



# ***MOBILE5-MEXICO DOCUMENTATION AND USER'S GUIDE***

*Final*

*Prepared for:*

Western Governors' Association  
Denver, Colorado

*and*

Binational Advisory Committee



November 20, 2000

# **MOBILE5-MEXICO DOCUMENTATION AND USER'S GUIDE**

**FINAL**

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## ACRONYMS

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ADEQ	Arizona Department of Environmental Quality
ARB	Air Resources Board
ATP	anti-tampering program
BERs	basic emission rates
°C	degrees Celsius
CDPHE	Colorado Department of Public Health and Environment
CO	carbon monoxide
g	gram
HC	hydrocarbon
hr	hour
I/M	inspection and maintenance
in <sup>2</sup>	square inch
INE	Instituto Nacional de Ecología (National Institute of Ecology)
km	kilometer
LAP	Local Area Parameter
lb	pound
LDDV	light-duty diesel vehicles
LDGV	light-duty gas vehicles
MVAG	Motor Vehicle Advisory Group
NO <sub>x</sub>	nitrogen oxides
QA	quality assurance
TNRCC	Texas Natural Resources Conservation Commission
TOG	total organic gases
U.S. EPA	U.S. Environmental Protection Agency
VKT	vehicle kilometers traveled
WGA	Western Governors' Association

# 1.0 INTRODUCTION

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This document describes the development of the MOBILE5-Mexico emission factor model. It also serves as a basic user's guide for the MOBILE5-Mexico model. MOBILE5-Mexico is a computer program that estimates hydrocarbon (HC), carbon monoxide (CO), and nitrogen oxide (NO<sub>x</sub>) emission factors for gasoline- and diesel-powered on-road motor vehicles. The basic structure of the MOBILE5-Mexico model is based upon the U.S. Environmental Protection Agency's (U.S. EPA's) MOBILE5a emission factor model. The main difference between MOBILE5a and MOBILE5-Mexico is that Mexico-specific emissions testing results were incorporated into the MOBILE5a model in order to derive the MOBILE5-Mexico model.

MOBILE5-Mexico calculates emission factors for eight vehicle types in five distinct regions in Mexico. The specific emission factor estimates depend upon various conditions such as ambient temperatures, average travel speed, vehicle operating modes, fuel volatility, and mileage accrual rates. Although some of the variables affecting vehicle emissions use default values, many of the required variables can be specified by the user. MOBILE5-Mexico can be used to estimate emission factors for any calendar year between 1960 and 2020. For each calendar year, the overall vehicle fleet consists of the 25 most recent vehicle model years.

## 1.1 Overview of Mexico Emissions Inventory Development Program

The development of the MOBILE5-Mexico model is part of the Mexico Emissions Inventory Development Program sponsored by the Western Governors' Association (WGA) and the National Institute of Ecology (INE) of Mexico. The overall focus of this larger effort is to build emissions inventory development capacity within Mexico. Other tasks under the Mexico Emissions Inventory Development Program include the development of a 10 volume series of emissions inventory manuals, various training materials, and pilot study emissions inventories in Mexicali and Tijuana. Funding for the Mexico Emissions Inventory Development Program is provided by U.S. EPA through WGA. In addition, generous technical support is provided by INE and other governmental organizations within Mexico.

## **1.2 Reasons for Development of MOBILE5-Mexico**

The MOBILE5-Mexico model was developed to estimate emission factors for on-road vehicles anywhere within Mexico. Prior to the development of the MOBILE5-Mexico emission factor model, a few Mexico-specific motor vehicle emission factor models had been developed, but these were designed for use in a specific metropolitan area (e.g., Mexico City, Ciudad Juárez, etc.). However, it was determined by INE and others that one national emission factor model was preferable compared to a large number of location-specific emission factor models. This parallels the development of the MOBILE5a emission factor model in the U.S. For example, instead of employing separate emission factor models for New York City, Chicago, and other individual metropolitan areas, MOBILE5a is applicable throughout the U.S. (with the regulatory exception of the state of California). In this way, a single emission factor model can be used anywhere in the country of Mexico. Location-specific differences are modeled by using different input parameters without requiring the development of an entire emission factor model for that particular location.

As described in Section 1.0, the basic structure of the MOBILE5-Mexico model is based upon the MOBILE5a emission factor model. Appropriate emissions rates and other model data from previously developed location-specific models for Mexico City and Ciudad Juárez were incorporated into the MOBILE5-Mexico model. Also, as part of the MOBILE5-Mexico development effort, additional emissions data were collected using a portable dynamometer in the city of Aguascalientes.

## **1.3 Appropriate Uses and Limitations of MOBILE5-Mexico**

MOBILE5-Mexico should be used in conjunction with Volume VI (*Motor Vehicle Inventory Development*) of the Mexico Emissions Inventory Program Manuals which was developed for INE and WGA (Radian, 1997a). The *Motor Vehicle Inventory Development Manual* is extremely useful in understanding the MOBILE5-Mexico model and developing appropriate assumptions and other input data. It is also an important tool for checking the results of the model using the described quality assurance (QA) procedures. Additional detailed information can be obtained from the *MOBILE5a User's Guide* (some relevant excerpts of this document are provided in Appendix A) (U.S. EPA, 1994). Only after applicable

recommendations in the *Motor Vehicle Inventory Development Manual* and *MOBILE5a User's Guide* are implemented should the user attempt to use MOBILE5-Mexico to estimate emission factors.

It is appropriate to use MOBILE5-Mexico for estimating emission factors for gasoline- and diesel-powered on-road motor vehicles within Mexico. The user can estimate the impact of changes in the overall vehicle fleet, such as the introduction of newer vehicles or the removal of older vehicles, the presence of U.S. vehicles, and other impacts such as inspection and maintenance (I/M) programs. The MOBILE5-Mexico model is not appropriate for estimating emission factors for nonroad vehicles (e.g., construction equipment and airport support vehicles). It should be noted that the MOBILE5-Mexico model assumes that the vehicle fleet will be driven on typical roadways. If the vehicle fleet is not driven on typical roadways, then driving behavior will be significantly different and the MOBILE5-Mexico model will not be as appropriate for estimating emission factors.

Also, as with any computer model, the accuracy of the model output is limited by the accuracy of the input data and the appropriateness of the assumptions made by the user. It is extremely important that the QA steps discussed in the *Motor Vehicle Inventory Development Manual* be implemented for the output results of the model.

Finally, it should be noted that the basic emission rates (BERs) of the MOBILE5-Mexico model are based upon a relatively small data set of emission testing results (< 1,000 vehicles). In particular, vehicle emissions testing has only been conducted in large metropolitan areas. Future updates of the model may address a larger quantity of emission test results, as well as emissions testing conducted in rural areas.



## 2.0 DEVELOPMENT OF MOBILE5-MEXICO MODEL

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MOBILE5-Mexico is based upon U.S. EPA's MOBILE5a emission factor model, as well as some location-specific emission factor models previously developed for several metropolitan areas in Mexico. The development of the MOBILE5-Mexico emission factor model also relied heavily upon expert advice provided by a Motor Vehicle Advisory Group (MVAG) assembled specifically for this project. The MVAG reviewed the design of the MOBILE5-Mexico model and greatly influenced the final version of the model. Representatives from the following organizations comprised the MVAG:

- INE;
- California Air Resources Board (ARB);
- Arizona Department of Environmental Quality (ADEQ);
- Texas Natural Resource Conservation Commission (TNRCC); and
- Colorado Department of Public Health and Environment (CDPHE).

### 2.1 Model Structure – Five Regional Types

For the development of MOBILE5-Mexico, Mexico was divided into five distinct regional types. The reason that these five regional types were established was because each of these regional types each exhibit some unique fleet and/or emission characteristics. The five regional types are briefly described below:

1. **Mexico City:** Mexico City and those surrounding areas that are characterized by similar air pollution regulations and I/M programs. Because of Mexico City's severe air pollution problems, motor vehicles are more strictly regulated there than in any other part of Mexico. In addition, the I/M programs currently in place in Mexico City are the most stringent in Mexico. The emission characteristics of Mexico City are also uniquely affected by high altitude (approximately 2,250 meters above sea level); other major metropolitan areas in Mexico are at lower altitudes.
2. **Interior Urban:** All metropolitan areas within the interior of Mexico (i.e., non-border areas) except for Mexico City (e.g., Guadalajara,

Monterrey, Aguascalientes, etc.). These areas have similar air pollution regulations; however, these regulations are not as stringent as in Mexico City. Some of these areas have also already implemented I/M programs.

3. **Interior Rural:** All non-urban areas within the interior of Mexico (i.e., excluding Mexico City and interior urban areas). With the exception of any applicable national regulations and standards, motor vehicles are unregulated in these areas. I/M programs are not present in these areas.
4. **Border Urban:** All metropolitan areas within the Mexico-U.S. border region (e.g., Ciudad Juárez, Mexicali, Tijuana, etc.). Because of the proximity to the U.S., air pollution regulations specific to the border area have been implemented. Some of these areas have also already implemented I/M programs. The border urban area fleets are greatly affected by the presence of U.S.-registered vehicles, as well as vehicles of U.S. origin that have been imported into Mexico.
5. **Border Rural:** All non-urban areas within the Mexico-U.S. border region (i.e., excluding border urban areas). Although some air pollution regulations specific to the border area may apply in these areas, I/M programs will not be relevant. Border rural area fleets may also be affected by the presence of U.S. vehicles, but probably not to the extent of border urban areas.

The MOBILE-Mexico model contains unique code for each of the three urban regional types (i.e., Mexico City, interior urban, and border urban). For the two rural regional types (i.e., interior rural and border rural), the model assumes that the Mexico-registered rural vehicles have essentially the same technology and maintenance characteristics as Mexico-registered vehicles found in border urban areas such as Ciudad Juárez or Mexicali. This assumption is necessary and reasonable because vehicle testing has not been conducted for interior rural and border rural vehicle fleets, and the number of rural vehicles is relatively few. The motor vehicle emissions from rural vehicle fleets compared to overall country-wide motor vehicle emissions is small enough that any difference between the border urban fleet emission rates assumed for rural vehicles and the actual rural fleet emission rates will be insignificant.

## **2.2 Incorporation of Existing Models (Mexico City and Border Urban Region)**

The Mexico City and border urban modules of the MOBILE5-Mexico model draw heavily on existing models.

In 1993, the MOBILE-MCMA model was developed to estimate motor vehicle emission factors for the Mexico City metropolitan area (Radian, 1993). The MOBILE-MCMA model was initially based upon U.S. EPA's MOBILE4 model. In 1996, MOBILE-MCMA was updated to account for differences between the MOBILE4 to MOBILE5 model (Radian, 1996a). Instead of using emissions testing data to develop BERs, Mexico City I/M test data from 1995 were combined with a "technology equivalence matrix" that mapped Mexico model year vehicles to equivalent U.S. model year vehicles in order to determine Mexico city-specific emission factors. Additional discussion of the technology equivalence matrix can be found in Table 3-2 of *Motor Vehicle Inventory Development Manual*. The MOBILE5-based MOBILE-MCMA model was directly incorporated into the MOBILE5-Mexico model for use in the Mexico City region. Relevant default values from MOBILE-MCMA are still applicable for using MOBILE5-Mexico for Mexico City.

In 1996, the MOBILE-Juárez model was developed to estimate motor vehicle emission factors for the Ciudad Juárez metropolitan area (Radian, 1996b). In support of this effort, approximately 200 vehicles were tested in Ciudad Juárez. The Ciudad Juárez emissions testing was conducted in 1995. As with the MOBILE-MCMA model, a technology equivalence matrix was also used in the development of the MOBILE-Juárez model. The MOBILE-Juárez model was incorporated into the MOBILE5-Mexico model for use in border urban regions. Some of the initial assumptions in the MOBILE- Juárez model were updated based upon fleet information collected from a recent motor vehicle emissions inventory conducted in Mexicali (ICAR, 1998). Because data collected in Ciudad Juárez and Mexicali were used for the development of the border urban module of the MOBILE5-Mexico model, the module is most appropriate for these two areas. However, because it is likely that the fleet characteristics in other border urban regions (e.g., Tijuana, Nogales, etc.) resemble Ciudad Juárez and Mexicali, it is also appropriate to use the border urban module of the MOBILE5-Mexico model for all border

urban regions. The default data provided in the border urban module are appropriate for modeling emission factors for Ciudad Juárez or Mexicali. For other border urban areas, these default data should be examined and, if necessary, modified to represent conditions for these specific border areas. Finally, as previously mentioned in Section 2.1, information from the border urban module of the model was utilized in the interior rural and border rural modules of the model.

### **2.3 Development of the Interior Urban Module**

In order to develop the interior urban module of the MOBILE5-Mexico model, it was necessary to incorporate information and assumptions appropriate for a representative city in the interior of Mexico. The MVAG selected the city of Aguascalientes as a representative interior urban city.

Local vehicle data collected in Aguascalientes were used to derive appropriate model assumptions. Methods used to collect the local data were very similar to those used previously in Ciudad Juárez. Local vehicle fleet and fuel information was obtained through Aguascalientes government officials. Emissions testing data were collected in 1998 on a portable dynamometer for over 200 Aguascalientes vehicles using appropriate testing protocols. These testing data were used to directly develop the necessary BERs and other assumptions required for the interior urban module. This is in contrast to the technology equivalence matrix which was used to develop BERs for the Mexico City and border urban modules. The process used to develop the BERs for the interior urban module is described elsewhere (Radian, 1998). A MOBILE-based model had previously been developed for use in Monterrey (MOBILE-Monterrey). However, it was felt that the testing data developed in Aguascalientes was of better quality than the data used in MOBILE-Monterrey. As was done for MOBILE-MCMA, MOBILE-Monterrey used limited testing data and a technology equivalence matrix to derive BERs. Also, because Monterrey is located relatively closer to the U.S. than most other interior urban areas, the influence of U.S. vehicles would likely be greater in Monterrey. For this reason, it was felt that the Aguascalientes data would be more representative of typical interior urban areas than Monterrey data.

The interior urban module is appropriate to use for all interior urban areas. Likewise, default data provided in the interior urban module are most appropriate for modeling emission factors for Aguascalientes. However, these default data can be used for other interior urban areas after careful examination and possible modification to represent conditions in these specific areas.

## 3.0 HOW TO RUN MOBILE5-MEXICO

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This section briefly describes how to run the MOBILE5-Mexico model. It focuses on the basics of the MOBILE5-Mexico input files and on the significant differences between the MOBILE5-Mexico and MOBILE5a emission factor models. More detailed information is located in the *Motor Vehicle Inventory Development Manual* or the *MOBILE5a User's Guide* (pertinent sections have been included in Appendix A).

To install MOBILE5-Mexico, create a hard drive directory and decompress all files from the supplied diskette to that directory.

To run MOBILE5-Mexico, go to the directory where the model code is stored and, at the DOS prompt, type "M5MEX" followed by the "enter" key.

After starting the model, the initial screen will request that a number for a specific Mexico region be entered. The five Mexico regions are:

- Mexico City (1);
- Interior Urban (2);
- Interior Rural (3);
- Border Urban (4); and
- Border Rural (5).

This initial Mexico region selection automatically directs the user into a specific model module. At this point, differences between modules are not apparent to model users (i.e., input and output file formats for different regions will look identical). However, each module contains different basic emissions data used to estimate region-specific emission factors.

After selecting a region, the MOBILE5-Mexico model prompts the user for an input file name. The file can have any valid DOS-permitted name (i.e., eight characters or less) that ends with a ".run" extension (e.g., "tijuana.run", etc.). This file must be located in the same

directory as the MOBILE5-Mexico executable program. Assuming that the model runs without any errors, then the model output will be contained in a similarly named output file with a “.out” extension (e.g., “tijuana.out”, etc.).

A sample input file is shown in Figure 3-1; a brief explanation of the data elements listed in the Control Section, One-Time Data Section, and Scenario Section are also provided below. Additional discussion of input files can be found in the *Motor Vehicle Inventory Development Manual* or the *MOBILE5a User's Guide*. The input file is an ASCII text file which is read by the MOBILE5-Mexico model's FORTRAN source code. The *MOBILE5a User's Guide* excerpts in Appendix A provide the required FORTRAN input file formats. Because FORTRAN is extremely “sensitive” to errors, an extra space or misplaced character can cause the model to crash or incorrectly estimate emission factors. For this reason, it is recommended that input files be created by modifying an existing input file rather than creating a new input file. Six input files (i.e., aguas.run, aguasim.run, juarez.run, juarim.run, mcma.run, and mcmain.run) have been included with the supplied diskette. As mentioned earlier, the input and output file formats will be identical regardless of the Mexico region selected.

### **3.1            Description of the Control Section**

The Control Section of the input file consists of 18 data element lines. With the exception of a descriptive title located on the second line, the remaining data elements are one-character “flags” which determine the required content and format of the remainder of the input file, as well as the program's output file. The flags also indicate how the model code will be executed. All of these flags are necessary for the model to run. A description of the Control Section data elements shown in the Figure 3-1 sample input file is given in Table 3-1. Recommended values for the Control Section data elements (i.e., input flag settings) are presented in Table 3-2.

1	PROMPT	<i>Input Prompt Flag</i>	<b>Control Section</b>
MOBILE5 - Mexico Sample File <i>Descriptive Title</i>			
1	TAMFLG	<i>Tampering Flag</i>	
1	SPDFLG	<i>Speed Flag</i>	
1	VMFLAG	<i>VMT (VKT) Flag</i>	
5	MYMRFG	<i>Mileage Accumulation/Registration Distribution Flag</i>	
5	NEWFLG	<i>Basic Exhaust Rate Flag</i>	
2	IMFLAG	<i>Inspection and Maintenance (I/M) Flag</i>	
1	ALHFLG	<i>Additional Correction Factor Flag</i>	
2	ATPFLG	<i>Anti-Tampering Program (ATP) Flag</i>	
5	RLFLAG	<i>Refueling Flag</i>	
2	LOCFLG	<i>Local Area Parameter (LAP) Flag</i>	
1	TEMFLG	<i>Temperature Flag</i>	
4	OUTFMT	<i>Output Format Flag</i>	
4	PRTFLG	<i>Pollutant Printout Flag</i>	
1	IDLFLG	<i>Idle Flag</i>	
4	NMHFLG	<i>Hydrocarbon Selection Flag</i>	
2	HCFLAG	<i>Hydrocarbon Printout Flag</i>	
96 50 68 20 03 03 078 2 1 2222 2111		<i>I/M Program Information</i>	<b>One-Time Data Section</b>
96 68 20 2222 21 078. 12111212		<i>ATP Information</i>	
Sample. A 18.9 36.1 06.5 06.5 93 1 1 1		<i>LAP Record</i>	
1 96 31.5 25.0 19.6 19.7 30.0 01	<i>1996 Scenario</i>		<b>Scenario Section</b>
1 00 31.5 25.0 19.6 19.7 30.0 01	<i>2000 Scenario</i>		
1 10 31.5 25.0 19.6 19.7 30.0 01	<i>2010 Scenario</i>		

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**Figure 3-1. Sample MOBILE5-Mexico Input File**



**Table 3-1. Description of Control Section Data Elements in Sample Input File**

<b>Variable/ Flag Name</b>	<b>Variable/Flag Value</b>	<b>Variable/Flag Value Definition</b>
PROMPT	1	No input prompting, vertical file
PROJID	MOBILE5-Mexico Sample File	Input file identifier
TAMFLG	1	MOBILE5a default tampering rates
SPDFLG	1	One average speed for all vehicle types
VMFLAG	1	MOBILE5a vehicle type VKT (vehicle kilometers traveled) mix used to estimate all-vehicle emission factor
MYMRFG	5	Mexico-specific annual mileage accumulation rates and/or registration distributions by age
NEWFLG	5	MOBILE5a basic exhaust emission rates; all new Clean Air Act requirements disabled
IMFLAG	2	One user-specified inspection and maintenance (I/M) program
ALHFLG	1	No corrections for air conditioner usage, extra vehicle load, trailer towing, humidity
ATPFLG	2	Anti-tampering program (ATP)
RLFLAG	5	No refueling emission factors
LOCFLG	2	One local area parameter (LAP) record for all input scenarios
TEMFLG	1	Temperature corrections using minimum and maximum daily temperatures
OUTFMT	4	80-column descriptive output format
PRTFLG	4	HC, CO, and NO <sub>x</sub> emission factors estimated
IDLFLG	1	No idle emission factors
NMHFLG	4	HC emission factors are for total organic gases (TOG)
HCFLG	2	Total and component HC emission factors

**Table 3-2. Recommended Mexico Values for Control Section Data Elements**

<b>Variable/ Flag Name</b>	<b>Recommended Value</b>	<b>Comments</b>
PROMPT	1	A value of "1" is typically used in the U.S.; other values are infrequently used.
PROJID	Not applicable	Any 80 character title is acceptable
TAMFLG	1	Alternate tampering rate data are rarely available; default tampering rates are acceptable.
SPDFLG	1	A value of "1" (one average speed for all vehicle types) is the most appropriate for general regional inventory use. Other values are used for more detailed modeling.
VMFLAG	1	A value of "1" (using default MOBILE-Mexico VKT mixes to calculate fleet average emission factors) is usually used. Other values are rarely used.
MYMRFG	5	A value of "5" allows Mexico specific annual mileage accumulation rates and registration distributions by age.
NEWFLG	5	Must be set to "5" to disable the effects of U.S. regulations (i.e., 1990 Clean Air Act Amendments).
IMFLAG	1 (2)	A value of "1" is recommended for most areas in Mexico (i.e., those areas without an I/M program). A value of "2" will be appropriate for all other areas with single I/M programs.
ALHFLG	1	Data needed to correct for air conditioning usage, extra vehicle load, trailer towing, and humidity effect (NO <sub>x</sub> only) are typically not available.
ATPFLG	1 (2)	A value of "1" is recommended for most areas in Mexico (i.e., those areas without anti-tampering programs, pressure checks, and purge checks). Many I/M programs in Mexico include visual anti-tampering checks; pressure and purge checks, however, are typically not utilized. A value of "2" can be used for those areas that have reasonably high visual anti-tampering check enforcement and compliance rate. At the present time, these areas are probably limited to Mexico City and Guadalajara.
RLFLAG	5	A value of "5" (no refueling emission factors to be calculated) should always be used because it is recommended that refueling emissions be calculated as area sources
LOCFLG	1 or 2	The selection of a value of "1" or "2" (one LAP record for <u>each</u> or <u>all</u> scenarios) depends solely upon the user's intended purpose.
TEMFLG	1 (2)	A value of "1" is generally recommended for typical emission inventories (e.g., daily, seasonal, or annual emission inventories). A value of "2" is appropriate only for short duration modeling (i.e., hourly basis).
OUTFMT	4	All other values are not appropriate for MOBILE5-Mexico.

**Table 3-2. (Continued)**

Variable/ Flag Name	Recommended Value	Comments
PRTFLG	4	It is recommended that a value of “4” (HC, CO, and NO <sub>x</sub> emission factors) be selected unless a pollutant-specific analysis is being conducted
IDLFLG	1 or 2	It does not matter if a value of “1” or “2” is selected because MOBILE5-Mexico does not provide idle emission factors
NMHFLG	3 or 4	It is recommended that a value of “3” or “4” be selected in order to get VOC or TOG emission factors (see Section 4.1 of Volume II [ <i>Emissions Inventory Fundamentals</i> ] of the Mexico Emissions Inventory Program Manuals for detailed descriptions of hydrocarbon classifications [Radian, 1997b]).
HCFLG	2	A value of “2” is recommended because an analysis of evaporative components can be easily performed.

### **3.2 Description of the One-Time Data Section**

The amount of input data that must be included in the One-Time Data Section of the input file depends upon the flag selection choices made in the Control Section. At a minimum, a Local Area Parameter (LAP) Record will be included. In the sample input file shown in Figure 3-1, there are additional input data describing an I/M program and an anti-tampering program (ATP). The following three figures provide a detailed description of the I/M Program Descriptive Input Record (Figure 3-2), the Anti-Tampering Descriptive Input Record (Figure 3-3), and the LAP Record (Figure 3-4).

### **3.3 Description of the Scenario Section**

The amount of input data that must be included in the Scenario Section of the input file also depends upon the flag selection choices made in the Control Section and the One-Time Data Selection. Figure 3-5 provides a detailed description of scenario records (with three scenarios for the years 1996, 2000, and 2010) with the minimum amount of data required. Single or multiple scenarios can be modeled.

In general, the guidance provided in the *MOBILE5a User's Guide* is applicable for the MOBILE5-Mexico model. The following exceptions should be noted:

- The MYMRFG input flag (the 6<sup>th</sup> data input line) should be set to “5” to account for Mexico-specific annual mileage accumulation rates and registration distributions by age, when such data are available.
- The NEWFLG input flag (the 7<sup>th</sup> data input line) should always be set to “5”; other input values cause the effects of U.S. regulations (i.e., the 1990 Clean Air Act Amendments) to be modeled.
- The OUTFMT input flag (the 14<sup>th</sup> data input line) should always be set to “4”; other input values are not appropriate for MOBILE5-Mexico.
- The following units should be used in MOBILE5-Mexico input files:
  - Vehicle speed (kilometers per hour [km/hr])
  - Temperature (degrees celsius [°C])
  - Reid vapor pressure (pounds per square inch [lb/in<sup>2</sup>])
- Emission factors generated in the MOBILE5-Mexico output files are given in units of grams per kilometer (g/km).









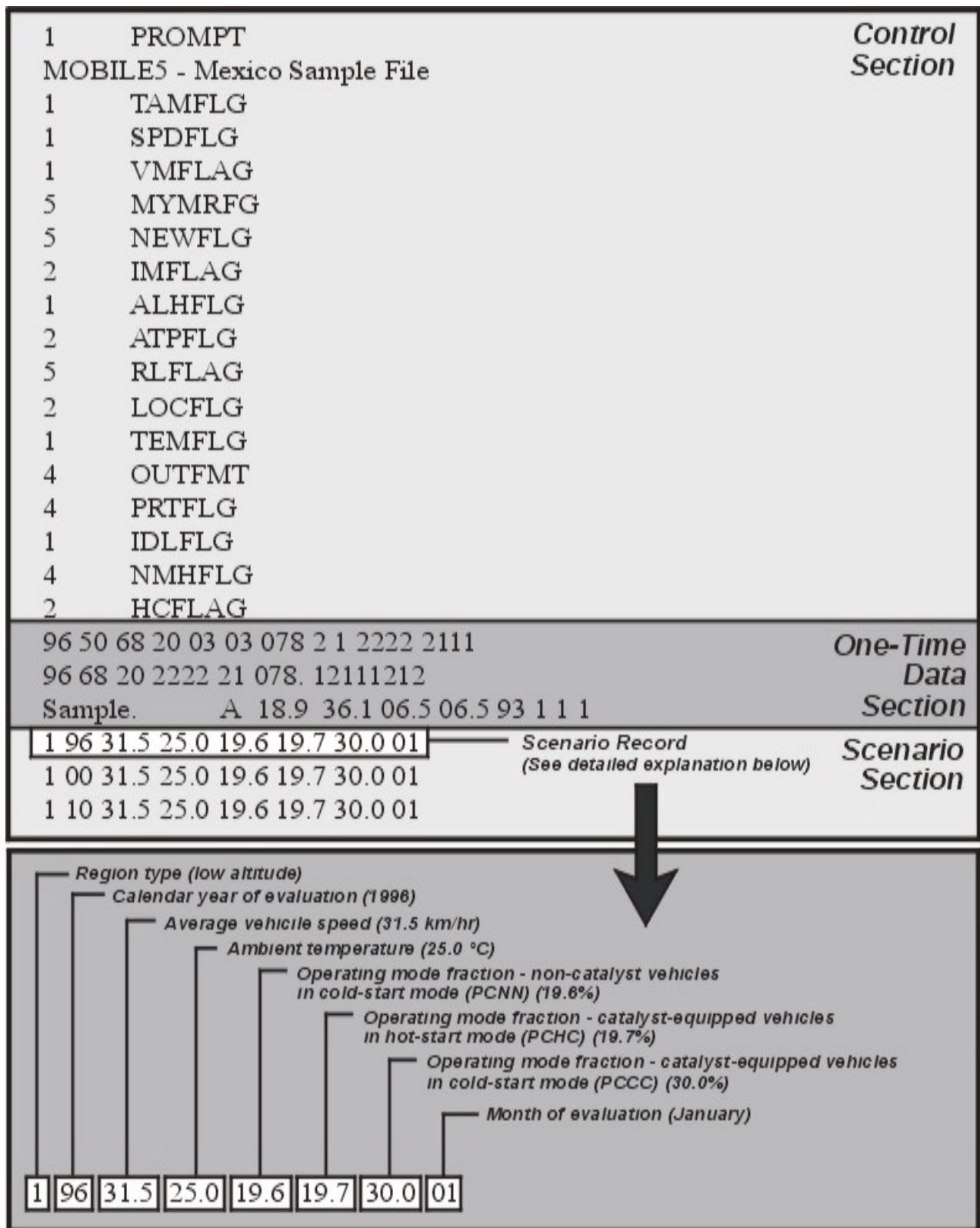


Figure 3-5. Sample MOBILE5-Mexico Scenario Record Parameters



For each region the model uses up to five other special files, depending upon the type of region that will be modeled. Each of these files has the extension “.inp”. Up to three of these “\*.inp” files should be modified before the model is used in any area except the default areas mentioned in Sections 2.2 and 2.3 (i.e., Mexico City, Ciudad Juárez, Mexicali, and Aguascalientes). These files contain the special data required for each of the five regions modeled by MOBILE5-Mexico and should only be modified with great care. These files are:

- **\*regmar.inp**: This file contains the estimated registration fractions and annual mileage information by model year for vehicles in the region to be modeled. The registration factors are decimal fractions (adding up to 1.00 for each vehicle type). The mileage accumulation rates are in km/100,000 km.

*Format*: Registration fractions – one title line, followed by 8 blocks of 25 numbers (the 25 numbers are in free format, arranged on three lines – two lines of 10 numbers and one line of 5 numbers).

Mileage accumulation rates – one title line, followed by 8 blocks of five lines each with 5 numbers in free format on each line.

In this file each block corresponds to a vehicle type. The order of the eight vehicle types is the same as in MOBILE5a. The 25 entries in each block correspond to the age of the vehicle, from 1 to 25 years old.

- **\*regmc.inp**: This file contains data on the total number of vehicles in the region to be modeled. There is one entry for each vehicle type. The one restriction to modifying this file is that the entries for light-duty gas vehicles (LDGV) and light-duty diesel vehicles (LDDV) must be equal. (The calculation of the fraction of LDDVs requires the initial unrealistic assumption that the number of LDGVs is equal to the number of LDDVs).

*Format*: One title line, followed by one comma-separated line. The order of the eight vehicle types is the same as in MOBILE5a.

- ***jzprops.inp***: This file is only used for modeling in the Mexico-U.S. border regions and contains eight numbers, one for each of the eight vehicle categories. The numbers represent the fraction of Mexican registered vehicles in each category (not the vehicles which were actually manufactured in Mexico). Although many vehicles located in Mexico cities in the Mexico-U.S. border region may have been manufactured in the U.S., most of these vehicles will be registered in Mexico. The lower limit for this fraction is 50%.

*Format*: One line, set up in free format with 8 numbers separated by spaces. The order of the eight vehicle types is the same as in MOBILE5a.

There are two other files with the “inp” suffix: agmxbers.inp and \*map.inp. However, these two files should not be modified by model users. If high-quality, local I/M data are available, then the \*map.inp files can be modified in future versions of MOBILE5-Mexico. The agmxbers.inp file contains basic emission rate information for interior urban areas. The \*map.inp files (i.e., agsmap.inp, jzmap.inp, jzovmap.inp, mxmap.inp) are used by the model for Mexico-U.S. border areas to assign the equivalency of technologies and emissions between local and U.S. vehicles, and to account for the use of U.S.-registered vehicles in border areas.

## 4.0 RECOMMENDATIONS FOR MOBILE5-MEXICO IMPROVEMENTS

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The MOBILE5-Mexico emission factor model provides the most accurate emission factors currently available for the vehicle fleet in Mexico. The model incorporates emissions testing, mileage accumulation, tampering, and driving behavior data collected in Mexico City, Ciudad Juárez, Mexicali, and Aguascalientes. Data collection in these different regions allows region-specific emission factors to be estimated.

However, similar to U.S. EPA's periodic improvements and modifications to the original MOBILE model, the MOBILE5-Mexico model should also be revised in the future through the incorporation of newly available data. New data will improve model parameters and overall model accuracy. Some suggested areas of improvement include:

- Perform additional emissions testing, especially in Mexico City. The existing data set is relatively small with a sample size of less than a 1,000 tests.
- Incorporate two new emissions testing data sets currently being developed: additional Ciudad Juárez vehicles by TNRCC and Tijuana vehicles by ARB.
- Conduct data collection for heavy-duty gas and diesel vehicles (e.g., emission rates, mileage accumulations, tampering rates, etc.). Previous studies have focused on light-duty vehicles. No on-road data exist for heavy-duty Mexican vehicles. Developing this data would require a heavy-duty chassis dynamometer laboratory. However, such a laboratory currently does not exist in Mexico.
- Assess the penetration of emission control technology into the Mexican vehicle fleet. Emission standards for newer vehicles has caused significant control technologies to be installed. However, the effects of these control technologies need to be quantified.
- Perform additional driving behavior studies. The Aguascalientes driving cycle study was a significant development, but further research is needed to properly quantify Mexican driving behavior. The new driving cycles could then be used to further improve emission factor data for the urban regions.

- Perform additional tampering surveys. The phase-out of leaded fuel in Mexico may dramatically decrease the tampering rates currently used in the model.
- If rural areas are found to contribute a significant amount to Mexico's mobile sources inventory, the MOBILE5-Mexico model should be updated to include specific data from those regions.

## 5.0 REFERENCES

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## **APPENDIX A**

### **EXCERPTS FROM U.S. EPA'S MOBILE5-USER'S GUIDE**