarized below:

<u>Value</u>	<u>Action</u>
1	Low-altitude
2	High-altitude
3	California LEV program, with emission credits based on assuming a specific I/M program (as discussed below and in Appendix 2B) for LEVs
4	California LEV program, with emission credits based on an I/M program other than as described below and in Appendix 2B, and/or with a different start year for the phase-in of LEVs to begin

Values of 3 or 4 are used to control the exhaust emission estimates for California LEV program vehicles. A value of 3 may be used if (1) the user wishes to have the LEV program begin in the 1994 model year, and (2)

the I/M program applied to these LEV program vehicles will meet the specific requirements outlined in section 1.3.6 and Appendix 2B.

If the value used for region is 3, this specific I/M program overrides the exhaust portion of any I/M program specified in the One-time Data section for the LEV program vehicles in the model years that are affected by the LEV program. However, in order to receive credit for the evaporative emissions benefits of functional pressure and purge tests of the evaporative emission control system, these tests must still be specified in the One-time Data section (see sections 2.1.11 and 2.2.6). In addition, the I/M program descriptive input record is still required in order to correctly account for the impact of I/M on pre-Tier 1 vehicles.

A value of 4 should be used for region if (1) the user desires to have the LEV program start later than the 1994 model year, regardless of the type of I/M program, or (2) the user wishes to estimate emission factors based on assuming that an I/M program not meeting the specific description of Appendix 2B (or an equivalent program as determined by EPA) is in place. In this case, I/M program credits are based on the I/M program specified by the user in the One-time Data section. If a value of 4 is used for region, the user must also include an LEV program parameter record, as discussed in section 2.3.7.

It is important to note that if the user specifies the California LEV program be modeled, by setting the value of this variable to 3 or 4, only future vehicles meeting the California program standards are assumed in the modeling. In other words, specifying the California LEV program does **not** include modeling of California standards for vehicles for any model years preceding the beginning of the LEV program. Thus emission factors for California areas cannot be modeled using MOBILE5.

#### 2.3.1.3 Use in MOBILE5

The region selected determines whether the MOBILE5 emission factor calculations will be based on low-altitude or high-altitude basic emission rates, and if applicable whether low-altitude or high-altitude I/M credits will be used. (Low- and high-altitude I/M credits are supplied in a separate input file of alternate credits. See section 2.2.5.) With the addition of two levels, the region selected also determines if the California LEV program is to be modeled, and if so, with what assumptions regarding I/M credits for those vehicles.

#### 2.3.1.4 Required Information

A value of 1 (low-altitude), 2 (high-altitude), 3 (low-altitude, California LEV program, and I/M credits based on the specific program discussed in Appendix 2B or an approved equivalent), or 4 (low-altitude, California LEV program, and I/M credits based on a program other than the specific program discussed in Appendix 2B or an approved equivalent) must be entered for the region. If "4" is selected as the value of the region variable, the user must also include an LEV Program Parameter Record, which will immediately follow the mandatory scenario descriptive record (region, calendar year, speed, etc.) and is described in section 2.3.7.

#### 2.3.1.5 Changes Since MOBILE4.1

There have been no revisions to how or where the REGION variable is input to the model since the release of MOBILE4.1. Values of 1 and 2 for REGION are exactly the same as in MOBILE4.1. The addition of values of 3 or 4, for modeling the impact of the California LEV program, is new in MOBILE5.

#### 2.3.1.6 Guidance

For the majority of MOBILE5 applications, low-altitude is the appropriate choice. For those areas designated as high-altitude by EPA for mobile source regulatory purposes only, generally those counties that lie "substantially" above +4000 ft MSL, high-altitude should be selected. A list of those counties EPA has designated as high-altitude appears in §86.088-30, paragraphs (a)(5) (ii) and (iv), Code of Federal Regulations.

The use of the California LEV program options in MOBILE5 is discussed further in section 2.3.7 and in Appendix 2B. Areas that opt-in to the LEV program will use values of 3 or 4 for the region variable in projection year inventories, depending on the I/M program to be operated. Again, the selection of one of the California LEV options will not affect the emission rates and other information used in calculating emission factors for vehicles of model years 1993 or earlier. In other words, selecting a California LEV option here will not provide emission factors for the California fleet -- the emission factors will be based on a Federally-certified fleet through model year 1993, with LEV program vehicles being phased in after the 1993 model year.

### **2.3.2 CALENDAR YEAR**

#### **2.3.2.1 Description**

The value used for calendar year in MOBILE5 defines the year for which emission factors are to be calculated. It is frequently referred to as the calendar year of evaluation.

#### **2.3.2.2 Options**

MOBILE5 has the ability to model emission factors for the years 1960 through 2020 inclusive.

#### **2.3.2.3 Required Information**

A value [the last 2 digits of the calendar year of evaluation (range 60-99 and 00-20)] must be entered.

#### **2.3.2.4 Changes Since MOBILE4.1**

There have been no revisions to this variable or how it is input to the model since the release of MOBILE4.1.

#### **2.3.2.5 Guidance**

Different uses of the emission factors calculated by MOBILE5 require special treatment. The base year (1990) inventories are to be based on a typical day in the pollutant season, most commonly summer for ozone and winter for CO. MOBILE5 provides the option for calculating emission factors as of January 1 or July 1 of the calendar year specified. This eliminates the need (in most cases) to interpolate between the results of two MOBILE runs in order to obtain representative summertime emission factors. Special care must be taken, however, in using interpolated results from the model, especially when estimating July emission factors in a calendar year that is followed immediately by a major change in some control program element (such as fuel volatility, or I/M program specification). Users should consult the guidance provided in section 2.3.6 (MONTH) before using interpolated emission factors.

CO inventories generally should be based on emission factors from a single calendar year of evaluation. For example, if the three-month period for which CO emissions are being modeled was December 1989 and January and February 1990, the use of 1990 for calendar year would be appropriate. If that three-month period is instead November 1990 - January 1991, then calendar year 1991 emission factors would be more appropriate. Questions regarding the best calendar year to use for CO modeling, if not addressed by the examples above, should be addressed to the appropriate EPA Regional Office.

Similar instructions apply to the development of reasonable further progress (RFP) inventories. For modeling of specific episode days, the best results will be obtained by interpolating exactly to the day being modeled. In attainment demonstrations, it is acceptable to account for fleet turnover through November 15 of the

year being modeled (which can be done by interpolation of emission factors for January 1 of the year being modeled and January 1 of the following year).

### 2.3.3 SPEED

#### 2.3.3.1 Description

Emission factors vary considerably with the average speed assumed. The value(s) input for speed in MOBILE5 will have a significant impact on the resulting emission factors for exhaust and running loss emissions. The speed correction factors have been revised since MOBILE4.1 for the mid-range of speeds (between 19.6 and 55 mph). The general curve describing HC and CO emission rates as functions of speed displays very high g/mi emission rates at very low speeds, with emissions decreasing (sharply at first, then more slowly) as average speed increases, until minimum emissions are reached at around 48 mph. In MOBILE5, the same emissions are assumed for all speeds from 48 to 55 mph for HC and CO. Above 55 mph, further increases in speed result in increased emissions. The behavior of NO<sub>x</sub> emissions as a function of speed have also been revised in MOBILE5.

In MOBILE5, "speed" refers to the average speed of vehicles over trips. This speed is simply the total trip distance divided by the total trip time. All trips in MOBILE5 assume a mix of idle, accelerations, decelerations, and cruises. Lower average trip speeds assume more stop-and-go driving, with more idle time and less steady-speed cruise time. Higher average speeds assume increased cruise operation, with decreased idle time and stop-and-go travel. As a result, MOBILE model results are most applicable to scenarios where vehicles are being operated over a variety of modes and are least appropriate for conditions where all vehicle operation is in a single mode (e.g., cruise) at a given speed.

EPA is continuing to evaluate new information on the behavior of exhaust emissions as a function of speed. The revisions in MOBILE5 have the effect of flattening the slope of the emissions-vs.-speed curves in the 19.6-48 mph range of speed for HC and CO emissions; in other words, the decrease in emissions with increasing speed is less pronounced in MOBILE5 than in MOBILE4.1. This revision agrees well with the data EPA has evaluated on emissions at different average speeds.

#### 2.3.3.2 Options

One average speed can be specified for all vehicle types (SPDFLG = 1), or eight average speeds, one for each vehicle type, can be specified (SPDFLG = 2). MOBILE5 will calculate emission factors for average speeds of 2.5 to 65.0 mph, in increments of 0.1 mph. If a speed below 2.5 mph is input, a warning message is issued by MOBILE5 and 2.5 mph is used in the calculations. Similarly, if a speed above 65 mph is input, a warning message is issued and 65.0 mph is used in the calculations. The range of average speeds for which emission factors can be calculated (2.5 to 65 mph) is the same as that used in MOBILE4.1.

#### 2.3.3.3 Use of Average Speed in MOBILE5

The data base on which all emission factor calculations are based is developed from vehicle test results at FTP conditions, including the average speed of 19.6 mph. MOBILE5 adjusts the emission factors for speeds other than 19.6 mph (20 mph for HDGVs and HDDVs) through the use of speed correction factors. Running loss HC emissions also vary with average speed, and that variation is reflected in the running loss emission factors produced by MOBILE5.

#### 2.3.3.4 Required Information



The modeler must supply either a single value of average speed which is assumed to apply to all vehicles (if SPDFLG = 1, 3, or 4), or eight values of average speed (one for each regulated vehicle class, if SPDFLG = 2) in the following order: LDGV, LDGT1, LDGT2, HDGV, LDDV, LDDT, HDDV, MC.

#### 2.3.3.5 Changes Since MOBILE4.1

The choices available (one average speed or eight vehicle-specific average speeds) and the associated data format requirements are unchanged from MOBILE4.1. As noted above (section 2.3.3.1), the correction factors applied to the emission factors for average speeds in the "mid-speed" range of 19.6-48 mph have been revised for MOBILE5. This also has the effect of changing the speed correction factors for average speeds of 48 to 65 mph.

#### 2.3.3.6 Guidance

The FTP driving cycle is intended to be representative of driving conditions typical of a standard commute in an urban area. Thus the use of 19.6 mph as the average speed applicable to all vehicle types is appropriate for approximate analysis of emissions from traffic in urban areas as a whole. However, such an approach is not suitable for SIP-related inventory preparation. Instead, vehicle miles traveled (VMT) should be consolidated into at least three average speed categories, and MOBILE5 used to estimate emission factors for each of those categories.

The average speed of the transient test cycle used for heavy-duty engine certification is 20 mph, which is representative of urban driving overall for these vehicles. Use of 19.6 mph as the average speed for all vehicles therefore leads to application of a very small speed correction factor to the HDGV and HDDV emission factors.

For some applications of MOBILE5, a single value other than 19.6 mph for average speed might be most appropriate. For example, to model emission factors typical of limited access highways, the use of a speed in the 55 to 65 mph range for all vehicle types would be appropriate.

When, as in SIP-related inventory preparation, MOBILE5 runs are required using speed(s) representative of certain areas (e.g., subsets of urban areas, specific highway links) or of certain times of day, there are often speed data available from local, regional, or state transportation planning agencies. The prediction of average speeds in the future is difficult, and may be a critical factor in some areas' ability to project compliance with SIP commitments and air quality standards. A discussion of how average speeds can be estimated from available data sources and additional guidance on the determination of average speeds for use in highway vehicle emission inventory development is provided in "Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources," EPA-450/4-81-026d (revised), 1992.

### 2.3.4 AMBIENT TEMPERATURE

#### 2.3.4.1 Description

Emissions vary considerably with ambient temperature. The value of temperature used to calculate the temperature correction factors for exhaust emissions, hot soak evaporative emissions, refueling emissions, and resting loss and running loss emissions will significantly affect the resulting emission factors.

If TEMFLG = 1 (see section 2.1.14), the temperature used to adjust the exhaust emission factors for all three exhaust pollutants, the hot soak component of evaporative emissions, the displacement component of refueling emissions, and resting loss and running loss emission factors will be calculated by MOBILE5 on the basis of the input minimum and maximum daily temperatures. The ambient temperature specified here will not be used. However, in all cases the value of ambient temperature must be between the values of minimum and maximum daily temperature.

If TEMFLG = 2, the value of ambient temperature specified here will be used as the basis of the temperature correction factors for all exhaust emissions, hot soak evaporative emissions, refueling emissions, and resting loss and running loss emissions. The input values for minimum and maximum daily temperatures will still be used in calculating the diurnal component of evaporative emissions. If the specified ambient temperature is inconsistent with the minimum and maximum daily temperatures (e.g., 20°F ambient with 60°F minimum and 84°F maximum), an error message will result and processing of the current scenario will be stopped.

#### 2.3.4.2 Options

The ambient temperature specified can range from 0°F (-18°C) to 110°F (43°C). If a temperature less than 0°F is input, a warning message will be issued, and 0°F will be used in the calculations (if TEMFLG = 2). Similarly, if a temperature greater than 110°F is input, a warning is issued, and 110°F is used in the calculations (if TEMFLG = 2).

#### 2.3.4.3 Use of Ambient Temperature in MOBILE5

The basic emission rates that underlie the emission factor calculations are developed from emission data from vehicles tested at FTP conditions, at a nominal test temperature of 75°F (24°C). MOBILE5 uses temperature correction factors to correct exhaust emission factors to temperatures other than 75°F. Temperature corrections are also applied to the hot soak component of evaporative HC emissions. Refueling, resting loss, and running loss emissions are all functions of temperature. If the value of TEMFLG = 2, the value input here for ambient temperature is used to determine these correction factors.

#### 2.3.4.4 Required Information

A value of ambient temperature in degrees Fahrenheit (°F).

#### 2.3.4.5 Changes Since MOBILE4.1

There have been no revisions to this variable's use or input data format requirements since the release of MOBILE4.1.

#### 2.3.4.6 Guidance

EPA generally recommends that the minimum and maximum daily temperatures be used to determine the temperatures for corrections to the emission factors if daily average emissions are to be estimated, rather than hour-by-hour emissions.

If this ambient temperature is used instead, the value specified depends in large measure on the purpose for which MOBILE5 is being used. Additional information and guidance on the determination of appropriate temperature values for use in SIP-related emission inventory preparation appears in "Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources," EPA-450/4-81-026d (revised), 1992.

The ambient temperature logically must be between the minimum and maximum temperatures. This is particularly important when HC emission factors are being modeled, since minimum and maximum temperatures are used in the evaporative emission component of those calculations, and the evaporative and exhaust components of the emission factor should be estimated on a consistent basis. Modeling of CO emission factors is more likely to focus on times with cooler temperatures, when most violations of the National Ambient Air Quality Standard (NAAQS) for CO occur.

### 2.3.5 OPERATING MODES (PCCN, PCHC, PCCC)

#### 2.3.5.1 Description

One important determinant of emissions performance is the mode of operation. EPA's emission factors are based on testing over the FTP cycle, which is divided into three segments (referred to as "bags"), each with differing associated emissions performance. The bags correspond to operating modes:

<u>Bag</u>	<u>Operating Mode</u>
1	Cold start
2	Stabilized
3	Hot start

Emission data from each of these bags reflect the fact that emissions generally are highest when a vehicle is in cold-start mode: the vehicle, engine, and emission control equipment (particularly the catalytic converter) are all at ambient temperature and thus not performing at optimum levels. Emissions are generally somewhat lower in hot start mode, when the vehicle is not yet completely warmed up but was not sitting idle for sufficient time to have cooled completely to ambient temperatures. Finally, emissions generally are lowest when the vehicle is operating in stabilized mode, and has been in continuous operation long enough for all systems to have attained relatively stable, fully "warmed-up" operating temperatures.

Vehicle operating modes (cold start, hot start, and stabilized operation) are determined in MOBILE5 by allocating the amount of vehicle travel to each of the three corresponding "bags" of the FTP described above. Emission factors for each bag are the cumulative emissions of that segment of the FTP averaged over the distance traveled during that segment. The cold-start bag (bag 1) is represented by the first 3.5 miles (approximately) traveled by a vehicle after a "cold-start," and the hot-start bag (bag 3) is represented by the first 3.5 miles of operation after a "hot-start."

The three variables PCCN, PCHC, PCCC are sufficient to completely define the percent VMT accumulated in each of the three operating modes by vehicles in each of two basic emission control configurations, non-catalyst and catalyst-equipped. Thus the input of values for percent VMT accumulated in hot start mode by non-catalyst vehicles, or in stabilized mode by non-catalyst or catalyst-equipped vehicles, is not required as input. MOBILE5 calculates these quantities from the three values entered.

The definitions of the three variables and how they together define the six vehicle type/operating mode combinations are shown below:

<u>Vehicle Type</u>	<u>Operating Mode</u>	<u>Defined in MOBILE5 as:</u>
Non-catalyst	Cold-start	PCCN
Catalyst	Hot-start	PCHC
Catalyst	Cold-start	PCCC
Catalyst	Stabilized	1.0 - PCCC - PCHC
Non-catalyst	Stabilized	1.0 - PCCC - PCHC (assumed equal to the stabilized VMT fraction for catalyst-equipped vehicles)
Non-catalyst	Hot-start	PCCC - PCCN + PCHC

The user should not expect the sum of PCCN + PCHC + PCCC to be 100 percent. While it is true that (percent VMT in cold-start mode) + (percent VMT in hot-start mode) + (percent VMT in hot stabilized mode) always equals 100 percent, for both catalyst-equipped and non-catalyst vehicles, the variables PCCN, PCHC, and PCCC are not equivalent to these variables.

The values of PCHC, PCCC, and PCCN are used in the calculation of the bag-dependent correction factors (such as temperature and volatility) for LDV, LDT, and MC emission factors. It is assumed that all diesel vehicles and all motorcycles are non-catalyst.

#### 2.3.5.2 Options

The three specified values must all be expressed as percentages (not as fractions). Each value must lie between 0.0 and 100.0. The sum of PCHC + PCCC must not exceed 100 percent. The value of PCCN logically should not be greater than that of PCCC, for the reasons discussed above.

#### 2.3.5.3 MOBILE5 Standard (FTP) Operating Mode Fractions

The values of the three variables corresponding to the conditions of the FTP cycle are:

PCCN	20.6 %
PCHC	27.3 %
PCCC	20.6 %

These values reflect the same assumptions and conditions that are reflected in other aspects of the Federal Test Procedure.

#### 2.3.5.4 Required Information

Three percentage values, reflecting the percentage of VMT (not the percentage of vehicles) accumulated by non-catalyst vehicles in cold-start mode (PCCN), by catalyst-equipped vehicles in hot-start mode (PCHC), and by catalyst-equipped vehicles in cold-start mode (PCCC).

#### 2.3.5.5 Changes Since MOBILE4.1

There have been no revisions in the definitions or in the use or format requirements of these variables since the release of MOBILE4.1.

#### 2.3.5.6 Guidance

EPA historically has defined cold starts to be any start that occurs at least four hours after the end of the preceding trip for non-catalyst vehicles and at least one hour after the end of the preceding trip for catalyst-equipped vehicles. Hot starts are those starts that occur less than four hours after the end of the preceding trip for non-catalyst vehicles and less than one hour after the end of the preceding trip for catalyst-equipped vehicles. The shorter time interval associated with the cold/hot start definition for catalyst-equipped vehicles reflects the fact that catalytic converters do not operate at intended efficiency until they are fully warmed up (to operating temperatures in the 600●F (316●C) range); thus catalyst-equipped vehicles reflect "cold-start" emissions performance after a much shorter off time than do non-catalyst vehicles, which do not depend on attainment of such high temperatures for stabilization of emissions performance.

In the absence of supporting data for values other than those listed above, EPA believes that the values reflecting FTP conditions are appropriate in many cases. This is particularly true when the emission factors being modeled are intended to represent a broad geographic area (Metropolitan Statistical Area, entire state) and/or time

period (days, months). When the modeling is intended to represent highly localized conditions (specific highway links) or very limited periods of time (as single hours), it may be possible to develop more representative values for these variables. Areas known to have average trip lengths significantly shorter or longer than 7.5 miles may also merit the use of alternate values.

Thus for SIP-related modeling, EPA will accept the use of the FTP operating mode values except for small scale scenarios where their use would clearly be inappropriate. EPA will not accept SIP-related modeling that includes different operating mode fractions for the base and projection years without adequate quantitative written justification.

There are several ways of approximating the percentage of VMT accumulated in each mode for each type of vehicle, although highly accurate determinations are not readily obtainable. Guidance on three possible methods for determining the cold-start/hot-start VMT fractions for non-catalyst and catalyst-equipped vehicles, including references to generally available data sources, appears in Chapter 8 of the report "Techniques for Estimating MOBILE2 Variables."

Some transportation emissions modeling approaches are based on the concepts of trip-start emissions and running emissions, rather than the method described above. MOBILE5 does not directly mesh well with this approach, but can be manipulated to do so. Modelers should contact EPA to discuss the suitability of this approach and for assistance in using MOBILE5 to develop the appropriate emission factors.

### **2.3.6 MONTH**

#### **2.3.6.1 Description**

MOBILE5 provides the user with the option of calculating emission factors for January 1 or July 1 of the calendar year of evaluation. This option is exercised by the addition of a value for "month" at the end of the mandatory scenario record, following the operating mode percentages. This feature is new in MOBILE5.

#### **2.3.6.2 Options**

Emission factors can be calculated as of January 1 or July 1 of the calendar year specified.

#### **2.3.6.3 Month in MOBILE5**

MOBILE4.1 always calculated emission factors on the basis of the fleet composition as of January 1 of the calendar year of evaluation. MOBILE5 allows the choice of January 1 or July 1. The month specified will affect the calculated emission factors in two ways: By changing the composition of the fleet (July 1 emission factors will reflect an additional six months of fleet turnover, or replacement of older vehicles by new vehicles), and how the effects of reformulated gasoline (RFG) are modeled. If the month selected is January, winter season RFG rules will be applied, while if the month selected is July, summer season RFG rules will be applied (see section 2.2.16).

The value of month is independent of temperature, fuel volatility, and other inputs, which still must be selected by the user in a way that is consistent with the intended application of the results. Section 2.3.6.6 provides cautions concerning the use of the July 1 option.

#### **2.3.6.4 Required Information**

The value of month is optional: If no value is supplied, January is assumed (equivalent to MOBILE4.1 modeling). To specify January or July, a value of 1 (January) or 7 (July) is entered here. No other values for

month can be entered. The value of month is a single integer digit (format **I1**), and it follows after the operating mode fractions and two blank spaces.

#### 2.3.6.5 Changes Since MOBILE4.1

This is a new feature of MOBILE5.

#### 2.3.6.6 Guidance

This option has two primary functions. For the modeling of summertime emission factors, the user formerly had to interpolate between two consecutive calendar years' emission factors calculated using the same summer condition inputs (such as temperature and fuel volatility). For example, July 1, 1990 emission factors were calculated as the average of calendar year (CY) 90 (1/1/90) and CY 91 (1/1/91) MOBILE4.1 runs. This option allows July 1 emission factors to be directly calculated by MOBILE5. In addition, the value of month provided here serves to determine the season for the modeling of reformulated gasoline effects on emissions, with January indicating winter season and July indicating summer season. The choice of January or July emission factors should be made in a logical way.

The July 1 emission factors are determined by simple interpolation between the results of two January 1 evaluations, just as though the calculations were performed using the results of two separate MOBILE5 runs. As a result, all of the cautions necessary when interpolating between two sets of January 1 MOBILE5 runs will apply when setting the model inputs. Since the interpolation is done automatically, there is a greater danger that MOBILE5 will misinterpret the intent of the user.

For example, consider the case where a user specifies that the fuel RVP (Reid vapor pressure) will change from 11.5 psi to 10.5 psi in 1989, and then evaluates summer emission factors for calendar years 1988, 1989, and 1990 using the July 1 option for month. Since the model interpolates between January 1 evaluations, the July 1 1988 emission factors are simply an interpolation of January 1 1988 and January 1 1989 emissions. Unfortunately, the January 1989 emission factors are calculated assuming 10.5 psi RVP fuel, since this change in RVP is specified to start in 1989. This means that the interpolated emission factors will be lower than they should be, since only 11.5 psi RVP fuel was actually available in July of 1988. The correct July 1988 emission factors can only be determined if both the January 1988 and January 1989 RVP levels match the RVP of fuel available in July of 1988. In this case, the July 1988 case should be run separately with a single RVP input (11.5 psi).

It is important to consider, when using the July month option, whether the user inputs will be properly interpreted by MOBILE5 for all specified calendar years of evaluation. The simple rule is to make sure that the conditions specified for the January 1st before and after the July 1 of interest both have the conditions you wish to assume for the July 1 date. The most common problems will involve conditions that change abruptly, such as fuel RVP. Conditions that phase in slowly, such as changes in an inspection and maintenance (I/M) program, will not cause similar problems, since few if any vehicles are immediately affected by I/M program changes on the first day of their implementation (January 1st).

### **2.3.7 LEV PROGRAM PARAMETER RECORD**

#### 2.3.7.1 Description

This record, which is required only if the value selected for "region" in the scenario descriptive record is "4" (see section 2.3.1), provides the user the ability to include the effects of opting in to the California low emission vehicle (LEV) program on a different schedule than is to be used in California, or of assuming an I/M program for LEV program vehicles that does not meet the criteria for maximum emission reductions described in Appendix 2B.

### 2.3.7.2 Options

This record provides the user the ability to select a start year for the phase-in of California LEV program that is later than 1994, and/or to have the I/M emission credits for LEV program vehicles be based on an I/M program other than as described in section 2.3.1 and in Appendix 2B.

### 2.3.7.3 Required Information

This record, if used, specifies the start year for phase in of LEVs and whether the I/M program assumed to apply to LEVs meets the criteria given in section 2.3.1 and in Appendix 2B. The format of this record is **I2,IX,I1**. The first value entered is the last two digits of the year that LEVs begin to be phased in, and the second is a flag indicating what assumptions are to be made regarding the I/M program for LEVs. Setting this flag to "1" means that an I/M program not meeting the criteria detailed in Appendix 2B will be applied to LEVs [i.e., the I/M program specified by the user in the One-time Data section; if no I/M program is specified in the One-Time Data section (IMFLAG = 1), then no I/M program will be applied to LEVs], while setting this flag to "2" means that the I/M program for LEVs fits the criteria discussed in Appendix 2B. Note that this means that if the value of region is set to 4, and the start year is 94 and the I/M flag is 2 on the LEV program parameter record, then the effect is identical to setting the value of region to 3 and not using the LEV program parameter record.

### 2.3.7.5 Changes Since MOBILE4.1

This is a new feature of MOBILE5.

### 2.3.7.6 Guidance

The user is encouraged to read closely the sections on inspection/maintenance (I/M) programs (section 2.2.5), the "region" variable on the Scenario record (section 2.3.1), and Appendix 2B for additional information on the modeling of LEV programs and the interaction of LEV and I/M programs.

Areas that opt-in to the California LEV program will use values of 3 or 4 for the REGION variable (section 2.3.1). Since no areas outside of California will implement LEV program requirements with the same start year as California, the value of 4 generally will be used for REGION and the LEV program parameter record will be required. In order to set the value of the I/M flag on the LEV program parameter record to "2", the area must also implement an I/M program for LEVs that meets the criteria set forth in Appendix 2B: (i) The I/M program for LEVs must include a transient loaded test, such as the IM240, and functional purge and pressure testing of the evaporative emission control system (see section 2.2.6.2); (ii) the program must include automated checks of the onboard diagnostic (OBD) system and repair requirements based on the results of this check; and (iii) the SIP must include provisions for auditing the in-use performance of LEV program vehicles and correcting any shortfalls that may be discovered in such audits.

It is noted again here that an I/M program meeting the criteria detailed in Appendix 2B is modeled by setting the appropriate flag values, as discussed above. The I/M program descriptive record (section 2.2.5) is not applied to LEV program vehicles if an I/M program meeting the criteria in Appendix 2B (or its equivalent as approved by EPA) is indicated. Note that this also means that the cutpoints to be used in an I/M program for LEVs *that meets the criteria detailed in Appendix 2B* are not entered on the I/M program descriptive record(s).

## **2.3.8 LOCAL AREA PARAMETER RECORD**

The local area parameter (LAP) record was discussed in sections 2.2.8 through 2.2.16, and is summarized in Table 2.2-10. It must appear in the Scenario data section if a different LAP record is to be applied to each scenario (LOCFLG = 1), and must appear in the One-time Data section if the same LAP record is to be applied for

all scenarios (LOCFLG = 2). If the user elects to supply diesel sales fractions by model year as input data by setting DSFLAG = 2 on the LAP record, then the LAP record must be included for each scenario. The information provided in sections 2.2.8 through 2.2.16 is applicable in either case. This record must be supplied, in either the One-time data section or the Scenario data section, for every MOBILE5 run.

### **2.3.9 OXYGENATED FUELS DESCRIPTIVE RECORD**

#### **2.3.9.1 Description**

If the user chooses to model the effects of the use of oxygenated fuels on exhaust emissions, then the value of OXYFLG on the LAP record must be 2 (section 2.2.14). If this option is chosen, then a record describing the market share and average oxygen content of oxygenated fuels in the time and area being modeled must be provided. This record must immediately follow the LAP record. Thus if the user is applying a single LAP record for all scenarios (LOCFLG = 2), this record will appear immediately after the LAP record and before any other One-Time Data that may also be included. If the user is applying a distinct LAP record for each scenario (LOCFLG = 1), then the LAP record is the second scenario record for each scenario, and this record immediately follows as the third scenario record for each scenario.

If the user is modeling reformulated gasoline (RFG), RFG provisions will take precedence over the provisions of any oxygenated fuels descriptive record input. This means that if RFG is assumed (RFGFLG = 2) and oxygenated fuels are assumed (OXYFLG = 2), the fuel oxygen content used in the emission factor calculations will be that defined by RFG and the oxygen content specified on this record will be overridden.

#### **2.3.9.2 Options**

The user has the choice of not accounting for the effects of oxygenated fuel use (by setting OXYFLG = 1 or leaving the space for OXYFLG blank), or of accounting for the effects of such fuels on exhaust emissions (by setting OXYFLG = 2).

#### **2.3.9.3 Use in MOBILE5**

If the user chooses to model the effects on exhaust emissions of the use of oxygenated fuels, the information detailed below is supplied and MOBILE5 uses it to estimate the reductions in exhaust emissions that result for gasoline-fueled vehicle types (LDGV, LDGT1, LDGT2, HDGV, and MC).

#### **2.3.9.4 Required Information**

If the user has set OXYFLG = 2, then the record containing this information must immediately follow the LAP record in the input data file. If the LAP record is in the One-Time Data section, then this record immediately follows it and precedes any other One-Time Data records that are being supplied. If the LAP records are in the Scenario section, then this record immediately follows each LAP record (as the third Scenario data record for each scenario).

The record consists of the following five variables:

- Ether blend market share (expressed as a fraction)
- Alcohol blend market share (expressed as a fraction)
- Average oxygen content of ether blend fuels (% weight, expressed as a fraction)
- Average oxygen content of alcohol blend fuels (% weight, expressed as a fraction)
- RVP waiver switch [integer value indicating whether alcohol-based oxygenated fuels must meet the same RVP limit as straight gasoline (value = 1), or have been granted a 1.0 psi waiver (value = 2)]



The format of this record is:

**4(F4.3,1X),I1**

To illustrate, the following oxygenated fuel input data record states that 3.5 percent of the fuel sold in the area is ether blends having an average oxygen content of 2.7 percent weight, that 12.9 percent of the fuel sold in the area is alcohol blends having an average oxygen content of 3.1 percent by weight, and that an RVP waiver is in effect allowing the volatility of the alcohol-based oxygenated fuels to be up to 1.0 psi RVP greater than the limit applicable to straight gasoline:

.035 .129 .027 .031 2

2.3.9.5 Changes Since MOBILE4.1

There have been no revisions to the oxygenated fuels input data since the release of MOBILE4.1.

2.3.9.6 Guidance

Areas that are known to have significant market penetration (two percent or greater market share) of ether blends and/or alcohol blends should attempt to accurately characterize the relative market shares and oxygen content of these fuel blends, and account for it in their emission factor modeling for SIP purposes. Areas having insignificant market penetration of both types of oxygenated fuels may safely disregard oxygenated fuels in their modeling.

EPA should be contacted for assistance in modeling the effects of oxygenated fuels if any of the following situations apply: (i) the fuels available in an area include blends containing both ether(s) and alcohol(s) in the same fuel, or (ii) an RVP waiver greater than 1.0 psi is applicable to oxygenated fuels in an area, or (iii) no RVP waiver is in effect but the volatility of base gasoline is currently below the regulated limit, or (iv) if two or more types of alcohol blends are marketed under different RVP waiver treatment. Additional guidance may be obtained through contacting the appropriate EPA Regional Office or the Office of Mobile Sources.

If the user has specified that reformulated gasoline (RFG) is to be accounted for in the emission factors by setting RFGFLG = 2 (see sections 2.2.8 and 2.2.16) and the season for which emission factors are being modeled is summer (indicated by value of 7 (July) for month on the scenario record, see section 2.3.6), then the oxygen content of the fuel is controlled by the provisions of the RFG regulations and any user input for average oxygen content is ignored. If the user specifies RFG and the season is winter (indicated by value of 1 (January) for month), the user-input oxygen content will be used rather than the default RFG oxygen content. Oxygen content of RFG is mandated in summer but not in winter. See section 2.2.16 for additional information.

**2.3.10 DIESEL SALES FRACTIONS**

2.3.10.1 Description

In section 2.2.15, the use of diesel sales fractions by model year for LDVs and LDTs in MOBILE5 is discussed. These fractions represent the share of all LDV (LDT) sales in a given model year which are diesel-powered, rather than gasoline-fueled, vehicles.

2.3.10.2 Options

The user can choose to supply sets of diesel sales fractions by model year for both LDVs and LDTs that are locality-specific (and different from the national sales fractions that are included in MOBILE5), or to use the national sales fractions. The options are exercised through the value assigned to DSFLAG, the second of the three optional flags at the right end of the LAP record. As noted previously, if the user is supplying diesel sales fraction data, it must be included in the Scenario data section and the LAP record(s) must also appear in the Scenario data section.

#### 2.3.10.3 Use in MOBILE5

MOBILE5, like earlier versions of the model, uses a single set of registration distributions by age and annual mileage accumulation rates to describe all LDVs (gasoline and diesel combined), and another such set to describe all LDTs. This is due in part to the fact that it is nearly impossible to develop such information for gas and diesel vehicles separately, and in part since there is little evidence to suggest that typical use patterns, mileage accumulation rates, and so forth are different for gas and diesel vehicles. The use of model-year-specific diesel sales fractions allows MOBILE5 to internally split the LDVs and LDTs into gas and diesel sub-categories, which have distinctly different emission rates and behaviors.

MOBILE4 contained forecasts of increasing diesel sales. MOBILE5 assumes that diesel sales after 1990 will show essentially no increase from current very low levels.

#### 2.3.10.4 Required Information

If the user is supplying alternate diesel sales fractions as input to the model, then the information immediately follows the LAP record and the oxygenated fuels descriptive record (if the oxygenated fuels record is present).

For each scenario, the user must supply the fractions of LDV and LDT sales that were diesel for each model year from the calendar year of evaluation back to 24+ model years ago. For example, if the calendar year of evaluation is 1990, then diesel sales fractions for model year 1990, 1989, 1988, ..., 1967, and 1966-and-older LDVs and LDTs must be provided. If two different scenarios are being run, both for the same calendar year but with other differences, then the same set of diesel fractions would have to be supplied again as part of the second scenario. If a scenario with calendar year 1995 was also being run, then the diesel sales fractions would represent model year 1995, 1994, ..., 1972, and 1971-and-older vehicles. The same values would be used for the model years in common to the two sets of sales fractions, but the five oldest model year values would "drop off the end" of the sequence and be replaced by sales fractions for the five most recent model years.

The 50 diesel sales fractions, 25 each for LDVs and LDTs, will constitute the next three records. The format of these records is:

**(20F4.3/  
20F4.3/  
10F4.3/)**

The values are entered in pairs: The first two values on the first record are the diesel sales fractions for LDVs and LDTs of age 1 (model year = calendar year of evaluation), the second two values are the sales fractions for LDVs and LDTs of age 2 (model year = one year before calendar year of evaluation), and so on, with the last two values on the third record being the sales fractions for age 25+ LDVs and LDTs (model year = 24+ years before calendar year of evaluation).

Note that there are no leading zeros or spaces in these input records. The fractions should be listed to three decimal places, one after another, with the values paired to represent cars then light trucks of each age. The MOBILE5 diesel fractions, formatted according to the requirements above, appear below (these fractions are for calendar year 1990, and represent model years 1990 through 1976-and-older).

.000.002.000.002.000.002.003.003.003.007.009.011.017.023.021.04 7.047.093.059.056  
 .044.035.021.018.009.008.005.000.003.000.002.000.003.000.002.00 0.002.000.001.000  
 .000.000.000.000.000.000.000.000.000

#### 2.3.10.5 Changes Since MOBILE4.1

There have been no revisions to the input or application of alternate diesel sales fractions since the release of MOBILE4.1.

#### 2.3.10.6 Guidance

This option is provided in MOBILE5 for two reasons. First, some users performing highway vehicle emission factor modeling may have access to vehicle registration data, or data from other sources, enabling them to characterize diesel sales of LDVs and LDTs in the area being modeled. Particularly if these sales fractions differ significantly from those included in MOBILE5, it will enhance the accuracy of the emission factors and inventory to use those sales fractions as model input. Second, as can be seen by the sharp rise and equally sharp fall of diesel sales in the late 1970s and early 1980s, it is extremely difficult to forecast diesel sales fractions for future model years. This provision will allow modelers to account for future increases in diesel sales, if such increases occur.

### **2.3.11 VEHICLE MILES TRAVELLED MIX by vehicle type**

The VMT mix by vehicle type was discussed in section 2.2.2. This record must appear in the Scenario data section if different VMT mixes are to be applied to each scenario (VMFLAG = 2), and must appear in the One-time data section if the same VMT mix is to be applied to all scenarios (VMFLAG = 3). The information provided in section 2.2.2 applies in both cases. This record is not required if the MOBILE5 VMT mix is to be used (VMFLAG = 1).

### **2.3.12 TRIP LENGTH DISTRIBUTION**

#### 2.3.12.1 Description

EPA has determined through its running loss emission test programs that the level of running loss emissions depends on several variables: the average speed of the travel, the ambient temperature, the volatility (RVP) of the fuel, and the length of the trip. "Trip length" as used here refers to the duration of the trip (how long the vehicle has been traveling), not on the distance traveled in the trip (how far the vehicle has been driven). Test data show that for any given set of conditions (average speed, ambient temperature, and fuel volatility), running loss emissions are zero to negligible at first, but increase significantly as the duration of the trip is extended and the fuel tank, fuel lines, and engine become heated.

The additional data obtained since the development of MOBILE4.1 allow running loss emissions to be modeled as a direct function of the input temperature, fuel volatility, and average speed. While an internal weighting of trip lengths (durations) is included in the model and is used to estimate the running loss emission factors, the user now has the option of supplying an alternate trip length distribution for use in estimating running loss emissions. If this option of specifying trip length distributions is not selected, then MOBILE5 will calculate the running loss emission factors on the basis of an internal assumed trip length distribution.

#### 2.3.12.2 Options

The user can let MOBILE5 estimate running loss emission factors using the internal trip length distributions (SPDFLG = 1 or 2), or can supply a set of trip length distributions (SPDFLG = 3 or 4).

### 2.3.12.3 Use in MOBILE5

For each combination of vehicle type and trip length category (see below), a value representing running loss emissions at the standard test speed, temperature, and volatility is contained in the coded data. This information, if supplied, is used in weighting these factors together to derive the fleet average emission factor, which then is corrected for average speed, temperature, and fuel volatility.

### 2.3.12.4 Required Information

If a modeler has the necessary information, a separate input data record of trip length distribution can be supplied as input and used in the calculation of running loss emission factors. This record must list the percentage of all travel (VMT) being accumulated over the time period that the emission factors apply for, in trips of the following lengths (durations):

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

The six percentage values specified must sum to 100%. The format of this record is:

**6(1X,F4.1)**

The record may appear in the One-Time data section or in each Scenario data section, depending on value of SPDFLG specified by the user.

### 2.3.12.5 Changes Since MOBILE4.1

There have been no changes made to the input of these variables or their interpretation and used by the model since the release of MOBILE4.1.

### 2.3.12.6 Guidance

Solid data on trip length distributions is not likely to be available in most cases. Thus for base year emission inventory development by States and others, EPA will accept the use of the internal trip length distributions for the estimation of running loss HC emission factors. The use of trip length distributions other than that included in MOBILE5 in the development of required base year emission estimates must be adequately documented for acceptance by EPA. Where the transportation modeling process can produce reliable inputs for trip length distribution, it will allow more accurate estimates of the benefits attributable to SIP measures which shorten average trip lengths without eliminating entire trips.

## **2.3.13 ADDITIONAL CORRECTION FACTORS FOR LIGHT-DUTY GASOLINE-FUELED VEHICLE TYPES**

### 2.3.13.1 General Description

MOBILE5 provides the capability of applying four additional correction factors to the exhaust emission factors for LDGVs, LDGT1s, and LDGT2s. These factors are used to represent conditions not typically assumed in MOBILE5 runs, which is why they are segregated from other correction factors (such as speed and temperature).

These factors allow for exhaust emission factors only to be adjusted to account for the emissions impact of air conditioning (A/C) usage, extra loading, and trailer towing. There is also a humidity correction factor, which applies only to exhaust NO<sub>x</sub> emissions and is also applied to motorcycles.

### 2.3.13.2 Options

Depending on the value assigned to the ALHFLG flag controlling the application of these additional correction factors, six or ten input values may be required.

When ALHFLG = 2, six values are required:

- 1) One A/C usage fraction (for all LDGVs and LDGTs)
- 2-4) Three extra load usage fractions (for LDGVs, LDGT1s, LDGT2s)
- 5) One trailer towing fraction (for all LDGVs and LDGTs)
- 6) One humidity level (for all LDGVs and LDGTs plus motorcycles)

The format of this record in the case where ALHFLG = 2 is:

**F4.2,3F4.2,F4.2,F4.0**

When ALHFLG = 3, ten values are required:

- 1) One A/C usage fraction (for all LDGVs and LDGTs)
- 2-4) Three extra load usage fractions (for LDGVs, LDGT1s, LDGT2s)
- 5-7) Three trailer towing fractions (for LDGVs, LDGT1s, LDGT2s)
- 8) One humidity level (for all LDGVs and LDGTs plus motorcycles)
- 9-10) Dry and wet bulb temperatures (used to calculate an A/C usage fraction for LDGVs and LDGTs).

The format of this record in the case where ALHFLG = 3 is:

**F4.2,3F4.2,3F4.2,F4.0,2F4.0**

Each of these five types of input (A/C, extra load, trailer towing, humidity, and temperature) is discussed below.

### 2.3.13.3 A/C Usage Fraction

#### 2.3.13.3.1 Description

If you wish to include the effect on the exhaust emission factors of A/C usage, enter a nonzero value for this variable and appropriate dry and wet bulb temperatures, as explained below.

#### 2.3.13.3.2 Options

This fractional value must be between zero and one ( $0.0 \leq AC \leq 1.0$ ).

In the six-value option (ALHFLG = 2), no correction factor for A/C usage will be applied, regardless of the value that is entered. Entering 0.0 as the value is recommended in this case.

In the ten-value option (ALHFLG = 3), this variable acts as a flag, and the A/C usage fraction will be calculated on the basis of the dry bulb and wet bulb temperatures (see section 2.3.10.7). If 0.0 is entered, no correction factor will be applied, although values of dry and wet bulb temperature must still be provided. To have a correction factor for A/C usage calculated and applied, enter a nonzero value ( $0.0 < AC \leq 1.0$ ) and appropriate values for dry and wet bulb temperatures.

#### 2.3.13.4 Extra Load Usage Fractions

##### 2.3.13.4.1 Description

These values are used to model the exhaust emissions impact of vehicles carrying an extra 500 lb (227 kg) load. If you wish to include this effect, three fractional values are entered (one each for LDGVs, LDGT1s, and LDGT2s), representing the fraction of all vehicles of the given type carrying such an extra load.

##### 2.3.13.4.2 Options

These values must all lie between zero and one. If the value entered is zero, no correction for the effects of extra load is applied.

#### 2.3.13.5 Trailer Towing Usage Fraction

##### 2.3.13.5.1 Description

These values are used to model the impact on exhaust emissions of vehicles towing trailers. If you wish to include this effect in your modeling, one or three fractions are entered representing the fraction of vehicles of a given type that are to be assumed to be towing trailers.

##### 2.3.13.5.2 Options

Any value for this fraction must lie between zero and one. If the value entered is zero, no correction for the effect of trailer towing is applied.

In the six-value option (ALHFLG = 2), one value is entered and is applied to LDGVs, LDGT1s, and LDGT2s. In the ten-value option (ALHFLG = 3), three values are entered, to be applied to LDGVs, LDGT1s, and LDGT2s.

#### 2.3.13.6 NO<sub>x</sub> Humidity Correction

##### 2.3.13.6.1 Description

This value is used to correct exhaust NO<sub>x</sub> emission factors for absolute humidity. The value entered is the absolute (specific) humidity, expressed as grains water per pound of dry air.

##### 2.3.13.6.2 Options

The value entered for absolute humidity must lie between 20 and 140. If the value entered is 75, corresponding to the absolute humidity condition of the FTP, then no correction will be applied.

### 2.3.13.7 Dry and Wet Bulb Temperatures

#### 2.3.13.7.1 Description

MOBILE5 will calculate the fraction of A/C-equipped vehicles actually using their air conditioning on the basis of a "discomfort index," which in turn is calculated from the dry bulb and wet bulb temperatures.

#### 2.3.13.7.2 Options

The values of each of these temperatures must be between 0● and 110●F (-18● and 43●C), inclusive. In addition, the wet bulb temperature must be less than or equal to the dry bulb temperature. If any of these conditions are not met, an error message will be issued by MOBILE5.

These values (in ●F) will be used to calculate the A/C usage fraction on the basis of the discomfort index only if the ten-value option is selected (ALHFLG = 3) and a nonzero value is entered for the variable AC. If used, this calculated value overrides the value read in for AC as part of the input.

### 2.3.13.8 Changes Since MOBILE4.1

There have been no revisions to any of the variables discussed in this section, or to how they are supplied to the model as input data, since the release of MOBILE4.1.

### 2.3.13.9 Guidance

In most areas, ozone pollution episodes occur during summer months and very warm to hot temperatures. It is reasonable to assume that vehicle air conditioning usage is high under such conditions. The basic emission rates in MOBILE5 already include additional loading intended to simulate the use of air conditioning. The additional air conditioning correction factors that are calculated in MOBILE5 are of uncertain accuracy. The emissions impact for late model year vehicles of operating the air conditioner is not well quantified, and the fraction of vehicles equipped with air conditioning is substantially higher for the vehicle fleet of the late 1980s and beyond than it was for the fleet of the late 1970s. Thus the use of the air conditioning corrections to the emission factors is acceptable, but is not required, in the development of SIP inventories. EPA will accept SIP inventories that do not attempt to explicitly account for vehicle air conditioning use. The same approach that is taken in developing the base year inventory must also be used for projection inventories.

The humidity correction for NO<sub>x</sub> emissions accounts for the fact that when "excess" water vapor is present, some of the heat of combustion heats water vapor rather than enhancing NO<sub>x</sub> formation. As with the air conditioning correction, EPA will accept SIP inventories that do not attempt to account for local humidity. If the humidity correction is applied in the base year, the derivation of the value used, including sources of data, must be detailed in the emission inventory supporting documentation, and it must also be used in any projection inventories.

If you believe that conditions applying to a specific application of MOBILE5 warrant the use of one or more of the correction factors described in this section, and desire guidance beyond that provided above, contact EPA for additional information (Emission Control Strategies Branch, 313/668-4417).

This completes the Scenario data section.

## **2.4 SUMMARY OF MOBILE5 INPUT SEQUENCE**

The following tables summarize the input sequence required for a MOBILE5 run, in the order required by the program. Records listed in parentheses are optional, and are only required if certain flags have been assigned specific values in the Control section, or if certain other options have been selected.



Table 2.1-1

**FLAGS CONTROLLING INPUT TO AND EXECUTION OF MOBILE5**

<u>Record Number</u>	<u>Variable Name</u>	<u>Content and Codes</u>	<u>Format</u>	<u>Refer to Section</u>
1	<b>PROMPT</b>	Flag indicating whether user is to be prompted for remaining input data  1 = No prompting, vertical format 2 = Prompting, vertical format 3 = No prompting, horizontal format 4 = Prompting, horizontal format	I1,3A1	2.1.1
	<b>IOUNEW</b>	Optional reassignments of output units (used in mainframe version only):  1 - Formatted reports unit (IOUREP) = 7 2 - Diagnostic messages unit (IOUERR) = 7 3 - Prompting messages unit (IOUASK) = 6  (Allowable values for each unit are 1, 2, 5, 6, 7, 8, or 9. Units 3 and 4 are reserved for reading I/M credit files.)		2.1.2
2	<b>PROJID</b>	80 characters for title to be echoed in output	20A4	2.1.3
3	<b>TAMFLG</b>	Flag for optional input of tampering rates  1 = Use MOBILE5 tampering rates 2 = Input alternate tampering rates <sup>1</sup>	I1	2.1.4
4	<b>SPDFLG</b>	Flag indicating how average speed is being input (one value for all vehicle types or eight values, one for each vehicle type); also used to indicate whether alternate trip length distribution data are supplied as input  1 = One average speed for all vehicle types <sup>2</sup> 2 = Eight average speeds, one for each vehicle type <sup>2</sup> 3 = One average speed for all vehicle types, plus one alternate set of trip length distribution data per scenario <sup>3</sup> 4 = One average speed for all vehicle types, plus one alternate set of trip length distribution data for all scenarios <sup>4</sup>	I1	2.1.5

Table 2.1-1 (continued)

**FLAGS CONTROLLING INPUT TO AND EXECUTION OF MOBILE5**

<u>Record Number</u>	<u>Variable Name</u>	<u>Content and Codes</u>	<u>Format</u>	<u>Refer to Section</u>
5	<b>VMFLAG</b>	Flag indicating VMT mix by vehicle type to be used in calculating all-vehicle emission factor from eight vehicle-class-specific emission factors  1 = Use MOBILE5 VMT mix 2 = Input one VMT mix for <u>each</u> scenario <sup>2</sup> 3 = Input one VMT mix for <u>all</u> scenarios <sup>1</sup>	I1	2.1.6
6	<b>MYMRFG</b>	Flag indicating optional input of annual mileage accumulation rates and/or registration distributions by age  1 = Use MOBILE5 values 2 = Input annual mileage accumulation rates <sup>1</sup> 3 = Input registration distributions by age <sup>1</sup> 4 = Input both annual mileage accumulation rates and registration distributions <sup>1</sup>	I1	2.1.7
7	<b>NEWFLG</b>	Flag indicating optional input of modifications to basic exhaust emission rates (BERs)  1 = Use MOBILE5 BERs 2 = Input one or more alternate BERs <sup>1</sup> 3 = Use MOBILE5 BERs and specify new evap test procedure <sup>1</sup> 4 = Input one or more alternate BERs <sup>1</sup> and specify new evap test procedure <sup>1</sup> 5 = Use MOBILE5 BERs and disable all new Clean Air Act requirements 6 = Input one or more alternate BERs <sup>1</sup> and disable all new Clean Air Act requirements	I1	2.1.8     2.2.4.2 2.2.4.2 2.2.4.2 2.2.4.2

Table 2.1-1 (continued)

**FLAGS CONTROLLING INPUT TO AND EXECUTION OF MOBILE5**

<u>Record Number</u>	<u>Variable Name</u>	<u>Content and Codes</u>	<u>Format</u>	<u>Refer to Section</u>
8	<b>IMFLAG</b>	Flag indicating whether effect of one (or two) I/M program(s) on emission factors is to be included in the emission factor calculations  1 = No I/M program is assumed to be operating 2 = User specifies a single I/M program and MOBILE5 models its impact on emissions <sup>1</sup> 3 = User specifies two I/M programs and MOBILE5 models their impact on emissions <sup>1</sup> 4 = User specifies a single I/M program (same as IMFLAG = 2), and beginning in 1994, emission credits based on assuming a specific I/M program* for Tier 1 vehicles override the user-specified program for LDGVs & LDGTs <sup>1</sup> 5 = User specifies two I/M programs (same as IMFLAG = 3), and beginning in 1994, emission credits based on assuming a specific I/M program* for Tier 1 vehicles override the user-specified program for LDGVs & LDGTs <sup>1</sup>	I1	2.1.9, 2A.1, 2B
9	<b>ALHFLG</b>	Flag indicating whether exhaust emission factors (gasoline-fueled vehicles only) are to be corrected for one or more of the following:  1 = No corrections 2 = Input six values <sup>2</sup> 3 = Input ten values <sup>2</sup>  (a) air conditioning usage, (b) extra vehicle load, (c) trailer towing, (d) humidity (NOx only)	I1	2.1.10
10	<b>ATPFLG</b>	Flag indicating whether effects of anti-tampering program (ATP), and/or of functional pressure and/or purge checks of evaporative emission control system, are to be included in emission factor calculations  1 = No ATP modeled 2 = ATP modeled <sup>1</sup> 3 = Functional pressure check of evap system modeled <sup>1</sup> 4 = Functional purge check of evap system modeled <sup>1</sup> 5 = ATP and functional pressure check of evap system modeled <sup>1</sup> 6 = ATP and functional purge check of evap system modeled <sup>1</sup> 7 = Functional pressure and purge checks of evap system modeled <sup>1</sup> 8 = ATP and functional pressure and purge checks of evap system modeled <sup>1</sup>	I1	2.1.11, 2A.2

\* See sections 2.2.5, 2.3.1, 2.3.7, and Appendix 2B for additional information on the specific I/M program that is assumed for Tier 1 vehicles when IMFLAG is set to 4 or 5.

Table 2.1-1 (continued)

**FLAGS CONTROLLING INPUT TO AND EXECUTION OF MOBILE5**

<u>Record Number</u>	<u>Variable Name</u>	<u>Content and Codes</u>	<u>Format</u>	<u>Refer to Section</u>
11	<b>RLFLAG</b>	Flag indicating whether, and how, refueling emission factors are calculated  1 = Calculate refueling emission factors using uncontrolled refueling emission rates 2 = Calculate refueling emission factors assuming use of Stage II vapor recovery system (VRS) <sup>1</sup> 3 = Calculate refueling emission factors assuming use of onboard VRS <sup>1</sup> 4 = Calculate refueling emission factors assuming use of both Stage II and onboard VRS <sup>1</sup> 5 = No refueling emission factors calculated	I1	2.1.12
12	<b>LOCFLG</b>	Flag indicating user input of local area parameter (LAP) record  1 = One LAP record input for <u>each</u> scenario <sup>2</sup> 2 = One LAP record input for <u>all</u> scenarios <sup>1</sup>	I1	2.1.13
13	<b>TEMFLG</b>	Flag indicating how temperatures to be used in correcting emission factors for effects of temperature will be determined from input (daily minimum/maximum and ambient) temperatures  1 = MOBILE5 calculates trip- and emission-weighted temperatures to be used in correcting emission factors from the input values of minimum and maximum daily temperature; the input value of ambient temperature is overridden by the calculated values  2 = The input value of ambient temperature is used to correct emission factors for temperature effects	I1	2.1.14

**NOTE:** This flag controls the temperatures used to correct exhaust, running loss, resting loss, and hot soak emissions only. Diurnal evaporative emissions and refueling emissions are always corrected for temperature on the basis of the input daily minimum and maximum temperatures.

<sup>1</sup> Record(s) must appear in One-time data section.

<sup>2</sup> Record(s) must appear in Scenario data section.

<sup>3</sup> Speed value(s) appear in usual location(s) on first Scenario data record; alternate trip length distributions appear as additional Scenario section data records.

<sup>4</sup> Speed value(s) appear in usual location(s) on first Scenario data record; alternate trip length distribution appears as additional One-Time data section record.

Table 2.1-2

**FLAGS CONTROLLING OUTPUT OF MOBILE5**

<u>Record Number</u>	<u>Variable Name</u>	<u>Content and Codes</u>	<u>Format</u>	<u>Refer to Section</u>
14	<b>OUTFMT</b>	Flag selecting the structure of the formatted emission factor output report  1 = 222-column numerical 2 = 140-column numerical 3 = 112-column descriptive 4 = 80-column descriptive 5 = 112-column descriptive, plus "by model year" tables 6 = Spreadsheet (CSV) output	I1	2.1.15
15	<b>PRTFLG</b>	Flag indicating pollutants for which emission factors are to be calculated and included in output  1 = Hydrocarbons (HC) only 2 = Carbon monoxide (CO) only 3 = Oxides of nitrogen (NOx) only 4 = All three pollutants	I1	2.1.16
16	<b>IDLFLG</b>	Flag indicating whether idle emission factors are to be calculated  1 = No idle EFs      2 = Include idle EFs	I1	2.1.17
<b>NOTE:</b> Idle emission factors are not provided by MOBILE5 (see sections 1.1.6, 2.1.17).				
17	<b>NMHFLG</b>	Flag indicating choice of composition for "hydrocarbon" emission factors  1 = Total hydrocarbons (THC) 2 = Non-methane hydrocarbons (NMHC) 3 = Volatile organic compounds (VOC) 4 = Total organic gasses (TOG) 5 = Non-methane organic gasses (NMOG)	I1	2.1.18
18	<b>HCFLAG</b>	Flag indicating how HC emission factors are presented in output  1 = No component EFs printed (sum of HC emissions only) 2 = Component and total EFs printed 3 = Component and total EFs printed, with detailed evaporative emission breakdown in grams (sum of HC emissions will exclude refueling)	I1	2.1.19

Table 2.2-1

**SUMMARY OF ALTERNATE TAMPERING RATE RECORDS**

(required if TAMFLG = 2)

See section 2.2.1 for additional information.

**NON-I/M CASE (IMFLAG = 1)**

		Allowable		
		<u>RecordFieldContent and DescriptionFormat Values</u>		
1-4 <sup>1</sup>	1-8 <sup>2</sup>	ZML for pre-1981 MY vehicles	8F8.4/	0.0 - 1.0
5-8 <sup>1</sup>	1-8 <sup>2</sup>	ZML for 1981-83 MY vehicles	8F8.4/	0.0 - 1.0
9-12 <sup>1</sup>	1-8 <sup>2</sup>	ZML for 1984 and later MY vehicles	8F8.4/	0.0 - 1.0
13-16 <sup>1</sup>	1-8 <sup>2</sup>	DR for pre-1981 MY vehicles	8F8.4/	0.0 - 1.0
17-20 <sup>1</sup>	1-8 <sup>2</sup>	DR for 1981-83 MY vehicles	8F8.4/	0.0 - 1.0
21-24 <sup>1</sup>	1-8 <sup>2</sup>	DR for 1984 and later MY vehicles	8F8.4/	0.0 - 1.0

**I/M CASE (IMFLAG = 2, 3, 4, or 5)**

		Allowable		
		<u>RecordFieldContent and DescriptionFormat Values</u>		
1-4 <sup>1</sup>	1-8 <sup>2</sup>	Non-I/M ZML for pre-1981 MY vehicles	8F8.4/	0.0 - 1.0
5-8 <sup>1</sup>	1-8 <sup>2</sup>	Non-I/M ZML for 1981-83 MY vehicles	8F8.4/	0.0 - 1.0
9-12 <sup>1</sup>	1-8 <sup>2</sup>	Non-I/M ZML for 1984 and later MY vehicles	8F8.4/	0.0 - 1.0
13-16 <sup>1</sup>	1-8 <sup>2</sup>	I/M ZML for pre-1981 MY vehicles	8F8.4/	0.0 - 1.0
17-20 <sup>1</sup>	1-8 <sup>2</sup>	I/M ZML for 1981-83 MY vehicles	8F8.4/	0.0 - 1.0
21-24 <sup>1</sup>	1-8 <sup>2</sup>	I/M ZML for 1984 and later MY vehicles	8F8.4/	0.0 - 1.0
25-28 <sup>1</sup>	1-8 <sup>2</sup>	Non-I/M DR for pre-1981 MY vehicles	8F8.4/	0.0 - 1.0
29-32 <sup>1</sup>	1-8 <sup>2</sup>	Non-I/M DR for 1981-83 MY vehicles	8F8.4/	0.0 - 1.0
33-36 <sup>1</sup>	1-8 <sup>2</sup>	Non-I/M DR for 1984 and later MY vehicles	8F8.4/	0.0 - 1.0
37-40 <sup>1</sup>	1-8 <sup>2</sup>	I/M DR for pre-1981 MY vehicles	8F8.4/	0.0 - 1.0
41-44 <sup>1</sup>	1-8 <sup>2</sup>	I/M DR for 1981-83 MY vehicles	8F8.4/	0.0 - 1.0
45-48 <sup>1</sup>	1-8 <sup>2</sup>	I/M DR for 1984 and later MY vehicles	8F8.4/	0.0 - 1.0

<sup>1</sup> Records are in sets of four -- one each for LDGVs, LDGT1s, LDGT2s, and HDGVs, in that order.<sup>2</sup> Fields 1-8 hold the ZML or DR of the tampering rate equation for the following components, in order:

- 1 Air pump disablement
- 2 Catalyst
- 3 Fuel inlet restrictor disablement
- 4 Overall misfueling
- 5 EGR system disablement
- 6 Evaporative emission control system disablement
- 7 PCV system disablement
- 8 Missing gas cap

Table 2.2-2

**SUMMARY OF ANNUAL MILEAGE ACCUMULATION RATES RECORDS**(required if MYMRFG = 2 or 4)<sup>1</sup>

See section 2.2.3 for additional information.

<u>Allowable Record</u>	<u>Field</u>	<u>Content and Description</u>	<u>Format</u>	<u>Values</u>
1	1-10	Average annual mileage accumulation <sup>2</sup> for LDGVs of ages 1, 2, ..., 10	10F7.5/	≥ 0.0
2	1-10	Average annual mileage accumulation <sup>2</sup> for LDGVs of ages 11, 12, ..., 20	10F7.5/	≥ 0.0
3	1-5	Average annual mileage accumulation <sup>2</sup> for LDGVs of ages 21, 22, ..., 25+	5F7.5/	≥ 0.0
4	1-10	Average annual mileage accumulation <sup>2</sup> for LDGT1s of ages 1, 2, ..., 10	10F7.5/	≥ 0.0
5	1-10	Average annual mileage accumulation <sup>2</sup> for LDGT1s of ages 11, 12, ..., 20	10F7.5/	≥ 0.0
6	1-5	Average annual mileage accumulation <sup>2</sup> for LDGT1s of ages 21, 22, ..., 25+	5F7.5/	≥ 0.0
7-9 <sup>3</sup>		Average annual mileage accumulation <sup>2</sup> for LDGT2s		
10-12 <sup>3</sup>		Average annual mileage accumulation <sup>2</sup> for HDGVs		
13-15 <sup>3</sup>		Average annual mileage accumulation <sup>2</sup> for LDDVs		
16-18 <sup>3</sup>		Average annual mileage accumulation <sup>2</sup> for LDDTs		
19-21 <sup>3</sup>		Average annual mileage accumulation <sup>2</sup> for HDDVs		
22-24 <sup>3,4</sup>		Average annual mileage accumulation <sup>2</sup> for MCs		

1 If both annual mileage accumulation rates and registration distributions by age are being input (MYMRFG = 4), the two sets of values must be internally consistent (see section 2.2.3.4).

2 Values as input as miles/100,000 (e.g., 24,358 miles is input as .24358).

3 Records continue in sets of three per vehicle type, following the structure shown above for LDGVs and LDGT1s.

4 For motorcycles only, values of .00000 should be used for ages 13 thru 25+ (see section 2.2.3.3).

Table 2.2-3

**SUMMARY OF REGISTRATION DISTRIBUTION BY AGE RECORDS**(required if MYMRFG = 3 or 4)<sup>1</sup>

See section 2.2.3 for additional information.

<u>Allowable Record</u>	<u>Field</u>	<u>Content and Description</u>	<u>Format</u>	<u>Values</u>
1	1-10	Registration distribution fractions <sup>2</sup> for LDGVs <sup>3</sup> of ages 1, 2, ..., 10	10F5.3/	0.0 - 1.0
2	1-10	Registration distribution fractions <sup>2</sup> for LDGVs <sup>3</sup> of ages 11, 12, ..., 20	10F5.3/	0.0 - 1.0
3	1-5	Registration distribution fractions <sup>2</sup> for LDGVs <sup>3</sup> of ages 21, 22, ..., 25+	5F5.3/	0.0 - 1.0
4	1-10	Registration distribution fractions <sup>2</sup> for LDGT1s <sup>3</sup> of ages 1, 2, ..., 10	10F5.3/	0.0 - 1.0
5	1-10	Registration distribution fractions <sup>2</sup> for LDGT1s <sup>3</sup> of ages 11, 12, ..., 20	10F5.3/	0.0 - 1.0
6	1-5	Registration distribution fractions <sup>2</sup> for LDGT1s <sup>3</sup> of ages 21, 22, ..., 25+	5F5.3/	0.0 - 1.0
7-9 <sup>4</sup>		Registration distribution fractions <sup>2</sup> for LDGT2s		
10-12 <sup>4</sup>		Registration distribution fractions <sup>2</sup> for HDGVs		
13-15 <sup>4</sup>		Registration distribution fractions <sup>2</sup> for LDDVs <sup>3</sup>		
16-18 <sup>4</sup>		Registration distribution fractions <sup>2</sup> for LDDTs <sup>3</sup>		
19-21 <sup>4</sup>		Registration distribution fractions <sup>2</sup> for HDDVs		
22-24 <sup>4,5</sup>		Registration distribution fractions <sup>2</sup> for MCs		

1 If both annual mileage accumulation rates and registration distributions by age are being input (MYMRFG = 4), the two sets of values must be internally consistent (see section 2.2.3.4).

2 Values must sum to 1.0 for each vehicle type. The registration distribution entered as data for MOBILE5 should be based on July 1; MOBILE5 will convert them to a January 1 distribution if emission factors for January 1 are requested.

3 The same set of registration distribution fractions must be entered for LDGVs and LDDVs, and the same set for LDGT1s and LDDTs (see section 2.2.3.4).

4 Records continue in sets of three per vehicle type, following the structure shown above for LDGVs and LDGT1s.

5 For motorcycles only, values of .000 should be used for ages 13 thru 25+ (see section 2.2.3.4).



Table 2.2-4

**SUMMARY OF ALTERNATE BER RECORDS**

(required if NEWFLG = 2, 4, or 6)

See section 2.2.4 for additional information.

<u>Record</u>	<u>Field</u>	<u>Content, Description, and Codes</u>	<u>Format</u>	<u>Allowable Values</u>
1	1	Number of BER records to follow	I3/	1 to 100
2 thru N+1	1	Code for region new BER applies to:  1 = low-altitude 2 = high-altitude	I1,1X	1 or 2
	2	Code for vehicle type new BER applies to:  1 = LDGV    5 = LDDV 2 = LDGT1   6 = LDDT 3 = LDGT2   7 = HDDV 4 = HDGV    8 = MC	I1,1X	1 to 8
	3	Code for pollutant new BER applies to:  1 = HC      2 = CO      3 = NOx	I1,1X	1 to 3
	4	First model year new BER applies to (last 2 digits)	I2,1X	60-99, 00-20
	5	Last model year new BER applies to (last 2 digits)	I2,1X	60-99, 00-20
	6	New Zero-mile level (ZML)	F6.3,1X	≥ 0.0
	7	New Deterioration rate (or DR1*)	F6.3,1X	≥ 0.0
	8	New DR2*	F6.3/	≥ 0.0

\* DR2 for model year 1981 and later HC, CO, and NO<sub>x</sub> BERs for LDGVs, LDGT1s, and LDGT2s only. Field 8 is blank for all pollutant BERs for other vehicle types.

Table 2.2-5

**SUMMARY OF NEW EVAPORATIVE EMISSION TEST PROCEDURE RECORDS**  
 (required if NEWFLG = 3 or 4)

See section 2.2.4.2 for additional information.

<u>Record</u>	<u>Field</u>	<u>Content, Description, and Codes</u>	<u>Format</u>	<u>Allowable Values</u>
1	1	Number of records to follow, specifying new evaporative emission test procedure phase-in schedule (equal to number of model year steps in phase-in schedule)	I1/	1 to 4
2 thru N+1 <sup>1</sup>	1	Model year of vehicles in phase-in schedule for new evaporative emission test procedure	I2	95-99 or 00-20
	2	Percentage compliance with new evaporative emission test procedure required in this model year	F5.0/	0.0-100.0

<sup>1</sup> Model years must be listed in order; percentages must not decrease from one year to the next.

Table 2.2-6

**SUMMARY OF I/M PROGRAM DESCRIPTIVE INPUT RECORD(S)**

(required if IMFLAG = 2, 3, 4, or 5)

**NOTE:** MOBILE5 will model the effects of one or two I/M programs on emission factors. If two I/M programs are to be modeled, an I/M Program Descriptive Record must be entered for each program.

See section 2.2.5 and Appendixes 2A and 2B for additional information.

<u>Field Section</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to</u>
1	Program start year  (Last 2 digits of first calendar year of program operation)	I2,1X	60-99,00-20	2A.1.2
2	Stringency level (percent)	I2,1X	10 to 50	2A.1.3
3	First model year  (Last 2 digits of oldest model year of vehicles included in program)	I2,1X	41-99,00-20	2A.1.4
4	Last model year  (Last 2 digits of latest model year of vehicles included in program)	I2,1X	41-99,00-20	2A.1.5
5	Waiver rate for pre-1981 model year vehicles (%)	F2.0,1X	0 to 50	2A.1.6
6	Waiver rate for 1981 and later model year vehicles (%)	F2.0,1X	0 to 50	2A.1.6
7	Compliance rate (%)	F3.0,1X	0 to 100	2A.1.7
8	Program type  1 = Test only 2 = Test and Repair (Computerized) 3 = Test and Repair (Manual)	I1,1X	1 to 3	2A.1.12 2A.1.13 2A.1.14
9	Inspection frequency  1 = annual                      2 = biennial	I1,1X	1 or 2	2A.1.8

Table 2.2-6 (continued)

**SUMMARY OF I/M PROGRAM DESCRIPTIVE INPUT RECORD(S)**

(required if IMFLAG = 2, 3, 4, or 5)

<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to Section</u>
10	Vehicle types subject to inspections  Enter 1 (not subject to inspection) or 2 (subject to inspection) for each vehicle type, in this order: LDGV, LDGT1, LDGT2, HDGV	411,1X	1 or 2 (in each column)	2A.1.9
11	Test type  1 = Idle test 2 = 2500/Idle test 3 = Loaded Idle test 4 = Transient (IM240) test (user <u>must</u> specify cutpoints)	11	1 to 4	2A.1.10
12	Flag to indicate whether user is supplying non-default cutpoints (if test type = 4, this flag <u>must</u> be set to 2)	11	1 or 2	1.3.5 & 2A.1.15
13-14	Flags to indicate whether alternate I/M credits are to be supplied by the user  Enter 1 (use MOBILE5 I/M credits) or 2 (read in alternate I/M credits from logical I/O device units 3 and 4, for Tech I-II and Tech IV+ vehicles, respectively. The filenames of the alternate I/M credit files must be entered immediately following the I/M program descriptive record(s).	211	1 or 2	2A.1.11 2A.1.17
15	User-supplied cutpoint for HC	1X,F4.2	0. to 999.	1.3.5
16	User-supplied cutpoint for CO	1X,F4.2	0. to 999.	&
17	User-supplied cutpoint for NO <sub>x</sub>	1X,F4.2	0. to 999.	2A.1.15
User specification of cutpoints is <u>mandatory</u> if transient (IM240) test type is specified, but is optional for the other test types (idle, loaded idle, 2500/idle). Default cutpoints of 220 for HC, 1.2 for CO, and 999 for NO <sub>x</sub> are assumed in MOBILE5 for the idle, loaded idle, and 2500/idle test procedures.				

Table 2.2-7

**SUMMARY OF ATP DESCRIPTIVE****INPUT RECORD**

(required if ATPFLG = 2, 5, 6, or 8)

See section 2.2.6 for additional information.

<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to Section</u>
1	Program start year  (Last 2 digits of first calendar year of ATP operation)	I2,1X	60-99,00-20	2A.1.2
2	First model year  (Last 2 digits of oldest model year vehicles included in ATP)	I2,1X	60-99,00-20	2A.1.4
3	Last model year  (Last 2 digits of latest model year vehicles included in ATP)	I2,1X	60-99,00-20	2A.1.5
4	Vehicle types subject to ATP inspections  Enter 1 (not subject to inspection) or 2 (subject to inspection) for each vehicle type, in this order: LDGV, LDGT1, LDGT2, HDGV	4I1,1X	1 or 2 (in each column)	2A.1.9
5	Program type  1 = Test only 2 = Test and repair	I1	1 or 2	2A.1.12 2A.1.13
6	Inspection frequency  1 = annual 2 = biennial	I1,1X	1 or 2	2A.1.8

Table 2.2-7 (continued)

**SUMMARY OF ATP DESCRIPTIVE INPUT RECORD**  
 (required if ATPFLG = 2, 5, 6, or 8)

<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to Section</u>
7	Compliance rate (percent)	F4.0,1X	0 to 100	2A.1.7
8	Inspections performed	811	1 or 2 (in each column)	

Enter 1 (inspection is not performed) or 2 (inspection is performed) for each type of inspection, in this order:

Air pump system	2A.2.3
Catalyst	2A.2.4
Fuel inlet restrictor	2A.2.5
Tailpipe lead deposit test	2A.2.6
EGR system	2A.2.7
Evaporative emission control system	2A.2.8
PCV system	2A.2.9
Gas cap	2A.2.10

Table 2.2-8

**SUMMARY OF FUNCTIONAL PRESSURE and/or PURGE TEST INPUT RECORD(S)**

(required if ATPFLG = 3, 4, 5, 6, 7, or 8)

See section 2.2.6.3 for additional information.

Pressure test information record required if ATPFLG = 3, 5, 7, or 8. Purge test information record required if ATPFLG = 4, 6, 7, or 8. If both are used, pressure test record precedes purge test record in input file.

<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to Section</u>
1	Start year  (Last 2 digits of first calendar year of program operation)	I2,1X	60-99,00-20	2A.1.2
2	First model year  (Last 2 digits of oldest model year vehicles subject to functional pressure or purge testing)	I2,1X	60-99,00-20	2A.1.4
3	Last model year  (Last 2 digits of latest model year vehicles subject to functional pressure or purge testing)	I2,1X	60-99,00-20	2A.1.5
4	Vehicle types subject to functional pressure or purge testing  Enter 1 (not subject to testing) or 2 (subject to testing) for each vehicle type, in this order: LDGV, LDGT1, LDGT2, HDGV	4I1,1X	1 or 2 (in each column)	2A.1.9
5	Program type  1 = Test only 2 = Test and repair	I1	1 or 2	2A.1.12 2A.1.13
6	Inspection frequency  1 = annual                      2 = biennial	I1,1X	1 or 2	2A.1.8
7	Compliance rate (percent)	F4.0	0 to 100	2A.1.7

Table 2.2-9

**SUMMARY OF STAGE II AND ONBOARD VRS DESCRIPTIVE INPUT RECORDS**

(required if RLFLAG = 2, 3, or 4)

See section 2.2.7 for additional information.

**Stage II VRS Input Record** (required if RLFLAG = 2 or 4)

<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>
1	Stage II start year  (Last 2 digits of calendar year in which Stage II requirement is first effective)	I2,1X	89-99,00-20
2	Phase-in period  (Number of years allowed for all stations subject to Stage II requirement to complete installation)	I1	1 to 9
3	Percent efficiency of Stage II VRS at controlling refueling emissions from LDGVs and LDGTs	1X,I3	0 to 100
4	Percent efficiency of Stage II VRS at controlling refueling emissions from HDGVs	1X,I3	0 to 100

**Onboard VRS Input Record** (required if RLFLAG = 3 or 4)

<u>Field</u>	<u>Content, Variable Name, Codes</u>	<u>Format</u>	<u>Allowable Values</u>
1	Onboard start year  (Last 2 digits of first model year vehicles are subject to onboard VRS requirement)	I2,1X	89-99,00-20
2	Vehicle types covered  Enter 1 (not covered) or 2 (covered) for each vehicle type, in this order: LDGV, LDGT1, LDGT2, HDGV	4I1	1 or 2 (in each column)



Table 2.2-10

**SUMMARY OF THE LOCAL AREA PARAMETER**

<u>RECORD</u>				
<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to Section</u>
1	Scenario name	4A4,1X		2.2.9
2	Fuel volatility class	A1	A,B,C,D,E 2.2. 16	1.4.2, 2.2.10,
3	Minimum daily temperature (●F)	F5.0	0.-100.	2.2.11
4	Maximum daily temperature (●F)	F5.0	10.-120.	2.2.11
<p>These temperatures are used to calculate diurnal evaporative and refueling HC emissions. If TEMFLG = 1, they are also used to calculate the temperatures used in correction of exhaust HC, CO, and NOx, hot soak evaporative, refueling, resting loss, and running loss emissions.</p>				
5	"Period 1" RVP (psi)  (Average fuel volatility for the area being modeled, for years prior to "Period 2" start year.)	F5.1	7.0-15.2	2.2.12
6	"Period 2" RVP (psi)  (Average fuel volatility for the area being modeled, for "Period 2" start and later years.)	F5.1,1X	7.0-15.2	2.2.13
7	"Period 2" start year  (Last 2 digits of first calendar year for which "Period 2" RVP is to be assumed)	I2	89-99,00-20	2.2.13
8	Oxygenated fuel flag*  (Indicates whether effect of oxygenated fuels on emissions is to be modeled)	1X,I1	1 or 2	2.2.14
9	Diesel sales fraction flag*  (Indicates whether user is supplying alternate LDV and LDT diesel sales fractions)	1X,I1	1 or 2	2.2.15
10	Reformulated gasoline flag*  (Flag indicates whether effect of reformulated gasoline on emissions is to be modeled)	1X,I1	1 or 2	2.2.16

\* Flag is optional. Settings are 1 = No and 2 = Yes. If missing, assumed to be "1".

Table 2.2-11

**SUMMARY OF BY MODEL YEAR INCLUSION RECORD**  
(required if OUTFMT = 5)

See section 2.2.17 for additional information.

<u>Field</u>	<u>Content, Description, and Codes</u>	<u>Format</u>	<u>Allowable Values</u>
1-8	Whether or not by model year output is desired for each of eight vehicle types, in this order:  LDGV, LDGT1, LDGT2, HDGV, LDDV, LDDT, HDDV, MC  1 = No                      2 = Yes	8I1	1 or 2
9	Whether or not by model year output of inspection and maintenance (I/M) program effects on emission factors is desired  1 = No                      2 = Yes	1X,I1	1 or 2



Table 2.3-1 (continued)

**SUMMARY OF THE SCENARIO RECORD(S)****Record 1: Scenario Descriptive Record (MANDATORY)** (continued)

<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to Section</u>
6	Month of evaluation  Optional input to indicate month for which emission factors are to be calculated. Values of 1 (January) or 7 (July) are permitted. If missing, assumed to be "1". <b>NOTE:</b> There are certain conditions that the user should be aware of when using the July 1 option. Please read section 2.3.6 before using the July 1 option.	2X,11	1 or 7	2.3.6

**Record 2: LEV Program Parameter Record (OPTIONAL)**  
(required only if REGION = 4 on Scenario Descriptive Record)

<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to Section</u>
1	Start year for phase-in of LEVs  Last two digits of first year of LEV phase-in	I2,1X	93-99,00-20	2.3.7
2	Flag indicating whether an I/M program meeting the criteria in Appendix 2B is to be assumed in modeling  1 = Standard or no I/M program assumed 2 = "Maximum benefit" I/M program meeting the criteria of Appendix 2B assumed	I1	1 or 2	2.3.7 Apdx 2B

**Record 3: LAP record -- for this scenario only (OPTIONAL)**  
(required only if LOCFLG = 1)

See Table 2.2-10

Table 2.3-1 (continued)

**SUMMARY OF THE SCENARIO RECORD(S)****Record 4: Oxygenated fuels descriptive record (OPTIONAL)**

(Required only if OXYFLG = 2 on LAP record. Appears immediately following LAP record in One-time Data section if LOCFLG=2; appears immediately following each LAP record in Scenario section if LOCFLG=1.)

<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to Section</u>
1	Ether blends market share	F4.3,1X	0.0-1.0	2.3.9
2	Alcohol blends market share	F4.3,1X	0.0-1.0	2.3.9
3	Average oxygen content of ether blend fuels (by weight)	F4.3,1X	0.0-0.027	2.3.9
4	Average oxygen content of alcohol blend fuels (by weight)	F4.3,1X	0.0-0.035	2.3.9
5	RVP waiver switch (Flag indicating whether oxygenated fuels are allowed to exceed regulated RVP limit by 1.0 psi: 1 = No, 2 = Yes)	I1	1 or 2	2.3.9

**Records 5-7: Diesel sales fractions (OPTIONAL)**

(Required only if DSFLAG = 2 on LAP record and LOCFLG = 1)

Three records containing fractions of LDV/LDT sales by model year that were diesel, starting with model year = calendar year of evaluation and ending with model year = (calendar year - 25)-and-older.

<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to Section</u>
1-20	LDV age 1, LDT age 1, LDV age 2, LDT age 2, . . . , LDV age 10, LDT age 10	20F4.3/	0.0-1.0	2.3.10
21-40	LDV age 11, LDT age 11, LDV age 12, LDT age 12, . . . , LDV age 20, LDT age 20	20F4.3/	0.0-1.0	2.3.10
41-50	LDV age 21, LDT age 21, LDV age 22, LDT age 22, . . . , LDV age 25+, LDT age 25+	10F4.3/	0.0-1.0	2.3.10

Table 2.3-1 (continued)

**SUMMARY OF THE SCENARIO RECORD(S)****Record 8: VMT mix by vehicle type record (OPTIONAL)**

(Required for each scenario if VMFLAG = 2; required in One-Time Data section if VMFLAG = 3)

<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to Section</u>
1-8	VMT fraction accumulated by each of eight vehicle types, in this order: LDGV, LDGT1, LDGT2, HDGV, LDDV, LDDT, HDDV, MC	8F4.3	0.0-1.0	2.2.2

**Record 9: Trip Length Distribution record (OPTIONAL)**

(Required for each scenario if SPDFLG = 3; required in One-Time Data section if SPDFLG = 4)

<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to Section</u>
	Percentage of total vehicle miles travelled (VMT) accumulated in trips of the following lengths of time (durations):			2.3.12
1	Under 10 minutes	1X,F4.1	0.0-100.0*	
2	11 to 20 minutes	1X, F4.1	0.0-100.0*	
3	21 to 30 minutes	1X, F4.1	0.0-100.0*	
4	31 to 40 minutes	1X, F4.1	0.0-100.0*	
5	41 to 50 minutes	1X, F4.1	0.0-100.0*	
6	51 minutes and longer	1X, F4.1	0.0-100.0*	

\* The sum of the six values entered must equal 100 percent.

Table 2.3-1 (continued)

**SUMMARY OF THE SCENARIO RECORD(S)****Record 10: Additional Correction Factor record (OPTIONAL)**

(Required only if ALHFLG = 2 or 3)

<u>Field</u>	<u>Content, Description, Codes</u>	<u>Format</u>	<u>Allowable Values</u>	<u>Refer to Section</u>
1	Air conditioning use fraction  (Percent of AC-equipped vehicles actually using AC)	F4.2	0.0-1.0	2.3.13.3 and 2.3.13.7
<p><b>Note:</b> If ALHFLG = 2, no AC usage correction factor will be applied, and the input value of this variable should be 0.0. If ALHFLG = 3, the input value is overridden by calculated value (see §2.3.10.3); however, a nonzero value must be entered here in order for the AC correction factor be calculated and applied.</p>				
2-4	Extra load fractions  (Percent of vehicles assumed to be carrying additional 500 lb load; fractions apply to LDGVs, LDGT1s, and LDGT2s, in that order)	3F4.2	0.0-1.0	2.3.13.4
5 or 5-7	Trailer towing fraction(s) (Percent of vehicles assumed to be towing trailers)	F4.2 or 3F4.2	0.0-1.0	2.3.13.5
<p><b>Note:</b> If ALHFLG = 2, one value is required and is used to calculate correction factor for all three vehicle types. If ALHFLG = 3, three values are required and are used to calculate correction factor for LDGV, LDGT1, and LDGT2, respectively.</p>				
6 or 8	Absolute humidity level  (Grains water per pound dry air, used to correct exhaust NOx emission factors)	F4.0	20.-140.	2.3.13.6
9, 10	Dry and wet bulb temperatures, in ●F  If ALHFLG = 3 <u>only</u> , these temperatures are used to calculate a "discomfort index," which in turn is used to estimate an A/C usage fraction (which then overrides the value input in Field 1 of this record).	2F4.0	0.-110.	2.3.13.7

Table 2.4-1

**SUMMARY OF THE MOBILE5 INPUT RECORD SEQUENCE**

<u>Input Record Sequence</u>	<u>Input Type</u>	<u>Refer to Section</u>
1 <b>PROMPT</b> flag record	CONTROL	2.1.1
(1-3 <b>IOUNEW</b> values)*	CONTROL	2.1.2
1 <b>PROJID</b> record	CONTROL	2.1.3
1 <b>TAMFLG</b> flag record <sup>1</sup>	CONTROL	2.1.4
1 <b>SPDFLG</b> flag record <sup>1</sup>	CONTROL	2.1.5
1 <b>VMFLAG</b> flag record <sup>1</sup>	CONTROL	2.1.6
1 <b>MYMRFG</b> flag record <sup>1</sup>	CONTROL	2.1.7
1 <b>NEWFLG</b> flag record <sup>1</sup>	CONTROL	2.1.8
1 <b>IMFLAG</b> flag record <sup>1</sup>	CONTROL	2.1.9
1 <b>ALHFLG</b> flag record <sup>1</sup>	CONTROL	2.1.10
1 <b>ATPFLG</b> flag record <sup>1</sup>	CONTROL	2.1.11
1 <b>RLFLAG</b> flag record <sup>1</sup>	CONTROL	2.1.12
1 <b>LOCFLG</b> flag record <sup>1</sup>	CONTROL	2.1.13
1 <b>TEMFLG</b> flag record <sup>1</sup>	CONTROL	2.1.14
1 <b>OUTFMT</b> flag record <sup>1</sup>	CONTROL	2.1.15
1 <b>PRTFLG</b> flag record <sup>1</sup>	CONTROL	2.1.16
1 <b>IDLFLG</b> flag record <sup>1</sup>	CONTROL	2.1.17
1 <b>NMHFLG</b> flag record <sup>1</sup>	CONTROL	2.1.18
1 <b>HCFLAG</b> flag record <sup>1</sup>	CONTROL	2.1.19
(24 or 48 tampering records) <sup>2</sup>		
if <b>TAMFLG</b> = 2	ONE-TIME	2.2.1
(1 <b>VMT</b> mix record)		
if <b>VMFLAG</b> = 3	ONE-TIME	2.2.2
(24 mileage accumulation rate by age records)		
if <b>MYMRFG</b> = 2 or 4	ONE-TIME	2.2.3
(24 registration distribution by age records)		
if <b>MYMRFG</b> = 3 or 4	ONE-TIME	2.2.3
(1 to 100 basic emission rate records)		
if <b>NEWFLG</b> = 2, 4, or 6	ONE-TIME	2.2.4
(2 to 5 records for terms of the new evaporative emission test procedure phase-in schedule)		
if <b>NEWFLG</b> = 3 or 4	ONE-TIME	2.2.4
(1 I/M program descriptive record)		
if <b>IMFLAG</b> = 2 or 4	ONE-TIME	2.2.5
(2 I/M program descriptive records)		
if <b>IMFLAG</b> = 3 or 5	ONE-TIME	2.2.5
(1 or 2 alternate I/M credit file names)		
if specified in fields 13-14 of I/M Program Descriptive Record	ONE-TIME	2.2.5.4
(1 ATP descriptive record)		
if <b>ATPFLG</b> = 2, 5, 6, or 8	ONE-TIME	2.2.6



Table 2.4-1 (continued)

**SUMMARY OF THE MOBILE5 INPUT RECORD SEQUENCE**

<u>Input Record Sequence</u>	<u>Input Type</u>	<u>Refer to Section</u>
(1 Pressure test information record) if ATPFLG = 3, 5, 7, or 8	ONE-TIME	2.2.6
(1 Purge test information record) if ATPFLG = 4, 6, 7, or 8	ONE-TIME	2.2.6
(1 or 2 refueling VRS descriptive records) <sup>3</sup> if RLFLAG = 2, 3, or 4	ONE-TIME	2.2.7
(1 Local Area Parameter record) <sup>4</sup> if LOCFLG = 2	ONE-TIME	2.2.8
(1 oxygenated fuel descriptive record) if LOCFLG = 2 and OXYFLG = 2	ONE-TIME	2.3.11
(1 trip length distribution record) if SPDFLG = 4	ONE-TIME	2.3.13
(1 by model year inclusion vector record) if OUTFMT = 5	ONE-TIME	2.2.18
1 Scenario Descriptive Record	SCENARIO	2.3
(1 LEV Program Parameter Record) if REGION = 4 on Scenario Descriptive Record	SCENARIO	2.3.7
(1 Local Area Parameter record) <sup>4</sup> if LOCFLG = 1	SCENARIO	2.2.8
(1 oxygenated fuel descriptive record) if LOCFLG = 1 and OXYFLG = 2	SCENARIO	2.3.9
(3 diesel sales fraction by model year records) if LOCFLG = 1 and DSFLAG = 2	SCENARIO	2.3.10
(1 VMT mix record) if VMFLAG = 2	SCENARIO	2.2.2
(1 trip length distribution record) if SPDFLG = 3	SCENARIO	2.3.12
(1 additional correction factor record) if ALHFLG = 2 or 3	SCENARIO	2.3.13

\* Required only if reassignment of output device numbers is desired.

1 These 16 flags are entered on one record (format I1, 15(1X,I1)) if PROMPT = 3 or 4.

2 24 records if IMFLAG = 1; 48 records if IMFLAG = 2.

3 Stage II record if RLFLAG = 2; onboard record if RLFLAG = 3; both records if RLFLAG = 4.

4 The Local Area Parameter record must appear in either the One-Time or the Scenario data section.

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## Appendix 2A

**INSPECTION/MAINTENANCE AND ANTI-TAMPERING PROGRAM TERMINOLOGY DEFINITIONS**

This appendix discusses the terminology used to describe inspection and maintenance (I/M) and anti-tampering (ATP) programs for purposes of modeling the emission benefits of such programs using MOBILE5. In general, MOBILE5 assumes that the I/M program is mandatory, periodic, and covers a well-defined group of vehicles. There are many details (e.g., instrument specifications) which are beyond the scope of this document. Program planners should consult with EPA (Emission Control Strategies Branch, 313/668-4417) if there are questions regarding I/M program requirements.

**2A.1 I/M PROGRAM TERMINOLOGY****2A.1.1 I/M**

I/M refers to "inspection and maintenance" programs, which are inspections of vehicles using a measurement of tailpipe emissions and which require that all vehicles with tailpipe emissions higher than emission levels specified by the program be repaired to pass a tailpipe emission retest. Inspections that are aimed at verifying the presence and proper connection of emission control devices and components are termed anti-tampering programs (ATPs). For convenience, such tailpipe I/M and ATPs are sometimes referred to collectively simply as "I/M programs" in other EPA documents.

**2A.1.2 Start Year**

The year in which the periodic inspection program first begins to require both inspection and repairs is called the start year. MOBILE5 only provides for a January 1st start date. Other start dates will require interpolation between two MOBILE5 runs to give accurate estimates of benefits. Separate and different start dates may be specified for a tailpipe I/M program and an ATP or other inspection program record. Changing program parameters (such as cutpoints, test type, etc.) generally does not change a program's start date. However, if a program makes such changes and wishes to evaluate the program before those changes have been fully implemented, program planners should consult EPA (Air Quality Analysis Branch, 313/668-4325).

Since MOBILE5 has two I/M program descriptive records, there can be two input values of the I/M program start year. In most cases, this will require that both records use the same start year. If a different start year is used for the second record, the I/M program credits for the vehicles covered under that program's description will be assumed to have begun being tested as of that second start date. This option will be useful if new vehicle classes or model year [ranges] are added to the [second] I/M program, after the start date of the first program.

**2A.1.3 Stringency**

Stringency refers to the tailpipe emission initial test failure rate expected in an I/M program among pre-1981 model year passenger cars or pre-1984 light-duty trucks, based on the short test emission cutpoints. The expected failure rate can be determined by applying the program cutpoints to a representative sample of vehicles tested, using the appropriate test procedure, in a survey. Actual failure rates reported by a program can also be used to determine stringency, but only when there is no possibility of significant testing or data reporting errors and a determination can be made as to which tests were initial (first time) tests. MOBILE5 assumes that the failure rate remains fixed at the stringency level for each evaluation year. MOBILE5 does not allow a stringency less than 10% or greater than 50%.

#### **2A.1.4 First Model Year**

The first model year refers to the oldest model year vehicle which is always included in the inspection program. MOBILE5 assumes that all vehicle classes have the same model year coverage and does not allow for a separate coverage period for each vehicle class. Some programs do not fix the model years covered by the program, and instead use a coverage "window" to define which vehicles must be inspected. For example, such a program may cover only vehicles 15 years old or younger. Such programs cannot be modeled accurately using MOBILE5 without special assistance.

#### **2A.1.5 Last Model Year**

The last model year refers to the youngest (newest) model year vehicle which is always subject to the inspection program. This allows for a program to cover only particular model years. Most programs routinely include new model year vehicles in the program as they reach one year of age. It is recommended that the maximum allowable last model year (2020) be input as the last model year, unless a special case requires some other input. MOBILE5's calculation of I/M credits already assumes that vehicles less than one year old are exempt from inspection, so input of the maximum last model year allows for maximum flexibility. For example, if vehicles are exempt from inspection until they are three years old, the last model year should be set equal to the calendar year of evaluation minus three.

#### **2A.1.6 Waiver Rates**

Many I/M programs waive the requirement to pass a retest if certain defined criteria are met. Waivers are often granted in I/M programs for vehicles whose owners have spent over a set dollar limit in attempting to comply with the program retest requirement.

The waiver rate inputs to MOBILE5 reduce the estimated benefit of the I/M program design. The waiver rates are always calculated as a percent of non-duplicate initial test failures. Waiver rates must be provided for pre-1981 and for 1981 and later model year light-duty vehicles. MOBILE5 assumes that tampered or misfueled vehicles cannot receive waivers, and so does not reduce the ATP benefit based on the waiver rate.

#### **2A.1.7 Compliance Rate**

Compliance rate refers to the level of compliance with the inspection program. For example, assume a program required that all passenger cars be inspected each year, and that 100,000 passenger cars were registered in the area covered by the program. If in a given year only 95,000 passenger cars completed the inspection process to the point of receiving a final certificate of compliance or waiver, it could be assumed that the remaining 5,000 vehicles had avoided the inspection requirement. The compliance rate for this program would then be 95%. The number of initial inspections should not be used to calculate the compliance rate, since some cars may drop out after failing one or more tests. The compliance rate input is also used to account for vehicles which are waived from compliance without any testing (e.g., vehicles with special testing problems or vehicles owned by certain types of owners).

MOBILE5 uses a single compliance rate to reduce both the I/M and ATP portions of the program benefits. The reduction in benefit is not linear. The benefit loss per vehicle assumes that the failure rate among non-complying vehicles will be larger than the expected failure rate in the fleet. As the rate of non-compliance increases, the non-complying failure rate will approach and finally equal the expected failure rate.

The following table shows the loss of benefit assumed for the enforcement fraction:

<u>Compliance Rate</u>	<u>Non-Compliance Rate</u>	<u>Non-Complier Failure Rate Adjustment</u>	<u>Fraction Benefit Loss</u>	<u>Fraction Benefit Remaining</u>
100%	0%	2.0	.000	1.000
99%	1%	2.0	.020	.980
98%	2%	2.0	.040	.960
97%	4%	2.0	.080	.920
95%	5%	1.5	.095	.905
90%	10%	1.4	.169	.831
85%	15%	1.3	.238	.762
80%	20%	1.2	.302	.698
75%	25%	1.1	.361	.639
70%	30%	1.0	.415	.585
50%	50%	1.0	.615	.385

### 2A.1.8 Inspection Frequency

MOBILE5 allows for two inspection frequencies. "Annual" means that all covered vehicles must be inspected once each year. "Biennial" means that each vehicle is inspected once every two years, such that half of the vehicles of each model year are inspected each calendar year. Any other inspection frequency would require alternate I/M credits provided by EPA.

### 2A.1.9 Vehicle Classes

MOBILE5 program benefits are calculated separately for each gasoline-fueled vehicle class. No emission benefits are estimated for diesel vehicles or motorcycles. The vehicle class designations are based on the certification standard definitions:

**LDGV:** light-duty gasoline-fueled vehicles (passenger cars).

**LDGT1:** light-duty gasoline-fueled trucks up to 6000 lbs gross vehicle weight (lighter pick-up trucks and vans).

**LDGT2:** light-duty gasoline-fueled trucks over 6000 lbs, and up to 8500 lbs GVW (heavier pick-up trucks and vans, and many commercial trucks).

**HDGV:** heavy-duty gasoline-fueled vehicles over 8500 lbs GVW (heavier commercial trucks, including highway hauling trucks).

Many areas do not use the same vehicle class designations in their vehicle registration data as are used in MOBILE5. In these cases care must be taken not to claim coverage for too many vehicles.

### 2A.1.10 I/M Test Types

There are four I/M test types allowed in MOBILE5. These test types only apply to the inspection of 1981 and newer model year passenger cars and 1984 and newer light-duty trucks. If pre-1981 model year vehicles are covered by either I/M program descriptive record, the benefits (emission reductions) determined for pre-1981 model year vehicles will be determined solely on the basis of the stringency (failure rate) value input. The stringency value is independent of test type. Therefore the test type assumed to apply for pre-1981 model

year vehicles can be different than that indicated on the I/M program descriptive record(s). The test type chosen by the user is assumed to be applied to all 1981 and newer passenger cars and 1984 and newer light-duty trucks both at the initial inspection and the retest. It is assumed that the default cutpoints used for the inspections are 1.2 percent CO and 220 ppm HC in all tests except for the IM240 test procedure.

**Idle Test** refers to a measurement of HC and CO emission concentrations of a fully warmed vehicle as it idles in neutral or park.

**2500/idle Test** refers to a measurement of HC and CO emission concentrations of a fully warmed vehicle at 2500 rpm in neutral or park, and again at idle. The vehicle must pass both at idle and at 2500 rpm in order to pass the test.

**Loaded/Idle Test** refers to a measurement of HC and CO emission concentrations of a fully warmed vehicle on a chassis dynamometer at a constant load, and again at idle in neutral or park. The vehicle must pass both at idle and at load in order to pass the test.

**Transient Exhaust Emission (IM240) Test** refers to a measurement of exhaust HC, CO and, in some cases, NO<sub>x</sub> emissions from a fully warmed vehicle on an inertial-weighted chassis dynamometer. The vehicle is operated over a transient driving cycle containing periods of acceleration, deceleration, idle, and cruise. The emissions and exhaust volume are measured and integrated over the 240 seconds of the testing cycle to give a composite score in grams emissions per mile of travel. The vehicle must pass emission level cutpoints for both HC and CO (and in some cases, NO<sub>x</sub>) in order to pass the test. The cutpoints and the test speed cycle determine the str

ingency of the test. Vehicles failing the transient test are required to be repaired such that they will be able to pass a transient retest using the same cutpoints.

#### **2A.1.11 Alternate I/M Credits**

In special cases where the design of the I/M program to be modeled does not fit into any of the categories defined in MOBILE5 (e.g., semi-annual or tri-annual inspection frequency), the model allows the user to supply a set of factors that will be used to determine the I/M program benefits. Normally these factors will be supplied by EPA at the request of the program manager or air quality planner.

#### **2A.1.12 Test Only Programs**

Test only (or inspection only) station inspection programs refer to those programs which completely separate the inspection of vehicles from the repair of vehicles. Usually high-volume inspection stations, run either by the local agency itself or by a contractor, will perform all initial tests and retests after repair. Garages and other repair facilities are not allowed to perform official tests. Independent, inspection only station programs are the standard used to determine the emission benefits for I/M and ATP program designs.

#### **2A.1.13 Test and Repair Programs (Manual)**

Test and repair (or inspection and repair) station inspection programs refer to those programs where the local program agency licenses service stations and garages to perform official inspections and reinspections. These licensed inspection stations are allowed to perform repairs on the vehicles they inspect. The number of licensed inspection stations in inspection and repair station programs is larger and the volume per station is smaller than for inspection only station programs.

Test and repair station programs have been found to be less effective than test only station programs. As a result, MOBILE5 reduces the emission benefits, relative to a test only station program design, by 50

percent for the I/M (tailpipe test) portion and 50 percent for the ATP portion of the program if the test and repair station program design is chosen. The 50 percent reduction in benefits from the tailpipe portion of the test includes the loss due to waivers, if any. Areas which can demonstrate that a currently operating network achieves greater emission reductions should contact EPA for assistance.

#### **2A.1.14 Computerized Inspection**

Some test and repair station I/M programs require the use of computerized emission analyzers. These analyzers contain small computers which keep track of all official inspection activity, automatically calibrate the instrumentation, and prompt the inspector during the inspection procedure. The computer also prepares a machine-readable record of all official inspections and calibrations, and will not allow inspections whenever it determines the instrumentation to be out of calibration.

MOBILE5 assumes that the I/M portion of a test and repair station computerized inspection program will be 50 percent as effective as a test only station program of similar stringency (i.e., the benefits of the program are discounted by 50 percent). As noted above, this benefit reduction includes the impact of waivers, if any, and is not applied on top of a waiver-related loss of potential benefits. Any area that has data to support the contention that a specific test and repair station computerized program is more efficient than this (i.e., that the program should have its benefits discounted by less than 50 percent relative to the benefits of a test only station program) is encouraged to contact EPA for assistance in verifying that contention and in modeling the impact of that program on the in-use emission factors. Test and repair station computerized inspection programs will also have the benefits from the ATP portion of the program reduced by 50 percent.

#### **2A.1.15 Cutpoints**

The term "cutpoints" refers to the numeric values of the emission levels used to determine the pass/fail status of a vehicle, as compared to the measured emission test results, under a given I/M test procedure. Exceeding the cutpoint(s) is considered as failing the emission test. A separate cutpoint is normally chosen for each pollutant of interest in the program. When more than one cutpoint is used (such as one for HC emissions and one for CO emissions), exceeding either or both cutpoints will cause the vehicle to fail the test. The combination of the emission test procedure used and the cutpoint(s) applied will determine the test failure rate.

In MOBILE5, the user-specified tailpipe emission cutpoints are used to determine the stringency of the I/M inspection for 1981 thru 1993 model year passenger cars (light-duty vehicles). Benefits for passenger car model years before 1981, and for light-duty truck model years before 1984, are determined by the "stringency level" input field on the I/M program descriptive record. The magnitude of I/M benefits for heavy-duty gas vehicles (HDGVs) is unaffected by user cutpoint inputs. There is no additional user input to indicate cutpoints for other, later model year groupings or for other vehicle classes (such as LDTs). Instead, MOBILE5 assumes that all 1994 and later model year passenger cars and 1984 and later model year light-duty trucks, which have different emission standards and in-use emissions performance, will be inspected using cutpoints that will result in similar reductions as are estimated for the 1981 thru 1993 model year passenger cars.

As a result, if the user intends to model these other model years and vehicle classes in such a way as to result in similar stringency as indicated by the choice of cutpoints for the 1981-1993 model year passenger cars, no further user-supplied information about stringency or cutpoints is required. For example, the set of cutpoints indicated in the recent enhanced I/M rulemaking were chosen to result in a similar stringency for each model year grouping and vehicle class. Therefore, to model the program indicated by the rulemaking, the user needs only to specify the cutpoints indicated for the 1981-1993 model year passenger cars as input to MOBILE5. The benefits for all other vehicle classes and model year groupings will be taken from that input. No further user input is required.

If the user intends that some later model years or vehicle classes are to have stringencies that are different than for the 1981-1993 model year passenger cars, then it may be necessary to perform multiple MOBILE5 runs, separately for each stringency. In this case, the user should consult with EPA on how best to choose cutpoint inputs for MOBILE5 to achieve the appropriate stringency for these other groups.

#### **2A.1.16 Multiple I/M Programs**

Caution must be used when using the option to enter multiple I/M program designs to model mid-stream changes in an area's I/M program. There are two parts to the emission reduction benefits achieved by I/M programs. First is the reduction achieved by repairs of vehicles identified by the tailpipe exhaust emission inspection. This reduction is determined by user specifications in the I/M Program Descriptive Record. The amount of the emission reduction for pre-1981 model year passenger cars and pre-1984 model year light-duty trucks will vary somewhat depending on the start date of the I/M program. For these vehicles, MOBILE5 assumes that there is residual benefit that accumulates the longer these vehicles have been involved in the I/M program. The benefit for 1981 and newer model year passenger cars, 1984 and newer light-duty trucks and all heavy-duty trucks is unaffected by the start date of the I/M program.

The second part of the emission reduction attributed to I/M programs is a reduction achieved by deterrence of tampering. This deterrence occurs when vehicle owners perform needed maintenance on their vehicles rather than risk failing the periodic tailpipe I/M inspection. Vehicle owners who may deliberately disable emission control components on their vehicles or inappropriately use leaded fuel may also be deterred by the risk of failing their I/M inspection. This deterrence is not related to or affected in any way by the addition of explicit visual inspections included in anti-tampering programs or the functional pressure and purge system checks. The benefits of these specific program elements are calculated separately.

MOBILE5 assumes that this deterrent effect begins when the I/M program first begins and is unaffected by the stringency of the I/M inspection. This means that an I/M program that starts in an earlier calendar year will have a greater overall effect on emissions than an equally stringent program started at a later date. In order for an I/M program to get all of the benefits to which it is entitled, care should be given to make the start date of the program indicated in the MOBILE5 I/M Program Descriptive Record input match the actual calendar year in which those vehicles were first inspected. If the user specifies two I/M program designs, both I/M Descriptive Records should indicate the same I/M program start date, unless the second I/M program description covers model years or vehicle classes that were not covered in the original I/M program design.

For example, a program will begin using the IM240 test procedure in 1994, covering all 1986 and newer vehicles. The original Idle Test-based I/M program began in 1984. This program can be modeled in MOBILE5 by describing the original I/M program design in the first I/M Program Descriptive Record and describing the IM240 portion of the program in the second I/M Program Descriptive Record, covering only 1986 and newer vehicles. However, since some of the benefit for the 1986 and newer model year vehicles comes from tampering deterrence, indicating a 1994 I/M program start date in the second I/M Descriptive Record will cause those vehicles to have less tampering deterrence benefit than they should, since these vehicles were always subject to I/M inspection. Since the repair part of the I/M benefit for these vehicles does not depend on the start date of the I/M program, the correct way to model the benefit for the 1986 and newer vehicles is to enter the 1984 start date for the original I/M program into the second I/M Descriptive Record as well. If, however, the original I/M program design did not include light-duty trucks and the program change beginning in 1994 now includes these vehicles, then a separate MOBILE5 run will be required to model the benefits for the light-duty trucks, indicating their actual 1994 I/M program start date.



**2A.1.17 Tech I-II and Tech IV+**

The calculation of I/M benefits for MOBILE5 was done by technology group, which can roughly be determined by model year for each vehicle type. These technology groups have come to be referred to by numbers. Within the Tech IV group, I/M credits are developed separately for each model year of LDGVs, with model year mapping to LDGTs based on similarity of emission control technology used. The table below summarizes the technology groupings used in MOBILE5 and their respective application to gasoline-fueled passenger cars and light trucks.

<u>Technology Grouping</u>	<u>LDGV</u>	<u>Model Years Covered</u>	
		<u>LDGT1</u>	<u>LDGT2</u>
I	Pre-1975	Pre-1975	Pre-1979
II	1975-80	1975-83	1979-83
IV+	1981+	1984+	1984+

Sets of alternate I/M credits may contain both Tech I and II credits, or Tech IV+ credits. This is usually indicated in the header block of the alternate I/M credit deck. Two data files (TECH12.D and IMDATA.D) provided with MOBILE5 contain the default set of I/M credits.

**2A.1.18 Evaporative Canister Purge System Check**

As part of a vehicle inspection program, the flow rate of the canister purge portion of the evaporative control system can be monitored during transient engine operation on a vehicle chassis dynamometer using a flow measurement device. Cutpoints for minimum flow rate can be set and used to determine vehicles passing and failing a purge system check. Vehicles failing the purge check are required to have the canister purge system repaired such that the vehicle will be able to pass a canister purge system retest.

For MOBILE5, vehicles were tested for canister purge using a flow sensor installed in the hose connecting the evaporative canister to the engine at the canister end. Cumulative flow was measured, in liters, over the IM240 transient speed cycle. Any vehicle with a cumulative flow of less than one liter was failed.

As with other tests, MOBILE5 reduces the benefits of the evaporative purge system check by 50 percent when either a test and repair station manual or computerized I/M program is chosen.

**2A.1.19 Evaporative System Pressure Check**

As part of a vehicle inspection program, the evaporative control system can be checked for leaks by pressurizing the fuel tank and related hoses and pipes. The pressure loss is monitored over time. Cutpoints for the maximum rate for which pressure can be lost can be set and used to determine vehicles passing and failing a pressure check. Vehicles failing the pressure check are required to have the evaporative system repaired such that the vehicle will be able to pass an evaporative system pressure retest.

For MOBILE5, vehicles were tested for pressure leaks by slowly introducing nitrogen to the evaporative system through the hose connecting the evaporative canister to the fuel tank at the canister end. When a stable reading of 14 inches of water (about 0.5 pounds per square inch) was reached, the pressure was monitored for two minutes. Any vehicle with a pressure of less than 8 inches of water after two minutes was failed.

As with other tests, MOBILE5 reduces the benefits of the evaporative purge system check by 50 percent when either a test and repair station manual or computerized I/M program is chosen.

## **2A.2 ATP TERMINOLOGY**

This section discusses the terminology used to describe ATP inspections for purposes of modeling the emission benefits of such programs using MOBILE5. In general, it is assumed that the program is mandatory, periodic, and covers a well-defined group of vehicles. A program which inspects for tampering only when a vehicle has failed its tailpipe I/M inspection, or only when a vehicle owner requests a test waiver, is not considered as an ATP in MOBILE5.

It is also assumed that the inspections are primarily visual rather than functional, and involve no disassembly or disconnection to gain access to hidden components (other than removal of the gas cap to view the fuel inlet restrictor). However, program planners are encouraged to define failure in broad enough terms of visual damage and proper operating condition so that any emission control component determined by the inspector to be non-functional can be properly failed and repaired. There are many details (such as replacement catalyst specifications) which are beyond the scope of this discussion. Program planners should consult with EPA's Office of Mobile Sources (Emission Control Strategies Branch, 313/668-4367) if there are questions regarding the requirements of ATP inspections.

### **2A.2.1 Anti-Tampering Programs (ATPs)**

Anti-tampering programs (ATPs) are periodic inspections of vehicles to detect damage to, disablement of, or removal of emission control components. Owners are required to restore the vehicle's emission control system and have the vehicle reinspected. Note that programs that inspect for tampering only those vehicles failing an I/M tailpipe test are not considered for MOBILE5 modeling purposes to have an ATP, and should not attempt to derive ATP emission reduction credits.

### **2A.2.2 Tampering and Misfueling**

Any physical damage to, or disablement or removal of, an emission control component is considered tampering in MOBILE5. This does not limit tampering only to deliberate disablements or only to those disablements of which the vehicle owner is aware. As a result, tampering can often be a result of poor maintenance as opposed to some action by the vehicle owner or a service mechanic.

Misfueling is the use of leaded fuel in any vehicle which is equipped with a catalytic converter. This includes inadvertent use of leaded fuel without the knowledge of the vehicle owner.

### **2A.2.3 Air Pump Inspection**

Air pump systems supply fresh air needed by the catalytic converter to reduce engine emissions before they leave the tailpipe. Inspectors should check for missing belts and hoses and proper connection at the exhaust manifold. Sometimes the entire pump and its plumbing are removed. A valve is sometimes used to route air away from the exhaust stream during certain operating modes. This valve should be checked for proper hose and wire connections. Often the air is injected directly into the catalytic converter underneath the vehicle. If so, this connection should be checked. Any missing, damaged or altered components of the air pump system should be replaced.

### **2A.2.4 Catalyst Inspection**

The catalytic converter, sometimes referred to simply as the catalyst, oxidizes excess hydrocarbon and carbon monoxide from the engine exhaust into water and carbon dioxide. Newer catalysts also reduce oxides of

nitrogen in the exhaust. The metals which accomplish this task are most commonly coated on a ceramic honeycomb inside the stainless steel shell of the catalyst. The catalyst resembles a muffler in some ways, but would not be confused with a muffler because it is farther forward on the vehicle, and its stainless steel shell will not rust.

Some cars will have more than one catalyst, so the number of catalysts expected should be determined before the inspection begins. Some catalysts are located very near the exhaust manifold, so the inspector should be sure to check the entire length of the exhaust piping from the exhaust manifold to the muffler before determining that the catalyst is not present.

Emission credit should not be claimed using MOBILE5 unless regulations provide a mechanism to assure that failed cars are correctly repaired with original equipment manufacturer (OEM) or approved aftermarket replacements. Program planners should consult with EPA to avoid incorrectly claiming credit.

### **2A.2.5 Fuel Inlet Restrictor Inspection**

Vehicles requiring the use of only unleaded gasoline have been equipped with fuel inlets that only allow use of narrow fuel nozzles. Leaded fuel is required to be dispensed only from pumps using wider nozzles. Any vehicle found to have a fuel inlet which allows a leaded fuel nozzle to be inserted, such as having the nozzle size restriction removed, is assumed to have used leaded fuel. Leaded fuel permanently reduces the ability of the catalytic converter to reduce emissions. Therefore, vehicles found with a fuel inlet which allows insertion of a leaded fuel nozzle should be required to replace the catalytic converter. In addition, the vehicle's fuel inlet should be repaired to only allow the insertion of unleaded fuel nozzles.

Repair of the fuel inlet restrictor only is not considered a repair which will reduce the emissions of the vehicle. The damage to the emission control of the vehicle occurs in the catalyst. It is the catalyst which must be replaced to result in any substantial emission reduction. The inlet restrictor must be replaced simply as protection for the new catalyst. No credit is given by MOBILE5 for a fuel inlet restrictor inspection unless an explicit check for the presence of the catalytic converter is also made. This catalyst inspection must be indicated as part of the ATP descriptive record in order to receive benefits.

MOBILE5 assumes that inspectors are not allowed to skip this inspection for such reasons as that the fuel inlet is concealed by a locked door.

### **2A.2.6 Tailpipe Lead Detection Test**

- Leaded fuel permanently reduces the ability of the catalytic converter to reduce engine emissions before they leave the tailpipe. Therefore, vehicles found to have used leaded fuel should be required to replace the catalytic converter. EPA has allowed for the use of a lead detection test in the vehicle tailpipe as a method to detect the use of leaded fuel. Since this is a chemical test, care must be taken to assure that the test is properly conducted and that the results are properly interpreted.

Vehicles with evidence of lead deposits in the tailpipe have used leaded fuel. The damage to the emission controls of the vehicle occurs in the catalyst, thus the catalyst which must be replaced to result in any substantial emission reduction. The tailpipe should also be replaced simply to avoid failing the test at the next inspection. ATPs which require failure of both the fuel inlet restrictor inspection and the tailpipe lead detection test before requiring replacement of the catalyst get credit for neither in MOBILE5, and should not indicate either inspection on the input records.

No credit is given by MOBILE5 for a tailpipe lead detection test unless an explicit check for the presence of the catalytic converter is also made. This catalyst inspection must be indicated as part of the ATP descriptive record in order to receive benefits.

### **2A.2.7 EGR Inspection**

The exhaust gas recirculation (EGR) system reduces oxides of nitrogen by routing some of the exhaust back into the intake manifold. The primary component of the system is the valve which controls the flow between the exhaust and intake manifolds, however, most systems are quite complex with various sensors and valves which control the operation of the system. Hoses may be plugged, either deliberately or by neglect. Any system observed with missing or damaged components or misrouted or plugged hoses and wires should be failed and repaired.

### **2A.2.8 Evaporative Control System**

The evaporative control system collects gasoline vapors from the gas tank and carburetor bowl and stores them in a charcoal canister. During certain engine operations, the canister purges, releasing the vapors which are routed to the engine to be burned. In addition to the evaporative canister itself, the system includes varying numbers of hoses, wires and control valves. Hoses may be plugged, either deliberately or by neglect. Any system observed with missing or damaged components or misrouted or plugged hoses and wires should be failed and repaired. This inspection flag is not used to indicate any functional purge or pressure testing of the evaporative emission control system. Emission reductions resulting from such testing must be calculated separately.

Vapors from the vehicle fuel tank will not be routed to the evaporative emission control system canister if the gas cap is leaking or missing. Therefore MOBILE5 will not give credit for an evaporative emission control system inspection unless there is also an explicit requirement for checking that a gas cap is present. This gas cap check must be indicated as part of the ATP descriptive record in order to receive benefits.

### **2A.2.9 PCV Inspection**

The positive crankcase ventilation (PCV) system routes the vapors from the crankcase to the intake manifold where they can be burned by the engine. The PCV system has two major loops. The most critical connects the crankcase with the throttle or the intake manifold with a hose and usually contains a valve. Another hose connects the crankcase with the air cleaner to provide the crankcase with filtered fresh air. Any system observed with damaged or missing components or with hoses misrouted or plugged, should be failed and repaired.

### **2A.2.10 Gas Cap Inspection**

Gas caps are actually part of the evaporative control system. Without a properly operating gas cap, fuel vapors from the gas tank would escape. On some vehicles, a missing gas cap will also cause the evaporative system canister to purge incorrectly. Inspectors should examine the fuel inlet area of each vehicle to determine that the gas cap is present. If not, the vehicle should be failed and the gas cap replaced. Inspectors should not be allowed to skip this inspection for such reasons as that the fuel inlet is concealed by a locked door.

## Appendix 2B

**MEMORANDUM ON EMISSION REDUCTION CREDITS  
FOR CALIFORNIA LOW EMISSION VEHICLES (LEVs)**

This appendix reproduces a memorandum issued by the Office of Mobile Sources (OMS) in April 1994 concerning the emission credits that can be attributed to implementation of the California low emission vehicle (LEV) program. The guidance in this memo is applicable to all MOBILE5 emission factor modeling that is to be used as part of the State Implementation Plan (SIP) process.

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April 8, 1994

MEMORANDUM

Subject: Emission Reduction Credits for California Low Emission Vehicles (LEV's)

To: Director, Air Management Division, Region 1  
 Director, Air and Waste Management Division, Region 2  
 Director, Air, Radiation, and Toxics Division, Region 3  
 Director, Air, Pesticides, and Toxics Management Division, Region 4  
 Director, Air and Radiation Division, Region 5  
 Director, Air, Pesticides, and Toxics Division, Region 6  
 Director, Air and Toxics Division, Regions 7, 8, 9, and 10

From: Phil Lorang, Director  
 Emission Planning and Strategies Division

This memo explains EPA's policy for the calculation of SIP credits for the California LEV program. This memo also addresses the issue of enhanced I/M options for LEV program vehicles, which was not discussed in the final rule on I/M program requirements.

Background

The state of California has adopted, and received an EPA waiver to implement, a Low Emission Vehicle (LEV) program. The LEV program consists of several sets of emission standards more stringent than the Tier 1 standards (TLEV, LEV, ULEV), a schedule of declining fleet average emission standards for non-methane organic gases (NMOG) which will drive the sales mix towards vehicles meeting the more stringent of the standard sets, and a sales mandate for zero-emitting vehicles (ZEVs). California has also adopted, and applied for an EPA waiver for, a requirement for advanced on-board diagnostic systems (OBD II) capable of detecting many emission defects causing vehicles to exceed their exhaust standards by as little as 50%. Other states have adopted or are considering the adoption of the California LEV program, including the OBD II requirements. These states require guidance regarding the amount of emission reductions that can be assumed for California vehicles in State Implementation Plans (SIP's).

The EPA Office of Mobile Sources (OMS) has reviewed the provisions of the final LEV regulations and has consulted with CARB staff and automobile industry engineers regarding the developing technology for compliance with both the emission standards and OBD requirements. Based on this review, OMS has formulated the following guidance for the calculation of SIP credits for each non-ZEV vehicle category (TLEV,

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LEV, ULEV) in the LEV program.<sup>1</sup> The overall SIP credit will depend on the mix of TLEVs, LEVs, ULEVs, and ZEVs, which will vary by model year and may depend on whether the fleet NMOG standard has also been adopted.<sup>2</sup> The purpose of this memo is to explain this guidance and its application in SIP submittals. Since any other state adopting California standards under Section 177 of the Clean Air Act is constrained to copy the California new vehicle program, EPA will apply a consistent policy to such states and to California itself.

This guidance has been incorporated into MOBILE5a, EPA's emission factor model. Actual procedures for selecting the LEV options in MOBILE5a are described separately in the MOBILE5a documentation (see Section 2.3.1 of the final version of the MOBILE5a User's Guide, to be issued shortly).

### Guidance

#### 1. Adjustments for certification vs. commercial fuel differences

Gasoline-fueled California vehicles are allowed to demonstrate compliance with California emission standards on a reactivity-weighted basis while operating on a "California Phase 2 Reformulated Gasoline." This fuel is expected to have advantages relative to EPA's Federal certification test fuel with respect to both mass emissions of VOC's, NOx, and CO and the reactivity of the VOC mixture. The use of California reformulated fuel in certifying LEV compliance affects the stringency of the numerical standards that apply to each LEV category. In California, all commercial fuel will have to meet the Phase 2 composition specifications, but in other states gasoline will not have to meet these specifications unless the states adopt them as their own. MOBILE5a will therefore apply adjustments to properly estimate the in-use emission levels of California cars when operating on other fuels. (It should be noted that MOBILE5a corrects all emission factor output to reflect actual commercial fuel effects; previous versions, in effect, assumed that the certification and commercial fuel were identical.)

#### 2. Credits based on the expectation that LEV vehicles will achieve substantial emission reductions beyond those from Federal vehicles

The California LEV program relies on advanced emission control technologies, clean gasoline, and an on-board diagnostic (OBD) system, which together with enhanced I/M or its equivalent are designed to assure that in-use vehicles emit at levels close to their respective emission standards. For purposes of obtaining emission benefits in a SIP that reflect this expectation (accounting for differences between Federal and California fuel requirements as discussed above), EPA requires that the following three components be included in the SIP: periodic IM240 emission testing with specific cutpoints, automated OBD system checks, and SIP commitments for auditing and corrections.

##### (a) Periodic IM240 emission testing with specific cutpoints

IM240 has been proven to be a practical and highly effective I/M test. EPA believes that a test-only I/M program that utilizes the IM240 test as described in the I/M Final Rule, with cutpoint modifications to match the lower emission standards for TLEV/LEV/ULEVs, is necessary to ensure the low in-use emissions described above. Therefore, EPA requires that such a program, or its approved equivalent as described below, must be included in order to obtain emission benefits in a SIP based on this assumption.

<sup>1</sup> With respect to ZEVs, SIP emission inventory projections should of course account for utility emissions associated with in-area generation of electric power to charge ZEVs. This aspect of accounting for LEV program effects is not susceptible to uniform guidance since it depends on the local situation regarding the sources of the incremental electric power and the utility emission controls that will be in place. However, MOBILE5a does produce output that will assist local inventory analysts [to] determine total travel by ZEVs in a given calendar year, which will assist in the estimation of recharging-dependent emissions from utilities.

<sup>2</sup> Although the legal issue of whether the fleet NMOG standard must be adopted has not been finally determined, EPA believes that adoption of the NMOG standard is likely to be a necessary component of any state LEV program, consistent with Clean Air Act Section 177. Furthermore, the fleet composition consequences of not adopting it are not yet clear. States should consult with OMS on this aspect of the credit calculation for the latest guidance.

In order to ensure that TLEV/LEV/ULEVs will have substantially better in-use performance than Tier 1 vehicles, lower IM240 inspection cutpoints are both necessary and appropriate. IM240 cutpoints of 0.6 THC, 10 CO, and 1.2 NO<sub>x</sub> for light-duty vehicles in the LEV program (compared to Tier 1 cutpoints of 0.7 THC, 10 CO, and 1.4 NO<sub>x</sub>) are required in order to achieve the emission benefits discussed above. A full list of cutpoints for all vehicle classes is given in an attachment to this memo.

(b) Automated OBD system checks

California vehicles will be required to have second generation systems for on-board diagnosis (OBD) of emission control problems. These OBD systems are intended to help both owners and I/M program computers identify cars in need of repair, and to aid in their effective and economical repair. OBD systems offer the potential to identify the presence of excess emissions, including those associated with cold start control system malfunctions, engine problems causing dangerous stress on the catalyst, and damage to the catalyst itself. OBD systems will be required on Federal vehicles as well. However, the California program requires OBD systems to detect emission increases as small as 50% of the applicable exhaust standard for certain system failures. Since LEV standards are substantially tighter than the Federal Tier 1 standards, California OBD systems must be capable of detecting smaller degrees of malperformance than Federal OBD systems, which will help assure that deterioration will be minimized.

OBD systems will include a standardized system for incorporation into I/M testing, including a "ready code" to ensure OBD test validity. The Clean Air Act requires OBD checks as part of an Enhanced I/M program. EPA will propose in a forthcoming rulemaking that OBD checks be required in basic I/M program[s] as well. Automation and test-only requirements are also critical to the effectiveness of an I/M program for LEVs, and are a condition for these credits. In addition, the expectation of periodic OBD checks will help motivate vehicle owners to seek repair early, before further damage to the emission control system occurs, thus avoiding some operation of unrepaired vehicles between inspections.

(c) SIP provisions for auditing and corrections

In combination with the enhanced I/M and automated OBD check programs described above, TLEV/LEV/ULEVs have a high probability of achieving in-use emission levels at or close to vehicle standards. However, because of the uncertainty inherent in new technologies, such as those required to meet the LEV standards, EPA believes that it is reasonable and necessary to include additional safeguards in SIPs that take credit for the LEV program based on this assumption. EPA will only allow this SIP credit if the SIP also includes provisions for a specific program for auditing the performance of TLEV/LEV/ULEVs and a program to take appropriate SIP revision action to correct or compensate for any shortfall in emissions performance discovered in the future.

The SIP must include a list of additional measures that will be among those considered and a timeline for consideration and action following any audit finding by the state itself or notification by EPA that a shortfall exists. Measures in this list could include among others more stringent I/M inspection standards (for example, IM240 standards set 50% above the in-use emission level assumed in the SIP credits), methods of cost pooling or other mechanisms to ensure full repair of vehicles under the original or more stringent inspection standards, old vehicle retirement, or additional reductions from other sources. Since the merits of one of these measures versus another or versus other measures identified later will depend on the size and causes of a shortfall in emission reductions, the SIP is not required to commit to implement any specific measures or number of measures. Of course, if California reaches similar audit findings and takes effective corrective action in its motor vehicle control program, other states that implemented the LEV program would have to follow, and would get the same benefits towards correcting their own shortfall.

If the three elements given above are part of the I/M SIP, EPA will approve SIP credit that is premised on a substantially reduced occurrence of in-use malfunctions and deterioration in the vehicle fleet, relative to that which has been observed on the most recent Federal and pre-LEV California production vehicles. The benefits would be essentially the same as those CARB itself has projected for the LEV program.

Credits for SIPs meeting these conditions have been included as an option in MOBILE5a. Details for modeling these options are given in the final MOBILE5a User's Guide (to be issued shortly). Sections 2.3.1

and 2.3.7 explain the procedures for modeling the LEV program with and without the I/M program described above. MOBILE5a users should be aware that due to the complexity of the model and the LEV and I/M programs, extra care must be taken when preparing input files to ensure that the desired programs are properly modeled. Users should note, for example, that an I/M program with the LEV program car cutpoints of 0.6/10/1.2 as described above is modeled by setting the values of specific flags, and not by changing the IM240 cutpoints in the I/M Program Descriptive Record.<sup>3</sup>

States may, if they choose, adopt an adequate combination of these additional measures initially, and not perform the audit program. In particular, adoption of IM240 cutpoints 50% above the in-use emission level assumed in the SIP credits is enough by itself to relieve a state from the requirement for an audit program.<sup>4</sup>

### 3. Evaporative emissions

MOBILE5a estimates that evaporative emissions from California and Federal vehicles will be the same, under a given fuel and inspection regime. This estimate may be revised in a subsequent version of the model, if differences in control technology and effectiveness are observed.

As in the case of all programs meeting EPA's enhanced I/M requirements, evaporative pressure and purge tests are also required in addition to the IM240 test, and the OBD system must be interrogated for emission control system fault codes, with the vehicle repaired as indicated by such codes. Inspections must be performed in a test-only format, to eliminate the possibility of error or evasion. Evaporative emissions would be the same as for Federal vehicles under the same inspection program.

### 4. Equivalent procedures

As always, OMS's intent is to achieve an emission control result rather than impose a design requirement. OMS will study vehicles meeting the California LEV requirements to determine the effectiveness of alternative inspection protocols for TLEV/LEV/ULEV vehicles which CARB or other states may submit in the future, and EPA will approve SIP revisions to the inspection protocol if the Administrator finds they are equivalent in effectiveness. As always, OMS will place great importance on the vehicle test fleet being representative of in-use vehicles and of the range of emission control system malfunctions to which they are subject in the real world, and on the technical appropriateness of the methods used to collect such data. Of course, EPA will apply a uniform policy to California and other states that have adopted California vehicle standards, and will consider data collected by all interested states.

### 5. Performance in the absence of the above-described periodic inspections

In most of the states considering adoption of the California emission standards, the largest ozone and CO nonattainment areas are classified as Serious or Severe, and are subject to the requirement for an enhanced I/M program. The I/M program described above will fit well into the enhanced I/M framework, although the cutpoints will be numerically lower. However, some areas receiving California vehicles will be subject to only a basic I/M program which will not be required to conduct three of the four high technology tests listed above

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<sup>3</sup> The credits discussed here are the same as those that are currently obtained by setting the REGION flag in MOBILE5a to "3" or the I/M flag in the LEV Program Parameter Record to "2". EPA plans to modify MOBILE5a to simplify the selection of these credits.

The credits in the current version of MOBILE5a assume no cost waivers and 100% vehicle owner compliance with the inspection requirement. If the SIP extends the \$450 cost waiver to LEVs, an adjustment must be made to account for the expected number of vehicles that are not fully repaired. OMS will provide guidance or a revised MOBILE version to allow this adjustment. Similarly, if more than a trivial degree of owner noncompliance is expected, adjustments must be made to reflect that credit loss.

<sup>4</sup> EPA has taken a similar approach in the recent California FIP proposal. The FIP proposal does not include these auditing provisions because it includes the Enhanced In-Use Compliance Program (EIUCP). However, because the EIUCP is a recall program not available to the states, the more stringent IM240 cutpoints given here (i.e., cutpoints 50% above the in-use emission level) are an alternative the states could adopt.



(OBD checks will be required in all I/M programs), or will not have any periodic inspection program in operation. States may need to prepare emission inventories for such areas.

The exhaust emission factors in MOBILE5a for LEV's in areas with no inspection program, or with only an Idle Test, 2500/Idle Test, or steady-state loaded exhaust test are lower than those for Federal vehicles under the same inspection regime by an amount equal to EPA's estimate of the difference in emission rates from "zero-mile" California vehicles versus "zero-mile" Federal vehicles. In other words, the in-use deterioration of the two vehicle types will be assumed to be the same. This assumption is likely to be conservative with respect to emission reductions in some or all of these areas; for example, basic I/M programs with OBD checks for LEVs would be expected to get some additional benefits that we currently have no basis for quantifying. This is in contrast to the lower in-use emission deterioration rates (lower by approximately the ratio of the LEV to Tier 1 standards) for low emission vehicles subject to an inspection program using OBD II checks and the IM240 cutpoints specified above for LEVs.

Emission credits for IM240 programs that have less stringent cutpoints than the "maximum" I/M program can also be calculated in MOBILE5a in the same way as the no-I/M and Idle Test I/M cases.

#### 6. Enhanced I/M performance standard for LEV's

Enhanced I/M programs are required to meet a performance standard which is defined by a particular program design listed in the I/M Final Rule. Any I/M program which would result in equivalent emission levels to this "enhanced performance standard" program would meet the requirements for enhanced I/M with respect to emission reductions. The description of the "enhanced performance standard" program in the I/M Final Rule includes cutpoints for both pre-Tier 1 and Tier 1 vehicles, but does not include cutpoints for LEV's.

At this point, EPA has not amended the I/M rule to specify what the "performance standard" program should be for LEV's. EPA has concluded, as guidance, that the "performance standard" cutpoints which define enhanced I/M for LEV program vehicles are the same as the cutpoints specified above as being needed to qualify for credits based on an assumption of vehicles meeting standards in use.

Attachment

#### Attachment to Emission Reduction Credits for California Low

#### Emission Vehicles (LEV's)

<u>Vehicle Class</u>	<u>IM240 Cutpoints (g/mi)</u>		
	<u>HC</u>	<u>CO</u>	<u>NOx</u>
LDV	0.6	10	1.2
LDT1a (0-3750 lbs LVW)	0.6	10	1.2
LDT1b (3750-5750 lbs LVW)	0.6	11	1.4
LDT2 (>6000 lbs GVW)	0.7	12	2.0

## Chapter 3

### MOBILE5 OUTPUT

#### 3.0 INTRODUCTION

This chapter describes all of the output that can be produced by the MOBILE5 highway vehicle emission factor model. There are four types of output: interactive user dialog (added for MOBILE4.1 and revised for MOBILE5, this "front-end" dialog is applicable for users operating MOBILE5 in a DOS-based personal computer (IBM, clones) or an Apple Macintosh computer environment), prompting messages, diagnostic messages (errors and warnings), and formatted emission factor reports. Relative to MOBILE4.1, most of the last three types of output are largely unchanged. Additional prompting, error, and warning messages have been added that deal with new features of the model, and other minor revisions have been made to some of these messages. MOBILE5 also offers a sixth (new) option for the formatted emission factor report (spreadsheet output, accessed by setting OUTFMT = 6), which is discussed in section 3.3.1.

#### 3.1 PROGRAM DRIVER ROUTINE

MOBILE5 will prompt the user on the screen with up to four questions, depending on the answers provided.

Interactive input mode (section 3.1.1) is provided by MOBILE5 if the user answers yes ("yes", "Yes", "y", or "Y") in response to the first question, "Do you want to use the interactive input model (Y/N)?" The input data required to run the model is normally too complex for the typical user to enter error-free from the keyboard; for example, entering alternate annual mileage accumulation rates or registration data by age with FORTRAN spacing is tiresome and unforgiving. The example input files in Chapter 5 will give the user a sense of the complexity of the input records. However, if the user is operating the MOBILE model for the first time then they may want to answer yes to get a global sense of the options and data input requirements. If the user has typed yes, Yes, y or Y, then MOBILE5 will respond with the following message: "Please enter the MOBILE5 output file name:" After that point the user is running MOBILE5 in the interactive input mode (section 3.1.1). THE USER IS ENCOURAGED TO AVOID THE INTERACTIVE INPUT MODE OPTION OF MOBILE5.

The second question (provided the user is not operating in the interactive input mode) is "Do you want to use the batch file input mode (Y/N)?" If the answer is yes, then the program responds, "Please enter the MOBILE5 batch filename:" After that point, the user is running MOBILE5 in the batch file input mode (section 3.1.2).

If the user answers no to both of the first two questions, the user is then prompted, "Please enter the MOBILE5 input filename:", followed by "Please enter the MOBILE5 output filename:" The first file name indicated by the user must contain a valid MOBILE5 input data file, such as those provided with the model as examples (see Chapter 5). The output is sent to the output file (the second file name) specified by the user. Inspection of this output reveals that it is broken up into two parts: diagnostic messages (section 3.2) and formatted report output (section 3.3).

Runtime messages (generated while the program is being executed) are written directly to the screen. The final message is "Run # <number of MOBILE5 runs>, INERR = <number of errors encountered in that particular MOBILE5 run>". After the runs have been completed, the message "DRIVER calls completed" will be written to the screen. See Chapter 4 for information on the implementation of logical input and output (I/O) device units.

### **3.1.1 INTERACTIVE INPUT MODE**

In general, EPA recommends that the input data for a MOBILE5 run be provided in a file rather than entered interactively. There are several advantages to using an input file rather than interactively entering the data. An input data file provides a permanent record of the options selected, which can then be stored in the computer without being retyped and printed. If there is an error in the input data file, then the input file can be edited and run again immediately. This is particularly useful when the user is supplying optional input data to replace values contained in the model, such as user-supplied tampering rates. This large quantity of input data is especially difficult to enter without error. Providing the data in a separate file, which can be printed and examined, facilitates the process of detecting and correcting input errors. The use of the interactive input mode has largely been superceded by the use of the program driver routine described above in MOBILE5, but has been retained in part to maintain compatibility with MOBILE4.1 input files.

If the user has elected to run MOBILE5 in the interactive mode by responding yes to the question "Do you want to use the interactive input model (Y/N)?", the next message the user sees is "Please enter the MOBILE5 output file name:". After an output file has been named, the next message to the screen will be "Please enter the PROMPT flag... (Enter 2 for Vertical or 4 for Horizontal Prompting)". There are two prompting formats: vertical input (PROMPT = 2) and horizontal input (PROMPT = 4). The use of the vertical data input option (PROMPT = 2) is recommended. If PROMPT = 2 or 4, the user is prompted for input data in the order required by MOBILE5 by a series of prompting messages (section 3.1.1.1). Prompt flag input values of one or three allow vertical and horizontal input of the data without prompting messages.

The user should note that if the value for the prompting flag is one or three, the user is nearly assured of making a format error, since the program will provide no indication of what is expected in terms of input data or format requirements. The input data required is in the same order as would be expected in a MOBILE5 data file and is generally formatted in the same way. All input format specifications are included with the interactive prompts. See Chapter 5 for example input files, and Chapter 2 for more detailed description of input data and format requirements.

#### **3.1.1.1 Prompting Messages**

When the user has selected to run the model in interactive mode and has opted to be prompted for the data inputs (PROMPT = 2 or 4), a series of prompting messages will appear on the screen. These messages will prompt the user for the remainder of the input data required for the MOBILE5 run, in the order required by the model. The ordering of the input data follows the presentation of the input data in Chapter 2 of this document. These prompting messages are written directly to the screen.

Since users are actively discouraged from operating MOBILE5 in interactive mode, these prompting messages are not detailed here. It is sufficient to note that prompting messages will appear for each of the control section data inputs (primarily flags, discussed in section 2.1), for each of the one-time data options that have been triggered by values assigned to the control flags (e.g., if the user sets MYMRFG = 3 and IMFLAG = 2, then the only one-time data section prompting messages issued will be those for alternate registration distributions by age and for an inspection and maintenance (I/M) program), and for the required scenario section data inputs and any optional scenario section inputs triggered by values assigned to the control flags. There are minor differences in the prompting messages depending on whether the user has chosen vertical (PROMPT =2) or horizontal (PROMPT = 4) data entry. The prompting messages will include format specifications describing the FORTRAN format requirements.

### **3.1.2 BATCH FILE INPUT MODE**

This option is a new enhancement to the MOBILE model for execution of multiple input data files. The batch file input mode is selected by responding yes to the second question after launching the MOBILE5 application ["Do you want to use the batch file input mode (Y/N)?"]. With this option, the user must prepare a simple text file which contains the input file names (and their paths, if they are not located in the local directory or folder) and the corresponding output file names. The names of the input files and respective output files must be listed on alternating lines. There is no limit to the number of pairs of lines of input and output filenames. An example batch file (M5.BAT) is included as one of the input/output examples supplied with the model.

While the model processes the input files, messages are printed on the screen. The number of pairs of input and output files is counted after being read. MOBILE5 writes out to the screen: "Processing batch file #1: <first input file name>". This message is repeated for every input file. At the end of the batch file MOBILE5 will say: "<number of input files>, Batch file(s) processed". Take note that each file in the batch input file may cause MOBILE5 to display one or more "Run # <n> INERR = <n>" messages. The final message is "Run # <number of MOBILE5 runs>, INERR = <number of errors encountered in that particular MOBILE5 run>". After the runs have been completed, the message "DRIVER calls completed" is generated to the screen. Therefore, the "DRIVER calls completed" message will appear once for each input file run successfully in the batch mode. In this situation it is possible to have several "runs" within each of the multiple input files. The environment in which this happens produces output such as (in abbreviated notation): processing batch, run with no errors, run again with no errors, calls complete, processing next batch, run again with no errors, and again, calls complete, two (or more) batch files processed.

## **3.2 DIAGNOSTIC MESSAGES**

### **3.2.1 INTRODUCTION**

Diagnostic messages are used to caution the user concerning user-supplied information. There are three types of diagnostic messages generated by MOBILE5: errors, warnings, and comments. An error will in all cases terminate processing of the current scenario, and in some cases will terminate processing of the entire run. Warnings and comments are included to assist users in the interpretation of the results.

Error messages indicate either that invalid input data were entered into MOBILE5, or MOBILE5 attempted to perform invalid operations. All error messages are prefixed by **\*\*\* Error** in this text for illustrative purposes, but in running the MOBILE5 model the asterisks do not appear. If a number follows **\*\*\* Error**, it is the value read by MOBILE5 for the variable in error (the variable name is also printed). If the error message is due to an input value that is out of bounds, the range of acceptable values is also printed. An error will stop a MOBILE5 run.

Warning messages indicate that MOBILE5 input data caused an operation not necessarily intended by the user, although the situation is not serious enough to be labeled an error. Nonetheless, users should examine the warning messages to ascertain the conditions that were modeled. Comments are a type of warning message that are printed for the user's information. Neither warning nor a comment will stop a MOBILE5 run.

The following diagnostic messages are new in MOBILE5:

M10, M11, M54, M55, M108 thru M110, M114 thru M116, M120, M135, M139, and M144 thru M152.

The following errors are considered to be "fatal" errors. If any of these errors occur, no further processing of the MOBILE5 input data will be performed:

M10, M11, M28, M53 thru M55, M60, M61, M82, M89, M97, M107, and M118.

The following diagnostic messages are generated by errors that may occur in using various internal diagnostic options in MOBILE5. These options are for EPA internal use only, thus none of these messages should be encountered in normal use:

M12, M13, M14, M15, M16, M119, M136, M140, M141, M142, and M143.

Finally, the following diagnostic message slots are not assigned in MOBILE5:

M74, M85, M102, M112, and M113.

Following is a list of the individual error, warning, and comment messages. In order to make the listing more useful to the MOBILE5 user, all of the messages are listed by message number (M## at the beginning of each message). MOBILE5 prints the message number as part of all diagnostic messages, allowing the user to quickly look up the message and its explanation in this section. The diagnostic message texts are all printed in boldface in this section.

The error messages M 122 through M 152 have been added to the program to assist users in isolating errors in the input data. As can be seen, the text of each message directs the user to the point in the input data file where the error occurred. In most cases, generation of one of these error messages means that the formatting of the data is incorrect. The user should check the input data file and required format specifications closely. See the relevant sections of Chapter 2 (MOBILE5 Input).

### **3.2.2 EXPLANATION of MESSAGES, LISTED by NUMBER (M##)**

#### **M 0 \*\*\* Error: Message code <nnn> is unknown**

This message should only be printed when the message printing subroutine QUITER is passed an undefined message code value. The run is aborted at this point.

#### **M 1 \*\*\* Error: <value of flag> out of bounds for flag <flag name>**

This message may be printed one or more times preceding message M53 and program termination. It will appear for each of the 16 input/output control flags which is in error. The number appearing after "\*\*\* Error:" is the value of the flag read by the program. Each of these messages indicates the value falls outside of the valid bounds for that flag. Allowable flag values are discussed in section 2.1 and summarized in Tables 2.1-1 and 2.1-2.

#### **M 2 \*\*\* Error: <n.nnn> out of bounds for Ether Blend market share (0. to 1.)**

This message is printed if the input value of the market fraction of ether/gasoline blends is not between zero and one. See sections 2.2.14 and 2.3.11.

#### **M 3 \*\*\* Error: <n.nnn> out of bounds for Alcohol Blend market share (0. to 1.)**

This message is printed if the input value of the market fraction of alcohol/gasoline blends is not between zero and one. See sections 2.2.14 and 2.3.11.

**M 4 \*\*\* Error: <n.nnn> out of bounds for Total Oxy Fuel market share (0.to 1.)**

This message is printed if the sum of the input values of the market fractions of ether/gasoline and alcohol/gasoline blends is not between zero and one. See sections 2.2.14 and 2.3.11.

**M 5 \*\*\* Error: <n.nnn> out of bounds for Ether Blend Oxygen Content (0.to 0.027)**

This message is printed if the input value of the average oxygen content of ether/gasoline blends is not between 0. and 0.027 (2.7 percent). See sections 2.2.14 and 2.3.11.

**M 6 \*\*\* Error: <n.nnn> out of bounds for Alcohol Blend Oxygen Content (0.to 0.035)**

This message is printed if the input value of the average oxygen content of ether/gasoline blends is not between zero and 0.035 (3.5 percent). See sections 2.2.14 and 2.3.11.

**M 7 \*\*\* Error: <n> out of bounds for Alcohol Blend RVP Waiver Switch (1 or 2)**

This message is printed if the input value of the oxygenated fuel RVP waiver switch is not 1 or 2. See sections 2.2.14 and 2.3.11.

**M 8 \*\*\* Error: Inconsistent Ether Blend input encountered****M 9 \*\*\* Error: Inconsistent Alcohol Blend input encountered**

Messages 8 and/or 9 are printed if the input values on the oxygenated fuels record have internal inconsistencies present. See sections 2.2.14 and 2.3.11.

**M 10 \*\*\* Error: <n> is not an allowable value for the Maximum I/M credit flag.**

This message is printed if the input value of the I/M indicator flag that is part of the low-emitting vehicle (LEV) program parameter record is not equal to zero or 1. See sections 2.3.7 and 2.3.1.

**M 11 \*\*\* Error: <nnnn> for LEV start year is less than 1994.**

This message is printed if the input value for the first model year of the LEV program on the LEV program parameter record is 1993 or earlier. The LEV program can only be modeled as starting in model year 1994 or later. See sections 2.3.1. and 2.3.7.

**M 17 \*\*\* Error: <value of VMTMIX> out of bounds for VMTMIX (0. to 1.)**

This message is printed if any value entered for VMTMIX (vehicle miles traveled fraction for any vehicle type) is not between 0. and 1. See section 2.2.2.

**M 18 \*\*\* Error:** <value of VMTMIX> **sum of VMTMIX is not equal to 1.**

This message is printed if the sum of VMTMIX values over all vehicle types is not equal to 1. Since individual VMTMIX values represent the fraction of total miles that each vehicle type contributes to the total vehicle miles traveled by the fleet, the sum of these fractions should equal 1. If the value of VMTMIX listed is 0.999 or 1.001, the problem is likely the result of roundoff error in the internal representation of these fractions in the computer, and no corrections are necessary. See section 2.2.2.

**M 19 \*\*\* Error:** <value of AMAR> **negative model year mileage**

This message is printed if the user-supplied annual mileage accumulation rate data for a specific combination of model year and vehicle type is negative. All annual mileage accumulation rates must be  $\geq 0.0$ . See Section 2.2.3.

**M 20 \*\*\* Error:** <value of JULMYR> **negative model year registration**

This message is printed if the model year registration fraction for a specific combination of model year and vehicle type is negative. Since this number represents the fraction of all vehicles in the fleet of a given age, it must be between 0 and 1 inclusive. See section 2.2.3.

**M 21 Warning:** <value of JULMYR> **registration with zero mileage****M 22 Warning:** <value of AMAR> **mileage with zero registration**

One of these messages is printed if, for a given vehicle age, vehicles either do not accumulate mileage yet make up a fraction of the fleet (M21), or do not make up a fraction of the fleet but accumulate mileage (M22). All vehicle type/model year combinations assumed to exist in the fleet must accumulate some mileage annually. For a given vehicle type and vehicle age, if either the mileage accumulation rate or the registration fraction is zero, both should be zero. See section 2.2.3.

**M 23 \*\*\* Error:** <value of NEWCT> **out of bounds for e.f. changes (1 to 100 pairs)**

This message is printed if the number of emission rate modifications is not between 1 and 100. MOBILE5 is limited to handling a maximum of 100 modifications to the basic emission rate equations. See section 2.2.4.

**M 24 \*\*\* Error:** <region code> **out of bounds for region (1 to 2)**

This message is printed if the value of region entered in the scenario record is not equal to 1 (low altitude) or 2 (high altitude). See section 2.3.1.

**M 25 \*\*\* Error:** <vehicle type code> **out of bounds for vehicle type (1 to 8)**

This message is printed if the vehicle type in the basic emission rate modification section is not equal to 1, 2, 3, 4, 5, 6, 7, or 8. See section 2.2.4 and Table 2.2-4. The eight vehicle types in MOBILE5 and their corresponding codes are listed below:

- 1 = light-duty gasoline-fueled vehicles (LDGV)
- 2 = light-duty gasoline-fueled trucks I (0-6000 lb GVW) (LDGT1)
- 3 = light-duty gasoline-fueled trucks II (6001-8500 lb GVW) (LDGT2)
- 4 = heavy-duty gasoline-fueled vehicles (8501+ lb GVW) (HDGV)
- 5 = light-duty diesel-powered vehicles (LDDV)
- 6 = light-duty diesel-powered trucks (0-8500 lb GVW) (LDDT)
- 7 = heavy-duty diesel-powered vehicles (8501+ lb GVW) (HDDV)
- 8 = motorcycles (MC)

**M 26 \*\*\* Error: <pollutant code> out of bounds for pollutant (1 to 3)**

This message is printed if the code for pollutant on the basic emission rate modification input section is not equal to 1, 2, or 3. MOBILE5 calculates emission factors only for 1 = hydrocarbons, 2 = carbon monoxide, and 3 = oxides of nitrogen. See section 2.2.4 and Table 2.2-4.

**M 27 \*\*\* Error: <value of MYFRST or MYLAST> out of bounds for year (1941 to 2020)**

This message is printed if the code corresponding to the first or last model year to have altered emission rates is not between 41 and 99 or 00 and 20 (corresponding to years 1941-1999 and 2000-2020). See Table 2.2-4 and section 2.2.4.

**M 28 \*\*\* Error: Excess data errors prevent further analysis**

This message is printed if the accumulated number of data input errors exceeds 50. The run is stopped at this point. All input data should be thoroughly checked and must be corrected before rerunning MOBILE5.

**M 29 \*\*\* Error: Last year cannot be less than first year**

This message is printed if the last model year to have its emission rates altered is less than (before) the first model year to be altered. See Table 2.2-4 and section 2.2.4.

**M 30 \*\*\* Error: <value of ZMLNEW> intercept must be positive**

This message is printed if a new zero-mile emission level entered as part of an alternate basic emission rate equation is  $\leq$  0.0. See Table 2.2-4 and section 2.2.4.

**M 31 Warning: <value of DRNEW> negative slope for aging vehicle**

This message is printed if a value for an exhaust deterioration rate entered as part of an alternate basic emission rate equation is negative. A negative deterioration rate implies improving emissions with increasing mileage accumulation. See Table 2.2-4 and section 2.2.4.

**M 32 \*\*\* Error: <value of ICYIM> out of bounds for year (1960 to 2020)**

This message is printed if the code indicating the year in which an inspection and maintenance (I/M) program is to begin does not fall between 60 and 99, or 00 and 20 (years 1960 to 2020). See section 2.2.5.



**M 33 \*\*\* Error: <value of ISTRIN> out of bounds for stringency (10 to 50)**

This message is printed if the stringency of the I/M program for 1980 and earlier LDVs or 1984 and earlier LDTs is not between 10 and 50 (percent). See Table 2.2-6 and sections 2.2.5 and 2A.1.3.

**M 34 \*\*\* Error: <value of CRIM> out of bounds for I/M Program compliance rate (0 to 100%)**

This message is printed if the specified value for compliance rate of an I/M program is not between 0 and 100 (percent) inclusive. See Table 2.2-6 and sections 2.2.5 and 2A.1.7.

**M 35 \*\*\* Error: <value of MODYR1> out of bounds for MODYR1 (1941 to 2020)**

This message is printed if the code representing the first model year under an I/M program is not between 41 and 99, or 00 and 20 (years 1941 and 2020). These years are the limits set by MOBILE5. See Table 2.2-6 and sections 2.2.5 and 2A.1.4.

**M 36 \*\*\* Error: <value of MODYR2> out of bounds for MODYR2 (1941 to 2020)**

This message is printed if the code representing the last model year under an I/M program is not between 41 and 99, or 00 and 20 (years 1941 and 2020). See Table 2.2-6, and sections 2.2.5 and 2A.1.5.

**M 37 \*\*\* Error: MODYR1 cannot be greater than MODYR2**

This message is printed if the first model year in an I/M program is greater (later) than the last model year in the program. See Table 2.2-6 and sections 2.2.5, 2A.1.4, and 2A.1.5.

**M 38 \*\*\* Error: <value of CY> out of bounds for year (1960 to 2020)**

This message is printed if the calendar year to be evaluated is not between 1960 and 2020 (60 to 99 or 00 to 20) inclusive. These are the only years for which MOBILE5 evaluates emission factors. See section 2.3.2 and Table 2.3-1.

**M 39 \*\*\* Error: <value of SPD(I)> speed must be positive**

This message is printed if the value for average speed (if SPDFLG=1), or any of the eight values of average speed (if SPDFLG=2), is  $\leq 0.0$ . See section 2.3.3.

**M 40 \*\*\* Error: <value of AMBT> valid ambient temperature is 0-110 deg (F)**

This message is printed if the specified value for ambient temperature value is not between 0 and 110 degrees Fahrenheit (-23 and 43 degrees Celsius). These are the limits for application of temperature correction factors in MOBILE5. See section 2.3.4.

**M 41 \*\*\* Error: <value of PCCN> out of bounds for PCCN (0. to 100.)**

This message is printed if the input value for percentage of miles traveled by non-catalyst vehicles in cold-start mode is not between 0 and 100 (percent). See section 2.3.5.

**M 42 \*\*\* Error: <value of PCHC> out of bounds for PCHC (0. to 100.)**

This message is printed if the input value for percentage of miles traveled by catalyst-equipped vehicles in hot-start mode is not in between 0 and 100 (percent). See section 2.3.5.

**M 43 \*\*\* Error: <value of PCCC> out of bounds for PCCC (0. to 100.)**

This message is printed if the input value for percentage of miles traveled by catalyst-equipped vehicles in cold-start mode is not between 0 and 100 (percent). See section 2.3.5.

**M 44 \*\*\* Error: <value of AC> out of bounds for AC (0. to 1.)**

This message is printed if the specified value of the fraction of air-conditioner-equipped vehicles using air conditioning is not between 0. and 1. inclusive. See section 2.3.10.3.

**M 45 \*\*\* Error: <value of XLOAD(I)> out of bounds for extra load (0. to 1.)**

This message is printed if the specified value for the fraction of vehicles assumed to be carrying an extra 500 lb load is not between 0. and 1. inclusive. See section 2.3.10.4.

**M 46 \*\*\* Error: <value of TRAILR(I)> out of bounds for trailers (0. to 1.)**

This message is printed if the specified fraction of vehicles assumed to be towing a trailer is not between 0. and 1. inclusive. See section 2.3.10.5.

**M 47 \*\*\* Error: <value of ABSHUM> out of bounds for humidity (20. to 140.)**

This message is printed if the specified value for absolute humidity is not between 20 and 140 (grains of water per pound of dry air) inclusive. See section 2.3.10.6.

**M 48 \*\*\* Error: There are no sales for vehicle <vehicle name>**

MOBILE5 assumes that no significant number of light-duty diesel vehicles (LDDVs) exist before the 1975 model year. Similarly, no significant number of light-duty diesel trucks (LDDTs) are assumed to exist prior to the 1978 model year. This message is printed if the user inputs a positive VMT fraction for LDDVs or LDDTs for calendar years in which they are assumed to be virtually nonexistent.

**M 49 \*\*\* Warning:** <value of CHKMYR> **MYR sum not = 1. (will normalize)**

This message is printed if the sum of registration fractions by model year for a given vehicle type do not sum to 1. If the model year age registration fractions do not sum to 1, MOBILE5 normalizes the fractions so that they do. If the value printed for the sum is 0.999 or 1.001, then the problem is likely the result of roundoff error in the internal representation of the numbers in the computer, and no corrections are necessary. See section 2.2.3.

**M 50 \*\*\* Error:** <value of ZEROML> **out of bounds for tampering rate intercept (up to 1.0)**

The zero-mileage level of tampering cannot exceed 100% of the fleet (1.0 as a fraction) for any combination of tampering type and vehicle type. See section 2.2.1.

**M 51 \*\*\* Error:** equation <equation number> **cannot be stored. Only 12 equations per pol/veh/reg case are allowed.**

This message is printed if the user attempts to enter more than 12 modified basic emission rate equations for any single combination of region, vehicle type, or pollutant. See section 2.2.4.

**M 52 Warning:** <value of SPD> **speed increased to 2.5 mph minimum**

This message is printed if the average speed (if SPDFLG = 1), or one or more of the eight average speeds (if SPDFLG = 2), is less than 2.5 mph. MOBILE5 increases the value to 2.5 mph, which is the minimum average speed for which speed correction factors are developed, and continues execution. See section 2.3.3.

**M 53 Comment:** **All flags must be corrected before rerunning**

This message is printed if one or more errors occur in reading the Control section flags. It should appear after a list indicating which flags are in error (see **M 1**). The run is aborted at this point. All flags in error must be corrected before the program will continue.

**M 54 \*\*\* Error:** **I/M credits for this program description not found.**

This message is printed if none of the available cutpoints in the I/M credit data file match the values MOBILE5 has been given by the user or those in default. See section 2.2.5.

**M 55 \*\*\* Error:** **Error return reading I/M credits.**

This message is printed if the I/M credit data file does not match the format that MOBILE5 is expecting. See section 2.2.5.

**M 56 Comment: A/C correction factor will be calculated. Value of inputted AC usage parameter is ignored.**

This message is printed if ALHFLG = 3 and a non-zero value for air conditioning usage fraction is entered. With ALHFLG = 3, the air conditioning usage fraction is calculated as a function of the input dry bulb and wet bulb temperatures. See sections 2.3.10.3 and 2.3.10.7.

**M 57 \*\*\* Error: WB temp cannot be greater than DB temp**

This message is printed if the input wet bulb temperature is greater than the input dry bulb temperature. The wet bulb temperature is always less than or equal to the corresponding dry bulb temperature. See section 2.3.10.7.

**M 58 Warning: Average miles/day is zero for vehicle class <IV> and model year <MY>**

This message is printed if Block Data Subprogram 14 has been incorrectly modified by the user.

**M 59 Warning: equation <equation number> zeroes all idle coefficients (and total) for IR = <region code>, IV = <vehicle code>, IP = <pollutant code>**

This message is printed when the user modifies the basic emission rate equations for the specified region, vehicle type, and pollutant. All alternative emission equations cause MOBILE5 to zero all idle emission equations corresponding to the region, vehicle type, and pollutant modified. (Note: The idle emission factor option is disabled in MOBILE5, as discussed in section 2.1.17.)

**M 60 \*\*\* Error: <pointer value> exceeds ub of highest myg in <index function name>****M 61 \*\*\* Error: default used for <year> in index function <index function name>**

These messages indicate that a default exit has been taken from an index function. These messages are generated by internal software error checks, and neither should occur unless the program code has been damaged. The run is halted at this point. The program must be corrected and re-compiled before another run.

**M 62 \*\*\* Error: <value of NEWREG> out of bounds for new e.f. region (1 or 2 only)**

This message is printed if the region to which a modified basic emission rate applies is specified to be other than 1 (low altitude) or 2 (high altitude). This specification of region is independent of the region specified in the Scenario descriptive record (section 2.3.1). See Table 2.2-4 and section 2.2.4.

**M63 \*\*\* Error: <value of sum PCHC + PCCC> out of bounds (0 ≤ PCHC + PCCC ≤ 100.)**

This message is printed if the sum of the cold-start and hot-start VMT percentages for catalyst-equipped vehicles is not between 0 and 100 percent inclusive. See section 2.3.5.

**M 64 \*\*\* Error:** <value of sum PCHC + PCCC - PCCN> **out of bounds (0. ≤ PCHC+PCCC-PCCN ≤ 100.)**

This message is printed if the sum of the cold- and hot-start VMT percentages for catalyst-equipped vehicles, less the cold-start VMT percentage for non-catalyst vehicles, is not between 0 and 100 percent inclusive. See section 2.3.5.

**M 65 \*\*\* Error: MYR of LDDV not equal to LDGV for JDJ = <value>**

**M 66 \*\*\* Error: MYR of LDDT not equal to LDGT1 for JDJ = <value>**

One or both of these messages is printed if the user enters a different registration distribution by age for LDGVs than for LDDVs (M65), or for LDGT1s than for LDDTs (M66). The registration distribution by age for the total LDV (or LDT) fleet is to be input twice, once each for the gasoline-fueled and diesel light-duty vehicles (or light-duty trucks). MOBILE5 apportioned total registrations into the separate gasoline-fueled and diesel groups based on diesel sales fractions by model year. See section 2.2.3.4.

**M 67 \*\*\* Error: EFFTP > 0. and GSF = 0. for vehicle <vehicle name>**

This message is printed if the named vehicle type has a positive basic emission rate and a zero registration distribution fraction. See section 2.2.3.

**M 68 \*\*\* Error: EFFTP ≤ 0. AND VMTMIX > 0. for vehicle <vehicle type>**

This message is printed if no exhaust emission rates exist for the named vehicle type, but vehicles of that type have accumulated a nonzero fraction of the total vehicle fleet mileage.

**M 69 \*\*\* Error: EFIDLE > 0. and GSF = 0. for vehicle <vehicle type>**

This message is printed if the named vehicle type has a positive idle emission factor and a zero registration distribution fraction. See section 2.2.3.

**M 70 \*\*\* Error: EFIDLE ≤ 0. AND VMTMIX > 0. for vehicle <vehicle type>**

This message is printed if the named vehicle type has a zero or negative idle emission rate and has accumulated a nonzero fraction of the total vehicle fleet mileage. See section 2.2.3.

**M 71 Comment: Current output unit numbers are:**

**IOUREP = "formatted report unit number"**

**IOUERR = "error/warning/comment unit number"**

**IOUASK = "prompt message unit number"**

This message is printed whenever any of the default output unit numbers are reassigned using the IOUNEW record in the Control section. See section 2.1.2.

**M 72 \*\*\* Error: <Value of ILDT(I)> out of bounds for I/M vehicle type flag (1 to 2)**

This message is printed if the value of ILDT(I) in the I/M program descriptive record, which represents whether the vehicle type indicated is or is not subject to inspection, is not 1 or 2. See Table 2.2-6.

**M 73 \*\*\* Error: <value of ITEST> out of bounds for short test type flag (1 to 4)**

This message is printed if the value of ITEST (I/M test type for Tech IV+ vehicles) is not 1, 2, 3 or 4. See Table 2.2-6.

**M 75 \*\*\* Error: <value of LAPSY> out of bounds for anti-tampering program start year**

This message is printed if the value of the start year for the selected anti-tampering program (ATP) is not in the range 1960 to 2020 (60-99 or 00-20). See Table 2.2-7 and section 2A.1.2.

**M 76 \*\*\* Error: <value of LAP1ST> out of bounds for anti-tampering program 1st model year**

This message is printed if the value of the first model year included in the selected ATP is not in the range 1941 to 2020 (41-99 or 00-20). See Table 2.2-7 and section 2A.1.4.

**M 77 \*\*\* Error: <value of LAPLST> out of bounds for anti-tampering program last model year**

This message is printed if the value of the last model year included in the selected ATP is not in the range 1941 to 2020 (41-99 or 00-20). See Table 2.2-7 and section 2A.1.5.

**M 78 \*\*\* Error: <value of LVTF LG (IVTAM)> out of bounds for anti-tampering vehicle type (1 to 2)**

This message is printed if the value entered for the ATP vehicle class inclusion flag for a particular vehicle type is not either 1 (not covered) or 2 (covered). See Table 2.2-7.

**M 79 \*\*\* Error: <value of EVP> out of bounds for evap ATP effectiveness rate (0. to 1.)**

This message is printed if the value calculated for the evaporative ATP effectiveness rate in the ATP effectiveness rate matrices generated by MOBILE5 is not in the range 0.0 to 1.0. These rates act as percentage credits, and hence must be nonnegative and not exceed unity.

**M 80 \*\*\* Error: <value of RATE> out of bounds for exh ATP effectiveness rate (0. to 1.)**

This message is printed if the value calculated for the exhaust ATP effectiveness rate in the ATP effectiveness rate matrices generated by MOBILE5 is not in the range 0.0 to 1.0. These rates act as percentage credits, and hence must be nonnegative and not exceed unity.

**M 81 \*\*\* Error: <value of RATE> out of bounds for AER matrix file column sum (0. to 1.)**

This message is printed if any column sum of each of the 4 exhaust ATP effectiveness rate matrices generated by MOBILE5 is not in the range 0.0 to 1.0. These rates act as percentage credits, and hence must be nonnegative and not exceed unity.

**M 82 \*\*\* Error: <value of INTYP> out of bounds for type of I/M inspection [1 (test only) or 2 (test and repair (computerized)) or 3 (test and repair (manual))]**

This message is printed if the value of the I/M program type specified in the I/M descriptive record is not 1, 2, or 3. The run is aborted at this point. See Table 2.2-6 and sections 2.2.5, 2A.1.12, 2A.1.13, and 2A.1.14.

**M 83 Comment: One or more evaporative temperatures (input daily maximum, input ambient, calculated hot soak, and/or calculated running loss) is 40°F or less, or the input daily minimum is 25°F or less; no evaporative emission factors (hot soak, diurnal, running loss, or resting loss) will be calculated**

This message is printed if (1) one or more temperatures calculated by MOBILE5 for correction of emissions (if TEMFLG = 1), or (2) the input ambient temperature (if TEMFLG = 2), is less than or equal to 40 degrees Fahrenheit (4 degrees Celsius); or (3) the input daily minimum temperature is less than or equal to 25 degrees Fahrenheit (-4 degrees Celsius). See section 2.2.11. Crankcase emissions will still be calculated, resulting in a small non-zero evaporative emission factor, representing crankcase emissions only, under these conditions.

**M 84 \*\*\* Error: <Value of IVOB(IV)> out of bounds for onboard VRS vehicle class flag (1 to 2)**

This message is printed if the value of the IVOB flag for vehicle type IV, indicating whether or not the vehicle type is subject to the requirements of an onboard vapor recovery system (VRS), is not 1 or 2. See Table 2.2-9 and section 2.2.7.

**M 86 \*\*\* Error: <value of NPHASE> out of bounds for no of stage II phase-in years (1 to 9)**

This message is printed if the value of NPHASE in the Stage II VRS descriptive record, representing the number of years allowed for complete phase-in of a Stage II VRS requirement, is not between 1 and 9. See Table 2.2-9 and section 2.2.7.

**M 87 \*\*\* Error: <value of IS2SY or IOBMY or IUESY> out of bounds for VRS or RVP controls start year**

This message is printed if any of the specified start years [for Stage II vapor recovery system (VRS), onboard VRS, or "period 2" fuel volatility (RVP)] is not between 1989 and 2020 (89-99 and 00-20). See sections 2.2.7 and 2.2.13.

**M 88 \*\*\* Error: <n.nnn> out of bounds for diesel sales fraction (0. to 1.)**

This message is printed if the user has supplied diesel sales fractions by model year for LDVs and LDTs, and one or more of the fractions is not between zero and one. See section 2.3.12.

**M 89 \*\*\* Error: <value of PROMPT> out of bounds for flag PROMPT (1 to 4)**

This message is printed if PROMPT does not equal 1, 2, 3, or 4. The run is stopped, and this correction must be made before the program will proceed. See section 2.1.1.

**M 90 Warning: <Value of RVP> RVP is reset to <new value>**

This message is printed if the input value for either "period 1" or "period 2" RVP, or the value of either of these after fuel weathering is accounted for, is outside the RVP limits of 7.0 to 15.2 psi inclusive; or, if the value of RVP to be used in the diurnal or hot soak evaporative emission factor calculation exceeds an upper limit for each that depends on the temperature to be used in that calculation. See Table 2.2-10 and sections 2.2.12 and 2.2.13. The value printed first is reset by MOBILE5 to <new value> before the emission factors are calculated.

**M 91 \*\*\* Error: <value of TEMMIN> out of bounds for minimum daily temperature****M 91 \*\*\* Error: <value of TEMMAX> out of bounds for maximum daily temperature**

One of these messages is printed if either the input minimum or maximum daily temperature is outside the limits set by MOBILE5 ( $0 \leq \text{minimum} \leq 100$ ,  $10 \leq \text{maximum} \leq 120$ ). See Table 2.2-10 and section 2.2.11.

**M 92 \*\*\* Error: Max daily temp = <value of TEMMAX> < min daily temp**

This message is printed if the minimum daily temperature is greater than the maximum daily temperature. See section 2.2.11.

**M 93 \*\*\* Error: <nnn.n> out of bounds for % TLVMT (set to zero.)**

This message is printed if the user is supplying trip length distribution data to be used in calculating running loss emission factors, and one or more of the values is not between zero and one. See section 2.3.13.

**M 94 \*\*\* Error: <nnn.n> % TLVMT sum not = 100. (will normalize)**

This message is printed if the user is supplying trip length distribution data to be used in calculating running loss emission factors, and the sum of the six values is not 100 (percent). MOBILE5 will normalize the input and continue execution. See section 2.3.13.

**M 95 \*\*\* Error: Ambient temperature = <value of AMBT> is < daily min temp or > daily max temp**

This message is printed if the ambient temperature (see section 2.3.4) is either less than the minimum daily temperature or greater than the maximum daily temperature (see section 2.2.11).



**M 96 Warning:** <Value of SPD(i)> **speed reduced to 65 mph maximum**

This message is printed if the average speed (if SPDFLG = 1) or one or more of the eight average speeds (if SPDFLG = 2) is greater than 65 mph. MOBILE5 reduces the value to 65 mph and continues execution. See section 2.3.3.

**M 97 \*\*\* Error:** <Value of A (vapor calculation equation coefficient)> **out of bounds for Wade Index calculation (CALUDI) of A, pass <value of JV (1 or 2; calculation iteration count)>: must be  $\geq 0.0$** 

This message is printed if an unrealistic combination of very high fuel volatility (RVP) and temperature values are used in the calculation of diurnal evaporative emissions. The run is aborted at this point. Re-check all input RVP and temperature values. See sections 2.2.11 - 2.2.13.

**M 98 Warning:** **Diurnal temperature rise (max temp - min temp = <value>) is > 40F; diurnal evaporative emission factors will be calculated, but may be inaccurate.**

This message is printed if the difference between the input daily minimum and maximum temperatures is greater than 40 F (22 C). See section 2.2.11.

**M 99 \*\*\* Error:** <Value of PCTEL> **out of bounds for Stage II efficiency for LDGV (0 to 100)****M 99 \*\*\* Error:** <Value of PCTEH> **out of bounds for Stage II efficiency for HDGV (0 to 100)**

One of these messages is printed if the specified value for the efficiency of the Stage II vapor recovery system (VRS) at controlling refueling emissions from LDGVs and LDGTs, or from HDGVs, is not between 0 and 100 (percent). See Table 2.2-9 and section 2.2.7.

**M 100 \*\*\* Error:** <Value of WAIVER(i)> **out of bounds for I/M Program waiver rate (0 to 50%)**

This message is printed if the values specified for either waiver rate for I/M programs (one for pre-1981 model year vehicles and one for 1981 and later model year vehicles) on the I/M program descriptive record is not between 0 and 50 percent inclusive. See Table 2.2-6 and sections 2.2.5 and 2A.1.6.

**M 101 \*\*\* Error:** <Value of IFREQ> **out of bounds for frequency of I/M inspection [1 (annual) or 2 (biennial)]**

This message is printed if the value for inspection frequency specified on the I/M program descriptive record is not 1 or 2. See Table 2.2-6 and sections 2.2.5 and 2A.1.8.

**M 103 \*\*\* Error:** <Value of ATPPGM> **out of bounds for type of ATP program [1 (test only) or 2 (test and repair)]**

This message is printed if the value for program type on the anti-tampering program (ATP) descriptive record is not 1 or 2. See Table 2.2-7, and sections 2.2.6 and 2A.1.12 and 13.

**M 104 \*\*\* Error: <Value of ATPFQT> out of bounds for frequency of ATP inspection [1 (annual) or 2 (biennial)]**

This message is printed if the value for inspection frequency on the ATP descriptive record is not 1 or 2. See Table 2.2-7 and sections 2.2.6 and 2A.1.8.

**M 105 \*\*\* Error: <Value of CRATP> out of bounds for ATP compliance rate, must be in the range 0.% to 100.%, inclusive**

This message is printed if the specified ATP compliance rate is not between 0 and 100 percent inclusive. See Table 2.2-7 and sections 2.2.6 and 2A.1.7.

**M 106 \*\*\* Error: <Value of DISTYP(I)> out of bounds for ATP disablement inspections [1 (no) or 2 (yes)]**

This message is printed if the value of any of the eight flags on the ATP descriptive record, indicating whether or not each of eight possible inspections is performed, is not 1 or 2. See Table 2.2-7 and sections 2.2.6 and 2A.2.3 through 2A.2.10.

**M 107 \*\*\* Error: Error reading ATP program description in the ONE-TIME data section**

This message is printed if there is an error in reading the ATP descriptive record. The run is aborted at this point. Check the formats and all input values closely. See Table 2.2-7.

**M 108 Warning: The user supplied compliance rates are not equal.**

**ATP compliance rate:** <value of CRATP, or (NA)>  
**I/M program #1 compliance rate:** <value of CRIM(1), or (NA)>  
**I/M program #2 compliance rate:** <value of CRIM(2), or (NA)>  
**Pressure Check compliance rate:** <value of CRPRS>  
**Purge Check compliance rate:** <value of CRPRG>

This message is printed if two or more applicable compliance rates are not identical. Since inspection and maintenance (I/M) programs, anti-tampering programs (ATP), and functional pressure and/or purge tests of evaporative emission control systems generally would be operated in combination, the user's attention is drawn to the inconsistency in compliance rates. See sections 2.2.5 and 2.2.6.

**M 109 Warning: The user supplied inspection frequencies are not equal.**

**ATP inspection frequency:** <annual, biennial, or (NA)>  
**I/M program #1 inspection frequency:** <annual, biennial, or (NA)>  
**I/M program #2 inspection frequency:** <annual, biennial, or (NA)>  
**Pressure Check inspection frequency:** <annual, biennial, or (NA)>  
**Purge Check inspection frequency:** <annual, biennial, or (NA)>

This message is printed if two or more applicable inspection frequencies are not identical. Since inspection and maintenance (I/M) programs, anti-tampering programs (ATP), and functional pressure and/or purge tests of evaporative emission control systems generally would be operated in combination, the user's attention is drawn to the inconsistency in inspection/test frequencies. See sections 2.2.5 and 2.2.6.

**M 110 Warning: The user supplied inspection types are not equal.**

**ATP inspection type:** <type of inspection, or (NA)>  
**I/M program #1 inspection type:** <type of inspection, or (NA)>  
**I/M program #2 inspection type:** <type of inspection, or (NA)>  
**Pressure Check inspection type:** <type of inspection, or (NA)>  
**Purge Check inspection type:** <type of inspection, or (NA)>

This message is printed if two or more applicable inspection types are not identical. Since inspection and maintenance (I/M) programs, anti-tampering programs (ATP), and functional pressure and/or purge tests of evaporative emission control systems generally would be operated in combination, the user's attention is drawn to the inconsistency in inspection type. See sections 2.2.5 and 2.2.6.

**M 111 \*\*\* Error: <Value of exhaust correction temperature or hot soak, running loss, or diurnal correction temperature> is < min daily temp or > max daily temp**

This message is printed if TEMFLG = 1 and one of the temperatures calculated for correction of exhaust, evaporative, running loss, or resting loss emissions is outside of the range of the specified minimum and maximum daily temperatures. Since these calculations use the input minimum and maximum daily temperatures to start with, this is an internal error check. If this message appears, and the minimum and maximum daily temperatures are correct and meet all of the necessary conditions, damage has occurred to either the source code or the compiled program. Re-compile and attempt the run again.

**M 114 Warning: Purge Check emission benefits assume the use of a dynamometer and the IM240 transient test procedure driving cycle.**

This message is printed if the model year coverage for the Purge Check covers model years not included by an I/M program using the IM240 transient test procedure see sections 2.2.5 and 2.2.6.

**M 115 \*\*\* Error: <value of NETPYR> out of bounds for number of ETP phase-in years (1 to 4)**

This message is printed if the input value for the number of phase-in years for the new evaporative emission test procedure (ETP) is less than one or greater than four. See section 2.2.4.

**M 116 \*\*\* Error: <value of ETPPIV(1-4)> is out of bounds for ETP phase-in rate (0 to 100%)**

This message is printed if the input value of any one of the 4 ETP phase-in rates (fraction of vehicles required to certify using new ETP in each model year) is not in the range 0.0 to 1.0. See section 2.2.4.

**M 117 \*\*\* Error: <n> out of bounds for by model year table pick (1 to 2)**

This message is printed if the values of the two flags at the end of the by model year inclusion vector are not 1 or 2. See section 2.2.18.

**M 118 \*\*\* Error: Input of diesel sales fractions not allowed in One-Time Data section**

This message is printed if the user sets DSFLAG = 2 on the LAP record and also sets LOCFLG = 2. See sections 2.2.15 and 2.3.12.

**M 120 \*\*\* Warning: <value of MEVAL> is out of bounds for evaluation month of a reformulated gas area. Must be 1 (Jan) or 7 (July). Season will default to summer.**

This message is printed if the input value of the month of evaluation is not equal to one or seven. See section 2.3.6.

**M 121 \*\*\* Warning: No emission credit from evaporative control system inspection will be given unless gas cap inspection also required**

This message is printed if an ATP is specified that includes evaporative emission control system inspection but does not include gas cap inspection. See section 2.2.6.4 and Table 2.2-7.

The error messages M 122 through M 152 have been added to the program to assist users in isolating errors in the input data. As can be seen, the text of each message directs the user to the point in the input data file where the error occurred. In most cases, the generation of one of these error messages means that the formatting of the data is incorrect. The user should check the input data file and formatting requirements closely. See the relevant sections of Chapter 2 (MOBILE5 Input).

**M 122 \*\*\* Error: Error occurred in reading mileage accrual rates**

**M 123 \*\*\* Error: Error occurred in reading registration distributions**

**M 124 \*\*\* Error: Error occurred in reading a vertically input flag**

**M 125 \*\*\* Error: Error occurred in reading a horizontally input flag**

**M 126 \*\*\* Error: Error occurred in reading a replacement tampering rate**

**M 127 \*\*\* Error: Error occurred in reading the VMT mix record**

**M 128 \*\*\* Error: Error occurred in reading the replacement emission factor rates**

**M 129 \*\*\* Error: Error occurred in reading the I/M program descriptive record**

**M 130 \*\*\* Error: Error occurred in reading the Stage II or onboard VRS input record**

**M 131 \*\*\* Error: Error occurred in reading the local area parameter record**

**M 132 \*\*\* Error: Error occurred in reading the scenario descriptive record**

**M 133 \*\*\* Error: Error occurred in reading the additional correction factor record**

**M 134 \*\*\* Error: Error occurred in reading the By Model Year selection flags**



**M 135 \*\*\* Warning: All effects of the 1990 Clean Air Act Amendments have been disabled.**

This message is printed to remind the user that the effects of new vehicle and fuel regulations required under the Clean Air Act Amendments of 1990 have been "turned off" if the input value of NEWFLG is five or six. See sections 2.1.8 and 2.2.4.

**M 137 \*\*\*Error: Error occurred in reading the oxygenated fuels descriptive record****M 138 \*\*\*Error: Error occurred in reading diesel sales fractions****M 139 \*\*\* Error: <value of IETPYR(1-4)> out of bounds for ETP phase-in year (1995 to 2020)**

This message is printed if the value input for any of the one to four phase-in years for the new evaporative emission test procedure (ETP) is not in the range 1995 to 2020. See section 2.2.4.2.

**M 144 \*\*\* Error: Error occurred in reading ETP parameters**

This message is printed if the input value of the ETP parameters does not match the format that MOBILE5 is expecting. See the section relating to the ETP option.

**M 145 \*\*\* Error: <value of MEVAL> is out of bounds for evaluation month 1 (Jan) or 7 (July)**

This message is printed if the input value for the month of evaluation is not equal to one or seven. See section 2.3.6.

**M 146 \*\*\* Warning: Diurnal emission are zero when Tmax-Tmin<1. The minimum and maximum temperatures of the day must be used to get the proper diurnal output.**

This message is printed if the input value of the minimum and maximum temperatures are not sufficiently different to calculate diurnal emission rates. See section 2.2.11.

**M 147 \*\*\* Error: User-supplied market share of oxygenated fuels has to be 100% for a reformulated gas area.**

This message is printed when several conditions have been met: If the input value of the oxygenated fuels flag is two, the input value of the reformulated gas flag is two, and the market share values specified in the oxygenated fuels record sum to a value less than one. See sections 2.2.14 and 2.2.16.

**M 148 \*\*\* Error: User-supplied market share weighted average of oxygen content has to be at least 2.1% for a reformulated gas area.**

This message is printed when several conditions have been met. If the input value of the oxygenated fuels flag is two, the input value of the reformulated gas flag is two, and the oxygen contents specified in the oxygenated fuels input record (for ether/gasoline and alcohol/gasoline blends) are such that the weighted average oxygenate content is less than 0.021. See sections 2.2.14 and 2.2.16.

**M 149 \*\*\* Error: <value of FVOLCL> is out of bounds for Fuel Volatility Class (A - E).**

This message is printed if reformulated gasoline requirements are being modeled and the input value of fuel volatility class is anything other than an upper-case letter A, B, C, D, or E. Sections 1.4.2, 2.2.10, and 2.2.16, which discuss the modeling of reformulated gasoline and the input of a value for fuel volatility class, should be closely reviewed.

**M 150 \*\*\* Error: <value of Pass/Purge/Pressure rate> is out of bounds for Pass/Purge/Pressure rate (0 to 100%).**

This message is printed if the input value of any one of the compliance rates for functional pressure or purge tests of the evaporative emission control system are not in the range 0.0 to 1.0. See section 2.2.6.3.

**M 151 \*\*\* Error: The Pass/Purge/Pressure rate sum <sum of rates> does not equal 100%)**

This message is printed if any values are included within the first 15 columns after (to the right of) the "month" variable on the scenario data record. The first 15 spaces after the last variable on each input record must be blank, as some of those locations are used for internal diagnostic inputs to the model.

**M 152 Warning: The I/M descriptive record field elements have changed from MOBILE4.1 to MOBILE5. The three year values 1) I/M start year, 2) Purge start year, and 3) Pressure start year have been replaced. Please consult the MOBILE5 Users Guide.**

This message occurs when a non-standard MOBILE4.1 input file, using either the pressure, purge and/or IM240 test procedures, is used as input for MOBILE5. See sections 2.2.5 and 2.2.6.

**M 153 Warning: Refueling emissions in grams per gallon are only available using the 120-column descriptive output option (OUTFMT = 3 or 5). See User's Guide to MOBILE5, chapters 2.1.15, 2.1.19, and 2.1.20 for more information.**

This message is printed whenever the user sets HCFLAG = 3 (requesting expanded evaporative emission factor output), and sets OUTFMT to values other than 3 or 5. See sections 2.1.15, 2.1.19, and 2.1.20.

**M 195 Warning: There is no user application of this feature which would be acceptable for submission to EPA**

This message is printed in conjunction with messages M12, M13, M14, M15, M16, M119, M136, M140, M141, M142, and M143. It is an additional warning to the user attempting to activate a feature of the model that is intended only for use by EPA.

### 3.3 FORMATTED REPORT OUTPUTS

Six types of formatted emission factor reports can be produced by MOBILE5. These reports include the information necessary to identify the scenario being studied and the calculated emission factors by vehicle type. The type of formatted report produced is controlled by the user through the value assigned to the OUTFMT flag in the Control data section. The structures of the formatted report formats are discussed below, and some are illustrated in Chapter 5 (MOBILE5 Examples).

The user specifies which of the six possible formatted reports is to be generated through assignment of a value to the OUTFMT flag in the Control data section (section 2.1.15). If OUTFMT = 1, 2, or 6, then MOBILE5 generates a formatted data set suitable for use as an input file for subsequent computer analysis ("numeric" output formats and "spreadsheet" format). If OUTFMT = 3 or 4, a report more suitable for visual inspection and analysis ("descriptive" format) is generated. These latter outputs are designed to provide a well-annotated record of the user's analysis. If OUTFMT = 5, the output produced by OUTFMT = 3 is produced along with additional tables providing detailed by model year emission factor information.

#### 3.3.1 MACHINE READABLE (OUTFMT = 1, 2, or 6)

The "long numeric output" (OUTFMT = 1) and the "spreadsheet output" (OUTFMT = 6) are very similar, and thus are described together in this section. Both options begin with a two-line header for every run. On the first line is the project identification label supplied by the user (section 2.1.3). On the next line is printed the MOBILE model version information [e.g., MOBILE5a (26-Mar-93)], followed by a blank line.

If OUTFMT = 1, a 222-column numerical format report is generated. OUTFMT = 1 contains four heading records, which provide minimal column descriptions. Column 1 contains the heading, "Reg" (printed on three rows). Column 2 contains the heading "CY". Columns 3-10 are spanned by the heading "Vehicle Speeds" (printed in row three). Column 11 contains the heading "Amb Tem" (printed on rows two and three). Columns 12-14 contains the heading "Cold/Hot Start" (printed on row three). Column 15 contains the heading "Alt. in Ft." (printed on rows two and three). Column 16 contains the heading "Pol" (printed on three rows). Columns 17-26 are spanned by the heading "Composite Emission Factors" and the subheadings "LDGV LDGT1 LDGT2 LDGT HDGV LDDV LDDT HDDV MC All Veh" (printed on rows two and three). Columns 27-34 are spanned by the heading "Vehicle Mix" and the headings "LDGV LDGT1 LDGT2 HDGV LDDV LDDT HDDV MC" (printed on rows two and three). Column 35 contains the heading "Scenario Title" (printed on row three). The three-line header is followed by a line of dashes underlining all of the columns described above.

If OUTFMT = 6, the spreadsheet readable format is generated. The data are in comma-separated variable (CSV) format, which is readable by either LOTUS or EXCEL spreadsheet software. At the top of each scenario, four lines of descriptive output are found. In the first row: column A contains the label "I/M Program:", column C indicates whether or not an I/M program is modeled (section 2.1.9), column E contains the label "Anti-tam Program:", column G indicates whether or not an ATP is modeled (section 2.1.11), column I contains the label "Reformulated Gas:", column K indicates whether or not a reformulated gasoline (RFG) program is modeled (section 2.2.16). In the second row: column A contains the label "Minimum Temp:", column C contains the minimum temperature for that scenario (section 2.2.11), column E contains the label "Maximum Temp:", column G contains the maximum temperature for that scenario (section 2.2.11), column I contains the label "Period 1 RVP:", column K contains the "Period 1" RVP value (section 2.2.12), column M contains the label "Period 2 RVP:", column O contains the "Period 2" RVP value (section 2.2.13), column Q contains the label "Period 2 start year:", and column T contains the period 2 start year (section 2.2.13).

Rows three and four are similar to those for OUTFMT = 1, except that the order of the columns has been changed to put the more important information toward the left side of the spreadsheet. The less important information has been moved toward the right of the spreadsheet. These changes are applicable to OUTFMT = 6



only (OUTFMT = 1 remains as it was in MOBILE4.1, with the one exception that the idle emission factor results have been removed). Column A contains the label "Pollutant" (printed on row four). Column B contains the label "Cal. Year" (printed on row four). Columns C-L are spanned by the label "Composite Emission Factors" and the label "LDGV ef LDGT1 ef LDGT2 ef LDGT ef HDGV ef LDDV ef LDDT ef HDDV ef MC ef All Veh" (printed on rows three and four). Column M contains the label "Amb. Temp." (printed on row four). Columns N-P are spanned by the label "Operating Percentages", and the label "Cold Hot Stabilized" (printed on rows three and four). Column Q contains the label "Alt. (Ft)" (printed on row four). Column Q contains the label "Region" (printed on row four). Columns S-Z are spanned by the label "Vehicle Speed" and the label "LDGV speed LDGT1 speed LDGT2 speed HDGV speed LDDV speed LDDT speed HDDV speed MC speed" (printed on rows three and four). Columns AA-AH are spanned by the label "Vehicle Mix" and the label "LDGV mix LDGT1 mix LDGT2 mix HDGV mix LDDV mix LDDT mix HDDV mix MC mix" (printed on rows three and four). Column AI contains the label "Scenario Title" (printed on row four).

The headers for both options are followed by a description of the month of evaluation (section 2.3.6) and one to eight records per scenario evaluated. The number of records produced for each scenario is determined by the values assigned in the Control section to PRTFLG (which determines which pollutants are to have emission factors calculated) and HCFLAG (which determines how the breakdown on HC emission factors by source is presented).

Each record of these two output formats consist of 35 subject columns. (In the description that follows, the term "column" is used to refer to the subject columns, while the term "character" is used to refer to the number of individual, one-space columns spanned by the subject column.) When OUTFMT = 6, the subject columns are ordered A, B, C, ..., X, Y, Z, AA, AB, ..., AI instead of 1, 2, ..., 35, and the characters are referred to as cells or labels depending on the context. The subject columns and the value(s)/cells/labels shown in each are described below:

Column 1: Region (OUTFMT=1). The column is one character wide (format I1). The column heading is "Reg" (printed vertically). The value shown is either 1 (low-altitude) or 2 (high-altitude). This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

Column 2: Calendar year of evaluation (OUTFMT=1). The column is three characters wide (format 1X, I2). The column heading is "CY." The value shown is the last 2 digits of the calendar year of evaluation. (Note that CY 2000-2009 will appear as 0, 1, ..., 9, not 00, 01, ..., 09.) This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records. See section 2.3.2.

Columns 3-10: Vehicle Speeds (OUTFMT=1). The column is 40 characters wide (format 8F5.1). The column heading is "Vehicle Speeds." The values shown are the average speeds used for each of the eight vehicle classes, in this order: LDGV, LDGT1, LDGT2, HDGV, LDDV, LDDT, HDDV, MC. If SPDFLG = 1, all eight speeds have the same value. In print, the values are separated by slashes (/). For example, if SPDFLG = 1 (section 2.1.5) and speed = 19.6 mph (section 2.3.3), this line appears:

19.6/19.6/19.6/19.6/19.6/19.6/19.6/19.6

This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

Column 11: Ambient Temperature (OUTFMT=1). The column is four characters wide (format 1X, I3). The column heading is "Amb Tem" on two lines. The value(s) that appear in this column depend on the value of TEMFLG (section 2.1.14). If TEMFLG = 1, the temperature(s) calculated by MOBILE5 based on the input minimum and maximum daily temperatures for the correction of exhaust HC, CO, and NOx emission

factors are printed on the applicable line. If TEMFLG = 2, the input ambient temperature (section 2.3.4) is echoed back on the exhaust emission factor records. This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records (exhaust, evaporative, refueling, running loss, and resting loss).

Columns 12-14: Operating Mode Fractions (OUTFMT=1). The column is 18 characters wide (format 3F6.1). The column heading is "Cold/Hot Start." The values that appear are the input values for PCCN, PCHC, and PCCC (section 2.3.5), in that order. This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

Column 15: Altitude (OUTFMT=1). The column is 7 characters wide (format F7.0). The column heading is "Alt. in Ft." on two lines. This feature is residual from earlier versions of the model. The value listed will be either 500 [if the input region is 1 (low- altitude)] or 5500 [if the input region is 2 (high-altitude)] (section 2.3.1). This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

Column 16: Pollutant (OUTFMT=1). The column is two characters wide (format 1X,A1). The column heading is "Pol" printed vertically. The values and their corresponding identification of pollutants are:

<u>Value</u>	<u>Pollutant</u>
1	Total HC (sum of exhaust, evaporative, refueling, running loss, and resting loss)
X	Exhaust HC
V	Evaporative HC (includes crankcase emissions)
R	Refueling HC
T	Running loss HC
S	Resting loss HC
2	Exhaust CO
3	Exhaust NOx

Columns 17-26: Composite Emission Factors (OUTFMT=1). The next ten columns are each eight characters wide (format 10F8.3). The column headings are "Composite Emission Factors" centered over all 80 characters, with the individual columns headed by "LDGV LDGT1 LDGT2 LDGT HDGV LDDV LDDT HDDV MC All Veh". These represent the emission factors for the pollutant identified in column 16, for the following vehicle classes in order: light-duty gasoline-fueled vehicles, light-duty gasoline-fueled trucks 1 (up to 6000 lb GVW), light-duty gasoline-fueled trucks 2 (6001-8500 lb GVW), all LDGTs together (weighted results for LDGT1s and LDGT2s), heavy-duty gasoline-fueled vehicles (over 8500 lb GVW), light-duty diesel vehicles, light-duty diesel trucks (up to 8500 lb GVW), heavy-duty diesel vehicles (over 8500 lb GVW), motorcycles, and all vehicles combined (weighted by the VMT mix; see below). The emission factors are listed to 3 decimal places (0.001 g/mi) in this type of formatted report.

Columns 27-34: VMT Mix (OUTFMT=1). The next eight columns are each six characters wide (format 8F6.3). The column headings are "Vehicle Mix" centered over all 48 columns, with the individual columns headed in order by: "LDGV," "LDGT1," "LDGT2," "HDGV," "LDDV," "LDDT," "HDDV," and "MC." The values are the VMT mix input by the user for the current scenario (section 2.3.8), or the VMT mix calculated by the model (if the user did not supply VMT mix as input data). This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

Column 35: Scenario Title (OUTFMT=1). The column is 17 characters wide (format 1X,4A4). The heading is "Scenario Title." The value is the echo of the scenario title input as part of the Local Area Parameter record. See sections 2.2.8 and 2.2.9 and Table 2.2-10.

Column A: Pollutant (OUTFMT=6). The column heading is "Pollutant". The labels and their corresponding identification of pollutants are:

<u>Value</u>	<u>Pollutant</u>
1	Total HC (sum of exhaust, evaporative, refueling, running loss, and resting loss)
X	Exhaust HC
V	Evaporative HC (includes crankcase emissions)
R	Refueling HC
T	Running loss HC
S	Resting loss HC
2	Exhaust CO
3	Exhaust NOx

Column B: Calendar year of evaluation (OUTFMT=6). The column heading is "Cal. Year". The value shown is the calendar year of evaluation (section 2.3.2). This column contains values on all emission factor records.

Columns C-L: Composite Emission Factors (OUTFMT=6). The column headings are "Composite Emission Factors", with the individual columns headed in order by: "LDGV LDGT1 LDGT2 LDGT HDGV LDDV LDDT HDDV MC All Veh". These represent the emission factors for the pollutant identified in column A, for the following vehicle classes in order: light-duty gasoline-fueled vehicles, light-duty gasoline-fueled trucks 1 (up to 6000 lb GVW), light-duty gasoline-fueled trucks 2 (6001-8500 lb GVW), all LDGTs together (weighted results for LDGT1s and LDGT2s), heavy-duty gasoline-fueled vehicles (over 8500 lb GVW), light-duty diesel vehicles, light-duty diesel trucks (up to 8500 lb GVW), heavy-duty diesel vehicles (over 8500 lb GVW), motorcycles, and all vehicles combined (weighted by the VMT mix; see columns AA-AH). The emission factors are listed to 3 decimal places (0.001 g/mi) in this type of formatted report.

Column M: Ambient Temperature (OUTFMT=6). The column heading is "Amb Tem" on one line. The value(s) that appear in this column depend on the value of TEMFLG (section 2.1.14). If TEMFLG = 1, the temperature(s) calculated by MOBILE5 based on the input minimum and maximum daily temperatures for the correction of exhaust HC, CO, and NOx emission factors are printed on the applicable line. If TEMFLG = 2, the input ambient temperature (section 2.3.4) is echoed back on the exhaust emission factor records. This column contains values on all emission factor records.

Columns N-P: Operating Mode Fractions (OUTFMT=6). The column heading is "Operating Percentages" with the individual cells in the row below "Cold Hot Stabilized." The values that appear are the input values for PCCN, PCHC, and PCCC (section 2.3.5), in that order. This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

Column Q: Altitude (OUTFMT=6). The column heading is "Alt. (Ft.)" on one line. This feature is residual from earlier versions of the model. The value listed is either 500 [if the input region is 1 (low- altitude)] or 5500 [if the input region is 2 (high-altitude)] (section 2.3.1). This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

Column R: Region (OUTFMT=6). The column heading is "Region". The value shown is either 1 (low-altitude) or 2 (high-altitude) (section 2.3.1). This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

Columns S-Z: Vehicle Speeds (OUTFMT=6). The column heading is "Vehicle Speeds." The values shown are the average speeds used for each of the eight vehicle classes, in this order: LDGV, LDGT1, LDGT2, HDGV, LDDV, LDDT, HDDV, MC. If SPDFLG = 1 (section 2.1.5), all eight speeds have the same value.

This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

Columns AA-AH: Vehicle Mix (OUTFMT=6). The column headings are "Vehicle Mix" centered over all 48 columns, with the individual columns headed in order by: LDGV, LDGT1, LDGT2, HDGV, LDDV, LDDT, HDDV, MC. The values are the VMT mix input by the user for the current scenario (section 2.3.8), or the VMT mix calculated by MOBILE5 if the user did not supply a VMT mix as input to the model. This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records

Column AI: Scenario Title (OUTFMT=6). The heading is "Scenario Title." The value is the echo of the scenario title input as part of the Local Area Parameter record.

### **3.3.2 142-COLUMN NUMERIC FORMAT (OUTFMT = 2)**

If OUTFMT = 2, a somewhat shorter numeric format report is generated. This report begins with a two-line header for every run. On the first line is the project identification supplied by the user (section 2.1.3), followed by MOBILE model version information [e.g., "MOBILE5a (26-Mar-93)"] on the next line, and then a blank line. As in the case of the longer numeric format reports discussed in the preceding section, it consists of three heading records providing minimal column descriptions, followed by one to eight records per scenario evaluated. The number of records produced for each scenario is determined by the values assigned to the PRTFLG and HCFLAG flags in the Control section.

If OUTFMT = 2, a 142-column numerical format report is generated. This report contains three heading records, which provide minimal column descriptions. Column 1 contains the heading, "Reg" (printed on three rows). Column 2 contains the heading "CY". Column 3 contains the heading "Amb Tem" (printed on rows two and three). Columns 4-6 contains the heading "Cold/Hot Start" (printed on row three). Column 7 contains the heading "Pol" (printed on three rows). Columns 8-17 are spanned by the heading "Composite Emission Factors" and the heading "LDGV LDGT1 LDGT2 LDGT HDGV LDDV LDDT HDDV MC All Veh" (printed on rows two and three). Columns 18-25 are spanned by the heading "Vehicle Mix" and the headings "LDGV LDGT1 LDGT2 HDGV LDDV LDDT HDDV MC" (printed on rows two and three). The three line header is followed by a line of dashes under all of the columns described above.

The headers are followed by a description of the month of evaluation (section 2.3.6) and one to eight records per scenario evaluated. The number of records produced for each scenario is determined by the values assigned to the PRTFLG and HCFLAG flags in the Control section (see section 2.1).

Each record of this output format consists of 25 subject columns. (In the description that follows, the term "column" is used to refer to the subject columns, while the term "character" is used to refer to the number of individual one-space columns spanned by the subject column.) Note that this output often will be truncated after a maximum of 132 columns if printed in landscape format on standard 8.5x11 inch paper and using standard fonts unless wrapped around. (See the discussion of carriage control characters provided in Chapter 4.) The subject columns and the value(s) shown in each are described below:

Column 1: Region. The column is one character wide (format I1). The column heading is "Reg" (printed vertically). The value shown is either 1 (low-altitude) or 2 (high-altitude) (section 2.3.1). This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

Column 2: Calendar year of evaluation. The column is three characters wide (format 1X, I2). The column heading is "CY." The value shown is the last 2 digits of the calendar year of evaluation. Note that CY 2000-2009 will appear as 0, 1, ..., 9, not 00, 01, ..., 09. This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records. See section 2.3.2.

Column 3: Ambient Temperature. The column is five characters wide (format 1X,I3,1X). The column heading is "Amb Tem" on two lines. The value(s) that appear in this column depend on the value of TEMFLG (section 2.1.14). If TEMFLG = 1, the temperature(s) calculated by MOBILE5 based on the input minimum and maximum daily temperatures for the correction of exhaust HC, CO, and NOx emission factors are printed on the applicable line. If TEMFLG = 2, the input ambient temperature (section 2.3.4) is echoed back on the exhaust emission factor records. This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

Column 4-6: Operating Mode Fractions. The column is 18 characters wide (format 3F6.1). The column heading is "Cold/Hot Start." The values that appear are the input values for PCCN, PCHC, and PCCC (see section 2.3.5), in that order. This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

Column 7: Pollutant. The column is two characters wide (format 1X,A1). The column heading is "Pol" printed vertically. The values and their corresponding identification of pollutants are:

<u>Value</u>	<u>Pollutant</u>
1	Total HC (includes exhaust, evaporative, refueling, running loss, and resting loss emissions)
X	Exhaust HC
V	Evaporative HC (includes crankcase emissions)
R	Refueling HC
T	Running loss HC
S	Resting loss HC
2	Exhaust CO
3	Exhaust NOx

Columns 8-17: Composite Emission Factors. The next ten columns are each seven characters wide (format 10F7.2). The column headings are "Composite Emission Factors" centered over all 70 characters, with the individual columns headed in order by: "LDGV:", "LDGT1", "LDGT2", "LDGT", "HDGV", "LDDV", "LDDT", "HDDV", "MC", and "All Veh." These represent the emission factors for the pollutant identified in column 7, for the following vehicle classes in order: light-duty gasoline-fueled vehicles, light-duty gasoline-fueled trucks 1 (up to 6000 lb GVW), light-duty gasoline-fueled trucks 2 (6001-8500 lb GVW), all LDGTs together (VMT-weighted results for LDGT1s and LDGT2s), heavy-duty gasoline-fueled vehicles (over 8500 lb GVW), light-duty diesel vehicles, light-duty diesel trucks (up to 8500 lb GVW), heavy-duty diesel vehicles (over 8500 lb GVW), motorcycles, and all vehicles combined (weighted by the VMT mix; see columns 18-25 below). The emission factors are listed to two decimal places (0.01 g/mi) in this type of formatted report.

Columns 18-25: VMT Mix. The next eight columns are each five characters wide [format 8(1X,F4.3)]. The column headings are "Vehicle Mix" centered over all 48 columns, with the individual columns "LDGV," "LDGT1," "LDGT2," "HDGV," "LDDV," "LDDT," "HDDV," and "MC." The values are the VMT mix input by the user for the current scenario (section 2.3.8). This column contains values on all exhaust emission factor records, but is blank for the component HC emission factor records.

### 3.3.3 112-COLUMN DESCRIPTIVE FORMAT (OUTFMT = 3)

If OUTFMT = 3, a well-annotated descriptive format output is produced. This format is designated for ease of visual inspection, with more complete labeling and heading information. The 112-column width allows this format to be printed in landscape format (sideways) on standard 8.5x11 paper.

The exact content of the report is determined by a number of flag settings. Information applicable to the entire run (all scenarios) is listed first, followed by a series of blocks, one per scenario evaluated. The scenario output blocks are separated by solid lines.

The first line of the report is the project title input by the user (section 2.1.1). The second line provides MOBILE model version information [e.g., "MOBILE5a (26-Mar-93)"]. This is followed by a blank line, diagnostic messages that are applicable to the next block of scenarios (unless output units have been reassigned), and then by optional information if applicable.

After the diagnostic messages, the information applicable to the entire run (all scenarios) is listed. For example, if the user has set the NEWFLG = 3 or 4 (section 2.1.8) the following is printed: "Evaporative Test Procedure Phase-in Years and Percentages:"

If one local area parameter record is to be applied to all scenarios (LOCFLG = 2), this information is printed on the next two lines. The first line lists the scenario name and the minimum and maximum daily temperatures. The second line lists the period 1 RVP, the period 2 RVP, and period 2 start year. Each is clearly indicated with a label.

Finally, one of the following messages will be printed before the individual scenario results, depending on the value assigned to NMHFLG in the Control data section. If NMHFLG = 1: "Total HC emission factors include evaporative HC emission factors"; if NMHFLG = 2: "Non-methane HC emission factors include evaporative HC emission factors"; if NMHFLG = 3: "Volatile organic compound emission factors include evaporative HC emission factors"; if NMHFLG = 4: "Total organic gasses emission factors include evaporative HC emission factors"; and if NMHFLG = 5: "Non-methane organic gasses emission factors include evaporative HC emission factors".

After the line indicating the start of a scenario output block, the following messages are printed for every scenario if applicable to that run:

If TAMFLG = 2:

"User-supplied tampering and misfueling rates"

If MYMRFG = 2:

"User-supplied mileage accrual distributions"

If MYMRFG = 3:

"User-supplied vehicle registration distributions"

If MYMRFG = 4:

"User-supplied mileage accrual distributions, vehicle registration distributions"

These messages are followed by four lines describing the scenario being modeled. The first line includes the description of the month of evaluation. The second line contains the calendar year of evaluation, indicates whether or not an I/M program is modeled, the ambient temperatures used to correct exhaust, and the region (low- or high-altitude). The three ambient temperatures apply in order to HC, CO, and NO<sub>x</sub> emissions. The third line indicates whether or not an ATP is modeled, the operating mode fractions and altitude (500 ft for low-altitude and 5500 ft for high-altitude). Finally the fourth line indicates whether or not there is a reformulated gasoline (RFG) program in effect. Each of these is clearly labeled.

Two additional lines containing the local area parameter record information follow, if LOCFLG = 1 (separate local area parameter record for each scenario). The first line lists the scenario name and the minimum and maximum daily temperatures. The second line lists the period 1 RVP, the period 2 RVP, and the period 2 start year. Each is clearly indicated by a label.

The next line starts with "Veh. Type:" and continues across with ten column headings. In order, these are LDGV, LDGT1, LDGT2, LDGT, HDGV, LDDV, LDDT, HDDV, MC, and All Veh. The remaining lines in the output each consist of an identifier at left, with the values for that line, for each of the ten vehicle types or groups, following under the appropriate headings.

The next line is "Veh. Speeds" with values entered only in the eight columns for which vehicle average speed is used to correct the emission factors. The next line is "VMT Mix:" with VMT fractions by vehicle class entered in the appropriate columns. (No speed or VMT Mix values will appear under the combined LDGT1 and LDGT2 "LDGT" column or the "All Veh" column.) If the user has chosen to model the California low-emitting vehicle (LEV) option (section 2.3.1) then the next line is "ZEV Fract:" with the percentages of zero-emitting vehicles (ZEVs) by vehicle class for LDGV and LDGT1 entered in the appropriate columns.

The next line reads "Composite Emission Factors (Gm/Mile)." This line precedes a set of one to eight lines of emission factors, depending on the pollutants to be printed (PRTFLG) and whether component HC emission factors are to be printed (HCFLAG). If all eight lines appear, they are in the following order:

<u>Value</u>	<u>Pollutant</u>
1	Total HC (includes exhaust, evaporative, refueling, running loss, and resting loss emissions)
X	Exhaust HC
V	Evaporative HC (includes crankcase emissions)
R	Refueling HC
	T    Running loss HC
S	Resting loss HC
2	Exhaust CO
3	Exhaust NO <sub>x</sub>

Unless the expanded evaporative emission factor output has been selected by the user (section 2.1.19), this will complete the output block for an individual scenario. If the expanded evaporative emission factor output is selected, then there will be one more section to the output. This last block of output will contain the detailed evaporative HC emission factors on three lines. On the first line is the message "Evaporative Emissions by Component", several spaces, "Weathered RVP:", the weathered RVP value, several spaces, "Hot Soak Temp:", and the hot soak temperature. On the second line: "(Hot Soak: g/trip, Diurnals & Multiples: g, Refueling: g/gal, Resting Loss: g/hr, Crankcase: g/mi)", several spaces, "Running Loss Temp:" and the running loss temperature. On the third line there are several spaces, "Resting Loss Temp:" and the resting loss temperature. Six additional lines of emission factors are then printed, lined up under the column headings for vehicle type from the standard emission factor portion of the output. These are labeled in order: Hot Soak, WtDiurnal, Multiple, Crankcase, Refuel, and Resting.

The use of these evaporative emission factors may be required for development of inventories that are spatially and temporally allocated, as required for input to many airshed models. The hot soak emission factor is in g/trip, corresponding to the hot soak emissions per vehicle per trip-end. The diurnal emission factor accounts for all full (one-day), partial, and zero diurnal events, weighted for the relative frequency of occurrence of each. The units are grams (grams per vehicle per day). The multiple diurnal emission factor represents only those vehicles actually experiencing multiple diurnal events, and is also in grams (grams per vehicle per day). The refueling emission factor in the expanded evaporative emission output is in grams per gallon of dispensed fuel (g/gal), and thus can be used in conjunction with fuel sales data (such as tax records) to estimate refueling emission inventories independently of vehicle miles traveled (VMT). See section 2.2.7.6. Running losses are presented in g/mi in this section as well, since (like exhaust emissions) they occur while a vehicle is traveling. Resting losses are presented as grams per hour (g/hr), and this emission factor is applicable to all vehicles for all hours (24 hours per day).

### **3.3.4 80-COLUMN DESCRIPTIVE FORMAT (OUTFMT = 4)**

If OUTFMT = 4, a well-annotated descriptive format output similar to that described in section 3.3.3 is produced. This format is also designed for ease of visual inspection, with complete labeling and heading information. The 80-column width allows this format to be printed in portrait format (vertically) on standard 8.5x11 paper.

The exact content of the report is determined by a number of flag settings. Information applicable to the entire run (all scenarios) is listed first, followed by a series of blocks, one per scenario evaluated. The scenario output blocks are separated by solid lines. See Chapter 5 for illustrative examples of the different output formats.

This output follows the order of information presented in section 3.3.3 above, with additional lines and minor format changes required in some cases to accommodate all of the information in the narrower overall width. The expanded evaporative emissions output will be omitted from the 80-columns descriptive format, even if the expanded emissions output is requested by setting the value of HCFLAG = 3.

### **3.3.5 BY MODEL YEAR OUTPUT FORMAT (OUTFMT = 5)**

The last form of formatted output report available through MOBILE5 is the by-model year option. In this option, the 112-column descriptive output (discussed in section 3.3.3) is produced, followed by additional tables providing information on the relative contributions of vehicles of each given model year in the calendar year fleet to the overall fleet emission factor for each vehicle type. The user can select which vehicle types the by-model year tables are produced for through the values assigned to the by-model year inclusion vector, discussed in section 2.2.18. The user also specifies whether tables showing inspection/maintenance (I/M) program effects on the emission factors, on a model year-specific basis, are to be produced.

This output option is only available for scenarios based on the January 1 date of evaluation. If July 1 emission factors are specified, then by-model year output cannot be produced. Users wishing to have by-model year emission factor tables with the emission factors evaluated as of July 1 can approximate them by interpolation of consecutive January 1 emission factors.

These tables (one table per vehicle type selected, per scenario; and one for I/M credits, if applicable and if coded "yes" for the I/M by-model year output flag) contain the following information:

First, the title of the MOBILE5 run (as entered by the user for "PROJID" in the Control section) and the Scenario title (as entered by the user on the Local Area Parameter record) are echoed back as identifiers. The next two lines give the vehicle type for which the table is applicable and the date of emission factor evaluation



(January 1, CY, where CY is the calendar year of evaluation entered by the user). If the user has chosen to model the LEV program option (section 2.3.1), then the next line is "Travel Fraction attributable to Zero Emitting Vehicles (ZEV) Model Years 1994 thru 2020" then a blank line and the heading "MY " followed by every model year in the fleet greater than or equal to 1994. Below each model year is a line as a heading indicator. On the next line is the heading "TF" with the values of the ZEV travel fraction for that model year under the appropriate columns. Then there is a blank line, followed by the rest of the table. The table is 19 columns wide by 28 rows long, with the first two rows consisting of column headings and the last row containing sums for some of the column entries. The remaining 25 rows represent the 25 model years of vehicles, ending in the CY of evaluation, in reverse order (newest vehicles first).

The first three columns (L to R) are labeled "Model Year", "TF", and "Miles". "Model Year" is the model year to which the other values of the row apply. "TF" is the travel fraction. It combines the registration distribution by age and the annual mileage accumulation rates by age to determine the fraction of all vehicle miles traveled (VMT) by the given vehicle class accounted for by vehicles of that row's model year in the evaluated calendar year. The TFs serve as the weighting factors to combine the model year-specific emission factors into a specific vehicle type's fleetwide emission factor. "Miles" represents the average odometer mileage of vehicles of model year MY on January 1 of calendar year CY, based on the average annual mileage accumulation rates by age used in the model.

The next eight columns are all spanned by the heading "HC", followed by four columns each under the headings "CO" and "NOx". The HC columns contain information on exhaust, evaporative, refueling, running loss, and resting loss emissions, while CO and NOx deal only with exhaust emissions. The columns common to all three pollutants have essentially the same descriptions.

"BEF4" contains the average exhaust emission factor, in grams per mile, for vehicles of model year MY on January 1 of calendar year CY. This emission factor already contains the following corrections to conditions specified by the user: temperature, fuel volatility (RVP), operating modes, and (if applicable) methane offsets and inspection/maintenance program reductions. The column headed "Tamper" shows the tampering offset (emission factor increase due to tampering) in grams per mile, also corrected for temperature, RVP, and operating mode. The tampering offsets are only produced for those vehicle types subject to tampering (LDGVs, LDGTs, and HDGVs).

The column headed "SALHCF" is the value of the combined correction factors for average trip speed entered by the user and "optional" corrections (air conditioning use, extra loading, trailer towing, and NOx humidity correction). If none of the optional correction factors are used, as is commonly the case, then SALHCF is simply the speed correction factor.

For CO and NOx, the last column labeled "FER" is then the average contribution of vehicles of model year MY, in calendar year CY, to the fleet average emission factor. This is calculated as:

$$\text{FER} = (\text{BEF4} + \text{Tamper}) * \text{SALHCF} * \text{TF}.$$

Thus the FERs can be summed to obtain the exhaust emission factor for that vehicle type as shown in the preceding (standard) portion of the output.

For HC, the remaining columns are model year-specific emission factors for the other components of HC emissions. The column "Evapor" represents the combined evaporative emission factor (hot soak, diurnals, multiple diurnals, and crankcase), including any offsets due to tampering. The column "Refuel," for gasoline vehicles only, is the model year-specific refueling emission factor, reflecting Stage II and/or onboard VRS control if applicable. "Runnin" and "Restin" are the running loss and resting loss model year-specific emission factors, respectively, for gasoline vehicles only. The FER for HC is then calculated as:

$$\text{FER} = <[(\text{BEF4} + \text{Tamper}) * \text{SALHCF}] + (\text{Evapor} + \text{Refuel} + \text{Runnin} + \text{Restin}) > * \text{TF}$$

For the I/M Program tables the first three columns are identical to the by vehicle table mentioned earlier in this section. The next two columns are spanned by the heading "HC", followed by two columns each for "CO" and "NOx". Under each pollutant heading is a column for Credit and Reduction. The columns headed "Credit" show the percentage of emissions eliminated by the I/M program specified by the user, if applicable to that model year, pollutant, vehicle and scenario. In some cases, an I/M program will increase NOx emissions so that the "benefit" of the program is negative ("disbenefit"). These reductions (or increases) in emissions have not been corrected for all parameters, and are shown only to demonstrate the relative contribution of each model year's vehicles to the total benefit.

In cases where vehicles of a specific model year are covered by an I/M program as detailed in the April 8, 1994 guidance memo (see Appendix 2B), an I/M program credit value is not calculated by MOBILE5. (The effects of I/M programs meeting the criteria of the April 8 Guidance Memo are modeled by a different algorithm that is used for more conventional I/M programs.) In such cases, a credit value of zero will be shown in this table. In general, if a benefit/disbenefit is not applicable to vehicles of a specific model year (for example, vehicles older than the oldest model year subject to the I/M requirement), then a zero will be output; and if the table is all zeroes, then the table will not be printed. The columns headed "Reduc" show the reductions/increases in emissions factors. The totals at the bottom under the twenty-fifth rows are the TF-weighted reductions, by pollutant.

Modelers who wish to use the by model year emission factors for some analyses and have additional questions not addressed above are encouraged to contact EPA for additional assistance.

## Chapter 4

### MOBILE5 IMPLEMENTATION

#### 4.0 INTRODUCTION

This chapter contains information on how the MOBILE5 program is stored on diskettes and tapes, and other information that may be useful in implementing MOBILE5 on different computer systems. Although an attempt has been made to make this information clear to novice computer users as well as veteran MOBILE model users, this section will not attempt to train users on all aspects of every computer system. Some knowledge of the system onto which the MOBILE model is to be loaded and operated is required.

#### 4.1 GENERAL INFORMATION

MOBILE5 is an official release of the Office of Mobile Sources (OMS), U. S. Environmental Protection Agency (EPA), for use in State Implementation Plans and other official EPA business. It is provided without restrictions. That is, the software application, source code, and all related files may be copied and distributed freely and may be used as a basis for other work. However, any unauthorized modifications to the program may nullify its usefulness for official EPA business.

The MOBILE5 model as released was written in standard FORTRAN77 computer language, using the ANSI X3.9-1978 standard published by the American National Standards Institute. No incompatibilities are known to exist between the MOBILE5 code and that standard.

The identical source code (including all comment records) was used for all official versions of the model made available, with the exception of necessary changes in the input/output (I/O) device allocations. There are seven device assignments required. These are listed below, followed by the variable name used to represent the device assignment in the program code. Some of these connections may be made to the same device number.

- |                              |            |
|------------------------------|------------|
| ○ Interactive input & output | (IOUASK)   |
| ○ Parameter file input       | (IOUGEN)   |
| ○ Error messages             | (IOUERR)   |
| ○ Program output             | (IOUREP)   |
| ○ Batch file input           | (IOBAT)    |
| ○ New Tech. I/M credits      | (IOIMD)    |
| ○ Old Tech. I/M credits      | (Device 3) |

The device for reading the inspection and maintenance (I/M) program credits for the vehicles using older (open-loop) technologies is "hard-coded" to device #3. Other device allocations are initialized in Block Data Subprogram 16. The first four I/O devices are also reset in subroutine GETIOU and are reset in the "driver" program (MAIN). IOBAT is set and used only in the driver program. IOIMD is set only in Block Data Subprogram 16.

The default setting for these devices vary and are discussed separately for each platform. If a user wishes to change the default settings, care should be taken that the settings are changed at all points where the device allocations are made. Otherwise, it is likely that the settings will revert back to the default values unexpectedly. In general, it is prudent for users not to attempt to change the device settings unless it is absolutely necessary.

Since the source code for all computer platforms is otherwise identical, a source code file available on one platform (such as DOS-based microcomputers) may be used on another platform (such as a mainframe computer or mini-computer) as long as the appropriate changes for that platform are made to the device allocations. However, this will require the user to have access to a FORTRAN 77 compiler capable of handling the MOBILE5 source code in order to re-create the executable application from the altered source code.

MOBILE5 will run the same way on all computer platforms and have all of the same options and capabilities. As a result, the same User's Guide may be used for all versions. There are some minor considerations that are platform-specific and are discussed in the remainder of this chapter.

First, there is sometimes a negligible difference in the model results (the emission factors calculated by MOBILE5) as run on DOS-based microcomputers, compared to results on the mainframe computer EPA uses to develop the model (Amdahl 5890-180E). The discrepancy is likely due to the number of significant digits that the computer system carries when doing calculations. The differences are small (less than one half of one percent), but they sometimes show up in larger numbers in the last digit of MOBILE5 output. As a result, for the sake of consistency, comparison or mixing of results from MOBILE5 runs executed on different computer platforms is not recommended.

Also, the FORTRAN compilers available to EPA for development of the release version of MOBILE5 are not the only ones available, but there are limits to the amount of exploration that can be done. It may be possible to re-compile MOBILE5 using a different compiler to avoid some of the limitations described in the sections covering microcomputers. However, EPA cannot assist users in their choice of a compiler or with running compiler software.

Given the above information, the released executable application for Apple Macintosh computers will run much more slowly than the same input run on DOS-based microcomputers. This is partially due to the fact that the use of math coprocessors is now required on DOS-based machines, and many of the newer DOS-based machines have faster clock speeds than typical Macintosh computers. However, EPA's testing indicates that even on comparable machines the Macintosh still runs much more slowly. One possibility is that the compiler EPA used for the Macintosh application is not as efficient as the compiler currently used for the DOS application. It may be possible that using a different compiler than EPA used would result in greater speed from the Macintosh. However, if the user is not planning on recompiling the program, and a large number of MOBILE5 runs need to be performed and program running time is an issue, then serious consideration should be given to using a high-speed DOS-based microcomputer for the task.

## **4.2 PROGRAM AVAILABILITY**

The Area and Mobile Source (AMS) subsystem of the Aerometric Information Retrieval System (AIRS) supports an interactive menu-driven interface to the MOBILE model. The AMS interface is provided for the purpose of developing inventories in AMS to meet State Implementation Plan (SIP) reporting requirements, but can be used for emission factor modeling purposes. AIRS is resident on the IBM mainframe computer system at EPA's National Computer Center (NCC) in Research Triangle Park, North Carolina. The AMS interface is available to anyone with access to the NCC computer. However, inventory development activities are restricted to authorized AIRS users. For information concerning access to the NCC computer, contact NCC User Support at 1-800-334-2405. Questions regarding the use and operation of AMS, including the MOBILE model interface, can be directed to the AMS Help Line at 1-800-828-6782.

The AMS MOBILE model interface performs all of the standard MOBILE model field validations and most reference checks on-line, such that data input errors which would cause the MOBILE model to fail can be corrected prior to running the model. Reports supplied by the MOBILE model are available in a hard copy or work file format. Resulting emission factors and model inputs are made available in AMS batch transaction

format for direct uploading into AMS. AMS currently supports both MOBILE4.1 and MOBILE5a, however, all new MOBILE5 input parameters may not yet be available as of this time.

For readers that prefer to obtain their own copy of the MOBILE5 model, the source code is available for three platforms. The standard release of MOBILE5 includes the FORTRAN source code, example input files, example output files and (in the case of DOS-based and Apple Macintosh microcomputers) an executable application file. Chapter 2 of this User's Guide is also provided on each microcomputer disk in a word processor format (WordPerfect Version 5.1). MOBILE5 is available for three computer platforms:

- Mainframe (9-track computer tape)
- DOS-based microcomputer (high-density 3-1/2" disk)
- Apple Macintosh (high-density 3-1/2" diskette)

The exact nature and content of each package is described in the section for that computer platform.

Commercial access to any of these packages may be obtained through the National Technical Information Service (NTIS). Paper and microfiche copies of this User's Guide will also be made available through NTIS. There will be a fee charged for providing copies. Address orders to:

National Technical Information Service  
5285 Port Royal Road  
Springfield, Virginia 22161  
(703) 487-4650

Copies of the DOS-based microcomputer package are available at the ten EPA Regional offices, and whenever possible this should be the source of the model for State and local governments. Versions of the model for other platforms are available from NTIS or directly from the Office of Mobile Sources (OMS):

MOBILE5 Emission Factor Project  
Air Quality Analysis Branch  
Emission Planning and Strategies Division  
U. S.. EPA/National Vehicle and Fuels Emission Laboratory  
2565 Plymouth Road  
Ann Arbor, Michigan 48105  
(313) 668-4325

The DOS version of MOBILE5 is also available through the U. S. EPA Office of Air Quality Planning and Standards (OAQPS) Technology Transfer Network (TTN) in North Carolina. This computer bulletin board system (BBS) allows any computer with a modem and with software capable of binary file downloads to access the files related to MOBILE5 directly at any time of day or week (except Monday mornings between 6:00 am and 12:00 pm ET, when TTN is down for maintenance). These files can be directly transferred to a microcomputer for immediate use.

Access to the TTN BBS is limited only to registered users. However, anyone can register by simply calling the BBS and answering the registration questions. Access to the MOBILE5 files is given immediately to registered users. Normal connections would use:

- Full duplex
- Eight data bits
- No parity
- One stop bit

Modem access is available for modem speeds of 1200 to 14,400 bits per second (bps) at:

(919) 541-5742

The files related to MOBILE5 are stored in the OMS section of the BBS, under "Models and Utilities." If assistance in using the BBS is required, or you have questions about the BBS, voice contact with the BBS is available at (919) 541-5384. There is also a Public Message section, where questions related to running and interpreting MOBILE5 can be left for response.

Any new information about problems, modifications, or plans related to MOBILE5 will be announced as a bulletin or in the public message area of this BBS. Keeping up with the messages on this BBS is a way to remain informed of any news related to MOBILE5 or future emission factor models.

### **4.3 MAINFRAME AND MINICOMPUTERS**

The MOBILE model is currently supported and maintained on the Michigan Terminal System (MTS) mainframe computer at Wayne State University in Detroit. With the advent of microcomputers, the need for access to this type of system by non-EPA users has been significantly reduced. If more information on how to access MOBILE5 on this system is needed, contact our office at the address and phone number indicated in the preceding section.

As discussed in the last section, MOBILE5 is also available as part of the Area and Mobile Source (AMS) subsystem of the Aerometric Information Retrieval System (AIRS), which supports an interactive menu-driven interface to the MOBILE model. AIRS is resident on the IBM mainframe computer system at EPA's National Computer Center (NCC) in Research Triangle Park, NC.

For users who would like to install MOBILE5 on their own mainframe (or minicomputer) system, MOBILE5 is available on 9-track computer tapes. A FORTRAN77 compiler program will be necessary to create an executable application on the destination system. The source code for the mainframe version of MOBILE5 is identical to the source code made available for other computer platforms, except for the default settings for the input and output (I/O) devices. If necessary, it is possible for the MOBILE5 source code and other files from another format (such as from a microcomputer diskette) to be uploaded to a mainframe or minicomputer.

#### **4.3.1 Input and Output Devices**

There are seven device assignments required to run the MOBILE5 model. Some of these default connections have been made to the same device number in the mainframe/minicomputer version of the model, as indicated in the following list:

○ Interactive input & output	(IOUASK)	Device 6
○ Parameter file input	(IOUGEN)	Device 1
○ Error messages	(IOUERR)	Device 7
○ Program output	(IOUREP)	Device 7
○ Batch file input	(IOBAT)	Device 19
○ New Tech. I/M credits	(IOUIMD)	Device 4
○ Old Tech. I/M credits		Device 3

The device for reading the I/M credits for vehicles using older (open-loop) technologies is "hard-coded" to device #3. Other device allocations are initialized in Block Data Subprogram 16. The first four I/O devices are also reset in subroutine GETIOU and are reset in the "driver" program (MAIN). IOBAT is set and used only in the driver program. IOUIMD is set only in Block Data Subprogram 16.

Some of these devices (IOUREP, IOUERR and IOUASK) can be reassigned using the IOUNEW parameters in the PROMPT record (see Chapter 2, section 2.1.2). If a user wishes to change the default settings directly in the source code, care must be taken that the settings are changed at all points where the device allocations are made. Otherwise, it is likely that the settings will revert back to the default values unexpectedly, with unpredictable results.

### 4.3.2 MOBILE5 Tape Characteristics

A standard MOBILE5 tape should have the following tape characteristics:

- Unlabeled, 9-track tape
- EBCDIC character set
- Density of 1600 bpi
- Fixed blocking, 15,000 characters per block
- Record length of 150 characters per record
- Files separated by tape marks

The tape will contain ten (10) files, with each unique file copied to the tape twice to allow for potential tape media errors. The files contained on each tape are:

- MOBILE5 source code
- Backup of MOBILE5 source code
- New Tech. I/M credits
- Backup of New Tech. I/M credits
- Old Tech. I/M credits
- Backup of Old Tech. I/M credits
- Example input file
- Backup of Example input file
- Example output file
- Backup of Example output file

The example input file contains a series of the example MOBILE5 runs put into a single MOBILE5 input. The example output file contains the results of running the example input file. Copies of the input file could be edited to make smaller,

more manageable MOBILE5 input files that can be used as templates for learning the input structure. Because of the limited record length, the long 222-column numerical format output will be truncated, but enough will remain to show the intent of the format. The user can simply run the example input on their own system to recreate the full output for that format.

### 4.3.3 Advice for Minicomputers

The default device assignments for MOBILE5 can cause problems on minicomputers. Although the Office of Mobile Sources (OMS) does not currently use a minicomputer, the following comments have been received from users with SUN SPARC systems using the UNIX operating system. The modifications discussed in this section are known to be correct only for SUN workstations; other systems may require different device assignments. Since the only difference between the source code for the various platforms is in the device assignments, the source code used for a minicomputer can come from any of the available platforms.

Standard device assignments for the SUN machines are "5" for input, "6" for output and "0" for error messages. The following device assignments were made in the main program:

◦ Interactive input & output	(IOUASK)	Device 6
◦ Parameter file input	(IOUGEN)	Device 11
◦ Error messages	(IOUERR)	Device 0
◦ Program output	(IOUREP)	Device 0

In addition, a new device assignment variable, IOUREAD, was created and assigned a value of "5". All statements asking for input from the screen [of the form "READ(IOUASK,...)"] were changed to "READ(IOUREAD,...)". A total of six read statements were changed, all of them in the main (driver) module of the program.

In Subroutine GETIOU, the user is allowed to define the device assignments. This capability needs to be eliminated. The following statements were suppressed:

```
IOUREP      =      IOUNEW(1)
IOUERR      =      IOUNEW(2)
IOUASK      =      IOUNEW(3)
```

The following statements, identical to the device assignments at the beginning of the program, were added instead:

```
IOUREP = 0
IOUERR = 0
IOUASK = 6
```

It is important to remember that the I/M credit files are read using device assignments "3" and "4". These values, therefore, should not be used for any other devices. Also, the I/M credit files, "imdata.d" and "tech12.d", must be named "IMDATA.D" and "TECH12.D" since UNIX machines are case sensitive.

The changes mentioned above have been tested by comparing program output from the DOS version of MOBILE5 and the SUN version, and the emission factor results obtained from these two test were identical. Other minicomputer systems may require different device assignments that those given above for SUN systems; however, any changes in the device assignments will not affect the validity of the results of the model.



## **4.4 DOS-BASED MICROCOMPUTERS**

The DOS version of MOBILE5 was compiled using the Lahey F77L-EM/32 version 4.02 FORTRAN compiler. MOBILE5a used version 5.0 of this compiler. The source code for this version of MOBILE5 is identical to the source code made available for other computer platforms, except for the default settings for the input and output (I/O) devices. If necessary, the MOBILE5 source code and other files from another format could be used, if the I/O devices are properly reset and if the user has access to FORTRAN compiler software capable of creating the executable application from the MOBILE5 source code.

### **4.4.1 DOS Microcomputer System Requirements**

The changes to the MOBILE model since the release of MOBILE4.1 (December 1991) have increased the size of the executable code such that it will no longer run within the DOS 640K memory limit. This requires that the program be run on a machine provided with and capable of using extended/expanded memory. In addition, the FORTRAN compiler used by EPA to produce a version of the MOBILE model that will run in extended/expanded memory can only produce executable code which requires both a machine which uses a 80386 (or better) microprocessor and which has a math coprocessor chip installed.

As a result, with the given understanding of the limitations of the compiler and the size of the program, MOBILE5 will require at minimum the following microcomputer hardware configuration for DOS machines:

- IBM-compatible 80386 (or better, such as 80486)
- At least two (2) megabytes of RAM memory.
- Math coprocessor chip (such as Intel 80387)

Microcomputers using the 80286 microprocessor will not be able to run the MOBILE5 model. Microcomputers using 80386- or 80486-based microcomputers without a math coprocessor also will not be able to run MOBILE5. Users of machines using DOS version 5.0 can use the DOS command "MSD" to determine if a math coprocessor is installed. MOBILE5 also apparently will not run in a DOS window of machines using the OS-2 operating system.

In addition to the hardware requirements, the FORTRAN compiler also makes use of a memory manager to access the RAM memory in excess of 640K. This sometimes conflicts with existing memory managers installed on these machines. The following sections will discuss how to configure your machine to avoid these conflicts. The compiler version used for MOBILE5a (26 March 1993) eliminated most of these problems.

Since some of these system requirements are a result of the particular FORTRAN compiler that was used, users with FORTRAN compilers may attempt to compile the source code themselves to have greater control over the characteristics of the final executable application. Users should refer to their compiler software documentation for further guidance.

### **4.4.2 DOS Input and Output Devices**

There are seven device assignments required to run the MOBILE5 model. Some of these default connections have been made to the same device number, as indicated in the following list:

○ Interactive input & output	(IOUASK)	Device 0
○ Parameter file input	(IOUGEN)	Device 5
○ Error messages	(IOUERR)	Device 6
○ Program output	(IOUREP)	Device 6
○ Batch file input	(IOBAT)	Device 19
○ New Tech. I/M credits	(IOUIMD)	Device 4
○ Old Tech. I/M credits		Device 3

The device for reading the I/M credits for vehicles using older (open-loop) technologies is "hard-coded" to device #3. Other device allocations are initialized in Block Data Subprogram 16. The first four I/O devices are also reset in subroutine GETIOU and are reset in the "driver" program (MAIN). IOBAT is set and used only in the driver program. IOUIMD is set only in Block Data Subprogram 16.

There should normally be no reason for a user to change the default settings. Some of these devices (IOUREP, IOUERR and IOUASK) can be set using the IOU NEW parameters in the PROMPT record (see Chapter 2, section 2.1.2). If a user wishes to change the default settings in the program code, care should be taken that the settings are changed at all points where the device allocations are made. Otherwise, it is likely that the settings will revert back to the default values unexpectedly, with unpredictable results.

#### 4.4.3 MOBILE5 DOS Diskette Characteristics

MOBILE5 for DOS-based microcomputers was originally released on a single 3-1/2" high density (1.44 MB) diskette containing five (5) files. All of the files are dated December 4, 1992. The five files are named and their size (memory requirement) are listed below:

○ M50READ.TXT	(8,322 bytes)
○ M50.EXE	(589,260 bytes)
○ M50EX.EXE	(219,960 bytes)
○ M50S.EXE	(470,912 bytes)
○ M50UG.EXE	(156,499 bytes)

The diskette containing the updated version of the model, MOBILE5a, also has five files. All are dated March 26, 1993. The file names and sizes are listed below:

○ M50AREAD.TXT	(18,085 bytes)
○ M50A.EXE	(637,851 bytes)
○ M50AEX.EXE	(103,433 bytes)
○ M50AS.EXE	(470,605 bytes)
○ M50AUG.EXE	(211,272 bytes)

M50READ.TXT (or M50AREAD.TXT) is a short DOS text file containing a brief explanation of what is on the diskette and how to access the files. This file also contains information, similar to the information in this section, describing the hardware requirements for running MOBILE5 on a DOS-based microcomputer and a list of the valid cutpoint combinations available in the I/M credit decks distributed with MOBILE5. The MOBILE5A.TXT file also contains a brief explanation of the changes to MOBILE5. This file can be read using editing or word processing software, or by using the command:

TYPE M50READ.TXT | MORE

#### 4.4.4 DOS Diskette Installation

M50.EXE (or M50A.EXE) is a self-extracting compressed file. This file should be copied to the directory in which the user wishes the MOBILE5 model to reside. Issue the command "M50.EXE" and the file will decompress into six (6) additional files. All of the files (except the F77L3.EER error file) will be dated December 4, 1992. These files are:

- MOBILE5.EXE (789,336 bytes)
- IMDATA.D (569,430 bytes)
- TECH12.D (62,551 bytes)
- F77L3.EER (40,432 bytes)
- M5.ICO (766 bytes)
- M5.PIF (545 bytes)

The MOBILE5a version, M50A.EXE, will also decompress into six files, all (except the F77L3.EER error file) dated March 26, 1993.

- MOBILE5A.EXE (889,632 bytes)
- IMDATA.D (569,424 bytes)
- TECH12.D (62,551 bytes)
- F77L3.EER (40,584 bytes)
- M5.ICO (766 bytes)
- M5.PIF (545 bytes)

The file MOBILE5.EXE (or MOBILE5A.EXE) is the executable application. The file IMDATA.D is an ASCII data file containing the inspection and maintenance (I/M) credits for newer model year vehicles. The file TECH12.D contains the I/M credits for older vehicles. The file F77L3.EER contains runtime error messages. The file M5.ICO can be used to install a custom Microsoft Windows icon when using MOBILE5 with Windows. The file M5.PIF is an example program information file that can be used when installing MOBILE5 with Microsoft Windows. Section 4.4.5 discusses how to install MOBILE5 with Windows and run the model.

M50S.EXE (or M50AS.EXE) is a self-extracting compressed file which contains the FORTRAN source code for the MOBILE5 model. Copy this file to the directory in which you wish the MOBILE5 source code to reside. Issue the command "M50S.EXE" and the file will decompress into a single file named MOBILE5.S. When decompressed, MOBILE5.S is 1,071,827 bytes. MOBILE5A.S will be 1,061,239 bytes. Unless the user wishes to recompile this source code using their own FORTRAN77 compiler, or wishes to transfer the source code to another computer platform (such as a minicomputer or mainframe), there is no need to decompress this file or even to keep a copy of the source code file on their hard disk.

The file M50EX.EXE (or M50AEX.EXE) is a self-extracting compressed file containing example MOBILE5 input files and the resulting outputs. Copy this file to the directory in which you wish the MOBILE5 examples to reside. Issue the command "M50EX.EXE" and the file will decompress into more than 50 additional files. Although most of the individual example files are small, together these files will use an additional 594,930 bytes of disk space. The MOBILE5a version (M50AEX.EXE) contains fewer example outputs (to conserve space) and decompresses into 234,060 bytes of disk space. Chapter 5 of this User's Guide discusses all of the available example files and includes printed versions of selected input and output files. EPA recommends that new users of the model read Chapter 2 thoroughly, combined with reference to these example files, as a means to understanding the input data structure of the MOBILE5 model.

The file M50UG.EXE (or M50AUG.EXE) is a self-extracting compressed file containing a draft copy of Chapter 2 of the MOBILE5 User's Guide in a word processing format (WordPerfect Version 5.1). If necessary, this file includes sufficient information to run MOBILE5 if the complete User's Guide is not available. Before printing this copy, users are cautioned to check the formatting of the document, since the defaults used in the creation may be changed when loaded on another machine. The document was originally formatted for 10 point Times-Roman and Helvetica fonts. Copy this file to the directory in which you wish to have Chapter 2 of the MOBILE5 User's Guide to reside. Issue the command "M50UG.EXE" and the file will decompress into a single file named M5UGCH2.W51 which will use 378,291 bytes. The updated MOBILE5a version of the draft User's Guide is broken into five smaller files:

- |            |                    |                 |
|------------|--------------------|-----------------|
| ○ CH2A.W51 | Sections 2.0 & 2.1 | (88,683 bytes)  |
| ○ CH2B.W51 | Section 2.2        | (126,692 bytes) |
| ○ CH2C.W51 | Section 2.3        | (80,222 bytes)  |
| ○ CH2D.W51 | Tables             | (126,733 bytes) |
| ○ CH2E.W51 | Appendix 2A        | (40,585 bytes)  |

#### **4.4.5 Installation with Microsoft Windows**

MOBILE5a (March 26, 1993) can be run under the 386 enhanced mode of Windows if sufficient memory is available. This will depend on the number and size of other applications that are open. However, MOBILE5 (December 4, 1992) can only be run within the standard mode of Microsoft Windows 3.n if certain steps are taken. First, any memory managers defined in the CONFIG.SYS file must be removed or commented out. Windows can be used to control memory allocation. Next, a program information file (PIF) must be created to define the memory space in which to run MOBILE5.

For example, MOBILE5 (or MOBILE5a) can be accessed from Windows by executing the MOBILE5.EXE (or MOBILE5A.EXE) application. The PIF must be created and allocate 2 MB (2,048 Kbytes) to the application. MOBILE5 will only run with Windows using standard mode. This PIF is then associated with the MOBILE5.EXE (or MOBILE5A.EXE) file using the Windows Program Manager. An example PIF for MOBILE5 and a custom icon have been included on the MOBILE5 diskette, labeled M5.PIF and M5.ICO, respectively. The custom icon can be installed using the FILE PROPERTIES option.

To start Windows in the standard mode, use the /S option when executing the WIN.COM command. The DOS command would appear:

```
WIN /S
```

MOBILE5a can be run in the 386 enhanced mode of Windows, so that the /S option is not necessary.

Double-clicking on the icon associated with the MOBILE5 PIF described above will run the MOBILE5 model. Similarly, a PIF can also be set up to access DOS directly, or DOS shell programs if the user prefers, as a method to run MOBILE5. Be sure to allocate sufficient memory to the PIF to run MOBILE5.

Different versions of Windows and different system configurations may be possible or necessary. Please refer to documentation which comes with your system for help in understanding and using MOBILE5 on your microcomputer system.

#### **4.4.6 DOS Memory Managers**

Most systems with expanded or extended memory use a memory manager (such as EMM386.COM) to access the RAM in excess of 640K. This memory manager is configured in the CONFIG.SYS file. When using MOBILE5 from DOS with a memory manager, this memory manager must define at least 2 MB (2,048 Kbytes) of expanded memory. The user guide for your system should be referred to in order to determine exactly how this must be done.

The MOBILE5 model contains its own memory manager, so if conflicts remain, the memory manager configuration can be removed altogether or commented out in the CONFIG.SYS file. MOBILE5 will then run in expanded memory using its own built-in memory manager.

The internal memory manager now used in MOBILE5a should have fewer conflicts with other memory managers. If running MOBILE5a without changes in the CONFIG.SYS appears to cause no conflicts, then the changes described above may not be necessary.

#### **4.4.7 Running MOBILE5 on a DOS-Based Microcomputer**

The file F77L3.EER should be kept in the directory in which the MOBILE5.EXE (or MOBILE5A.EXE) executable application is kept. This file is used when runtime errors occur and supplies text for the error messages. If this file is not available, the error messages will only supply the error numbers, which will require compiler documentation in order to decipher. The two I/M program data files (IMDATA.D and TECH12.D) should normally be kept in the same directory from which you will run MOBILE5.

To execute the application, invoke the application name at the DOS prompt (by typing the name MOBILE5 or MOBILE5a and returning) or double-click on the MOBILE5 icon (when using Windows). The program will return with prompts which will determine the source of input information and the location to which output will be written (see Chapter 3, section 3.1). The program will prompt the user in the same way on all computer platforms. For more information about the prompts, refer to Chapter 3 of this User's Guide.

MOBILE5 has been written to attempt to make use of the ability of DOS-based machines to access information that does not reside in the local directory. As a result, any time the MOBILE model asks for a filename, the user may also supply a DOS path with the filename. This will allow input and output file information to reside in directories other than the one in which the MOBILE5 model resides.

For example, the two I/M credit files, IMDATA.D and TECH12.D, normally must be in the directory from which MOBILE5 is run. However, if the two flags in the I/M Program Descriptive record are set to ask for non-default I/M credits, the filenames (with a DOS path) can be specified within the input file. This would allow the I/M credit files to reside in another directory.

The name of the directory which contains the MOBILE5.EXE file can be added to the PATH statement in the AUTOEXEC.BAT file, which will allow MOBILE5 to be invoked from any directory. MOBILE5 also has an option to allow the use of multiple separate input files with individual output files. This "batch option" allows the directory path to be included in the filenames, so that the individual input and output files can be kept in separate directories, if desired. See Chapter 3 (section 3.1.2) for more information on the batch option.

When printing, MOBILE5 includes special characters in the first column of the output. These characters are meant to be carriage controls for mainframe-type line printers. These carriage controls will be ignored by most microcomputer printers and are simply printed, appearing as "0", "1", "+" and so on in the first (leftmost) column.

An additional output option is now available to assist users in transferring MOBILE5 results into spreadsheets and other data processing software available on microcomputers (e.g., Lotus 1-2-3, Excel). This option (discussed in Chapter 2, section 2.1.15 and Chapter 3, section 3.2.1) creates output with variables separated by commas [comma-separated variable (CSV) format] and text with quotations that can be readily input into most spreadsheet programs (except Lotus 1-2-3 versions less than 3.0, and others that may have limitations on the length of text stream inputs).

#### **4.4.8 Editing MOBILE5 Input Files**

Any word processing software or other text editor can be used to create or modify the example MOBILE5 input files to match user requirements. Careful reading of the relevant sections of Chapter 2 as an aid while editing the example files is the easiest way to insure that the proper formats and record orders are maintained. However, when using word processing software the user should be careful to always save input files only as DOS text documents (ASCII text). Converting and saving MOBILE5 input files as word processing documents will add hidden characters to the file which will not be properly processed by the MOBILE model. Input files which have been inadvertently converted to a word processing document can be recovered by saving the file again as a DOS text file. Simple text editors will not normally add unwanted characters to a file.

To determine if an input has hidden characters, use the TYPE command available in DOS to list the input file to the screen. Any characters shown which were not intended to be in the file will likely cause problems when the file is read by the MOBILE model. An example of the TYPE command, with an option to pause after each screen of characters would be:

```
TYPE <filename> | MORE
```

When altering or creating MOBILE model input files, the user should be wary of adding text or comments after the input of needed parameters in an input record. There are numerous inputs which are not documented in this User's Guide which were used to check for errors in the code. These inputs are not necessary for normal MOBILE runs, but they can be triggered by unexpected characters at the end of normal input records. It is advised that in an input file that users generally not enter unnecessary text or comments before column 55, and otherwise avoiding text within 15 spaces after the last necessary input. All of the example inputs contain comments to assist users. Users may alter and append these comments without fear, but should avoid entering text in any columns before the start of these comments.

### **4.5 APPLE MACINTOSH MICROCOMPUTERS**

The Apple Macintosh version of the MOBILE5 and MOBILE5a models were compiled using the MacFortran/020 V2.4 FORTRAN compiler. The source code for these versions of MOBILE5 are identical to the source code made available for other computer platforms, except for the default settings for the input and output (I/O) devices. If necessary, the MOBILE5 source code and other files from another format could be used, if the I/O devices are properly reset and if the user has access to FORTRAN compiler software capable of creating the executable application from the MOBILE5 source code.

#### **4.5.1 Macintosh Microcomputer System Requirements**

Users with Apple Macintosh systems should not experience any new problems with MOBILE5 (or MOBILE5a) as long as sufficient RAM memory (at least 2 megabytes) is available. There are separate MOBILE5 applications available on the diskette for systems with and without math coprocessors. There are no known conflicts with other applications or versions of the operating system.

#### 4.5.2 Macintosh Input and Output Devices

There are seven device assignments required to run the MOBILE5 model. Some of these default connections have been made to the same device number in the DOS-based microcomputer version of the model, as indicated in the following list:

○ Interactive input & output	(IOUASK)	Device 9
○ Parameter file input	(IOUGEN)	Device 9
○ Error messages	(IOUERR)	Device 6
○ Program output	(IOUREP)	Device 6
○ Batch file input	(IOBAT)	Device 19
○ New Tech. I/M credits	(IOUIMD)	Device 4
○ Old Tech. I/M credits		Device 3

The device for reading the I/M credits for vehicles using older (open-loop) technologies is "hard-coded" to device #3. Other device allocations are initialized in Block Data Subprogram 16. The first four I/O devices are also reset in subroutine GETIOU and are reset in the "driver" program (MAIN). IOBAT is set and used only in the driver program. IOUIMD is set only in Block Data Subprogram 16.

There should normally be no reason for a user to change the default settings. Some of these devices (IOUREP, IOUERR and IOUASK) can be set using the IOUNEW parameters in the PROMPT record discussed in Chapter 2 (section 2.1.2). If a user wishes to change the default settings in the program code, care should be taken that the settings are changed at all points where the device allocations are made. Otherwise, it is likely that the settings will revert back to the default values unexpectedly, with unpredictable results.

#### 4.5.3 MOBILE5 Macintosh Diskette Characteristics

MOBILE5 was released on a single 3-1/2" high density (1.4 MB) diskette containing five (5) files. All of the files are dated March 26, 1993. The names and sizes of these files are listed below:

○ M50 Read Me	(6K bytes)
○ M50 EXAMPLE	(342K bytes)
○ M50 FORTRAN	(291K bytes)
○ M50 MAC	(437K bytes)
○ M50 UG	(120K bytes)

The MOBILE5a diskette contains seven (7) files. All files are dated March 26, 1993. The names and sizes of these files are listed below:

○ M50a Data	(196K bytes)
○ M50a Examples	(372K bytes)
○ M50a FORTRAN	(298K bytes)
○ M50a MAC	(138K bytes)
○ M50a MAC ndp	(138K bytes)
○ M50a U. G.	(162K bytes)
○ Please Read Me	(14K bytes)

M50 Read Me (or Please Read Me) is a short text file containing a brief explanation of what is on the disk and how to access the files. This file also contains information, similar to the information in this section, describing the hardware requirements for running MOBILE5 on an Apple Macintosh microcomputer and a list of the valid cutpoint combinations available in the I/M credit decks distributed with MOBILE5. The MOBILE5a Please Read Me file also contains a brief explanation of the changes to MOBILE5. This file can be read using editing or word processing software.

#### 4.5.4 Macintosh Diskette Installation

M50 MAC is a self-extracting compressed file application. When this file is executed (by double-clicking on the icon), this file will ask which folder the resulting decompressed MOBILE5 model is to reside in. The files will decompress into six (6) files. All files will be dated December 4, 1992. The names and sizes of these files are listed below:

- MOBILE5 apl (407K bytes)
- MOBILE5 no math apl (416K bytes)
- IMDATA.D (558K bytes)
- TECH12.D (63K bytes)
- f77.rl (20K bytes)
- m81.rl (14K bytes)

The MOBILE5a diskette has these files, in three separate self-extracting files. All of the extracted files will be dated March 26, 1993.

<u>Compressed File</u>	<u>Extracted File</u>	<u>Size</u>
M50a MAC	MOBILE5a no math apl	436K bytes
M50a MAC ndp	MOBILE5a apl	427K bytes
M50a Data	IMDATA.D	566K bytes
M50a Data	TECH12.D	63K bytes
M50a Data	f77.rl	20K bytes
M50a Data	m81.rl	14K bytes

The file MOBILE5 apl (or MOBILE5a apl) is the executable application for Macintosh machines equipped with math coprocessors. The file MOBILE5 no math apl (or MOBILE5a no math apl) is the executable application for Macintosh machines without math coprocessors. The file IMDATA.D is an ASCII data file containing the I/M credits for newer model year vehicles. The file TECH12.D contains the I/M credits for older vehicles. The file f77.rl contains FORTRAN runtime library. The file m81.rl is the math coprocessor runtime library.

M50 FORTRAN (or M50a FORTRAN) is a self-extracting compressed file application which contains the FORTRAN source code for the MOBILE5 model. When this file is executed (by double-clicking on the icon), this file will ask which folder the resulting decompressed MOBILE5 source code to reside in. The decompressed source code file MOBILE5.FOR is 1,041K bytes, and the file MOBILE5a.FOR is 1,070K bytes. Unless the user wishes to recompile this source code using their own FORTRAN 77 compiler or wishes to transfer the source code to another computer platform (such as a minicomputer or mainframe), there is no need to decompress this file or even to keep a copy of the source code file on their hard disk.

M50 EXAMPLE (or M50a Examples) is a self-extracting compressed file application containing example MOBILE5 input files and the resulting outputs. When this file is executed (by double-clicking on the icon) this file will ask which folder you wish the resulting decompressed MOBILE5 examples to reside. The



file will decompress over 50 additional files. Although most of the individual example files are small, together these files will require nearly 2 megabytes of disk space. Chapter 5.0 lists and discusses all of the available example files. It is strongly recommended that new users in particular use the examples as a starting point to understand the input structure of the MOBILE5 model.

The file M50 UG (or M50a U. G.) is a self-extracting compressed file application containing a draft copy of Chapter 2 of this User's Guide in a Microsoft Word Version 4.0 word processing format. If necessary, this file is sufficient information to run the MOBILE5 model if the complete User's Guide is not available. Before printing, users are cautioned to check the formatting of the document, since the defaults used in the creation may be changed when loaded on another machine. When this file is executed (by double-clicking on the icon), this file will ask which folder the resulting decompressed MOBILE5 User's Guide (Chapter 2) is to reside in. The decompressed file (Chapter 2, Dec 4, 1992) will require 302K bytes of disk space. The updated MOBILE5a version of Chapter 2 was broken down into five (5) smaller files:

- CH2.a - Sections 2.0,2.1
- CH2.b - Section 2.2
- CH2.c - Section 2.3
- CH2.d - Tables
- CH2.e - Appendix 2A

All of these files are dated March 26, 1993, and together they will require 417K bytes of disk space.

#### **4.5.5 Running MOBILE5 on an Apple Macintosh**

The two runtime library files (f77.rl and m81.rl) must be kept in the folder from which MOBILE5 is run, or they may be kept in the System Folder, which will make them available from any other folder. The two I/M program data files (IMDATA.D and TECH12.D) must be kept in the folder from which MOBILE5 is run. The input files and any batch run files must be in the same folder as the MOBILE5 application.

The user should choose which MOBILE5 application to use, depending on whether their Macintosh has or does not have a math coprocessor. Some applications, such as Microsoft Excel, will indicate whether or not a math coprocessor is present by choosing About Excel from the Apple menu. In order to save disk space, there is no need to keep both versions of the MOBILE5 application available on the disk.

To execute the application, double-click on the MOBILE5 icon or choose FILE OPEN from the system menu. A window will appear with the MOBILE5 standard prompts. The program will prompt the user in the same way on all computer platforms. For more information about the prompts, see Chapter 3.

When printing, MOBILE5 includes characters in the first column of the output. These characters are meant to be carriage controls for mainframe-type line printers. These carriage controls will be ignored by most microcomputer printers and will simply be printed.

An output option is now available to assist users in transferring MOBILE5 results into spreadsheets and other data processing software available on microcomputers. This option (discussed in Chapter 2, section 2.1.15) creates output with variables separated by commas and text with quotations that can be readily input into most spreadsheet programs (except those programs that have limitations on the length of text stream inputs).

## Chapter 5

### MOBILE5 EXAMPLES

#### 5.0 INTRODUCTION

Listing of inputs and outputs for nine examples (sections 5.1.1 through 5.1.9) are provided to illustrate various aspects of MOBILE5. The user is encouraged to try two or more of these examples to ensure that the model as compiled is running properly. In addition, the reader is encouraged to run the example input file MEGA.IN, after reading Chapter 2, in order to get a global sense of the options and data input requirements. All files listed in the section 5.1 example index below are available on disk and on the TTN BBS.

Any word processing software or other text editor can be used to modify the example MOBILE5 input files to match user requirements. This is the easiest way to insure that the proper formats and record orders are maintained. However, when using word processing software the user should be careful to save input files only as DOS text documents (ASCII text). Converting and saving input files as word-processing documents will add hidden characters to the file which will not be properly processed by the MOBILE model.

You can determine if an input has had hidden characters by using the TYPE command available in DOS to list the input file to the screen. Any characters shown which were not intended to be in the file will cause problems when the file is read by MOBILE5. An example of the TYPE command, with an option to pause after each screen of characters would be:

```
TYPE <filename> | MORE
```

Another problem that may occur when editing MOBILE5 input files is determining proper column location. When using word-processing software to edit these input files, if the file is viewed or printed using a proportional font, some characters in each row will take up more or less column space than other characters. All MOBILE5 input and output files assume that all characters take up equal column space (non-proportional spacing). It is helpful then to always use a non-proportional font (such as Courier) when viewing or printing MOBILE5 input or output files.

#### 5.1 MOBILE5 EXAMPLE INDEX

The following files are included with electronic copies of MOBILE5 (either on disk or via the bulletin board system). A brief description accompanies each filename to help the user find specific examples. An asterisk (\*) after the filename indicates that the input file and its corresponding output file are presented in sections 5.1.1 through 5.1.9.

Note to BBS users: The nine input and output examples indicated by asterisks (\*) in the list below are those included with paper copies of this document. They are not reproduced as part of these User's Guide files on the BBS, but are included in the file M5AEX2.EXE.

<u>Filename:</u>	<u>Description:</u>	
ALH3BLK.IN	ALHFLG=3;	corrections for A/C usage based on dry and wet bulb temperatures, extra load, trailer towing, humidity (NOx only).
ALH3SPD2.IN	ALHFLG=3,	SPDFLG=2; corrections for A/C usage, load, trailers, humidity; speeds for each vehicle class on the scenario description record.
ATP8.IN	ATPFLG=8;	shows use of functional purge and pressure evaporative emission control system checks, includes by-model year output (OUTFMT=5).
HC1.IN	HCFLAG=1;	prints sum of all HC components.
HC2.IN	HCFLAG=2;	prints sum and component (exhaust, evaporative, refueling, running loss, and resting loss) HC emission factors, components in grams/mile.
HC3.IN	HCFLAG=3;	prints sum and component HC emission factors (see HC2.IN), components in various units in expanded evaporative emission output, excludes refueling emissions in the sum.
HIM.IN	*	IMFLAG=3, ATPFLG=8; 1) Recommended Biennial Enhanced I/M Design. 2) Annual Enhanced I/M. Both inputs show midstream change in I/M programs. (See section 5.1.1)
HORIZ.IN	PROMPT=3;	horizontal data input.
IDL1.IN	IDLFLG=1;	no idle emission factors calculated.
IDL2.IN	IDLFLG=2;	idle emission factors calculated and printed. This flag has been disabled in MOBILE5. (See section 2.1.17).
IM3BLK.IN	*	IMFLAG=3, ATPFLG=1, OUTFMT=5; midstream switch in I/M models, includes by model year inclusion vector and I/M data filenames. (See section 5.1.2)
LAP.IN	*	OXYFLG=2, DSFLAG=2; shows oxygenated fuels record and diesel sales fraction record. (See section 5.1.3)
MAR.IN	MYMRFG=2;	user-supplied mileage accumulation rates.
MASTER.IN		Includes all files listed here.
MEGA.IN	*	Demonstration of every possible one-time data section input, showing relative order. (See section 5.1.4)

MYM4BLK.IN	*	MYMRFG=4; user-supplied mileage accumulation rates and registration distributions by age. (See section 5.1.5)
NEW4BLK.IN	NEWFLG=4;	user-supplied modifications to the basic emission rates and to implementation details on the new evaporative emissions test procedure.
NMH1.IN	NMHFLG=1;	calculates total hydrocarbon (THC) emission factors.
NMH2.IN	NMHFLG=2;	calculates non-methane hydrocarbon (NMHC) emission factors.
NMH3.IN	NMHFLG=3;	calculates volatile organic compound (VOC) emission factors.
NMH4.IN	NMHFLG=4;	calculates total organic gases (TOG) emission factors.
NMH5.IN	NMHFLG=5;	calculates non-methane organic gases (NMOG) emission factors.
OUTFMT1.IN	OUTFMT=1;	222-column numerical format output.
OUTFMT2.IN	OUTFMT=2;	140-column numerical format output.
OUTFMT3.IN	OUTFMT=3;	112-column descriptive format output.
OUTFMT4.IN	OUTFMT=4;	80-column descriptive format output.
OUTFMT5.IN	OUTFMT=5;	by-model year output format: table of by model year emission factors provided, along with standard 112-column descriptive format.
OUTFMT6.IN	OUTFMT=6;	spreadsheet output format.
PRT1.IN	PRTFLG=1;	calculate and print HC emission factors only.
PRT2.IN	PRTFLG=2;	calculate and print CO emission factors only.
PRT3.IN	PRTFLG=3;	calculate and print NO <sub>x</sub> emission factors only.
PRT4.IN	PRTFLG=4;	calculate and output emission factors for all three pollutants.
REG2.IN		High-altitude run.
REG3.IN		California Low-emitting Vehicle (LEV) run.
REG4.IN	*	LEV run with parameter record. (See section 5.1.6)
RL2BLK.IN	*	RLFLAG=2; enter Stage II vapor recovery system (VRS) parameters. (See section 5.1.7)
RL4.IN	RLFLAG=4;	enter both Stage II and onboard VRS parameters.

SPD3VM2.IN	*	SPDFLG=3, VMFLAG=2; one average speed for all vehicle types, with user-supplied trip length distributions and VMT fractions for each scenario. (See section 5.1.8)
SPD4VM3.IN	*	SPDFLG=4, VMFLAG=3; user-supplied trip length distributions and VMT fractions in the one-time data section. (See section 5.1.9)
SPD4BLK.IN	SPDFLG=4;	user-supplied trip length distributions in the one-time data section.
TAM2.IN	TAMFLG=2,	OUTFMT=5; user-supplied tampering rates with by model year output.
TAM2BLK.IN	TAMFLG=2,	LOCFLG=1; user-supplied tampering rates, distinct local area parameter record for each scenario.
TAM2IM3.IN	TAMFLG=2,	IMFLAG=2, OUTFMT=5; user-supplied tampering rates and basic I/M program with by model year output.
VM3BLK.IN	VMFLAG=3;	user-supplied VMT fractions in the one-time data section.

5.1.1.1 HIM.IN Input File Listing

5.1.1.2 HIM.OUT Output File Listing

5.1.2.1 IM3BLK.IN Input File Listing



5.1.2.2 IM3BLK.OUT Output File Listing

5.1.3.1 LAP.IN Input File Listing

5.1.3.2 LAP.OUT Output File Listing

5.1.4.1 MEGA.IN Input File Listing

5.1.4.2 MEGA.OUT Output File Listing

5.1.5.1 MYM4BLK.IN Input File Listing

5.1.5.2 MYM4BLK.OUT Output File Listing

5.1.6.1 REG4.IN Input File Listing



5.1.6.2 REG4.OUT Output File Listing

5.1.7.1 RL2BLK.IN Input File Listing

5.1.7.2 RL2BLK.OUT Output File Listing

5.1.8.1 SPD3VM2.IN Input File Listing

5.1.8.2 SPD3VM2.OUT Output File Listing

5.1.9.1 SPD4VM3.IN Input File Listing

5.1.9.2 SPD4VM3.OUT Output File Listing

## Chapter 6

### MOBILE5 INFORMATION SHEETS

#### **6.0 INTRODUCTION**

MOBILE5 information sheets are a series of documents intended to present information of interest to users of the MOBILE model, and in some cases to provide model users with detailed information about techniques that can be used to more accurately model highway vehicle emission factors and avoid potential errors. When referring to "MOBILE5" in these information sheets (and throughout this document), EPA should be understood as referring to the latest official release version of the model. At the time of publication of this User's Guide, the latest version of the model is MOBILE5a, released March 26, 1993.

All of the MOBILE5 Information Sheets are available on the Technology Transfer Network (TTN) computer bulletin board system (BBS), in the OMS (Office of Mobile Sources) section, under "Models and Utilities." Any microcomputer equipped with a modem can be used to access the BBS and to download files. The phone number for the TTN BBS is (919) 541-5742. All files are made available to users as soon as they have answered a few registration questions and are logged in as registered users. The TTN BBS can be called at any time (24 hours/day, 7 days/week) with the exception of Monday mornings from 8:00 am to 12:00 noon Eastern time, when the system is down for maintenance.

Since the Information Sheets contain information on running the model and avoiding potential errors in the emission factor calculations, users are encouraged to maintain a file of these sheets in their copy of the User's Guide. As new Information Sheets are issued they will be sent to all EPA Regional Offices, loaded onto the TTN BBS, and mailed directly to all model users who have completed and returned the mailing list form provided at the end of each Information Sheet. This form need only be completed and returned once.