METHODOLOGY FOR CALCULATING VEHICLE MILES TRAVELED (VMT)

State of California Department of Consumer Affairs

Bureau of Automotive Repair
Engineering and Research Branch

BAR ENGINEERING
Engineering Clean Air

Methodology for Calculating

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1.0   INTRODUCTION

This report presents an estimate of the average vehicle miles traveled (VMT) in 1999 by a motor vehicle registered and operated in California. The purpose of estimating the annual VMT is to help evaluate the effectiveness of the California's Inspection and Maintenance (I/M) program, also known as the Smog Check program. The Bureau of Automotive Repair (Bureau) is the state agency charged by statute to implement and administer the I/M Program.

This report only estimates the VMT for motor vehicles that are subject to the I/M program.

2.0   VEHICLE COVERAGE

According to the statutes that govern California's I/M program, only certain motor vehicles are subject to the I/M program. Vehicles that meet the following criteria are required to participate in the I/M program:

- Model-year: From 1974 to the current model-year.[1]
- Fuel type: Includes vehicles powered by gasoline[2], liquefied propane gas, compressed natural gas, methanol, ethanol, or a combination of these fuels.
- Vehicle type: Passenger cars, light-duty trucks, medium-duty vehicles, and heavy-duty trucks.

The Bureau has developed and promulgated into regulation exhaust emissions standards for vehicles that are subject to the I/M program. One of the factors used to determine the applicable standards is vehicle type. The Bureau uses the following vehicle type classifications in the development and application of exhaust emissions standards:

- Passenger car means any vehicle designed primarily for transportation of persons. Coupes, sedans and station wagons are common body types for passenger cars.

- Light-duty truck means any vehicle that has a manufacturer's gross vehicle weight rating (GVWR) of not greater than 6,000 pounds and is designed primarily for purposes of transporting property.

- Medium-duty vehicle means any vehicle having a manufacturer's GVWR of greater than 6,000 pounds but not more than 8,500 pounds.

Heavy-duty truck means any vehicle with a manufacturer's GVWR that exceeds 8,500 pounds.

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[1]   Vehicles less than four model-years old are exempt from the biennial inspection requirement.

[2]   According to records kept by the Department of Motor Vehicles, over 99.9% of the vehicles subject to the I/M program are powered by gasoline.

By regulation, the Bureau has exempted the following vehicles from the I/M program:

- Vehicles exclusively powered by diesel fuel or electricity.
- Vehicles with an engine displacement of less than 50 cubic inches.
- Any two-cylinder or two-cycle vehicles.

California's I/M program is divided into three program areas: enhanced, basic and change-of-ownership. In the enhanced and basic areas, a smog check inspection is required every two years as well as upon a change-of-ownership of the vehicle; in the remaining areas, an inspection is necessary only upon a change-of-ownership. In the enhanced areas, a loaded-mode, dynamometer-based test is used, but the remaining areas utilize a static, two-speed idle test.

VMT results are calculated as a function of vehicle model-year, vehicle type and I/M program area.

3.0   DATA SELECTION CRITERIA

Every smog check station is electronically linked to centralized, vehicle information database (VID) operated by a private entity under contract to the Bureau. Smog check inspection results are created by BAR-90 Test Analyzer Systems (TAS, used in basic and change-of-ownership areas) and BAR-97 Emissions Inspection Systems (EIS, used in enhanced areas), and then electronically transmitted to the VID and stored there.

In calculating the VMT, the Bureau only used valid smog check inspection records as well as data from DMV records. Invalid test records, defined as aborted test records, hands-on test records and training mode test records, were not used in the calculations due to concerns about reliability and accuracy. Because newer model-year vehicles are exempt from the biennial Smog Check requirements, an increase in the sample size was necessary. Consequently, the Bureau used DMV records with matching Smog Check records in the current processing year to calculate the VMT for newer vehicles.

As mentioned earlier, in most areas, smog check inspections are required on a biennial basis and upon a change in the vehicle's ownership. The Bureau's VMT calculations compare the information regarding the smog check inspections performed in the current processing year with the smog check inspections performed two years prior to the current processing year. Three years of data are used to provide the highest percent of matching tests. The following chart specifies the months of VID data to be used for this methodology.

Processing year	Previous months	Current months
1998	1/96 – 12/97	1/98 - 12/98
1999	1/97 – 12/98	1/99 - 12/99
2000	1/98 – 12/99	1/00 - 12/00
2001	1/99 – 12/00	1/01 - 12/01

All of the data for the tests performed in previous months and current months being processed are sorted separately by Vehicle Identification Number (VIN), test date and test time.

As mentioned earlier, the are two sources of VID data: TAS inspection units and EIS inspection units. Admittedly, the data record structure created and transmitted by each type of unit is different. However, the careful processing of the records eliminates this difference. The necessary information is extracted from each valid record and then placed in a data file in which all records are of the same data structure. From smog check inspection records transmitted to the VID, the Bureau extracts VIN, smog check inspection date and time, vehicle model-year, odometer reading, gross vehicle weight rating (GVWR)(if applicable) and test record source (from BAR-90 TAS or from BAR-97 EIS). From DMV records, the Bureau extracts VIN, registration expiration date, vehicle model year, the year the vehicle was first sold and the smog check inspection due date.

4.0   DATA PROCESS

A VIN is a unique and permanent identifier for each vehicle. For vehicle model-years 1974 through 1995, smog check inspection records from previous years and current processing years are matched by VIN. For 1996 and newer model-years, Smog Check records from the current processing year are matched with DMV records by VIN. Data are discarded when 1) a comparison of VIN matched records results in a model year difference that is greater than one year or 2) the vehicle's odometer reading was recorded as zero for either matching test.

Once a valid match is found, the Bureau uses the following methodology to calculate VMT. First, the number of days between the tests is calculated. For 1996 and newer model-year vehicles, the early date is calculated by the year vehicle was first sold combined with the month and day that the next smog check inspection is due, as derived from DMV records. In order to minimize vehicle travel mileage deviation and reduce sample bias, data are discarded when a comparison of VIN matched records results in a smog check test date difference of less than 365 days (one year). In addition, when there were more than two records for a unique VIN, the records resulting in the greatest test date difference were used.

Second, the odometer difference between the matched tests from previous year and current processing year is calculated. For 1974 through 1995 model-year vehicles, the odometer reading A is obtained from the previous year, and the odometer reading B is obtained from the current processing year. For 1996 and newer model-year vehicles, the odometer reading A is assumed to be zero on the date the vehicle was first sold, and odometer reading B is obtained from the current processing year.

For each unique vehicle, the odometer difference is the result of subtracting A from B $(B-A)$. When the difference falls outside the realistic norm, it is a strong indicator the odometer stopped functioning, and the recorded information is suspect. As a quality control measure, data are discarded when:
1) $B-A = 100,000$, which probably indicates the difference is caused by the odometer reading's rollover from previous year, which was not recorded; or
2) $B-A = 0$, which means no mileage difference; or
3) $B-A = 1$, which also means no mileage difference because the difference is probably caused by the decimal point of the odometer reading from current processing year, which was rounded up to a integer when reading B was recorded; or

4) *B-A* = 99,999, which means no mileage difference because the difference is probably caused by the odometer reading's rollover from the previous year and by the decimal point of the odometer reading from current processing year, which was rounded down when readings *A* and *B* were recorded; or

5) *B-A* = 100,001, which means no mileage difference because the difference is probably caused by the odometer reading's rollover from the previous year and by the decimal point of the odometer reading from current processing year, which was rounded up when readings *A* and *B* were recorded; or

6) *B-A* < 0, which is not logical because odometer reading *B* should be larger than odometer reading *A* if the vehicle has been driven.

Third, a vehicle's miles traveled per day are calculated by the odometer difference (*B-A*) divided by the number of days between the tests. The Bureau then multiplies the result by 365 to determine the vehicle miles traveled per year. In order to minimize technician entry errors in the odometer readings, vehicle miles traveled per year limits are imposed. If matched tests indicate greater miles traveled than the maximum limit, the data are discarded. The maximum limits are as follows:

VEHICLE AGE	MAXIMUM MILES TRAVELED PER YEAR
< 2	60,000
= 2	50,000
> 2	40,000

Furthermore, data are discarded when VMT is not greater than five miles since the Bureau assumes that if a vehicle travels five miles or less annually, the vehicle may not be currently operated. The vehicle owner may have filed a certificate of non-operation with DMV, thereby eliminating the need for a smog check inspection.

- The average VMT is calculated based on these factors:
- Vehicle model-year, ranging from 1974 through 1999;
- Vehicle type; and
- I/M program area.

The vehicle's model-year is found through the use of smog check inspection records from the current processing year. Vehicle type is determined by the vehicle's GVWR entered by the smog check inspection records, using the following assumptions:

- If GVWR equals zero, the vehicle is classified as a passenger car since the TAS and EIS inspection units do not require the smog check technician to enter a GVWR for passenger cars.
- If GVWR is more than zero and is equal to or less than 6,000 pounds, the vehicle is classified as a light-duty truck.
- If GVWR is more than 6,000 pounds but is less than or equal to 8,500 pounds, the vehicle is classified as a medium-duty vehicle.
- If GVWR exceeds 8,500 pounds, the vehicle is classified as a heavy-duty truck.

The I/M program area is determined by the source of the smog check inspection record. If a TAS unit creates the smog check inspection record, the vehicle is presumed to be from a basic and/or change-of-ownership program area. If EIS inspection unit generates a smog check inspection record, the vehicle is presumed to be from an enhanced area.

July 1999 is the month of the average vehicle test due date in the current processing year in this study. To obtain the overall average VMT for all vehicles, the number of vehicles subject to the I/M program by model-year in July 1999 is obtained from the smog check fleet travel fraction calculator[3] (See Table 4). The overall average VMT for all vehicles is the result of the sum of the vehicle fractions by model-year multiplied by the average VMT by model-year. Because the vehicle distributions by vehicle type or program area are not available, the Bureau assumed that the vehicle distributions were the same for all vehicle types and in all program areas.

5.0   RESULTS

Using the methodology described in this report, the Bureau has calculated the number of vehicles with matching records, and the average vehicle miles traveled by model-year, vehicle type, and I/M program area. The results are presented in the following table. A total of 6,324,399 vehicle records were used to perform the VMT calculations.

Annual VMT by Vehicle Type and Program Area

Vehicle Type	Enhanced	Basic or Change of Ownership	Statewide
Passenger Car	11,936	11,489	11,794
Light Duty Truck	12,717	12,272	12,556
Medium Duty Vehicle	12,511	12,312	12,425
Heavy Duty Truck	11,150	10,618	10,971
All Vehicle Types	12,132	11,720	11,995

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[3]   Smog Check fleet travel fraction calculator is a tool designed by the Bureau of Automotive Repair to allow the user to consider both vehicle attrition and growth rates when developing monthly vehicle fleet data by model year for 1966 through 1999 vehicles.