California Environmental Protection Agency

Air Resources Board

Vapor Recovery Test Procedure

PROPOSED: TP - 201.2A

DETERMINATION OF VEHICLE MATRIX FOR PHASE II ~~VAPOR RECOVERY~~ SYSTEMS ~~OF DISPENSING FACILITIES~~

Adopted: April 12, 1996
Amended_____

Note: this document consists of the text of the proposed amendment to procedure TP-201.2A. Proposed deletions are noted by ~~strikeout~~ and proposed additions are noted by underline.

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
AIR RESOURCES BOARD

Vapor Recovery Test Procedures

TP-201.2A

Determination of Vehicle Matrix for Phase II Systems

1 Applicability

Definitions common to all certification and test procedures are in:

D-200 Definitions for Vapor Recovery Test Procedures

For the purpose of this procedure, the term "ARB" refers to the State of California Air Resources Board, and the term "ARB Executive Officer" refers to the Executive Officer of the ARB or his or her authorized representative or designate.

This test procedure can be used to determine the characteristics of a test fleet of vehicles which, when tested by other test procedures, can yield data representative of the total vehicle fleet.

2 Principle and Summary of Testing Procedure

~~The sample of vehicles to be used in method TP-201.2 for testing vapor control systems shall be made up of vehicles representative of the on the road vehicle population in terms of vehicle miles traveled (VMT). This calculation procedure produces such a representative vehicle matrix. The distribution in terms of model year can be derived from the VMT portion of the calculated input to EMFAC. EMFAC is the ARB computer model for estimating on road motor vehicle emissions and is administered by the Technical Support Division of ARB. Distribution in terms of manufacturer can be derived from the number of registered vehicles for each make and model year which can be obtained from the Department of Motor Vehicles.~~

A representative matrix of vehicle counts in various categories is calculated from registered vehicle data and other information. Vehicles are categorized by model year and by make and/or vehicle type. The number of vehicles specified in the matrix for each category is such that the average number of miles traveled in

California by vehicles in each category is substantially similar.

3 Biases and Interferences

~~This section heading is not applicable to this procedure.~~

The number of vehicle miles traveled is not identical to the amount of gasoline used by vehicles in a category because gasoline consumption per mile will vary. Correction for differences in gasoline consumption rate is considered impractical. It is also impractical to calculate a matrix where the vehicle miles traveled in each category is identical because of the need to round values off to integer vehicle counts in the matrix and include entire model years in categories.

~~4 SENSITIVITY, RANGE, AND PRECISION~~

~~This section heading is not applicable to this procedure.~~

~~5 EQUIPMENT~~

~~This section heading is not applicable to this procedure.~~

~~6 CALIBRATION PROCEDURE~~

~~This section heading is not applicable to this procedure.~~

~~7 PRE-TEST PROTOCOL~~

~~This section heading is not applicable to this procedure.~~

~~8 TEST PROCEDURE~~

~~This section heading is not applicable to this procedure.~~

~~9 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)~~

~~This section heading is not applicable to this procedure.~~

~~10 RECORDING DATA~~

~~This section heading is not applicable to this procedure.~~

~~11~~4 CALCULATING ~~RESULTS~~THE VEHICLE MATRIX

The criteria defining vehicle categories and the information on which calculations are based shall be chosen such they are reasonable and appropriate as determined by the ARB Executive Officer. The same matrix shall be used for all testing performed in any calendar year, except that the Executive Officer may approve an alternative matrix to be used in special cases where a vapor recovery system is demonstrated to serve a vehicle population substantially different from the California vehicle population as a whole.

The vehicle makes and types, and models, and the number of vehicles per cell in the examples below are for illustration purposes only. More cells and other models, or vehicle makes and/or types, and different numbers of vehicles ~~per cell~~or categories shall be included at the discretion of the ARB Executive Officer. The calculation procedures described below are illustrative only and other reasonable and appropriate procedures may be specified or approved by the Executive Officer provided only that the resulting matrix delineates a diverse and representative variety of vehicles and vehicle counts are determined considering estimated vehicle miles traveled by vehicles in each category.

At the Executive Officer=s discretion, testing of any particular vapor recovery system may be required to include, in addition to the vehicle matrix, a supplementary list of vehicles or vehicle categories having features or equipment which may pose particular challenges or incompatibilities with that vapor recovery system.

~~11.1~~4.1 Obtain Vehicle Make, Model, and Type Information

Obtain the number of ~~registered~~ vehicles in various categories~~by manufacturer and by model year from the~~ from an appropriate source such as annual reports from the California Department of Motor Vehicles ~~(DMV)~~. ~~The data shall resemble~~An example of data for automobile categories defined by model year and make is illustrated by the following :

Number of ~~Registered~~ Vehicles

MODEL (e.g.)	CHRYSLER	FORD	GM	TOYOTA	HONDA	OTHER	TOTAL
YEAR							
1991	109,563	344,867	334,974	218,577	191,174	378,731	1,577,886
1990	138,427	352,293	323,953	203,156	189,973	460,906	1,668,708

etc.

~~11.2~~4.2 Obtain Vehicle Miles Traveled ~~(VMT)~~Information By Model Year

Obtain data for the projected values for the number of vehicle miles traveled or percent of vehicle miles traveled in various model years ~~(VMT) in~~ expected in the current calendar year from an appropriate source such as projected values provided by ARB=s EMFAC modeling program. Include only gasoline fueled vehicles. ~~EMFAC7EWT output. This is the vehicle population, trip, and VMT fraction input data for EMFAC. The required data are the fractions of the total VMT by each vehicle model year. The passenger car population for this data set is divided into three groups; non-catalytic gasoline, catalytic gasoline, and diesel powered. Use only the catalytic gasoline vehicles for this calculation. The data will appear similar to~~ An example of such data is illustrated by the following:

~~Distribution of VMT~~Percent of Vehicle Miles Traveled by Vehicle Model Year

MODEL YEAR	PERCENT OF VEHICLE MILES TRAVELED	~~VEHICLES PER 100 CAR TEST~~
1991	6.9	~~6.9~~
1990	10.5	~~10.5~~
1989	10.7	~~10.7~~
1988	10.3	~~10.3~~
1987	9.3	~~9.3~~
1986	8.2	~~8.2~~
1985	7.4	~~7.4~~

etcetera (percentages should add up to 100)

~~1984~~	~~6.7~~	~~6.7~~
~~1983~~	~~6.0~~	~~6.0~~
~~1982~~	~~5.2~~	~~5.2~~
~~1981~~	~~4.7~~	~~4.7~~
~~1980~~	~~4.1~~	~~4.1~~
~~1979~~	~~2.9~~	~~2.9~~
~~1978~~	~~2.4~~	~~2.4~~
~~1977~~	~~2.0~~	~~2.0~~
~~1976~~	~~1.5~~	~~1.5~~

~~1975 1.1 1.1~~
~~1974 0 0~~

~~The diesel vehicles are not fueled with vapor recovery equipment and shall not be included in the matrix. The non-catalytic vehicles were produced before 1979 and most were built before fillpipe standards and vapor emission standards were established for vehicles. They currently account for only 4% of the total VMT's and this fraction decreases each year. So the non-catalytic vehicles also need not be included in the matrix.~~

~~11.3~~4.3 ~~VMT~~Calculate Estimated Vehicle Miles Traveled ~~per~~ for Each Make and/or Type Category and Each Model Year

Calculate the estimated vehicle miles traveled or percentage of vehicle miles traveled for each category of vehicle make or type in each model year using the data obtained above. For example, calculate that because there were 109563 1991 model Chrysler vehicles and 1,577,886 total 1991 model vehicles, and projected vehicle miles traveled for 1991 vehicles is 6.9% of all vehicle miles traveled, the projected percentage of vehicle miles traveled by 1991 model Chrysler vehicles will be 6.9% x (109563/1577886) or 0.4791%.
~~Multiply the VMT fraction for each model year (step 11.2) times the number of registered vehicles by each manufacturer (step 11.1) for the corresponding model year. The resulting products are proportional to the miles traveled by each manufacturer's vehicles, for each model year.~~

~~11.4 VMT per Make for All Years~~

~~Sum the products of step 11.3 for each manufacturer. These sums represent the total VMT for each manufacturer. Select at least five manufacturers responsible for the highest VMT sums. These five (or more) manufacturers will be used to establish columns in the matrix. A last column called "Others" will include the vehicles from all other manufacturers.~~

~~11.5~~4.4 Calculate the Cumulative Percentage of Vehicle~~s~~ Miles Traveled for each Model Year

~~Determine the number of vehicles from each model year which are required by the 100-car matrix. To do this, convert the VMT fractions of step 11.2 to percents by multiplying by 100%. These percent numbers also equal the number of vehicles required in the 100-car test for each model year. For example if 10% of all VMT's are traveled by 1990 model vehicles, the 100-car matrix would include ten 1990 vehicles.~~

~~It is most accurate to maintain fractions through the calculations and round to~~

~~whole vehicle numbers only at the last step of determining the matrix.~~

Calculate the number of vehicle miles traveled in each model year as a percentage of vehicle miles traveled in all model years and, for each model year, the cumulative percentage of vehicle miles traveled by vehicles as new or newer than vehicles in that model year.

Model Year	Percent of Total	Cumulative Percent
1991	6.9	6.9
1990	10.5	17.4
1989	10.7	28.1
1988	10.3	38.4
1987	9.3	47.7
1986	8.2	55.9
1985	7.4	63.3
etc		

11.64.5 Divide Model Years into Category Groups~~Percentage of Vehicles by Make for each Model Year~~

~~Obtain the fractions of registered vehicles by manufacturer for each model year. This shall be done for the five main manufacturers (step 11.4) and for the "Others" total. First, sum the numbers of registered vehicles of all manufacturers for each model year. Second, divide this sum into the registered vehicle numbers of each of the five main manufacturers and "Others" to get the desired fraction. For example, a recent calculation yielded:~~

~~Percentage of Registered Vehicles by Manufacturer for Each Model Year~~

~~MODEL YEAR~~	~~CHRYSLER~~	~~FORD~~	~~GM~~	~~TOYOTA~~	~~HONDA~~	~~OTHERS~~	~~TOTAL~~
~~1991~~	~~6.9~~	~~21.9~~	~~21.2~~	~~13.9~~	~~12.1~~	~~24.0~~	~~100.0%~~
~~1990~~	~~8.3~~	~~21.1~~	~~19.4~~	~~12.2~~	~~11.4~~	~~27.6~~	~~100.0%~~
~~etc.~~							

Using the cumulative percentages of vehicle miles traveled previously calculated for each model year, divide the model years into groups each representing approximately the same percentage of vehicle miles traveled. As an illustrative example, dividing model years into 5 groups each representing approximately

20% of vehicle miles traveled would be done as follows using the example data above: 1990-1991 model years represent 17.4% of vehicle miles traveled, 1988-1989 model years represent 21.0%, 1985-1987 model years represent 24.9% of vehicle miles traveled, etc. Trial and error selection of model years may be necessary to arrive at an arrangement with the most equal division of vehicle miles traveled in each category group of model years. Do not subdivide model years. The groups will normally represent percentages of vehicle miles traveled which are only approximately equal.

11.74.6 Calculate Percentage of Vehicle Miles Traveled In Each Model Year Category by Vehicles in Each Vehicle Make or Type Category ~~Yearly Matrix Values~~

Sum the percentage of vehicle miles traveled for each category of vehicle in each model year category. For example using data above, because 1991 Chrysler vehicles represent 0.4791% of total vehicle miles traveled and 1990 Chrysler vehicles represent 0.8710%, the total percentage of vehicle miles traveled by Chrysler vehicles for the 1990-1991 model year category is 1.3501%.

~~Distribute the vehicles for each model year (step 11.5) among the six columns (step 11.4). The number of vehicles assigned for each manufacturer shall be proportional to the fraction of registered vehicles (step 11.6) for each model year. A recent example follows:~~

~~Number of Vehicles for 100-car Matrix by Manufacturer and Model Year~~

~~MODEL YEAR~~	~~CHRYSLER~~	~~FORD~~	~~GM~~	~~TOYOTA~~	~~HONDA~~	~~OTHERS~~	~~TOTAL~~
~~1991~~	~~0.48~~	~~1.51~~	~~1.46~~	~~0.96~~	~~0.83~~	~~1.66~~	~~6.9~~
~~1990~~	~~0.87~~	~~2.22~~	~~2.04~~	~~1.28~~	~~1.20~~	~~2.90~~	~~10.5~~

~~etc.~~

11.84.7 Calculate the Vehicle Count Matrix

Select a constant AK@ with a value of approximately 2. Calculate a count of vehicles to be tested in each category of vehicle make or type and each model year range by rounding off the product the constant AK@and the percentage of vehicle miles traveled by vehicles in that category of make or type and model year range. Calculate the total of the resulting counts of vehicles in all categories of vehicle make or type and all model year ranges (the total will be approximately 200). Adjust the value of the constant AK@ in small increments by trial and error,

and recalculate the total, until the total is exactly 200. This is best done using a spreadsheet program.

An illustrative example of a completed table of vehicle counts is shown below.

1992 200-VEHICLE MATRIX							
MODEL YR	CHRYSLER	FORD	GM	TOYOTA	HONDA	OTHER	TOTALS
89-92	3	12	11	8	7	13	54
86-88	6	9	10	9	4	16	54
82-85	5	9	11	6	4	13	48
77-81	3	6	9	3	2	9	32
< 77	3	4	5	0	0	2	12
TOTALS	18	40	46	26	17	54	200

~~The vehicle matrix shall be constructed per the requirements of the certification procedure. Examples for two such requirements are given below:~~

~~11.8.1 Vehicle Cell Limits~~

~~The following example shows the results of constructing a vehicle matrix for August 1992 with a ten vehicle cell limit. Any other matrix with another cell limits, such as less than five vehicles per cell, shall be constructed in the same manner.~~

~~Combine the data into groups of model years to facilitate filling the matrix during the 100-car field test. Beginning with the current year, add previous years in succession until a maximum of ten vehicles accumulate in any cell. This group of model years will form the first row of cells. Repeat this process starting with the next preceding year to determine the group of years for the second row of cells. Repeat until all previous years combined yield less than 10 vehicles in any cell. This will normally require four rows of cells and the result will resemble the following table:~~

100 VEHICLE MATRIX AUGUST 1992							
MODEL YR	CHRYSLER	FORD	GM	TOYOTA	HONDA	OTHER	TOTALS
89-92	2	6	5	4	3	7	27
86-88	3	5	5	4	2	8	27
82-85	2	4	6	3	2	7	24
77-81	1	3	5	2	1	4	16
< 77	1	2	2	0	0	1	6
TOTALS	9	20	23	13	8	27	100

Be careful when rounding to whole numbers of vehicles. This can result in a matrix with slightly more or less than 100 vehicles. One can often determine the best place to add or subtract a vehicle by comparing the sums of rounded numbers and unrounded numbers for each row and column.

11.8.2 Special Cell Limits

Other cell limits shall be placed outside the totals for vehicle cell limits, as required by the application of the certification procedure.

For example, a requirement for

> "at least five vehicles with 89-92 model years with a vehicle tank vapor return line entering the fillpipe above the unleaded restrictor"

would place a "5" in a special limit column to the right of the "TOTALS" column and in the "89-92" row. The row at the bottom of the table would be unaffected except for the addition of a total cell for the sum of the vehicles required by the special limit.

Regardless of the number of special limits required, the total number of vehicles in the matrix shall remain 100.

Be careful when applying special limits, or the resources required to find suitable vehicles can be increased beyond practical limits.

~~12 REPORTING RESULTS~~

~~This section is reserved for future specification.~~

~~13 ALTERNATIVE TEST PROCEDURES~~

~~Test procedures, other than specified above, shall only be used if prior written approval is obtained from the ARB Executive Officer. In order to secure the ARB Executive Officer's approval of an alternative test procedure, the applicant is responsible for demonstrating to the ARB Executive Officer's satisfaction that the alternative test procedure is equivalent to this test procedure.~~

~~(1) Such approval shall be granted on a case-by-case basis only. Because of the evolving nature of technology and procedures for vapor recovery systems, such approval shall not be granted in subsequent cases without a new request for approval and a new demonstration of equivalency.~~

~~(2) Documentation of any such approvals, demonstrations, and approvals shall be maintained in the ARB Executive Officer's files and shall be made available upon request.~~

~~14 REFERENCES~~

~~This section is reserved for future specification.~~

~~15 FIGURES~~

~~This section heading is not applicable to this procedure.~~