CRC Report No. E-116

ASSESSMENT OF MOVES MODEL EVAPORATIVE EMISSION INPUTS

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COORDINATING RESEARCH COUNCIL, INC.
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CRC Project No. E-116:

Assessment of MOVES Model Evaporative Emission Inputs

prepared for:

Coordinating Research Council

June 15, 2017

prepared by:

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1. EXECUTIVE SUMMARY

Hydrocarbon (HC) emissions associated with fuel evaporation were first identified as a significant source of ozone precursors in the late 1960s. Given the contribution of this source to the total HC emissions inventory and to ambient air quality problems, efforts were begun to develop approaches for reducing these emissions. The primary approaches to evaporative emissions control have been reductions in fuel volatility and implementation of a series of increasingly more stringent new vehicle evaporative emissions standards by the U.S. Environmental Protection Agency (EPA) and the California Air Resources Board (CARB). It should also be noted that, pursuant to Section 177 of the Clean Air Act, states outside of California have the authority to adopt California standards and several have done so.

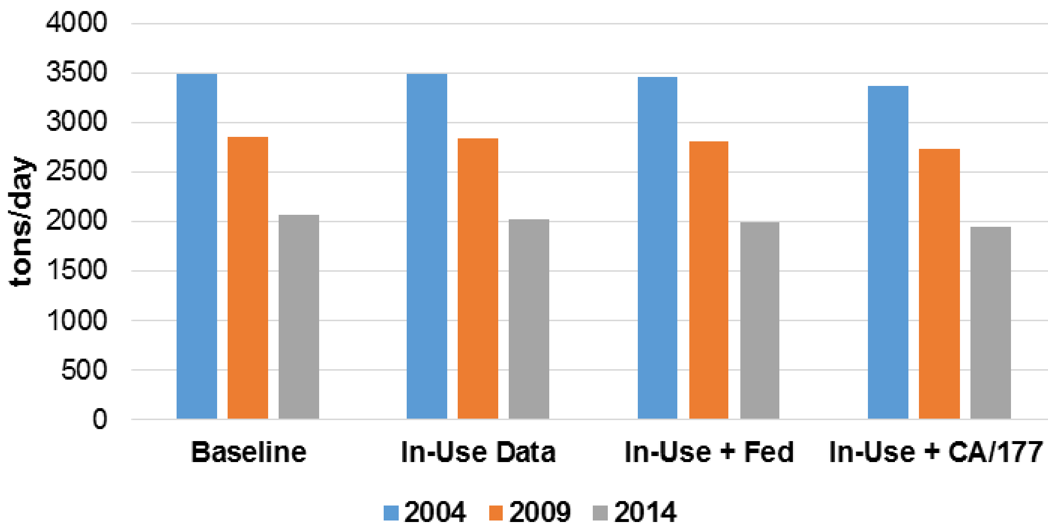
In light of the contribution of gasoline-powered vehicles to hydrocarbon (HC) emissions, the impact of those emissions on air quality, and the application of increasingly stringent standards, there is also a critical need for being able to accurately estimate the magnitude of those emissions. In response, U.S. EPA incorporated methodologies for estimating evaporative emissions into the agency's MOBILE and later Motor Vehicle Emissions Simulator MOVES emission inventory models. At present, the most recent version of these models is MOVES2014a.

There are a number of questions regarding the accuracy of MOVES2014a in estimating evaporative emissions. These relate to (1) the way in which vehicles are mapped into evaporative emissions technology groups, which depend on the evaporative standards to which the vehicles were certified; and (2) how MOVES results would be impacted through the inclusion of new evaporative emissions data. The existence of separate EPA and CARB standards and the implementation of CARB standards in other states means that two geographical regions must be considered: (1) a region where the EPA standards apply and (2) a region that includes California and the states adopting CARB standards under Section 177.

Both of the above issues were investigated in detail in this study. The study found that there are significant issues with both the way in which vehicles are classified and how incorporation of new data affects evaporative emissions estimates generated using MOVES2014a. However, the impacts of the identified issues affect evaporative emissions estimates in both directions—i.e., some lead to higher estimates and others to lower estimates.

The impacts of changes in model input parameters and the use of technology group mappings based on historical data on MOVES2014a evaporative emission estimates can be seen in Figure ES-1. This figure presents nationwide evaporative emissions inventory data for calendar years 2004, 2009, and 2014 for the following four inventory scenarios.*

Figure ES-1
Impact of Updates to MOVES2014a Nationwide Evaporative Emissions Estimates in 2004, 2009, and 2014



1. "Baseline" represents the default, federal base case of the MOVES2014a model.

2. "In Use Data" includes updates to the MOVES2014a emission factors with the results of the evaluation of more recent in-use data resources completed under this project. Those resources covered new emission rates for specific evaporative processes and additional canister performance statistics as described in Section 4 of this report.

3. "In Use + Fed" includes the in-use data updates of (2) above in combination with a revised federal regulatory implementation schedule based on an evaluation of merged certification and registration databases. The certification and registration database evaluations are described in Section 3 of this report.

4. "In Use + CA/177" includes the in-use data updates of (2) above in combination with a California plus Section 177 states regulatory implementation schedule modeled on a nationwide basis. The implementation schedule is based on the merged certification and registration database evaluation of Section 3.

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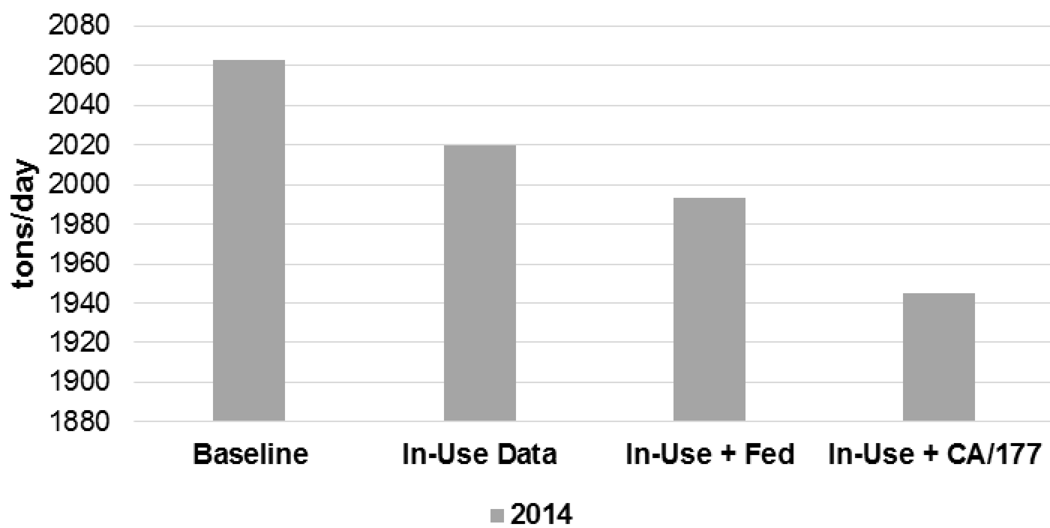
* Inventories represent nationwide, evaporative HC emissions (expressed at total hydrocarbons or THC) for light-duty on-road vehicles for an average July day for each year reported.

As shown, the impacts of the changes in MOVES estimates resulting from the use of updated information are relatively small in the context of the strong downward trend in evaporative emissions resulting from more stringent new vehicle certification standards. However, as noted above, this finding reflects the fact that the updated data result in both upward and downward impacts on MOVES evaporative emissions estimates. Although difficult to observe from Figure ES-1, the magnitude of the impacts increases on a percentage basis over time as the updates primarily impact newer vehicles that comprise an increasing fraction of the vehicle fleet in later years.

To better see the magnitude of the impacts, the results for calendar year 2014 are shown using an expanded scale in Figure ES-2. As shown, the cumulative effect of all updates in that year amounts to a reduction in estimated evaporative emissions on the order of 120 tons per day of HC emissions or roughly 6% relative to the current MOVES2014a estimates reflected in the baseline.

Figure ES-2
Impact of Updates to MOVES2014a Nationwide Evaporative Emissions Estimates



2. INTRODUCTION

This section provides background information regarding vehicle evaporative emissions standards, U.S. EPA's approaches for modeling evaporative emissions, and the goals of this project.

2.1 Background

Hydrocarbon (HC) emissions associated with fuel evaporation were first identified as a significant source of ozone precursors in the late 1960s. Given the contribution of this source to the total HC emissions inventory and to ambient air quality problems, efforts were begun to develop approaches for reducing these emissions. The primary approaches to evaporative emissions control have been reductions in fuel volatility and implementation of a series of increasingly more stringent new vehicle evaporative emissions standards by the U.S. EPA and CARB.

The EPA and CARB evaporative emissions standards apply to gasoline-powered passenger cars and light-duty trucks, with truck standards generally being higher to account for their being equipped with larger fuel tanks. Test procedures, test fuels, and testing temperatures have changed over time as a better understanding of evaporative emissions processes and the design of control systems has evolved. In addition, requirements that vehicles be equipped with on-board refueling vapor control systems have also been established. These standards are summarized in detail in Appendix A.

At present, as a result of EPA and CARB standards and testing procedures, evaporative emission control systems are designed to control the following:

- Hot soak emissions, which occur immediately (up to one hour) following vehicles operation;
- Diurnal emissions from vehicles that are parked for extended periods of time;
- Running loss emissions, which occur during vehicle operation;
- Emissions of fuel vapor during vehicle refueling; and
- Emissions associated with fuel permeation of fuel system components.

2.2 Problem Statement

In light of the contribution of gasoline-powered vehicles to HC emissions, the impact of those emissions on air quality, and the application of increasingly stringent standards, there is also a critical need for being able to accurately estimate the magnitude of those emissions. To address this need, U.S. EPA incorporated methodologies for estimating evaporative emissions into the agency's MOBILE and later Motor Vehicle Emissions Simulator MOVES emission inventory models. The most recent version of these models is MOVES2014a.

For purposes of developing evaporative emission inventories, MOVES2014a maps vehicles into technology categories based on the new vehicle evaporative and refueling emissions standards to which they were certified. These mappings, which are performed on a vehicle model-year basis, are shown in Table 2-1; the actual standards, test fuels, and test procedures that apply to light-duty gasoline vehicles are summarized in Appendix A. The mappings of Table 2-1 are applied to both the federal and California/Section 177 state regulatory regions.*

Table 2-1
MOVES2014a Vehicle Evaporative Emission Mappings

Model Year Group	Evaporative Emission Standard
1971-1977	Pre-control
1978-1995	Early control - Tier 0
1996	80% Tier 0; 20% Tier 1
1997	60% Tier 0; 40% Tier 1
1998	10% Tier 0; 90% Tier 1
1999-2003	Tier 1
2004-2015	Tier 2
2016-2017	60% Tier 2; 40% Tier 3
2018-2019	40% Tier 2; 60% Tier 3
2020-2021	20% Tier 2; 80% Tier 3
2022+	Tier 3

The MOVES model estimates evaporative emissions from four physical processes: (1) permeation, (2) tank vapor venting (TVV), (3) liquid fuel leaks, and (4) refueling. Within each process (other than refueling), vapor emissions are modeled separately for

* As described in Section 3 of this report, MOVES2014a includes supplementary guidance (see Reference 8) for the modeling of California standards as adopted by Section 177 states.

the three modes of (1) engine operation, (2) hot soak, and (3) cold soak.* The modal evaporative emission rate method, unique to MOVES, is supported by data collected under several CRC-sponsored studies as well as other resources.[1,†] Key evaporative emission elements of MOVES2014a relative to predecessor models include incorporation of algorithms from the agency's "DELTA" model for estimating TVV emissions during the cold soak mode for evaluating multiday diurnals, which was developed as part of the Tier 3 rulemaking.[2,3] Another is the approach used for estimating TVV from vapor leaks in evaporative canisters by defining vapor leak emission rates and leak frequencies by model year group and age. These leak rates and frequencies were developed from evaporative emissions data collected through portable SHED (i.e., PSHED) field studies.[4,5]

There are, however, a number of questions regarding the accuracy of MOVES2014a to evaporative emissions estimates. The first of these is that the model mappings shown in Table 2-1 fail to accurately account for the historic deployment of evaporative emissions control system technologies; it is not strictly correct with respect to either federal or California/Section 177 state standards. Others can be seen in on-going EPA efforts to evaluate and improve the MOVES2014a model. For example, one issue being investigated by EPA that is germane to this effort is improving the ability to model canister degradation, which implies that the model's TVV estimates are too low.[6] EPA also cites ambient studies that suggest an overall underestimation of evaporative emissions from vehicles (while soaking).[7]

2.3 Project Objectives

Given the above, the objective of the E-116 project consists of reviewing to the extent possible the inputs and data that MOVES2014a uses to estimate evaporative emissions. The specific goals of the project were as follows:

1. Develop an improved database regarding the actual historic deployment of the various types of evaporative emission control technologies used on passenger cars and light-duty trucks based on integration of calendar and model year specific registration data and evaporative emissions certification data;

2. Utilize the merged registration and certification database to develop an inventory of light-duty fleet evaporative emissions and standards (e.g., grams/vehicle/day);

3. Identify and assess available data relevant to evaporative emissions that were not used in the development of MOVES2014a and revise model inputs in light of those data; and

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* Refueling emissions are not mode specific.

† Under the modal approach, the history of the vehicle operation (trip frequency, trip duration, and soak period between trips) is factored into the MOVES inventory method. As such, when evaluating evaporative emissions, MOVES processes calculations on an hourly time resolution using real-world trip characteristics data, and daily emissions are then summed over the individual 24 hours.

4. Assess the impacts of using improved data regarding the historical deployment of evaporative emission control systems and changes to model inputs developed through the assessment of nationwide evaporative HC emission levels during calendar years 2004, 2009, and 2014 and compare those results to results obtained from MOVES2014a.

2.4 Report Organization

The development of the historical evaporative emission standard certification database is described in Section 3. The identification and assessment of new data and the development of adjusted model inputs are documented in Section 4, while the results obtained inserting the historical database and adjusted model inputs into MOVES2014a are summarized in Section 5.

3. DEVELOPMENT OF HISTORICAL DATA REGARDING EVAPORATIVE EMISSIONS CONTROL SYSTEMS

MOVES2014a maps model-year groupings of vehicles to the evaporative emission standards to which they were certified, which in turn generally defines the characteristics of the vehicles' evaporative emission control systems. The mappings used for both passenger cars and trucks in MOVES2014a for areas where the federal vehicle emission control program (as opposed to the California program in place in that state and the Section 177 states) is in place are shown again in Table 3-1.

Table 3-1
MOVES2014a Vehicle Evaporative Emission Mappings

Model Year Group	Evaporative Emission Standard
1971-1977	Pre-control
1978-1995	Early control - Tier 0
1996	80% Tier 0; 20% Tier 1
1997	60% Tier 0; 40% Tier 1
1998	10% Tier 0; 90% Tier 1
1999-2003	Tier 1
2004-2015	Tier 2
2016-2017	60% Tier 2; 40% Tier 3
2018-2019	40% Tier 2; 60% Tier 3
2020-2021	20% Tier 2; 80% Tier 3
2022+	Tier 3

The "early control" model year group includes both the 6-gram standard (model years 1978 to 1980) and the 2-gram or "Tier 0" standard (model years 1981 to 1998). As shown, MOVES2014a accounts for the phase-in of the enhanced or "Tier 1" emission standards but assumes full compliance with the "Tier 2" evaporative standards beginning with the 2004 model year despite the phase-in provided by EPA regulations. Finally, MOVES accounts for the recently promulgated Tier 3 evaporative emissions standards by assuming a phase-in starting with the 2016 model year.

As indicated in Section 2 and Appendix A, there are specific differences in the California and federal evaporative emission requirements. However, when MOVES is applied in Section 177 states where the California vehicle program is in effect, EPA's supplementary guidance[8] retains the mapping shown in Table 3-1 and only adjusts the impacts of evaporative permeation emissions for the zero-emission vehicle (ZEV) component of the California program.*

The MOVES evaporative emission mappings are clearly approximations for both areas where the federal and California vehicle programs are in place, and the impact of these approximations on the model's evaporative emission estimates is unclear. Given this, an extensive effort was undertaken to develop a database that identifies the actual evaporative emission standards to which 1979 through 2015 model-year vehicles were certified in both areas using vehicle registration and EPA certification data. The development of this data is described below.

3.1 Data Sources

3.1.1 Vehicle Registration Data

Light-duty registration data for each state were purchased from IHS Automotive for the three calendar years of interest in this study—2004, 2009, and 2014. These data contained vehicle counts stratified by the following fields:

- State of Registration;
- Vehicle Make;
- Vehicle Model;
- Trim (where applicable);
- Model Year;
- Engine Displacement;
- Number of Cylinders;
- Fuel Type (gasoline, diesel, hybrid, electric, CNG, hydrogen fuel cell, etc.);
- Drive Type (FWD, RWD, AWD, etc.);
- Gross Vehicle Weight (GVW) Class and
- Curb Weight.

The data received from IHS contained 2,774,494 vehicle configuration records covering all 50 states and model years and reflected total registered light-duty vehicle counts (for GVW Class 3 and below) of 243 million, 250 million, and 258 million vehicles in calendar years 2004, 2009, and 2014, respectively.

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* The shortfalls of the supplementary guidance (see Reference 8) are (1) the differences between federal and California regulatory implementation schedules are not addressed, (2) vehicles certified to the optional zero-evaporative standard are not accounted for, (3) ZEV adjustment to permeation emissions are based on credits not vehicle counts, and (4) the ZEV adjustment to the evaporative processes other than permeation is not completed.

3.1.2 EPA Certification Data

EPA's Annual Certification Test Result Report database[9] was the source of data regarding the standards to which vehicles were certified, as well as for evaporative emissions certification data. These data are available at the individual model configuration level. Online files covering model years from 2015 (the newest model year to appear in the fleet in calendar year 2014) to 1979 were downloaded from EPA's website. For model years from 2015 through 1999, two separate files were available from EPA, as described below.

1. *Models* – A file showing the correspondence between each vehicle model configuration (i.e., model year, model, engine size and fuel type combination) and the tested evaporative and exhaust emission families used to represent them.*

2. *Evap Tests* – A file containing the evaporative emission test results, applicable standards, certification region (i.e., federal, California, 50-state), regulatory standard level (e.g., Federal LEV-II Evap), test fuel, and test procedure (e.g., 2 or 3-day enhanced evap, 1-hour hot soak plus diurnal, running loss, etc.). It also contains key vehicle configuration attributes such as make, model, engine size, curb and gross vehicle weight and the tested evaporative emission family ID to which linkages with the Models file and registration data can be established.

For model years 1998 and earlier, there is less consistency in the EPA certification data in terms of its organization and format. First, for model years 1998 and earlier, there are no separate "Models" files available to identify those model configurations for which a given evaporative family test applied. (Some of this test-to-model configuration correspondence was incorporated within the 1998 and 1997 "Evap Tests" files, but a number of gaps remained.) The format of the 1996 and earlier model year Evap Tests files was not consistent with that for the later model years, and it was determined that there were no data available from EPA for the 1994 and 1995 model years. These facts created some issues in the development of the historical evaporative emissions certification data as indicated below.

3.2 Data Development

3.2.1 Registration Data Processing

Registration data records from IHS were classified as being associated with California and Section 177 states or a federal program and are based on the state, vehicle model year, and GVW class. Table 3-2 shows the model year and GVW class specific adoptions of the California standards for each Section 177 state from EPA's Cross-Border Sales Policy[10] that were used to assign registration records for light-duty vehicles

* Manufacturers can certify vehicles across multiple models using test results from individual exhaust and evaporative engine families that represent them. Thus, the Models file provides the correspondence between evaporative family tests and the vehicle model configurations each test represents.

(≤ 8,500 lb GVW). Using this approach, the California and Section 177 state areas contained 15%, 17%, and 21% of registered light-duty vehicles in calendar years 2004, 2009, and 2014, respectively, with the increasing fractions representing the growth in areas adopting the California vehicle program over time.

Table 3-2
Section 177 States and Date of Adoption of California Standards

	Starting Model Year		
State	**PC + LDT (≤ 6000 lb) GVW ≤ 1**	**MDV (6001-8500 lb) GVW = 2**	**Notes**
New York	1994	2004	1995 model year is excluded
Massachusetts	1995	2003	
Vermont	2000	2004	
Maine	2001	2003	
Connecticut	2008	2009	
Pennsylvania	2008	***NA***	
Rhode Island	2008	2009	
New Jersey	2009	***NA***	Start is date specific, 1/1/2009
Oregon	2009	2009	
Washington	2009	***NA***	
Maryland	2011	2011	
Delaware	2014	2014	
New Mexico	2016	2016	Start is date specific 1/2/2016

NA – not applicable
Source: EPA Cross-Border Sales Policy

The processed registration data were then sorted by the stratification variables (make, model, trim, model year, engine size, fuel type, etc.) and reorganized into a structure for subsequent merging of each vehicle configuration “stratum” with similarly stratified EPA certification data.

3.2.2 EPA Certification Data Processing

As noted above, the EPA certification data for 1999 and later model years were formatted consistently and were processed for merger with the registration data. In addition, the evaporative emission control system’s butane working capacity (in grams) was decoded from the evaporative test group ID for all vehicles in this model-year range and added to the data record. More detailed processing of the 1998 and earlier model-year data was required for reasons discussed above, and it must again be noted that there were no EPA certification data available for model years 1994 and 1995. This required interpolation of data as described in Section 3.2.3. In addition, because of year-to-year changes in the format of files for model years older than 1992, a decision was made to simply extrapolate the 1993 model-year data to the earlier model years. This approach was assumed to be reasonable given that there was likely to be little change in evaporative certification emission levels for these older vehicles, as both federal and California standards were essentially constant prior to that model year.

3.2.3 Data Merging and Database Development

Model Year Specific Record Matching – Once the vehicle registration and EPA certification data were processed and restructured, records were matched by model and model year. This required use of automated "lookup" logic to match stratified vehicle configuration records, followed by manual assignment of records where the automated lookups failed or produced obvious mismatches.

Data Merging – Once the record matching was completed, appropriate records from the registration and certification data files were merged into a combined table within each model year. There was only one registration record for each vehicle configuration. However, the certification file structure contained repeated records (in varying number) reflecting the various combinations of the following four elements:

- Evaporative Test Procedure (two-day, three-day hot soak & diurnal, running loss, pre-enhanced);
- Test Fuel;
- Certification Region (which is similar, but not identical to geographic area); and
- Standard Level (e.g., federal Tier 1, Tier 2, LEV-II, California LEV-II, California LEV-II Zero Evap, etc.).

Appendix B contains a set of tables showing the list of codes and descriptions EPA uses to define each of these elements in its evaporative certification databases.

The evaporative certification data were sorted in a manner for which logic was written to load all combinations of these certification test elements into a single record (corresponding to a vehicle configuration in the registration file) spanning multiple columns.

As noted above, the Certification Region field in the EPA databases is similar, but required mapping into the two geographic areas (California + Section 177 states vs. federal). Table 3-3 shows the Certification Region codes used across all model years of EPA's light-duty vehicle emissions certification databases. The columns "CA+177" and "Federal" show which geographic area they apply to, accounting for instances where they apply to all 50 states. The "Geo. Area Code" column at the right shows the code assigned in the merged spreadsheets where C=California+177 States, F=Federal, and B=Both (All 50 states).

Table 3-3
Certification Region-to-Geographic Area Mapping Scheme

Cert Region Code	Cert Region Description	Geographic Area CA+177	Geographic Area Federal	Geo. Area Code
C	California + CAA Section 177 States	X		C
CA	California + CAA Section 177 States	X		C
CE	CALIF + NLEV (NE TRADING REGION)	X	X	B
CL	CALIF + NLEV (ALL STATES)	X	X	B
FC	Tier 2 Federal and California	X	X	B
NF	CLEAN FUEL VEH + NLEV(ASTR) + CA	X	X	B
NL	NLEV - ALL STATES	X	X	B
CF	CLEAN FUEL VEHICLE		X	F
F	Federal		X	F
FA	FEDERAL ALL ALTITUDE		X	F
NE	NLEV - (N.E. TRADING REGION)		X	F

It was necessary to map these 11 Certification Region codes into one (or both) of the two geographic areas for proper representation of the two different sets of regulatory standards within the fleet inventory database. Within the merged dataset, certification data were then mapped into California + Section 177 state vs. federal test results and standards and associated with the registered vehicle populations tabulated for each region by vehicle model configuration.

During the data merging, vehicles within the registration database with GVW Class 2 (6,001-10,000 lb GVW) were identified as being either above or below the 8,500 lb GVW limit of the federal light-duty vehicle category. This was done by using actual GVW values from the certification database for each merged vehicle configuration. Those vehicles below the 8,500 lb light-duty vehicle cut-off were re-classified as “2A” and those above as “2B” with the latter being eliminated from the database.

<u>Integration of Merged Data into Inventory Database</u> – The final step in data processing consisted of concatenating each model year file with merged registration and certification data into a combined fleet dataset covering all model years analyzed. These data were then filtered into separate dataset containing only valid vehicle types (light-duty < 8,500 lb GVW) and fuel types subject to evaporative testing (e.g., vehicles fueled by diesel, electricity, and natural gas vehicles were excluded). A minor number of corrections were also applied where apparent errors in the EPA certification data were discovered, such as the presence of a 0.2 gram/mile standard for running loss instead of the actual 0.05 gram/mile.

In addition, it should be noted first that, for purposes of this study, the federal Tier 2 and California Near Zero LEV II standards were assumed to be equivalent. In addition, for vehicles certified to the optional California "zero-evaporative emission" standard, a determination was made as to whether these were also sold with the same evaporative emissions control system in states where the federal vehicle program is in place based on certification emission test results.

For model years 1994 and 1995 (for which individual vehicle certification data were missing from EPA's database), model year fleet estimates of certification test results and standards were interpolated from data for the 1993 and 1996 model years using California and federal-specific phase in schedules for the enhanced evaporative standards.

Tabular presentations of the historical vehicle populations as well as model-year average certification standards, canister capacities, and certification emission results are provided in Appendix C by study year, vehicle type (passenger car and light-duty truck), and region (California + Section 177 states or federal). Tabular presentations of the percentage of gasoline-fueled light-duty vehicles certified to each specific evaporative emission standard are shown again by study year, vehicle type, and region in Appendix D for 1993 and later model year vehicles in light of the simplifying assumptions made regarding 1992 and earlier model-year vehicles described above.

3.3 Comparison of MOVES Assumptions to Registration/Certification Data

3.3.1 MOVES Mappings

Once the processing and assembly of the vehicle registration and certification data were completed, the results were compared to assumptions incorporated into MOVES through the mappings shown in Table 3-1. The point of departure for these comparisons is Figure 3-1, which shows the fractions of passenger cars and light-duty trucks assumed in MOVES to be certified to the different evaporative emission standards for model years 1993 to 2015.

The corresponding results obtained for the federal region from the development of the historical certification emissions data performed here are presented in Figure 3-2 and Figure 3-3, respectively, for passenger cars and light-duty trucks based on the 2014 calendar year fleet. As shown, the primary differences are as follows:

1. MOVES underestimates the fraction of passenger cars and light-duty trucks certified to Tier 1 standards during the 1996 and 1997 model-years and overstating that fraction for the 1999 model-year;

2. MOVES overestimates the fraction of passenger cars and light-duty trucks certified to Tier/LEV II Near Zero standards in the 2004 to 2006 model-years; and

3. MOVES does not account for vehicles certified to LEV II Zero standards during the 2003 through 2015 model-years and the presence of vehicles certified to Tier 3/LEV III standards in the 2015 model-year.

Similar comparisons between the MOVES default (Figure 3-1) can be made for the California and Section 177 state area through Figure 3-4 and Figure 3-5, which show the certification distribution for passenger cars and light-duty trucks, respectively, based on the 2014 calendar year fleet. Further comparisons can be made between the federal and California + Section 177 state regions using Figure 3-2 and Figure 3-4 for passenger cars and Figure 3-3 and Figure 3-5 for light-duty trucks. Overall, the major differences between the MOVES assumptions and the historical data for the California + Section 177 state region are similar to those listed above with respect to the federal region. The differences between the federal and California + Section 177 state region tend to be small, with the most notable being somewhat higher fractions of Tier 2/LEV II Near Zero and LEV II Zero in the California + Section 177 state passenger car fleet for the 2005 and later model years.

Figure 3-1
Percent of Gasoline-Powered Fleet by Evaporative Standard
MOVES2014a Default, Passenger Cars, and Light-Duty Trucks

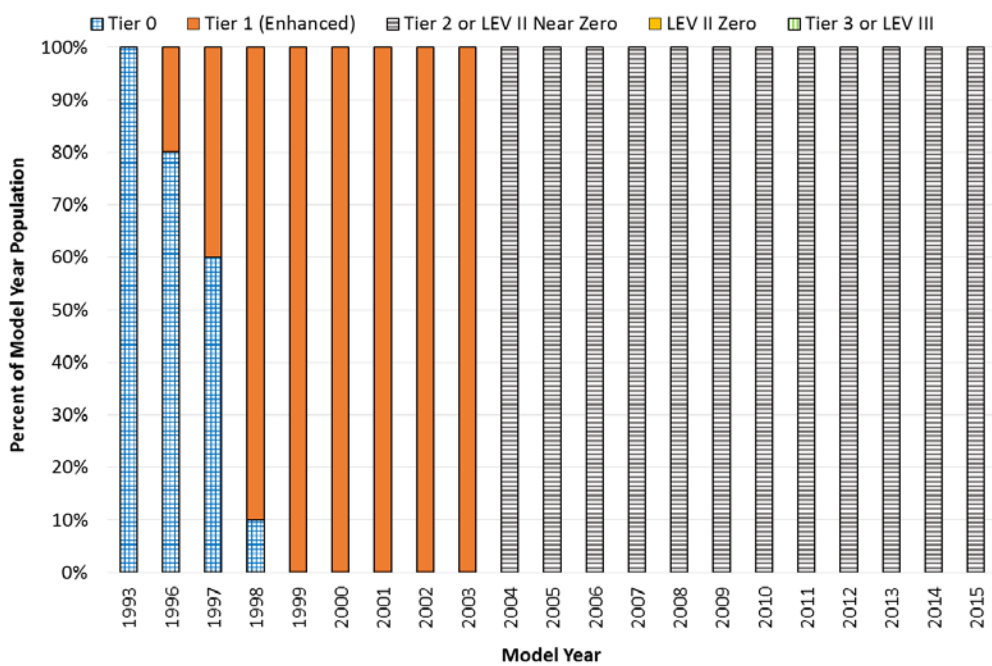


Figure 3-2
Percent of Gasoline-Powered Fleet by Evaporative Standard
2014 Registration Data, Federal Regulatory Region, Passenger Cars

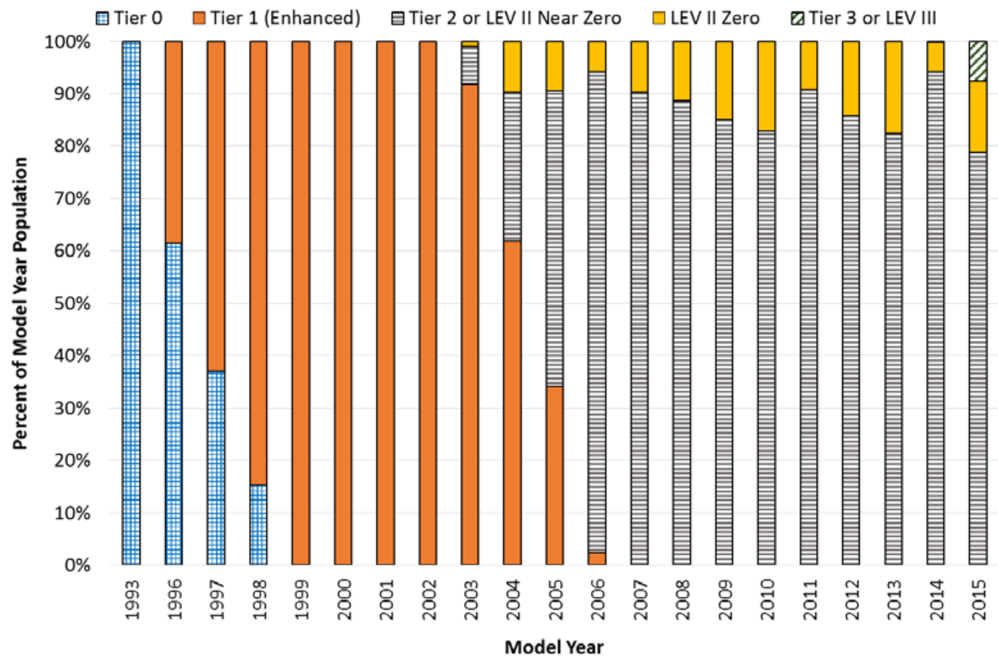


Figure 3-3
Percent of Gasoline-Powered Fleet by Evaporative Standard
2014 Registration Data, Federal Regulatory Region, Light-Duty Trucks

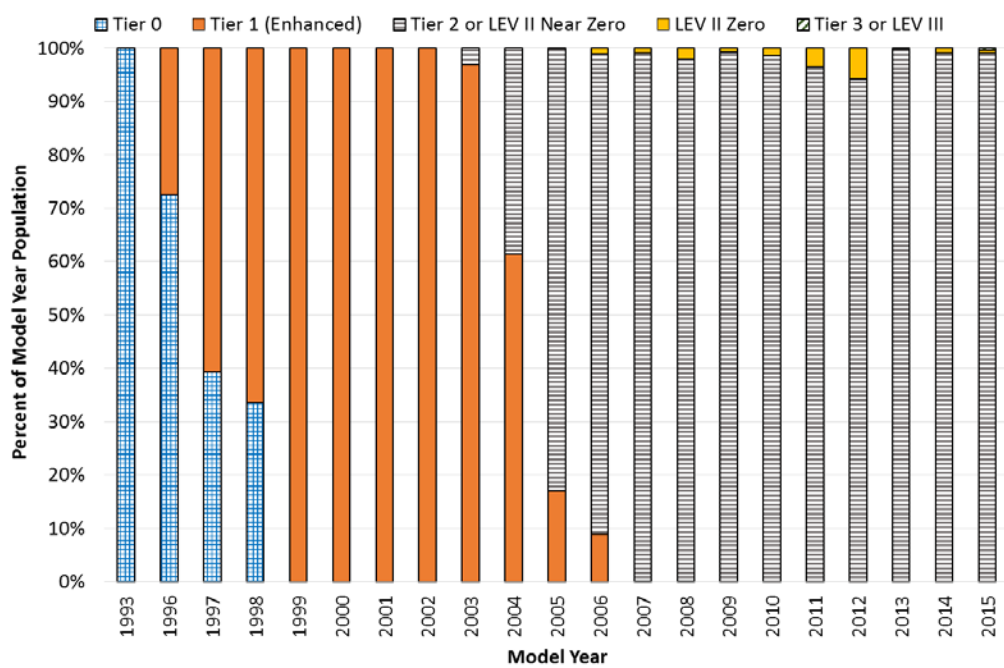


Figure 3-4
Percent of Gasoline-Powered Fleet by Evaporative Standard
2014 Registration Data, California Regulatory Region, Passenger Cars

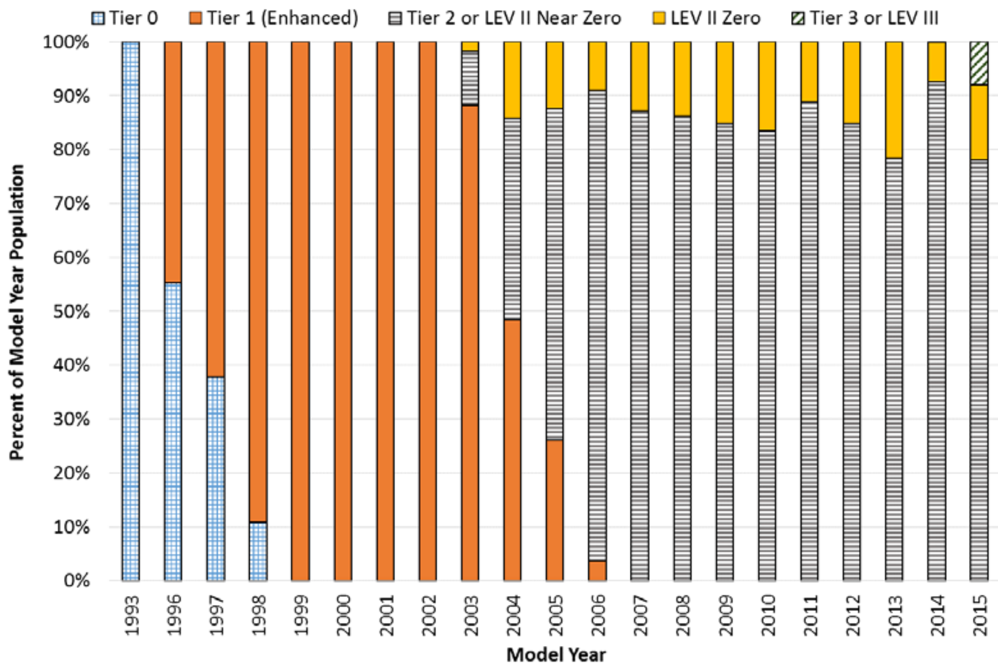
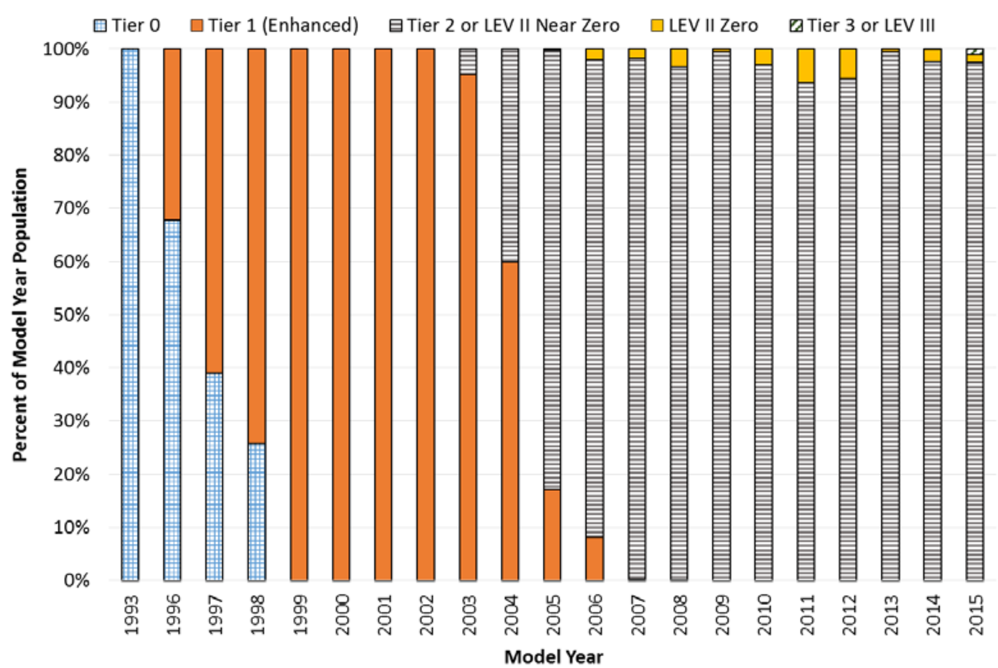


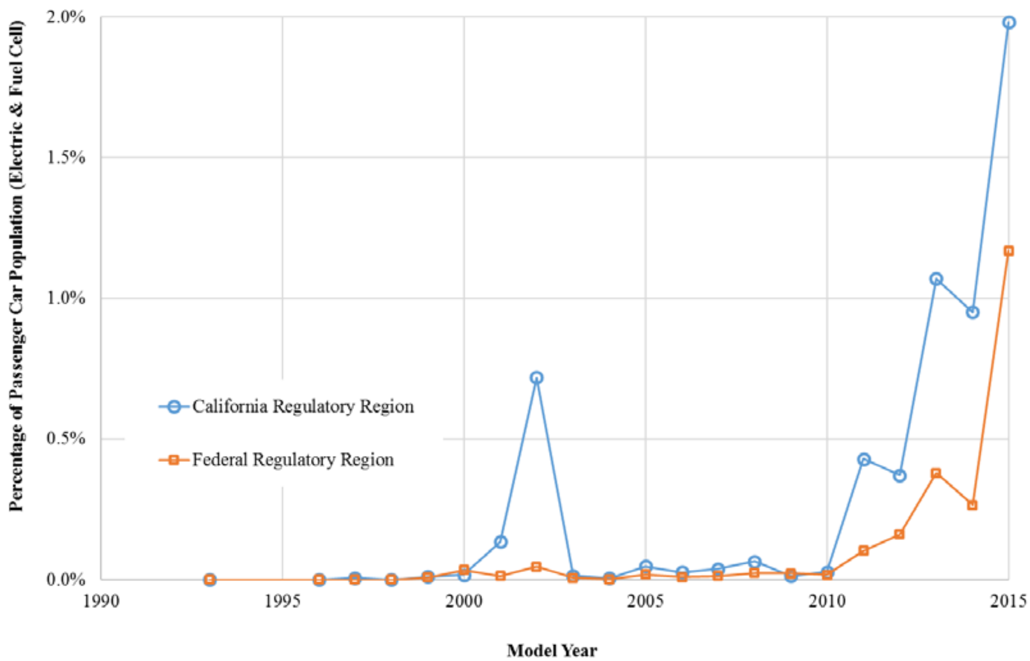
Figure 3-5
Percent of Gasoline-Powered Fleet by Evaporative Standard
2014 Registration Data, California Regulatory Region, Light-Duty Trucks



3.3.2 ZEV Penetration

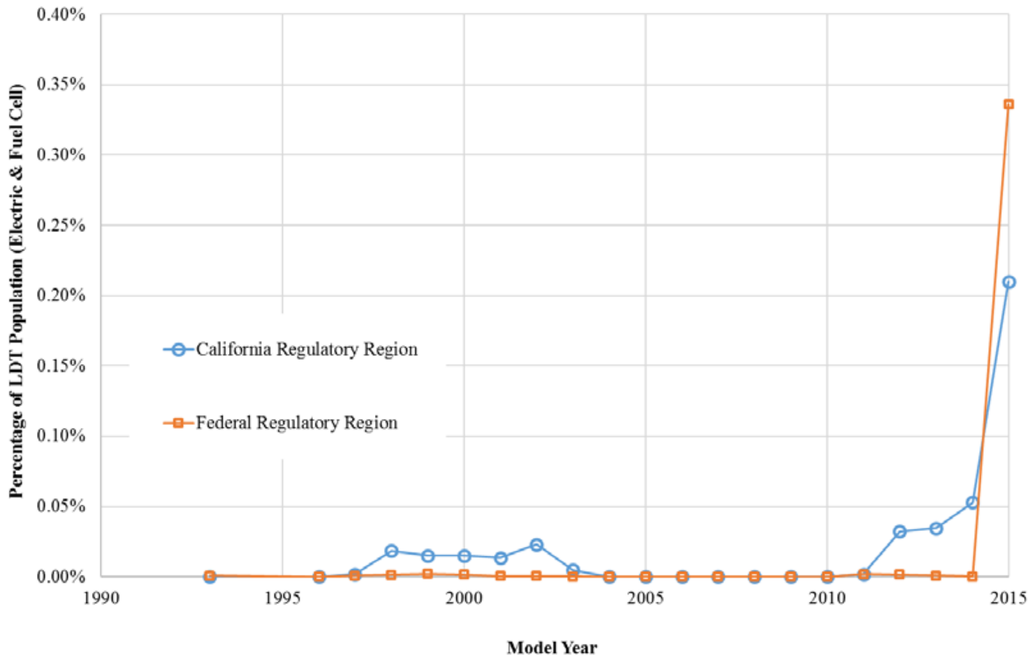
The MOVES model handles electric vehicles as a separate engine type (not a separate evaporative standard). In this analysis, the certification data for "electric" or "fuel cell" vehicles were handled collectively as ZEVs. For inventory development, ZEVs are handled as "electric" vehicles in the MOVES data input. The default MOVES assumptions are that there are no ZEVs or electric vehicles in operation.* The actual populations of ZEV vehicles observed in the federal regulatory and California + Section 177 state regions are shown as a function of model year in Figure 3-6 and Figure 3-7 for passenger cars and light-duty trucks, respectively, based on the 2014 calendar year data.

Figure 3-6
Percentage of ZEVs by Model Year
2014 Registration Data, Passenger Cars



* As described in Reference 8, the exception to this is for permeation evaporative emissions following EPA's California standards guidance; for this case, EPA assumes an electric vehicle proportion for PCs equal to the proportion of ZEV credits for this one pollutant process only.

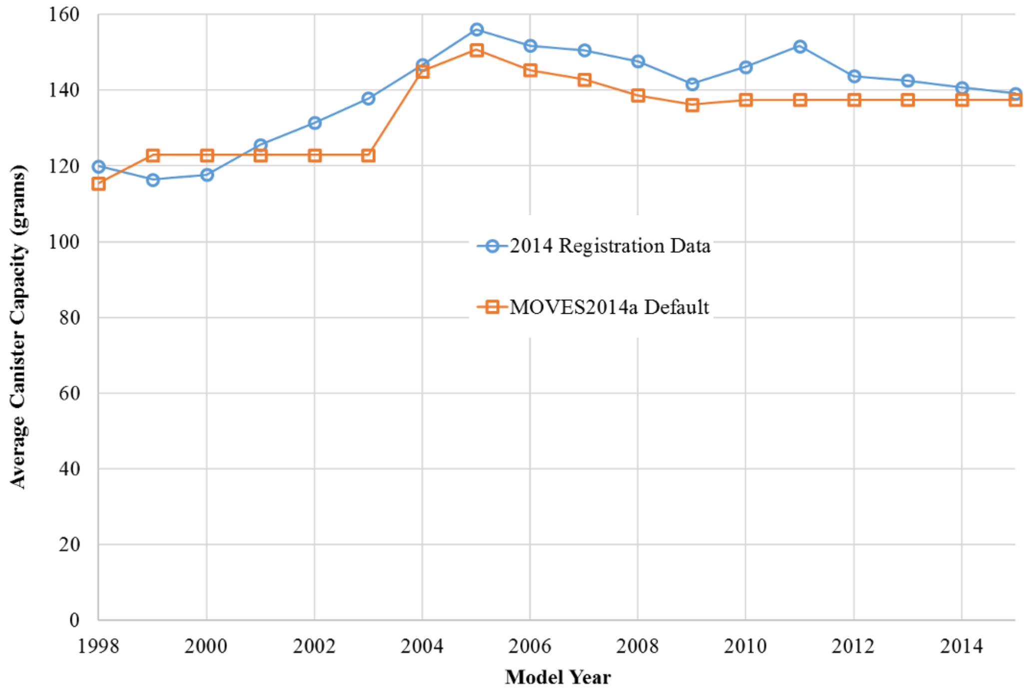
Figure 3-7
Percentage of ZEVs by Model Year
2014 Registration Data, Light-Duty Trucks



3.3.3 Canister Capacity

MOVES data for model-year canister capacities (and fuel tank volumes) are expressed as the light-duty fleet total (collective over both passenger cars and light-duty trucks combined). The national average canister capacity (both regulatory regions) from the certification data analysis is presented in Figure 3-8 alongside the MOVES2014a defaults. The results of the historical data analysis are generally similar to the MOVES defaults, but more often than not slightly greater capacities were observed from the historical data.

Figure 3-8
National Average Light-Duty Gasoline Vehicle Canister Capacity
2014 Registration Data and MOVES2014a Default



4. REVIEW OF IN-USE EVAPORATIVE EMISSIONS DATA

This section of the report reviews and assesses selected MOVES2014a evaporative emissions modeling methodologies in light of independent in-use vehicle data not used in model development.

The MOVES model estimates evaporative emissions from the five physical processes summarized in Table 4-1. Within each process (other than refueling), evaporative emissions are modeled separately for the three operating modes of engine operation, hot soak, and cold soak.* Methods, data, and emission rates are generally distinct for each process and mode combination in MOVES2014a. Moreover, tank vapor vented (TVV) includes emissions from both *canister breakthrough* and *vapor leaks* which are modeled individually.

Table 4-1
MOVES2014a Evaporative Processes and Operating Modes

Evaporative Emissions Process	Operating Modes
Tank vapor vented (TVV)	Engine operation, hot soak, cold soak
Permeation	Engine operation, hot soak, cold soak
Liquid fuel leaks	Engine operation, hot soak, cold soak
Refueling vapor	None distinguished
Refueling spillage	None distinguished

Based on a literature review, in-use data on evaporative emissions and control system characteristics were collected to: (a) evaluate five individual elements of the MOVES model and (b) develop alternative inputs to assess the sensitivity of MOVES evaporative emissions estimates. The evaluations of these data and results are summarized in this section. In addition, important findings related to related to model's evaporative emissions estimation methodology that go beyond updates to the input databases themselves are also identified; a detailed assessment, however, was outside the scope of this study.

* Hot soak is the portion of the soak period when the engine temperature exceeds ambient temperature (i.e., the period immediately after operation); cold soak is the period when ambient and engine temperatures are equal.

The five individual elements and in-use data used in the evaluation are summarized in Table 4-2, which lists the element of MOVES evaluated, the affected evaporative emissions process, and the source of the data used in the evaluations. The subsequent discussions of each element provide an overview and explanations of the data analysis, development of alternative MOVES inputs, and other findings.

Table 4-2
Summary of Five Evaluation Elements

Evaluation Element	Evaporative Process	Data Resource
Tank Vapor Vented (TVV) Rates During Operation for Tier 2 Vehicles	TVV (engine operation)	CRC E-77
DELTA Model Calibration for Tier 2 Vehicles*	TVV (cold soak)	EPA Multiday Study
Canister Working Capacity Degradation	TVV (cold soak)	CARB canister testing of scrapped vehicles
Permeation Rates for Tier 2 vehicles	Permeation	CRC E-101 (data pulled from multiple references)
ORVR and Two-Day Diurnal Test Deterioration	Refueling vapor, TVV (cold soak), permeation	Manufacturers' In-Use Verification Program (IUVP) data

4.1 Tank Vapor Vented (TVV) Rates During Operation for Tier 2 Vehicles

4.1.1 Overview

The existing Tier 2 vehicle TVV rates during operation are based on an innovative test program referred to as the "Tier 2 Running Loss Test Program" that measured emissions with and without implanted leaks where TVV emissions were isolated from other evaporative processes and measured. The test program encompassed five vehicles and two fuels and provided a total of ten data points.

The MOVES2014 Evaporative Methodology Technical Support Document (TSD) describes the overall TVV method and how the test program data were incorporated into the development of model input.[1] The TSD also contains the assumptions used to convert test results to the standard conditions assumed in the input database and a discussion of the references and studies used to define the proportion of leaking and non-leaking vehicles.

* DELTA is a separate set of algorithms within MOVES that estimates TVV emissions during cold soak for non-vapor-leaking vehicles.

Based on the literature review performed here, data from CRC projects E-77-2b and E-77-2c that were not used as part of the MOVES TVV rate development for Tier 2 vehicles were identified for use in the evaluation.[11,12] These studies quantified emissions from canister breakthrough only (i.e., suitable for vehicles without vapor leaks).* There are 15 additional data points from these studies representing six Tier 2 vehicles tested on multiple fuels. Revised Tier 2 TVV rates at standard conditions were estimated using the combined data from both programs (25 data points).

<u>4.1.2 Data Analysis</u>

The 15 data points obtained from the CRC E-77 projects are shown in Table 4-3.† These measurements represent the total mass of TVV emissions through the canister during repeat LA-92 tests conducted at an ambient temperature of 86°F degrees. Three tests had measurable breakthrough emissions; 12 tests recorded no emissions.

Table 4-3
CRC E-77 Data: Canister Breakthrough Emissions during Operation Non-Vapor-Leaking Tier 2 Vehicles

Vehicle	Fuel Specifications		Canister Breakthrough (grams)
	RVP (psi)	Ethanol (vol. %)	
210b	10	10	0
210b	7	10	0.14
210b	9	0	0
210b	7	0	0
213b	10	10	0
213b	7	10	0
213b	9	0	0.61
213b	7	0	0
222b	10	10	0
222b	7	10	0
222b	9	0	0
222b	7	0	0
222c	9	20	0
213c	9	20	0.82
210c	9	20	0

* Elements and results from CRC E-77 were used elsewhere of the MOVES evaporative methodology; however, the canister breakthrough emissions during operation were not used.
† Tier 2 measurements with vapor leaks (e.g., Vehicle 221b) are excluded. For those tests with vapor leaks, the test protocol did not isolate TVV emissions from permeation emissions.

The individual results were converted to standard conditions as those conditions are defined for MOVES input. Input TVV rates are reported in grams per hour and defined specifically to a 9 RVP gasoline at an ambient temperature of 95°F.* The resulting mean TVV rate from the E-77 data shown in Table 4-3 is 0.131 grams/hour at standard conditions.†

The value of 0.131 grams/hour is substantially higher than the MOVES2014a rate of 0.005 grams/hour for non-vapor-leaking Tier 2 vehicles. Combining the individual tests from the E-77 projects and the Tier 2 running loss study produces a TVV rate of 0.084 grams/hour at standard conditions compared to the MOVES rate of 0.005 grams/hour. Although this value represents a significant increase in the TVV rate from non-vapor-leaking Tier 2 vehicles, it should be noted that a majority of TVV emissions during operation come from those vehicles with vapor leaks—which, for a Tier 2 vapor-leaking vehicle, is 3.52 grams/hour at standard conditions—but this could not be evaluated in this study.

4.1.3 MOVES Input Development

The TVV rates during operation are contained in the *emissionratebyage* table in the MOVES default database. TVV rates in grams/hour are input into the model as a function of age where the age of the vehicle differs in the assumed proportions of vapor-leaking and non-vapor-leaking vehicles. The fraction of vapor-leaking vehicles differs in areas with I/M programs, and therefore two separate sets of TVV rates by age are input into MOVES (one for I/M areas and one for non-I/M areas). The fraction of vapor-leaking Tier 2 vehicles by age is shown in Table 4-4.

Combining the proportions shown in Table 4-4 with the emission rates described above results in the TVV rates (during operation) by age bin, which is the format required by the *emissionratebyage* table. The model input rates at standard conditions are summarized in Table 4-5 and depicted in Figure 4-1 and Figure 4-2.

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* The evaporative methodology TSD (Reference 1) documents the applicable ambient temperature and RVP adjustment factors for TVV rates during engine operation.

† The total test cycle of two successive LA-92 tests is 48 minutes long and covers 19.6 miles.

Table 4-4 MOVES2014a Percent of Tier 2 Vehicles with Vapor Leaks		
Age Bin (Years)*	**Vapor-Leaking Rate, No-I/M Case**	**Vapor-Leaking Rate, I/M Case**
0-3	1.3%	1.0%
4-5	3.0%	2.3%
6-7	4.2%	3.1%
8-9	5.3%	4.0%
10-14	7.4%	5.4%
15-19	10.2%	7.6%
20-30	14.8%	11.0%

Table 4-5 TVV Rates during Operation (grams/hour) at Standard Conditions Tier 2 Vehicles				
Age Bin (Years)	**No-I/M Case**		**I/M Case**	
	MOVES2014a	**Updated Analysis**	**MOVES2014a**	**Updated Analysis**
0-3	0.051	0.129	0.040	0.119
4-5	0.111	0.187	0.086	0.163
6-7	0.153	0.229	0.114	0.191
8-9	0.192	0.266	0.146	0.222
10-14	0.265	0.339	0.195	0.270
15-19	0.364	0.435	0.272	0.346
20-30	0.525	0.593	0.392	0.462

* MOVES2014a models vehicle ages in bins (and not each age year individually). For example, a single emission rate is used for all vehicles ages 0 to 3 years old.

Figure 4-1
Tank Vapor Venting Rates during Operation, Standard Conditions
Tier 2 Vehicles, No-I/M Case

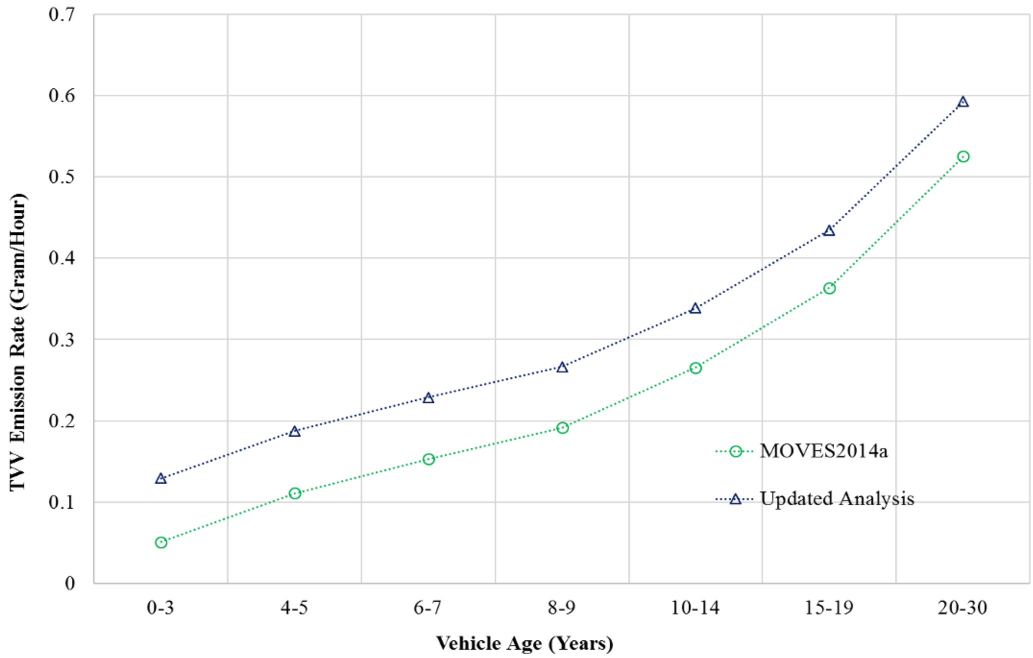
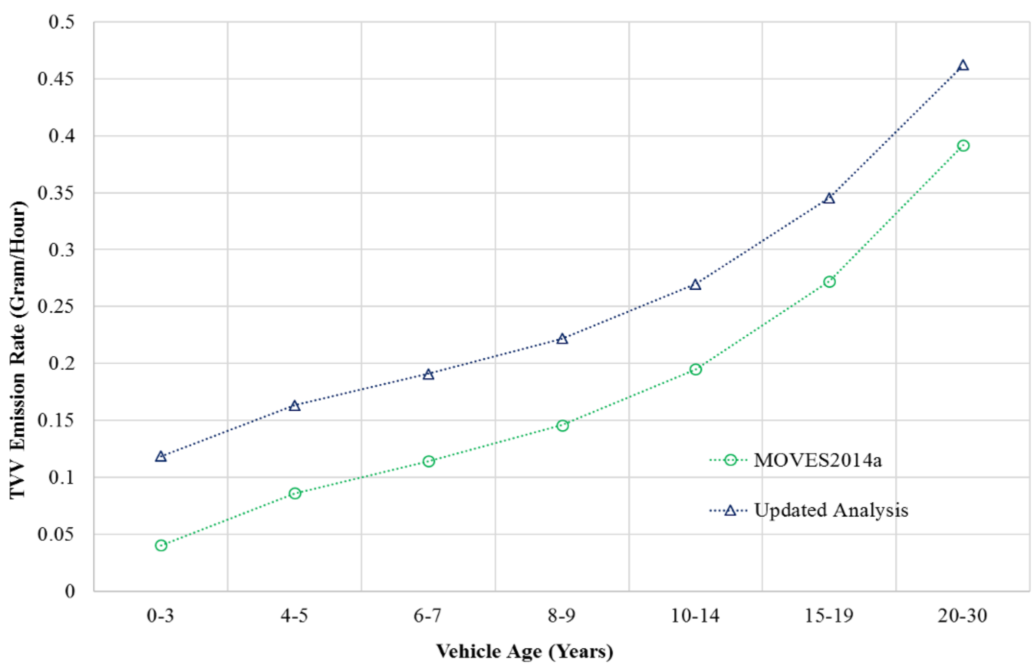


Figure 4-2
Tank Vapor Venting Rates during Operation, Standard Conditions
Tier 2 Vehicles, I/M Case



4.1.4 Other Findings

Other key findings from this evaluation element are outlined below.

1. ***There is a remarkable amount of uncertainty remaining in the model's Tier 2 vehicle TVV emission rates during operation for both vapor-leaking and non-vapor-leaking vehicles***. The variance observed in the underlying test record is large, the test data results are not normally distributed, and the data sample size is small.

2. ***There appears to be a significant sensitivity of TVV emission rates (during operation) to gasoline RVP, which is not reflected in MOVES.*** A 13-fold increase in the mean TVV rate for vehicles with vapor leaks was observed in the Tier 2 running loss test program between two test fuels of 7.7 and 10 psi.[*] The MOVES model adjustment factor applied to TVV rates (for the difference between 7.7 and 10 psi gasoline at 95°F degrees) is an increase by a factor of 1.41. The order of magnitude difference between the RVP effect of the model versus that observed in the Tier 2 test program should be investigated.

3. ***The TVV rate (during operation) for vapor-leaking Tier 2 vehicles appears to be trip-length dependent, and MOVES' use of a uniform gram/hour rate for all trips—independent of length—warrants review.*** Another innovative element of the Tier 2 Running Loss Test Program was that the measurements were collected over three distinct phases of the 72-minute driving cycle;[†] within these data, however, a disproportionate quantity of the emissions occurred during the third phase.[‡] Given this, the average rate that has been used in MOVES may not be representative of a typical vehicle trip since, in MOVES, the median trip length is between 9 and 10 minutes in duration as compared to the 72 minutes used in generating the emissions data.

4.2 DELTA Model Calibration

4.2.1 Overview

The DELTA model is a separate set of algorithms within MOVES2014a that estimates the mass of TVV emissions during cold soaks, for non-vapor-leaking vehicles. DELTA estimates TVV emissions as a function of tank vapor generated (TVG) and the physical interactions with the canister (e.g., breakthrough and back-purge). DELTA was created for MOVES2014 in order to estimate the impacts of multiday cold soak events (also

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* Mean observed TVV rate (during operation) for vapor-leaking Tier 2 vehicles was 3.8 and 0.29 grams/hour at 10 and 7.7 psi, respectively.

† The test cycle consisted of a FTP-72 test (Phase 1), two successive NYC cycles (Phase 2), and a FTP-72 test (Phase 3), with two minutes of idle between each phase.

‡ Fuel tank temperature build increases with trip length.

known as “multiday diurnals”). The calibration of DELTA adjusts the results for actual measured TVV emissions versus the theoretical/ideal case (based on canister working capacity). Data from the CRC E-77 were used to develop the existing DELTA calibration and include test results from 18 Tier 2 vehicles.

The DELTA model documentation[2] discusses the fundamental method and the calibration completed, and the TSD describes the overall TVV emissions method (during cold soaks) and how the DELTA algorithms interface with MOVES. Data from an EPA multiday diurnal test program[13] that were not used in the calibration of DELTA were identified for use in the evaluation; this included results from nine Tier 2 vehicles. Using all 27 of the available data points, the DELTA model calibration was revised with the updated, collective data record from 27 Tier 2 vehicles.

4.2.2 Data Analysis

The multiday diurnal study measured evaporative emissions over a 14-day cold soak for nine Tier 2 vehicles. Separate measurements were made for vapor entering the canister (i.e., vehicle canister weight), vapor venting (i.e., external canister weight), and permeation emissions (emissions otherwise occurring in the SHED). TVG emissions are the sum of the vehicle and external canister weight changes while TVV emissions are those captured by the external canister. Two test sequences were completed for the nine Tier 2 vehicles—once for each of the two test fuels (10% ethanol blends with RVP of 9 and 10 psi, respectively).

Relevant to this analysis are the TVV and TVG emissions from the multiday study. Figure 4-3 summarizes the TVV and TVG emissions by individual vehicle (V1 through V9) and fuel combination (F1 and F2).

Following the EPA method, the TVV-TVG plots were “normalized” and test fleet averages were taken. The TVV-TVG normalization was (1) to redefine the X-axis by dividing by theoretical canister capacity and (2) to redefine the y-axis by dividing by TVG. The normalized TVV-TVG plot is shown for three cases in Figure 4-4: the existing MOVES/DELTA (18 vehicles), the multiday study (9 vehicles) and the combined data (27 vehicles). In this format, by normalizing for canister capacity, it is suitable to calculate fleet averages across multiple vehicles.

The fundamental nature of the calibration can be seen in Figure 4-4. In brief, the test program data show that some portion of TVG is vented prior to reaching the theoretical canister capacity (i.e., the point when TVG/TCC=1). This is the non-ideal behavior that is captured by the DELTA algorithms. The combined data used in the updated analysis show a different TVV-TVG profile. While the difference between the multiday study and the existing MOVES/DELTA appears to be substantial, it is important to recognize that the vast majority of vehicle time soaking (i.e., engine off time) is spent with canister loading well below the theoretical canister capacity. In the updated analysis, TVV emissions are greater for $TVG/TCC \leq 0.55$; TVV emissions are less for $TVG/TCC > 0.55$.

Figure 4-3
TVV-TV Plot, Multiday Study Data

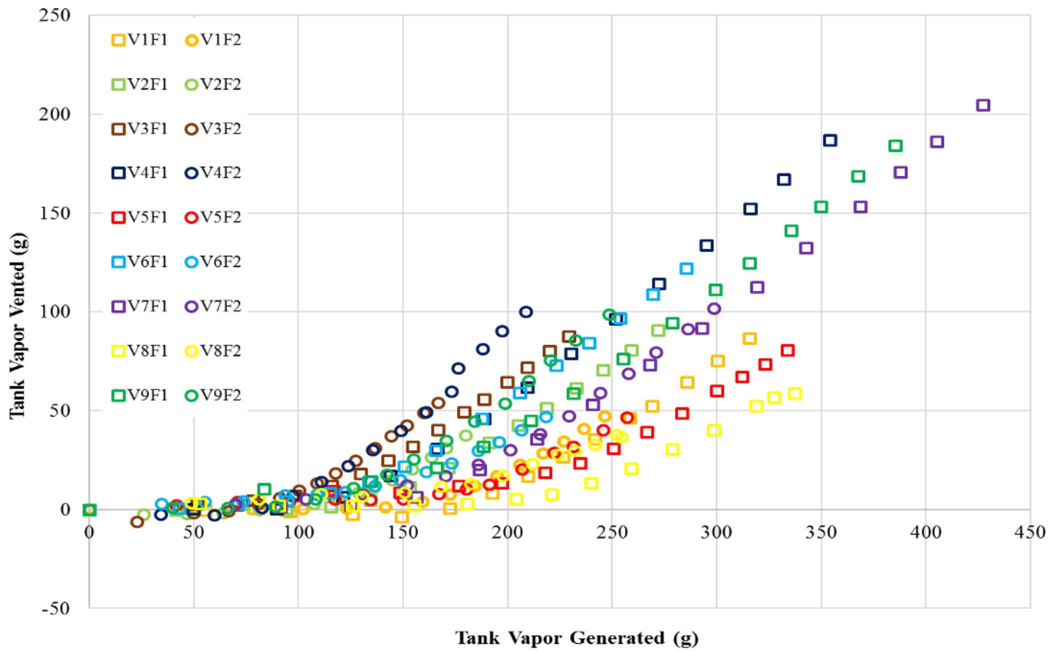
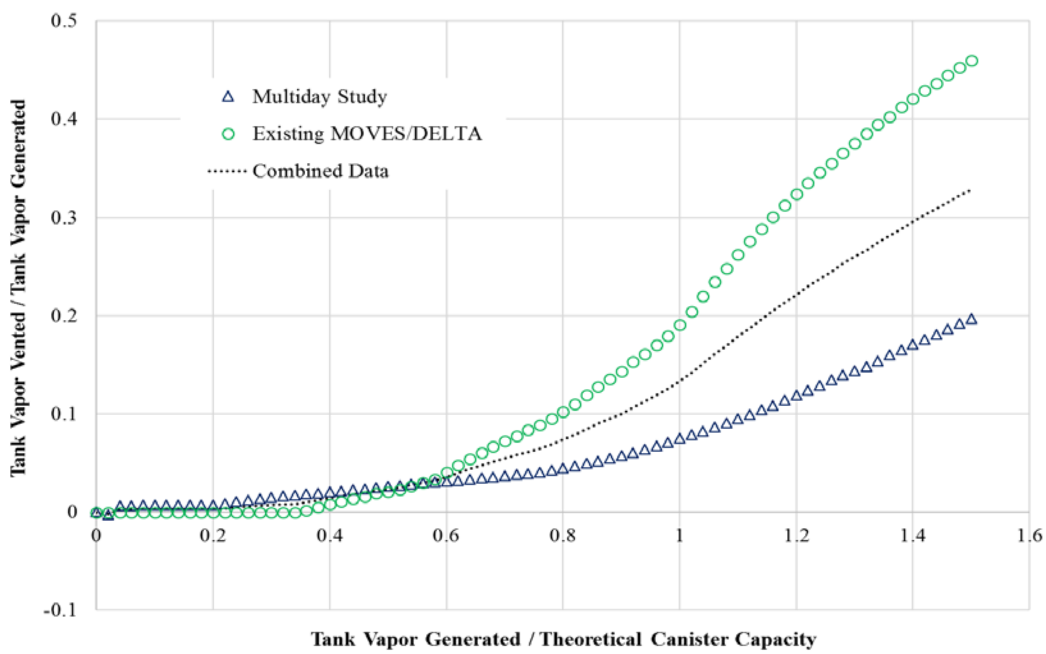


Figure 4-4
Normalized TVV-TVG Data
Test Fleet Averages, Tier 2 Vehicles



A regression analysis was performed on the raw normalized data to yield a TVV/TVG equation as a continuous function. The form of the equation chosen by EPA is a rotated hyperbolic function of the form shown below.*

$$y = \frac{-(Bx+E) \pm \sqrt{(Bx+E)^2 - 4C(Ax^2+Dx+F)}}{2C}$$

The regression fit was completed with a Levenberg-Marquardt algorithm (i.e., a damped least squares method) using Pro Fit v7.0.8 software.† Table 4-6 summarizes the curve fit coefficients for the existing MOVES/DELTA case and the updated analysis. It is these equation coefficients that are used as MOVES2014a modeling input to estimate TVV emissions (during cold soak) from non-vapor-leaking Tier 2 vehicles.

The accuracy of the curve fit below TVG/TCC ≤ 1 was examined separately to ensure that this range was adequately represented by the regression analysis; the results are presented in Figure 4-5. As shown, the curve fit was found to be reasonable for canister loadings below the theoretical capacity.

Lastly, Figure 4-6 presents the same individual vehicle and fuel data of Figure 4-3 but also includes the final regression curve fit equation specific to the multiday study data.‡ The regression equation format and the estimated coefficients appear to represent the original data reasonably well.

Table 4-6
DELTA Model TVV-TVG Equation Coefficients
Tier 2 Vehicles

Updated Analysis	Existing MOVES/DELTA	Updated Analysis
A	-0.071	-0.024
B	-1.20	-1.13
C	1.15	1.34
D	3.12	-0.895
E	187	168
F	20	31

* The model uses only positive values from the equation; negative values (occurring near zero) are modeled as zero.
† The EPA curve fit was replicated as a validation step to confirm the coefficients determined by the agency and to confirm consistency in the underlying method; the agreement was satisfactory.
‡ A separate curve fit was completed using just the multiday study data for review and verification purposes.

Figure 4-5
Equation Fit at TVG/TCC < 1

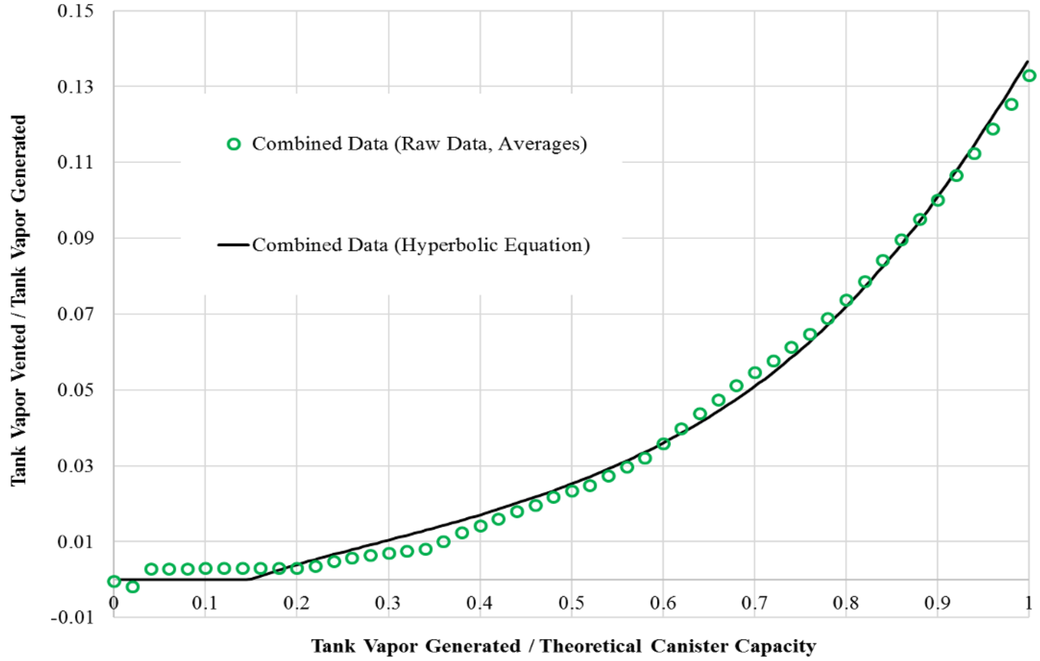
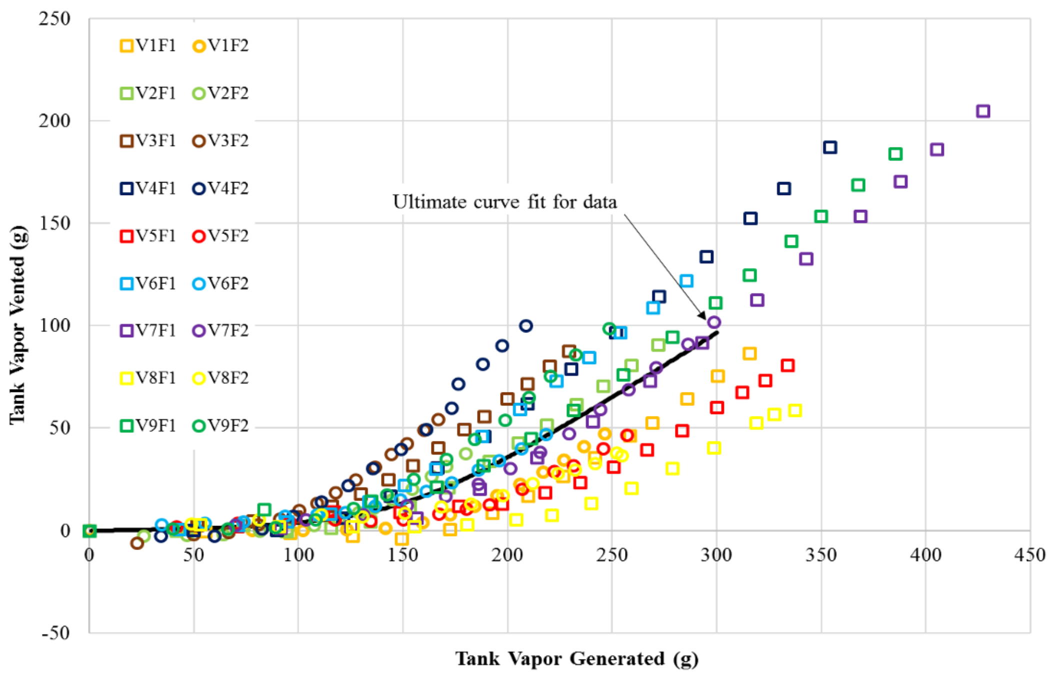


Figure 4-6
TVV-TVG Plot, Multiday Study Data
With Regression Curve Fit



4.2.3 MOVES Input Development

The equation for estimating TVV emissions during cold soaks is included in the *cumtvvcoeffs* table in the MOVES default database. The updated analysis is usable in MOVES by substituting the corresponding equation coefficients reported in Table 4-6. The analysis completed and coefficients reported represent the results specific to Tier 2 vehicles. The data of *cumtvvcoeffs* are indexed by vehicle age bin; these regression coefficient results have no age dependence.

4.2.4 Other Findings

There were no other findings to report for this evaluation element.

4.3 Canister Working Capacity Degradation

4.3.1 Overview

Canister capacity is an explicit modeling variable in the method to estimate TVV emissions during cold soak for non-vapor-leaking vehicles. As described in Section 4.2, the DELTA algorithms rely on a TVG correlation normalized by average canister capacity; the model then relies on fleet average canister capacity input to calculate TVV emissions (during cold soak) for non-vapor-leaking vehicles. The current, existing fleet average canister values are input by model year, and the capacity values are assumed to remain constant[*] rather than decrease over time. Again, the MOVES2014 evaporative methodology TSD describes the overall TVV method and the default values for canister capacity.

CARB recently collected 40 canisters from scrapped vehicles and completed a working capacity determination.[14] Up to four working capacity determinations were completed for each canister, and repeatability was good. Comparing these data to the certification working capacity for canister in each vehicle yields an estimated change in working capacity at the end of the service life.

4.3.2 Data Analysis

Of the 40 canisters collected by CARB, it was possible to assign 34 with values for both the original certification working capacity and an end of service life working capacity. The results of the 34 canisters is shown in Table 4-7, which reports the mean value of the end of service life working capacity determinations and the percent of working capacity remaining. Overall, a mean value of 83% of certification capacity remaining at the end of service was obtained. A review of underlying variables showed the results to be normally distributed and found no significant deviations in this mean value when data

* Notably, changes in canister capacity impact the TVV emissions from non-vapor-leaking vehicles. For the remaining, modes and processes of the evaporative emissions inventory canister capacity is implicit in the emission rate inputs, but not an explicit modeling variable.

were organized by certification standard (Tier 0 or enhanced evaporative standards), mileage, or model year.

Table 4-7
CARB Canister Capacity Tests of Scrapped Vehicles

Vehicle	Model Year	Odometer	Weight (lbs)	Certification Working Capacity (grams)	Working Capacity Determination (grams)	% of Working Capacity
1	1992	221,286	3,930	30	32	107%
2	1996	N/A	4,940	45	30	66%
3	1990	N/A	4,382	58	60	104%
4	1992	273,073	4,550	58	74	127%
7	1991	259,469	5,291	43	47	109%
9	1995	123,615	5,240	45	22	49%
10	1997	296,242	2,952	65	44	68%
12	1998	N/A	3,578	101	100	99%
13	1998	191,006	5,060	140	128	91%
14	1999	150,170	5,000	101	72	71%
15	1996	N/A	5,360	98	91	93%
17	1990	177,908	3,415	47	36	76%
18	1996	189,591	3,413	30	33	109%
19	1993	213,404	4,420	47	30	65%
21	1994	N/A	4,912	108	73	68%
22	1992	135,268	2,850	47	30	64%
23	1992	240,608	4,135	47	39	84%
24	1997	N/A	2,647	115	81	70%
25	1989	147,870	4,900	98	62	64%
26	1999	N/A	3,990	130	101	78%
27	1995	N/A	7,000	65	47	73%
28	1995	222,338	N/A	89	84	94%
29	2003	144,241	2,337	150	124	83%
30	1996	135,268	4,150	95	116	122%
31	2002	N/A	3,657	101	126	83%
32	1996	240,608	3,060	47	40	86%
33	1998	184,370	N/A	104	94	91%
34	2001	109,557	3,310	105	102	97%
35	1998	243,949	4,165	80	68	85%
36	1988	139,165	4,470	50	32	63%
37	2000	108,392	5,600	111	82	74%
38	1995	200,292	4,185	35	32	90%
39	1999	126,362	3,726	165	79	48%
40	1999	143,858	4,040	115	75	65%

4.3.3 MOVES Input Development

The data field for average canister capacity is included in the *cumtvvcoeffs* table in the MOVES default database. These data are organized by age bin. The percent of working capacity remaining was factored into the default data according to the vehicle age bin. The 83% of working capacity was assumed for the oldest age bin (20 to 30 years old), and a linear profile was assumed for the remaining age bins as shown in Table 4-8. For the updated analysis, the factors of Table 4-8 were applied to the default fleet average canister capacity data of each vehicle age bin.*

Table 4-8
Age-Specific Adjustment Factors to Fleet Average Canister Capacity

Vehicle Age Bin (Years)	Percent of Certification Working Capacity Remaining
0-3	100%
4-5	98%
6-7	96%
8-9	94%
10-14	91%
15-19	86%
20-30	83%

4.3.4 Other Findings

Summarized below are other key findings from this evaluation element.

1. ***Additional study is needed in this area.*** The CARB data collection represent an interesting first look at the issue of working capacity degradation, but is far from definitive as there are uncertainties about the chain-of-custody and vehicle condition/history.†

2. ***Canister working capacity degradation, if shown to be significant, should be accounted for in MOVES.*** MOVES currently assumed that TTV emissions during cold soak can be expressed as a function of only vapor leaks and leaking vehicle frequencies. Given the results of the CARB data collection effort, future

* It was noted during the process of changing canister capacity assumptions in the *cumtvvcoeffs* table that the data field *averageCanisterCapacity* did not appear to work correctly (inventory results were insensitive to changes in values). An alternate workaround approach was defined that incorporated the alternate canister capacity assumptions directly into the data field of t*vvEquation*.
† The USEPA has noted that the evaluation of additional capacity data from scrapped vehicle canisters is forthcoming.

data collection efforts should include consideration of canister capacity degradation and incorporate that effect into MOVES as appropriate. It should also be noted that this effect is already accounted for to some degree in MOVES, given that data from in-use vehicles have been used in the development of the model.

4.4 Permeation Rates

4.4.1 Overview

The existing MOVES approach assumes that there is no reduction in permeation emission rates for Tier 2 evaporative standards relative to those estimated for vehicles meeting the Tier 1 evaporative standards. The MOVES2014 TSD describes the data sources and assumptions of the existing permeation rate method.

The CRC E-101 project[15] assembled a database of permeation test results not included in MOVES, representing 17, 12, and 5 unique vehicles meeting Tier 1, Tier 2 and LEV II zero evaporative standards, respectively. From these data, the mean Tier 1 vehicle permeation rate (at standard conditions) was found to be remarkably similar to the existing permeation rate in MOVES, whereas the Tier 2 vehicle permeation emission rate estimated was 63% below that assumed in MOVES.* The latter permeation rate is a suitable update to the existing model method for Tier 2 vehicles.

4.4.2 Data Analysis

The data record of permeation emission rates of Tier 2 vehicles is summarized in Table 4-9. The Tier 2 permeation emission rate data were assembled from CRC E-65,[16] CRC E-77,[17,18] and the EPA multiday studies.[13] Standard conditions for permeation emission rates—defined for model input—are non-ethanol-containing gasoline at an ambient temperature of 72°F. Over these 12 vehicles, the mean permeation emission rate was estimated as 4.12 mg/hour.

* A single permeation input rate at standard conditions is input into MOVES which serves as the basis for evaluating all three modes of engine operation, hot soak, and cold soak. The modeling method uses predicted fuel temperature by mode to calculate the modal permeation emission rate. This updated analysis impacts all three modes of permeation emissions.

Table 4-9 Permeation Rates of Tier 2 Evaporative Standard Vehicles, Standard Conditions			
Test Program	**Model**	**Model Year**	**Permeation Rate (mg/hr)**
CRC E-65-3	Taurus	2004	0.88
CRC E-77	Taurus	2007	3.87
CRC E-77-2	Taurus	2006	2.46
CRC E-77-2	Camry LE	2004	4.20
CRC E-77-2b, E-77-2c	Ram 1500	2004	9.12
CRC E-77-2b, E-77-2c	Impala	2004	9.50
EPA Multiday Study[a]	Focus	2009	1.72
EPA Multiday Study[a]	Camry	2009	2.64
EPA Multiday Study[a]	Altima	2008	2.70
EPA Multiday Study[a]	Silverado	2006	3.04
EPA Multiday Study[a]	Outlook	2009	3.49
EPA Multiday Study[a]	Taurus	2008	5.79

a. The permeation emission rate reported represents the first 24 hours of the 14-day multiday cold soak period of this study. The permeation emission rate is observed to decline with increasing soak period duration. The first 24 hours is considered comparable to the existing permeation rate data record of MOVES.

4.4.3 MOVES Input Development

The permeation emission rates are contained in the *emissionratebyage* table in the MOVES default database. Emissions rates in grams/hour are input into the model as a function of age. For the case of Tier 2 vehicle permeation emissions, the emission rate does not vary (i.e., deteriorate) with age. The existing and updated analysis permeation rates for Tier 2 vehicles by age are shown in Table 4-10.

Table 4-10 Permeation Rates (grams/hour) at Standard Conditions Tier 2 Vehicles	
Existing MOVES2014a	**Updated Analysis**
0.0102	0.0041

4.4.4 Other Findings

Summarized below are the other key findings from this evaluation element.

1. ***Permeation emission rates vary by soak duration as observed in the EPA multiday study.*** Permeation emission rates were observed to decrease over time during the 14-day period over which they were measured. This phenomenon should be investigated further to determine its relation to actual in-use permeation rates.

2. ***Mean permeation emission rate for the LEV II zero evaporative standards (2.0 mg per hour), as reported in the CRC E-101 project report, is similar to the MOVES Tier 3 standard permeation emission rate of 2.6 mg per hour***.[15] In the inventory analyses of this study (as described in Section 5), vehicles meeting the LEV II zero evaporative standard and the federal Tier 3 standard were treated equivalently in terms of the evaporative emission rates assigned.

4.5 ORVR and Two-Day Diurnal Test Deterioration

4.5.1 Overview

Increases in emissions during onboard refueling vapor recovery (ORVR) and two-day diurnal testing as a function of vehicle age were investigated using data from manufacturers' testing of vehicles under the In-Use Verification Program (IUVP) established by EPA and CARB regulations. The evaluation included data from 2004 to 2011 model year vehicles certified to Tier 2 evaporative standards provided by EPA.[19,*]

The IUVP evaporative test data are relevant for the two primary reasons noted below.

- The ORVR test is directly comparable to the refueling vapor process of MOVES2014a.

- The two-day diurnal test represents a combination of two emissions processes: tank vapor vented (TVV) emissions during cold soak and permeation emissions.

IUVP data (from 2000 to 2009 model year vehicles) were used in MOVES2014a to define the mean ORVR effectiveness. The mean ORVR effectiveness of 98% control of refueling vapor assumed does not vary by age in the model (i.e., MOVES assumes no deterioration of refueling vapor emissions). According to EPA's analysis,[20] the 98% control assumption equates to an ORVR emission rate of 0.07 grams/gallon.

IUVP data are not used in the MOVES2014A methods for either TVV or permeation emissions. There is no deterioration assumed for the permeation emissions from Tier 2 vehicles (as noted in Section 4.4.3). TVV emissions from Tier 2 vehicles do deteriorate with age through adjustments to the proportions of vehicles with vapor leaks as a function of age (as shown previously in Table 4-5).

* 2011 was the newest model year requested as the goal of the evaluation was to look at age-based deterioration and the IUVP includes vehicles up to 5 or 6 years old.

4.5.2 Data Analysis

EPA provided IUVP evaporative test records for 4,163 2004 to 2011 model year light-duty gasoline vehicles. The database included ORVR and two-day diurnal tests. The data were reviewed and Tier 2 or LEV II certified vehicles were extracted. Other inconsistent records were eliminated when the pollutant or emission rate units recorded did not properly match the correct values of the ORVR and two-day diurnal tests. The final database evaluated consisted of 1,900 two-day diurnal test records and 1,497 ORVR test records.

The age of the vehicle in years was assigned to each record of the database calculated based on the calendar year of the test date minus the vehicle model year. Vehicles aged 0 to 6 years were observed in the database. The mean odometer was 42,858 miles.

The statistics of the IUVP ORVR data analysis are summarized in Table 4-11, which reports the mean ORVR test, the median ORVR test and the frequency over the ORVR standard of 0.20 grams/gallon. The test data were skewed (log-normally distributed) as shown by the difference between mean and median test result. Figure 4-7 presents the log-normal distribution plot of the raw data. The trend line presented is the linear trend in the natural log of the test result.

Table 4-11
IUVP ORVR Data Analysis Statistics
2004 to 2011 Model Year Tier 2 Vehicles

Age	Count	Mean Odometer	Mean ORVR Test (g/gal)	Median ORVR Test (g/gal)	Frequency Over Standard
0	94	15,193	0.042	0.019	2.1%
1	483	20,466	0.045	0.018	1.9%
2	49	26,812	0.068	0.040	4.1%
3	75	60,761	0.067	0.034	5.3%
4	439	70,449	0.058	0.023	4.8%
5	340	75,452	0.064	0.023	6.2%
6	17	78,223	0.051	0.034	0.0%

Figure 4-7
IUVP ORVR Tests by Vehicle Age

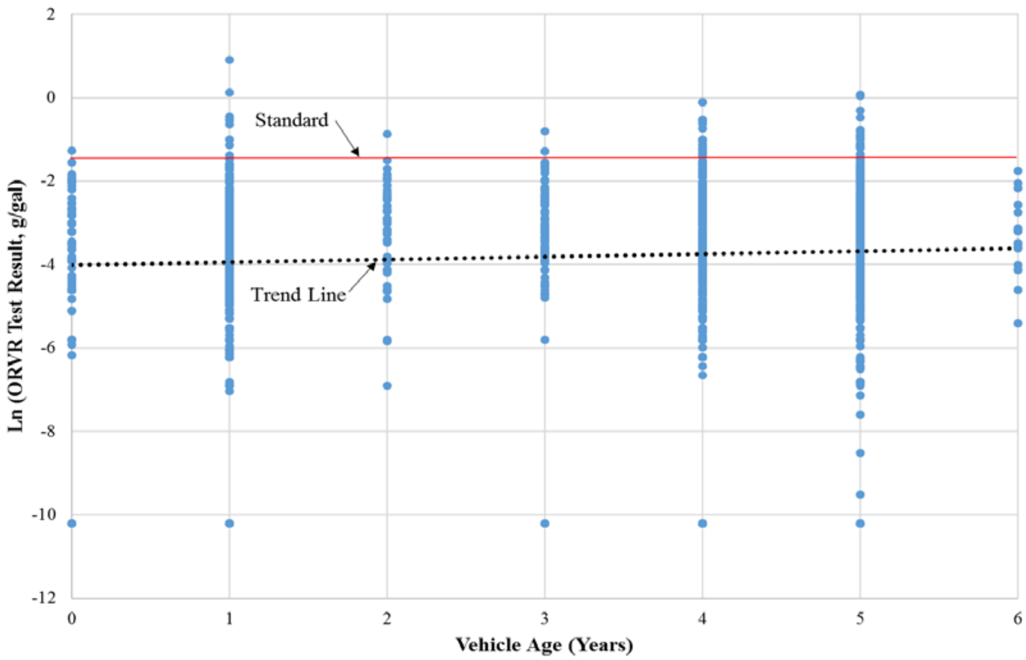


Figure 4-8 summarizes the emission trend analysis as a function of age of the IUVP ORVR data. The observed emissions trend from the IUVP data record is extrapolated to the full 30 years of vehicle service life tracked by MOVES. The mean trend shown is defined as the linear trend in normal space of the raw test results. The median trend is the linear trend in logarithmic space of the raw test results (as shown in Figure 4-7). In both cases, the trend is capped at 20 years, which is the MOVES2014a assumption that exhaust and evaporative emissions deterioration levels off at this age.* Figure 4-8 also shows the assumed MOVES2014a assumption of 0.07 grams per gallon; the ORVR standard of 0.20 g/gal is not shown.

The statistics of the IUVP two-day diurnal data analysis are summarized in Table 4-12. The two-day diurnal data were normalized by dividing the result by the standard, so that multiple standards observed could be evaluated in a single distribution. Table 4-12 reports the mean R/S test result, the median R/S test result, and the frequency over the standard (by definition, the R/S standard = 1.0). The test data in the R/S format were skewed (log-normally distributed) as shown by the difference between the mean and the median test results. Figure 4-9 presents the log-normal distribution plot of the raw data reported as R/S. The trend line presented is the linear trend in the natural log of the test result.

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* This plateauing assumption is observed in large-scale in-use exhaust programs (e.g., I/M and remote sensing data evaluations).

Figure 4-8
IUVP ORVR Data Trend Analysis

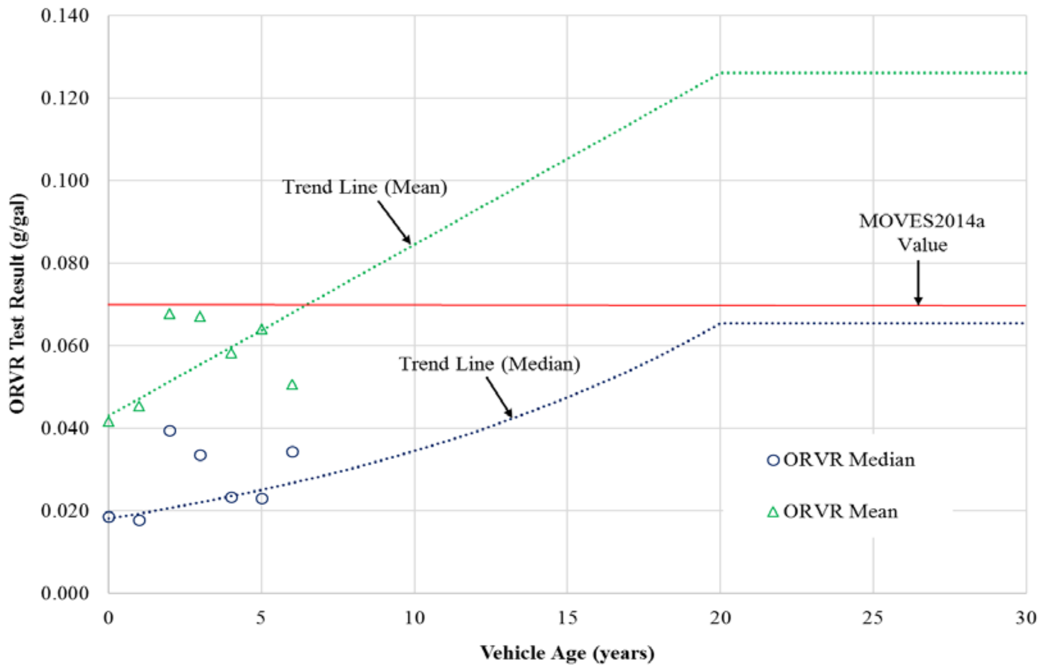


Table 4-12 IUVP Two-Day Diurnal Data Analysis Statistics Results Normalized to Result/Standard (R/S) Basis 2004 to 2011 Model Year Tier 2 Vehicles					
Age	**Count**	**Mean Odometer**	**Mean R/S Test**	**Median R/S Test**	**Frequency Over Standard**
0	58	14,957	0.50	0.42	3.4%
1	402	19,961	0.59	0.37	4.0%
2	42	29,213	0.51	0.38	14.3%
3	36	58,118	0.63	0.49	8.3%
4	226	66,764	0.70	0.42	10.6%
5	161	74,150	0.50	0.38	5.6%
6	13	75,488	0.44	0.35	7.7%

Figure 4-9
IUVP Two-Day Diurnal Tests by Vehicle Age
Normalized by Result/Standard (R/S)

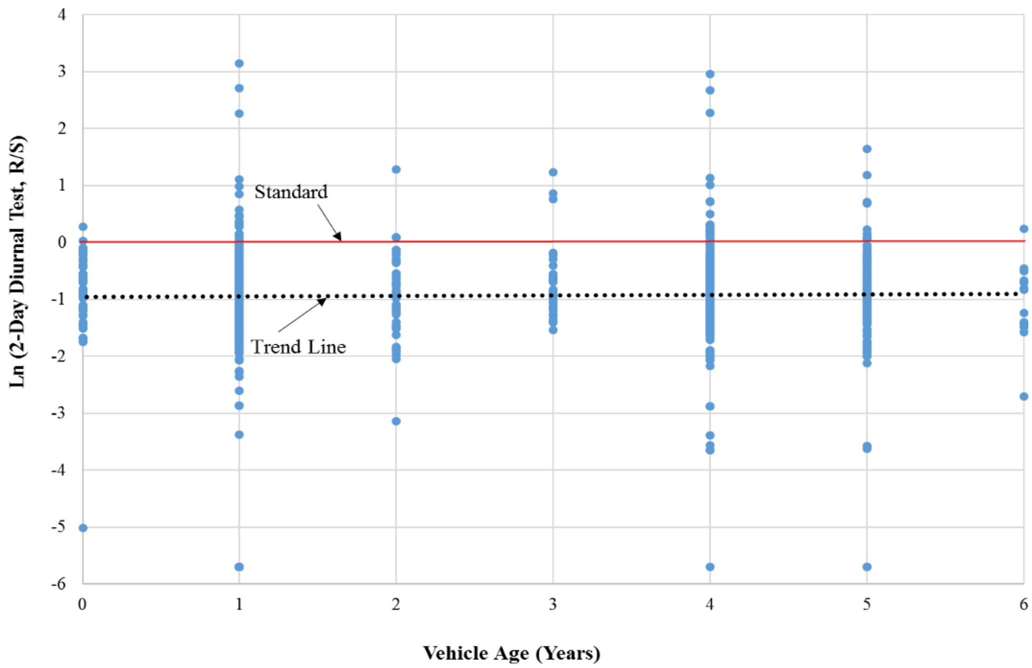
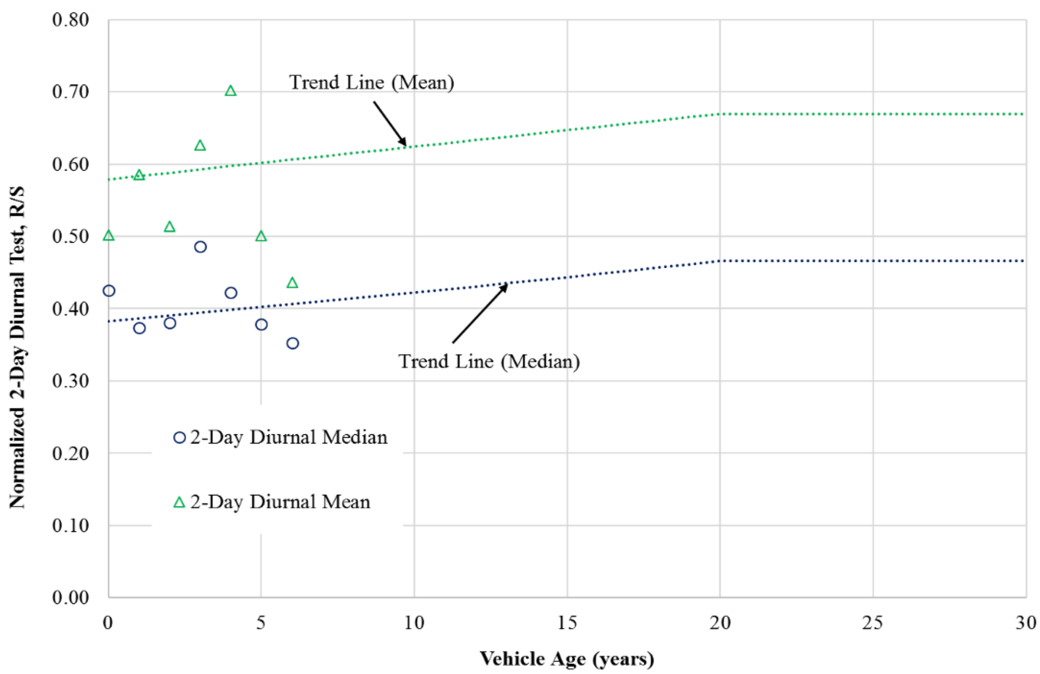


Figure 4-10 summarizes the emission trend analysis as a function of age of the IUVP two-day diurnal data. The observed emissions trend from the IUVP data record is extrapolated to the full 30 years of vehicle service life tracked by MOVES. The mean trend shown is defined as the linear trend in normal space of the raw test results. The median trend is the linear trend in logarithmic space of the raw test results (as shown in Figure 4-7). Again, in both cases, the trend is capped at 20 years. There is no method in MOVES to replicate the two-day diurnal test conditions as the sum of TVV and permeation emissions processes, so there is no point of comparison to the MOVES method in this figure. Note that the “standard” in this plot is, by definition of the normalization completed, R/S =1.0.

Figure 4-10
IUVP Two-Day Diurnal Data Trend Analysis
Normalized by Result/Standard (R/S)



4.5.3 MOVES Input Development

The IUVP deterioration trend analysis was not incorporated into MOVES inputs for the reasons outlined below.

- For the ORVR data, the two data tables used by MOVES to define the refueling vapor do not have any age variation by which to model deterioration. As such, only a single average ORVR effectiveness can be modeled (by model year). The current MOVES assumption of an effective mean ORVR value of 0.07 g/gal is similar to the overall mean of the IUVP data of 0.06 g/gal, which is expected due to overlapping data sources. If the IUVP mean ORVR trend is included, the useful life average ORVR result from this analysis equals 0.08 g/gal.*

- For the two-day diurnal data, there is no mechanism for parsing out these results into the two MOVES processes of TVV and permeation emissions.

* In a skewed distribution, such as these ORVR test results, there is statistical basis for using the median result in place of the mean. If this were done, the refueling vapor emissions in MOVES2014 would be significantly reduced.

4.5.4 Other Findings

Other key findings from this evaluation element are summarized below.

1. ***The IUVP data are limited to vehicles no more than 5 or 6 years old and are unlikely to accurately reflect average emissions over the lifetime of a vehicle.*** As noted above, MOVES estimates of refueling emissions from ORVR-equipped vehicles are based only on IUVP data from relatively new vehicles. In order to properly account for potential changes in refueling emissions vapor emissions over the lifetime of vehicles, data from vehicles older than 5 to 6 years old would need to be collected. Moreover, there are recruitment and screening procedures to remove atypical vehicles from the IUVP; this protocol may skew the representativeness of the vehicle sample obtained.

2. ***MOVES does not currently account for the impact of canister vapor leaks on refueling emissions.*** Although the impact of canister vapor leaks on TVV emissions is accounted for in MOVES, such leaks are also likely to impact refueling emissions. Given this, testing to determine these impacts should be performed and the results incorporated appropriately into MOVES.

3. ***Data on fuel spillage during refueling of ORVR vehicles are needed.*** MOVES estimates of refueling emissions from ORVR-equipped vehicles are dominated by emissions associated with fuel spillage, rather than tank vapor emissions. The refueling spillage emission rates of MOVES are not current nor are they supported by actual data from ORVR-equipped vehicles—rather, MOVES is based on vehicle spillage data collected during the 1980s on non-ORVR vehicles and the assumption that ORVR will result in a 50% reduction in spillage.

5. MOVES2014A INVENTORY ANALYSIS

This section presents the results of substituting the historical data regarding vehicle evaporative emission control systems (Section 3) and the revised Tier 2 evaporative inputs (Section 4) for the existing MOVES assumptions/and inputs. These results are presented in terms of nationwide on-road, light-duty evaporative emission inventories estimated for a July average day in calendar years of 2004, 2009, and 2014. Multiple calendar years were selected to examine temporal impacts of the changes to the MOVES model which have differential impacts as a function of model-year and certification level in addition to the overall temporal decreases in evaporative emissions resulting from the increasingly stringent evaporative emission standards.

5.1 Inventory Scenarios

The MOVES2014a model was applied to estimate national emission inventories for light-duty gasoline vehicles. The inventories were assessed for a July average-day in calendar years 2004, 2009, and 2014. Four emission inventory scenarios were quantified, as summarized in Table 5-1 and described further below.

Table 5-1
Emission Inventory Scenarios

Scenario	Name	Description
1	Base Case	Existing MOVES evaporative inventory
2	In-Use Updates	Baseline inventory plus updates based on in-use data evaluation (as described in Section 4)
3	In-Use Updates & Federal Region Data	Scenario 2 plus updates to the historical data used in MOVES for the federal region (as described in Section 3)
4	In-Use Updates & California + Section 177 State Region Data	Scenario 2 plus updates to the historical data for the California and Section 177 state region (as described in Section 3)

Scenario 1 represents the current MOVES default assumptions for the federal regulatory case. One correction was made to this scenario to adjust emission rates for the Tier 0 to

Tier 1 evaporative standards transition. It was determined during this project that the phase-in to Tier 1 (or enhanced evaporative standards) was not handled consistently for all evaporative emissions processes. The emission inventory results without (MOVES default) and with this correction are reported as Scenarios 1A and 1B, respectively. However, given the identification of this error, Scenario 1B was used as the MOVES "base case" involving substitution of the historical mappings and updated inputs described in Sections 3 and 4.

Scenario 2 updates Scenario 1B by substituting the alternative MOVES inputs developed for vehicles certified to Tier 2 emission evaporative emission standards based on the evaluation of in-use data described in Section 4 of this report. Scenario 2 includes all of the alternative MOVES inputs that were developed as well as the actual canister capacity data developed during this project as described in Section 3.

Scenario 3 includes all the Scenario 2 inputs plus the historical new vehicle certification mappings developed for the federal region as described in Section 3. The updated mappings account for both the historical certification standards, canister capacities, and ZEV penetration rates.

Scenario 4 includes all the Scenario 2 inputs plus the historical new vehicle certification mappings developed for the California + Section 177 state region areas as described in Section 3. The updated mappings again account for both the historical certification standards, canister capacities, and ZEV penetration rates.

For each scenario, the MOVES model was operated using the specifications listed below.

- Calendar years = 2004, 2009 and 2011
- Month = July
- Day of week = weekday and weekend; results are reported as the combined "average day"
- Domain scale = national
- Region = national
- Vehicle classes = gasoline passenger cars, passenger trucks and light commercial trucks; results reported by the PC and LDT regulatory classes only
- Default fleet, activity data, speed distributions and fuels

5.2 MOVES Input Development

MOVES input data for the modeling scenarios were prepared for each scenario as described below.

5.2.1 Scenario 1 (MOVES Base Case)

Scenario 1A reflects the MOVES default evaporative inputs.

Scenario 1B is the Base Case scenario which corrects the inconsistent phase-in of the Tier 1 standards. The MOVES evaporative methodology TSD indicates that (as shown in Table 3-1), the phase-in for the Tier 1 (enhanced evaporative) standards was supposed to be 20% 1996 MY, 40% 1997 MY, and 90% 1998 MY. However, during this project it was determined that MOVES assumes 100% compliance with the Tier 1 standard beginning with the 1996 model year for TVV emission rates (during hot soak and engine operation). Scenario 1B corrects this and has MOVES follow the 20/40/90 implementation schedule that U.S. EPA indicated it intended to implement.
This correction affects only estimates of TVV emissions and was implemented by modifying the model-year emission rates of the data table *emissionratebyage* to correctly reflect the Tier 1 phase-in.

5.2.2 Scenario 2 (In-Use Updates)

Scenario 2 is based on Scenario 1B but includes the following alternative evaporative modeling input data for vehicles certified to Tier 2 standards:

1. Updates to the TVV emission rates during option (see Section 4.1),
2. The revised DELTA model calibration (Section 4.2),
3. Canister working capacity degradation (Section 4.3),
4. Updated permeation emission rates (Section 4.4), and
5. Updated national average canister capacity assumptions (Section 3.4.4).

The updates to TVV and permeation emission rates, at standard conditions, were incorporated into the data table *emissionratebyage*. Updated emission rates were for Tier 2 certified vehicles (2004 and later model years).

The remaining updates (DELTA model coefficients and canister assumptions) were incorporated into the *cumtvvcoeffs* data table.

5.2.3 Scenario 3 (In-Use Updates & Federal Region Data)

Scenario 3 follows from Scenario 2 and includes the historical data developed for the federal region:

1. Updated model year certification standards distributions (Section 3.4.2), and
2. Updated ZEV penetration rates (Section 3.4.3).

The updated model year certification standards distributions were used to develop new model year specific emission rates for each evaporative process. The updated emission rates were then incorporated into the data table *emissionratebyage*.

The ZEV penetration rates by model year were incorporated into the *avft* data table.

Additional input considerations are noted below.

- In the application of the model-year results for certification standards and ZEV penetration rates, the input assumed for each calendar year was based on the registration data of that same calendar year. For example, the model-year distribution for certification standards based on the 2009 registration data was used for the 2009 calendar-year analysis.

- The model input for permeation emission rates does not differentiate passenger cars from light-duty trucks, and the updated analysis included vehicle-class-specific certification distributions. Completing this scenario necessitated processing PC and LDT emission inventories separately to keep the distinct permeation emission rate assumptions.

- The emission rates assigned to the LEV II Zero standard were those of the MOVES Tier 3 emission rates. The basis for this equivalency is that LEV III and Tier 3 evaporative emission rates are effectively the Zero evaporative standard extrapolated to the entire gasoline fleet, as explained in CARB's regulatory documentation.[21]

5.2.4 Scenario 4 (In-Use Updates & California + Section 177 State Region Data In-Use)

Scenario 3 is based on Scenario 2 and includes the following historical data developed for the California + Section 177 state region:

1. Updated model year certification standards distributions (Section 3.4.2), and
2. Updated ZEV penetration rates (Section 3.4.3).

Again, the updated model year certification standards distributions were used to develop new model year specific emission rates for each evaporative process. The updated emission rates were then incorporated into the data table *emissionratebyage*.

The ZEV penetration rates by model year were incorporated into the *avft* data table.

The additional issues described above for Scenario 3 apply to Scenario 4. In addition (as noted elsewhere in this report), the California LEV II Near Zero standard was assumed equivalent to the federal Tier 2 standard and Tier 2 emission rates.

5.3 Results by Scenario

The nationwide evaporative hydrocarbon inventories for the scenarios are shown in Table 5-2, Table 5-3, and Table 5-4 for calendar years 2004, 2009 and 2014 calendar, respectively, and are presented graphically by scenario in Figure 5-1 through Figure 5-5. General observations are outlined below.

- TVV emissions are the greatest contributor to the total evaporative inventory for all calendar years and scenarios.

- Refueling vapor is the second greatest contributor to the total evaporative inventory for 2004 and 2009. In 2014, permeation, rather than refueling vapor, is the second greatest contributor for four out of five scenarios given the impact of phasing in vehicles with ORVR systems.

- The total evaporative emission inventory declines markedly over time for all scenarios, driven by reductions in TVV and refueling vapor emissions due to the changes made in evaporative control systems necessary to comply with increasingly stringent standards and the implementation of ORVR requirements.

Table 5-2
National Evaporative THC Inventory Results (tons/day)
July Average Day, Calendar Year = 2004

Scenario	Vehicle Class	Permeation	Tank Vapor Vented	Liquid Leaks	Refueling Vapor	Refueling Spillage	Total
1A	PC	400.4	941.5	178.4	416.4	43.8	1,980.5
	LDT	182.3	392.5	77.8	618.0	42.1	1,312.6
	Total	***582.7***	***1,334.0***	***256.2***	***1,034.4***	***85.9***	***3,293.2***
1B	PC	400.4	1,069.6	178.4	416.4	43.8	2,108.6
	LDT	182.3	464.6	77.8	618.0	42.1	1,384.8
	Total	***582.7***	***1,534.1***	***256.2***	***1,034.4***	***85.9***	***3,493.3***
2	PC	397.4	1,073.8	178.4	416.4	43.8	2,109.8
	LDT	179.3	467.0	77.8	618.0	42.1	1,384.2
	Total	***576.7***	***1,540.8***	***256.2***	***1,034.4***	***85.9***	***3,493.9***
3	PC	388.1	1,044.1	178.3	416.4	43.8	2,070.7
	LDT	181.2	470.0	77.8	618.0	42.1	1,389.1
	Total	***569.3***	***1,514.1***	***256.1***	***1,034.4***	***85.9***	***3,459.8***
4	PC	384.5	1,034.1	178.2	416.4	43.8	2,057.0
	LDT	172.8	397.4	78.3	617.9	42.1	1,308.6
	Total	***557.4***	***1,431.5***	***256.5***	***1,034.3***	***85.9***	***3,365.6***

Table 5-3 National Evaporative THC Inventory Results (tons/day) July Average Day, Calendar Year = 2009							
Scenario	**Vehicle Class**	**Permeation**	**Tank Vapor Vented**	**Liquid Leaks**	**Refueling Vapor**	**Refueling Spillage**	**Total**
1A	PC	389.2	682.3	198.4	261.0	38.2	1,569.1
	LDT	214.6	342.4	115.6	427.7	40.7	1,141.0
	Total	***603.9***	***1,024.7***	***314.1***	***688.7***	***78.9***	***2,710.2***
1B	PC	389.2	778.1	198.4	261.0	38.2	1,665.0
	LDT	214.6	395.2	115.6	427.7	40.7	1,193.8
	Total	***603.9***	***1,173.2***	***314.1***	***688.7***	***78.9***	***2,858.8***
2	PC	370.6	786.9	198.4	261.0	38.2	1,655.1
	LDT	199.5	401.3	115.6	427.7	40.7	1,184.9
	Total	***570.1***	***1,188.2***	***314.1***	***688.7***	***78.9***	***2,840.0***
3	PC	359.4	762.1	198.0	261.0	38.2	1,618.7
	LDT	202.3	401.3	115.6	427.7	40.7	1,187.6
	Total	***561.7***	***1,163.4***	***313.6***	***688.7***	***78.9***	***2,806.3***
4	PC	354.6	753.9	197.8	260.9	38.2	1,605.3
	LDT	191.1	351.1	116.1	427.7	40.7	1,126.6
	Total	***545.7***	***1,104.9***	***313.8***	***688.6***	***78.9***	***2,732.0***

Table 5-4 National Evaporative THC Inventory Results (tons/day) July Average Day, Calendar Year = 2014							
Scenario	**Vehicle Class**	**Permeation**	**Tank Vapor Vented**	**Liquid Leaks**	**Refueling Vapor**	**Refueling Spillage**	**Total**
1A	PC	264.8	434.4	210.7	119.9	33.2	1,063.0
	LDT	186.0	272.2	154.2	261.6	40.1	914.1
	Total	***450.8***	***706.6***	***364.9***	***381.5***	***73.3***	***1,977.0***
1B	PC	264.8	486.5	210.7	119.9	33.2	1,115.0
	LDT	186.0	305.8	154.2	261.6	40.1	947.7
	Total	***450.8***	***792.3***	***364.9***	***381.5***	***73.3***	***2,062.7***
2	PC	231.2	496.7	210.7	119.9	33.2	1,091.7
	LDT	157.7	314.2	154.2	261.6	40.1	927.8
	Total	***388.9***	***810.9***	***364.9***	***381.5***	***73.3***	***2,019.5***
3	PC	223.5	478.7	209.7	119.9	33.2	1,064.8
	LDT	160.4	311.7	154.1	261.6	40.1	927.8
	Total	***383.9***	***790.4***	***363.8***	***381.4***	***73.2***	***1,992.7***
4	PC	219.9	473.1	209.3	119.8	33.1	1,055.2
	LDT	150.3	283.0	155.0	261.6	40.1	889.9
	Total	***370.2***	***756.0***	***364.3***	***381.4***	***73.2***	***1,945.1***

Figure 5-1
National Evaporative Inventory, Total Hydrocarbons
Scenario 1A – MOVES Base Case

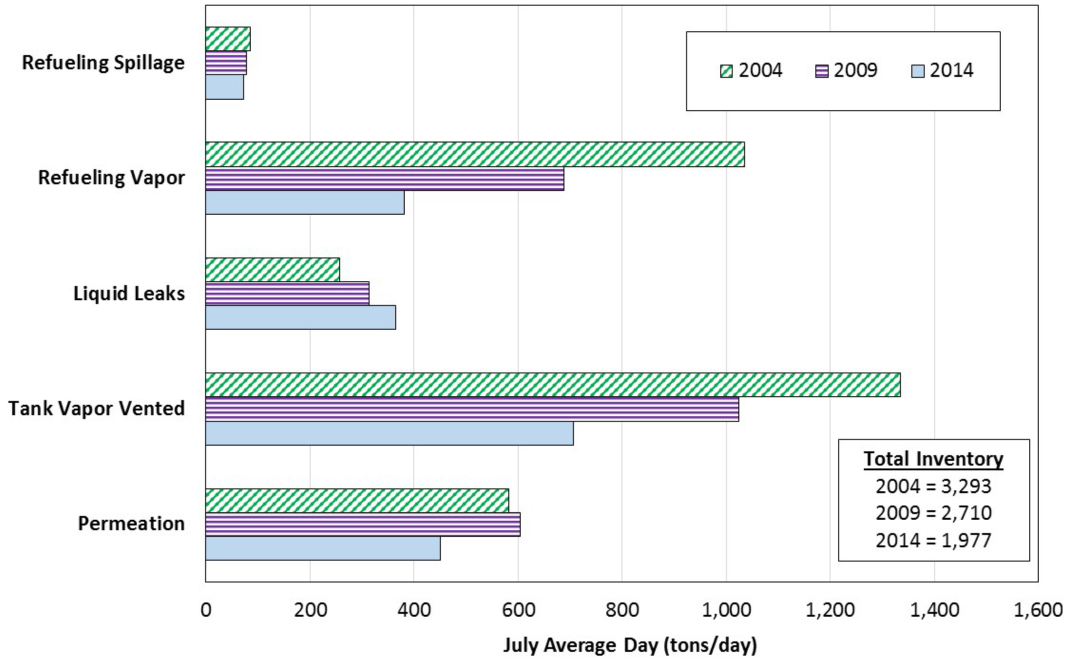


Figure 5-2
National Evaporative Inventory, Total Hydrocarbons
Scenario 1B – Corrected Base Case

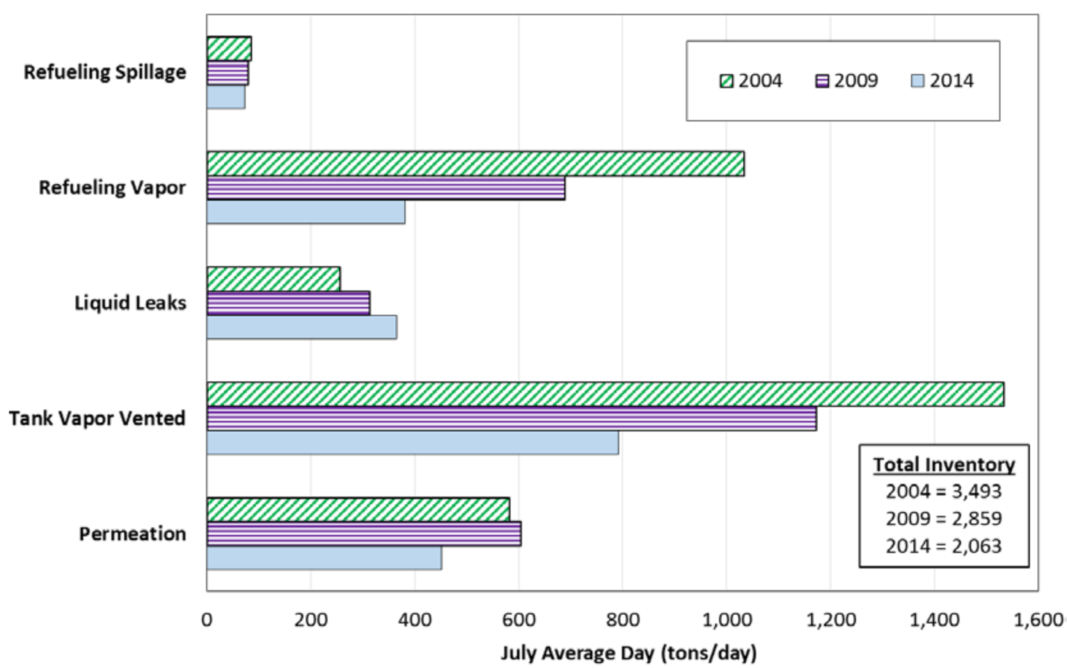


Figure 5-3
National Evaporative Inventory, Total Hydrocarbons
Scenario 2 – In Use Updates

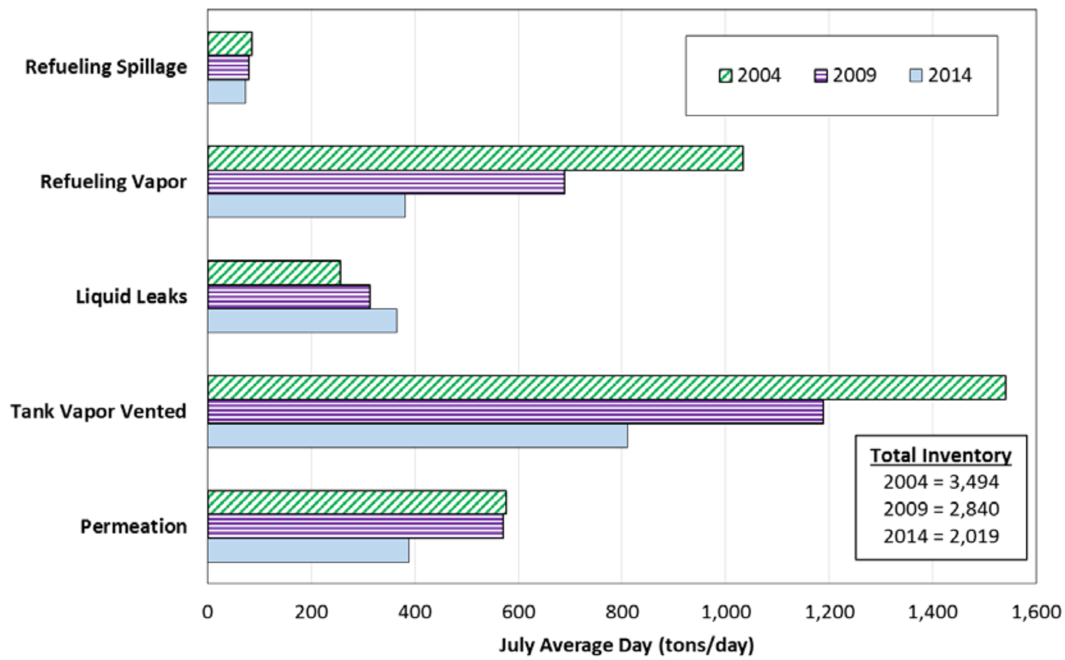


Figure 5-4
National Evaporative Inventory, Total Hydrocarbons
Scenario 3 – In Use and Federal Regulatory Updates

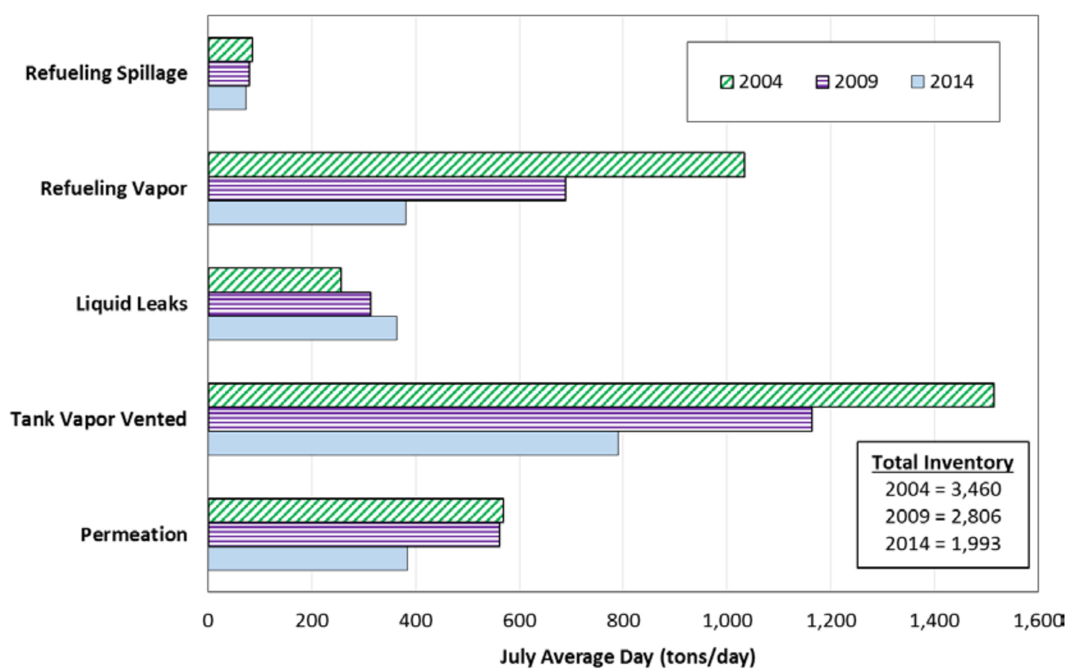
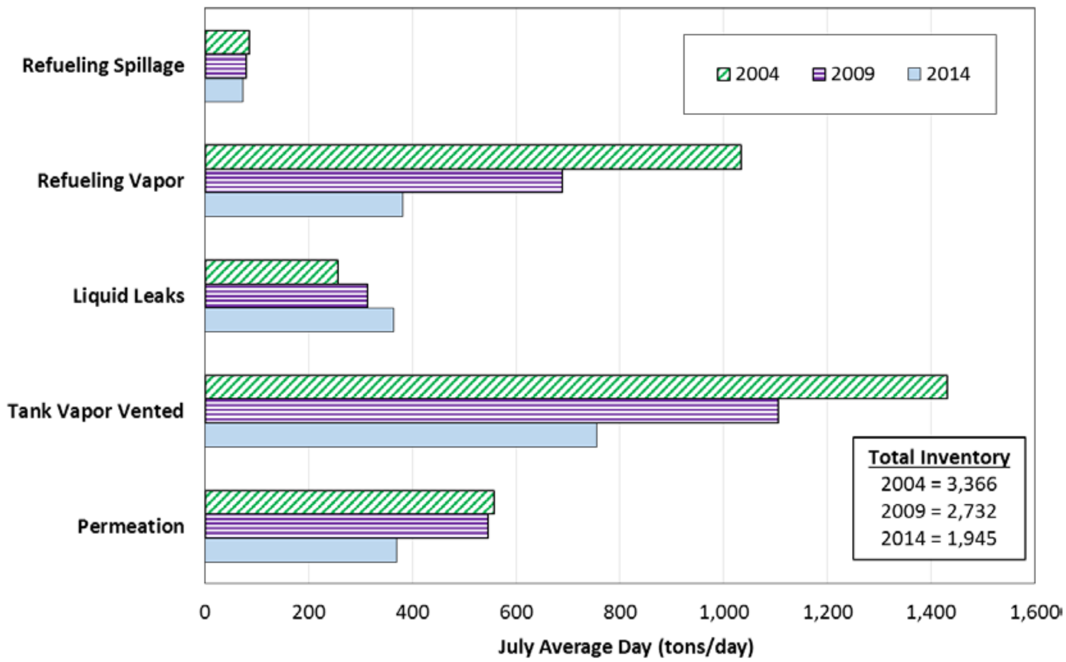


Figure 5-5
National Evaporative Inventory, Total Hydrocarbons
Scenario 4 – In Use and California Regulatory Updates



5.4 Differences Between Selected Scenarios

The effects of differences between key scenarios are discussed below.

5.4.1 Impact of the Base Case Correction (Scenario 1B Minus Scenario 1A)

The correction to the Base Case to include the EPA assumption of the Tier 1 phase-in on all TVV emission rates has an impact on the estimated evaporative inventory, as shown in Table 5-5. The correction results in an additional 200, 149, and 86 tons per July average day in 2004, 2009, and 2014, respectively. The equates to a 15%, 15%, and 12% increase in the TVV inventory in years 2004, 2009, and 2014 respectively, and a 6%, 5%, and 4% increase in the total evaporative inventory in those same years.

Table 5-5 Impact of Base Case Correction (1B Minus 1A) National Evaporative THC Inventory Results (tons/day)							
Year	**Vehicle Class**	**Permeation**	**Tank Vapor Vented**	**Liquid Leaks**	**Refueling Vapor**	**Refueling Spillage**	**Total**
2014	PC	0.0	52.0	0.0	0.0	0.0	52.0
	LDT	0.0	33.6	0.0	0.0	0.0	33.6
	Total	***0.0***	***85.7***	***0.0***	***0.0***	***0.0***	***85.7***
2009	PC	0.0	95.8	0.0	0.0	0.0	95.8
	LDT	0.0	52.8	0.0	0.0	0.0	52.8
	Total	***0.0***	***148.6***	***0.0***	***0.0***	***0.0***	***148.6***
2004	PC	0.0	128.0	0.0	0.0	0.0	128.0
	LDT	0.0	72.1	0.0	0.0	0.0	72.1
	Total	***0.0***	***200.1***	***0.0***	***0.0***	***0.0***	***200.1***

5.4.2 Impact of the In-Use Updates (Scenario 2 Minus Scenario 1B)

The set of in-use updates discussed in Section 4 impact the permeation and TVV portions of the evaporative inventory inventory, as shown in Table 5-6. The permeation emissions are affected by the new Tier 2 specific emission rates; the TVV emissions are affected by new Tier 2 emission rates and the changes in the canister capacity assumptions.

The permeation emissions decrease by 6, 34, and 62 tons per July average day in 2004, 2009, and 2014, respectively. These equate to reductions of 1%, 6%, and 13% of the permeation inventory in 2004, 2009, and 2014.

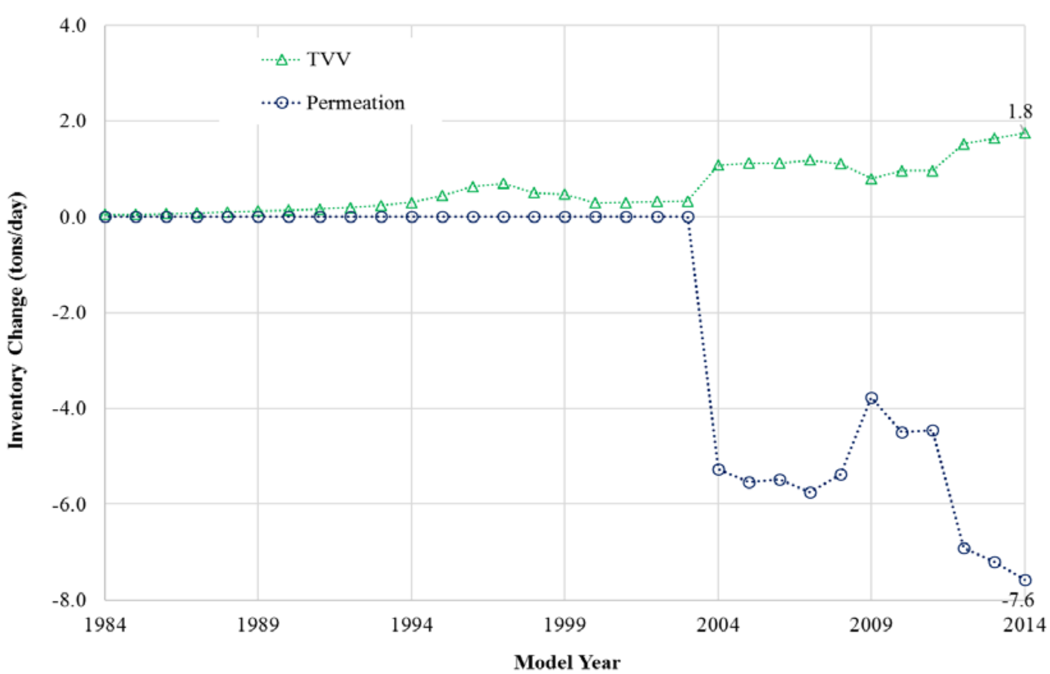
The TVV emission increase by 7, 15, and 19 tons per July average day in 2004, 2009, and 2014, respectively. These equate to increases of 0.4%, 1%, and 2% of the TVV inventory in 2004, 2009, and 2014.

Because most of the updates were focused on Tier 2 vehicles, emission changes due to the updates begin with the 2004 model-year, as shown in Figure 5-6, which illustrates the 2014 inventory changes by individual model year. Also shown in Figure 5-6 are the TVV and permeation inventory changes for the 2014 model year (in 2014) of +1.8 tons/day and -7.6 tons/day, respectively. These changes equate to +22% in the model year's TVV inventory and -60% in the model year's permeation inventory. As such, the in-use updates are more significant when examined on a Tier 2 vehicle basis.*

* The drop in inventory change with the 2009 model year observed in Figure 5-6 is related to the recession and the drop in vehicle sales.

Table 5-6 Impact of In-Use Updates (2 Minus 1B) National Evaporative THC Inventory Results (tons/day)							
Year	**Vehicle Class**	**Permeation**	**Tank Vapor Vented**	**Liquid Leaks**	**Refueling Vapor**	**Refueling Spillage**	**Total**
2014	PC	-33.5	10.2	0.0	0.0	0.0	-23.3
	LDT	-28.3	8.4	0.0	0.0	0.0	-19.9
	Total	***-61.8***	***18.6***	***0.0***	***0.0***	***0.0***	***-43.2***
2009	PC	-18.7	8.8	0.0	0.0	0.0	-9.9
	LDT	-15.1	6.1	0.0	0.0	0.0	-8.9
	Total	***-33.8***	***15.0***	***0.0***	***0.0***	***0.0***	***-18.8***
2004	PC	-3.0	4.2	0.0	0.0	0.0	1.2
	LDT	-3.0	2.4	0.0	0.0	0.0	-0.6
	Total	***-6.0***	***6.6***	***0.0***	***0.0***	***0.0***	***0.6***

Figure 5-6
2014 Impact (Scenario 2 Minus 1B) by Model Year
Ton per July Average Day



5.4.3 Impact of the Federal Regulatory Updates (Scenario 3 Minus Scenario 2)

Comparing Scenario 3 and Scenario 2 isolated the inventory changes related to the mapping of certification standards for the federal region regulatory and accounting for the ZEV penetration rate. However, the ZEV penetration rates are small, and the primary inventory difference observed is due to changes in the certification standard mapping assumed for the federal region.

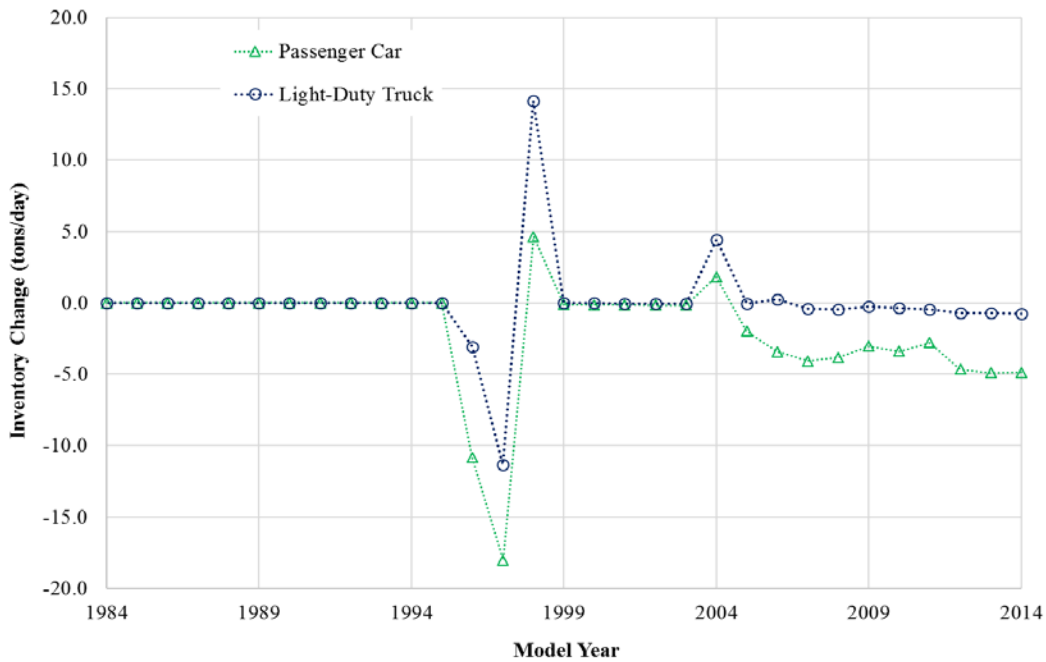
Table 5-7 presents the inventory impacts of Scenario 3 minus Scenario 2. The inclusion of the updated certification and ZEV assumptions results in decreases in the total inventory of 34, 34, and 27 tons per average July day in 2004, 2009, and 2014, respectively. These reductions amount to 1% of the total evaporative inventory for each of those years.

Table 5-7
Impact of Federal Regulatory Updates (3 Minus 2)
National Evaporative THC Inventory Results (tons/day)

Year	Vehicle Class	Permeation	Tank Vapor Vented	Liquid Leaks	Refueling Vapor	Refueling Spillage	Total
2014	PC	-7.7	-18.0	-1.1	0.0	0.0	-26.8
	LDT	2.7	-2.5	-0.1	0.0	0.0	0.0
	Total	***-5.1***	***-20.5***	***-1.2***	***0.0***	***0.0***	***-26.8***
2009	PC	-11.2	-24.8	-0.5	0.0	0.0	-36.4
	LDT	2.8	0.0	0.0	0.0	0.0	2.7
	Total	***-8.4***	***-24.8***	***-0.5***	***0.0***	***0.0***	***-33.7***
2004	PC	-9.3	-29.7	-0.1	0.0	0.0	-39.1
	LDT	1.9	3.0	0.0	0.0	0.0	4.9
	Total	***-7.3***	***-26.7***	***-0.1***	***0.0***	***0.0***	***-34.2***

The total inventory reductions of Table 5-7 do not fully document the considerable variation by model year in the inventory differences between these two scenarios. Figure 5-7 illustrates the total inventory impact by model year for passenger cars and light-duty trucks separately. There are two key impacts: first are the large spikes in inventory differences due to the changes to the Tier 1 and Tier 2 phase-in period, with some of these inventory differences being off-setting; second is the reduction in emissions from 2004 and later model years, which is due to the LEV II Zero evaporative standard, which is more predominant in the passenger car fleet. This plot shows that use of the correct regulatory phase-in is important to the inventory results and that the impact of the LEV II Zero evaporative standard is significant.*

Figure 5-7
2014 Impact (Scenario 3 Minus 2) by Model Year
Total Evaporative Inventory, Tons per July Average Day



<u>5.4.4 Impact of the California Regulatory Updates (Scenario 4 Minus Scenario 2)</u>

Comparing Scenario 4 and Scenario 2 isolated the inventory changes related to the proper mapping of certification standards for the California + Section 177 states' regulatory ZEV penetration rates for that region. Again, the ZEV penetration rates are small, and the primary inventory difference observed is due to changes in the certification standards assumed for the California regulatory case.

Table 5-8 presents the inventory impacts of Scenario 4 minus Scenario 2. The inclusion of the updated certification and ZEV assumptions results in decreases in the total inventory of 128, 108, and 74 tons per average July day in 2004, 2009, and 2014, respectively. These equal reductions of 4% in the total evaporative inventory for each of those years.

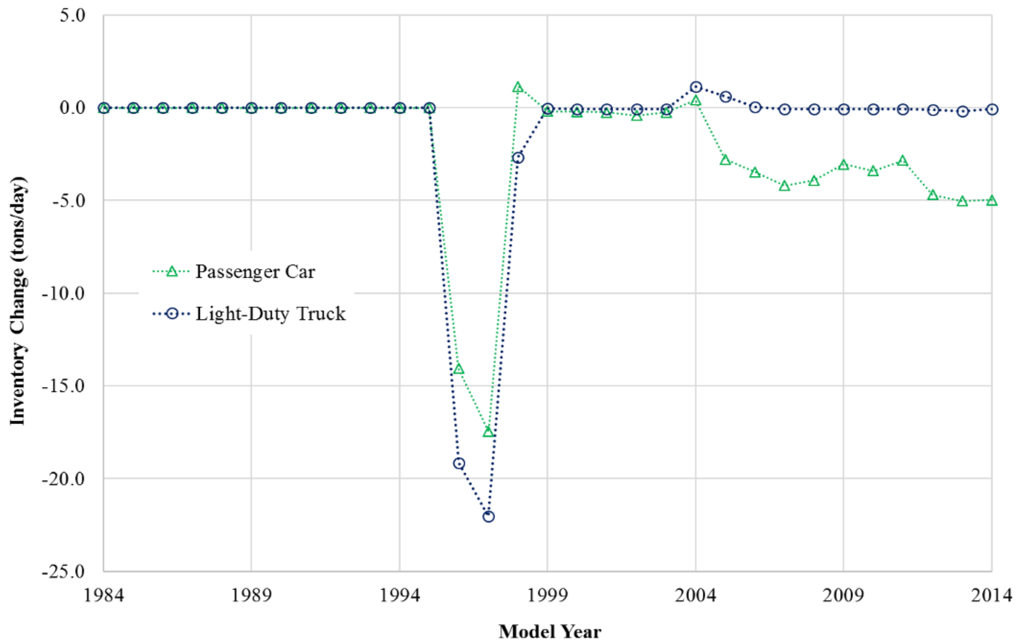
* In comparing Scenarios 3 and 4, the California regulatory update (Scenario 4) reduces emissions a nominal amount further than the federal regulatory update (Scenario 3). That difference is due to (1) earlier transition to Tier 1 and LEV II standards and (2) a higher percentage of vehicles certifying to the LEV II zero evaporative standards.

Table 5-8 **Impact of Federal Regulatory Updates (3 Minus 2)** **National Evaporative THC Inventory Results (tons/day)**							
Year	**Vehicle Class**	**Permeation**	**Tank Vapor Vented**	**Liquid Leaks**	**Refueling Vapor**	**Refueling Spillage**	**Total**
2014	PC	-11.3	-23.6	-1.5	0.0	-0.1	-36.5
	LDT	-7.4	-31.3	0.8	0.0	0.0	-37.9
	Total	***-18.7***	***-54.9***	***-0.7***	***-0.1***	***-0.1***	***-74.4***
2009	PC	-16.0	-33.0	-0.7	0.0	0.0	-49.8
	LDT	-8.4	-50.2	0.4	0.0	0.0	-58.2
	Total	***-24.4***	***-83.3***	***-0.2***	***-0.1***	***0.0***	***-108.0***
2004	PC	-12.8	-39.6	-0.3	0.0	0.0	-52.8
	LDT	-6.5	-69.6	0.5	-0.1	0.0	-75.6
	Total	***-19.3***	***-109.2***	***0.3***	***-0.1***	***0.0***	***-128.4***

Figure 5-8 illustrates the total inventory impact by model year for passenger cars and light-duty trucks separately. There are two key impacts: first are the large spikes in inventory differences at the Tier 1 phase-in period; second is the reduction in emissions from 2004 and later model years, which is due to the LEV II Zero evaporative standard, which is more predominant in the passenger car fleet.*

* In comparing Scenarios 3 and 4, the California regulatory update (Scenario 4) reduces emissions a nominal amount further than the federal regulatory update (Scenario 3). That difference is due to (1) earlier transition to Tier 1 and LEV II standards and (2) a higher percentage of vehicles certifying to the LEV II Zero evaporative standards.

Figure 5-8
2014 Impact (Scenario 4 Minus 2) by Model Year
Total Evaporative Inventory, Tons per July Average Day



6. REFERENCES

1. EPA, 2014. Evaporative Emissions from On-Road Vehicles in MOVES2014, EPA-420-R-14-014, available at *www3.epa.gov/otaq/models/moves/documents/420r14014.pdf*

2. EPA, 2011. The DELTA Model: Improved Evaporative Emissions Modeling for EPA MOVES, DRAFT, Office of Transportation and Air Quality, October 13, 2011.

3. EPA, 2013. DELTA: A Multiple-day Cold Soak Emissions Calculator for MOVES, available at *www3.epa.gov/otaq/models/moves/documents/faca-meeting-jan2013/04-delta.pdf*

4. Timothy H. DeFries, J. Lindner, S. Kishan, and C. Palacios. "Investigation of Techniques for High Evaporative Emissions Vehicle Detection: Denver Summer 2008 Pilot Study at Lipan Street Station," 2009

5. Timothy H. DeFries. "Estimated Summer Hot-Soak Distributions for Denver's Ken Caryl IM Station Fleet," 2013.

6. EPA, 2015. Canister Degradation Study, 25th CRC Real World Emissions Workshop, March 24, 2015.

7. Kota, Sri Harsha et al., 2014. Estimation of VOC emission factors from flux measurements using a receptor model and footprint analysis. Atmospheric Environment 82: 24-35.

8. "Instructions for Using LEV and NLEV Inputs for MOVES2014," EPA-420-B-14-060a, U.S. Environmental Protection Agency, October 2014

9. *www.epa.gov/compliance-and-fuel-economy-data/annual-certification-test-data-vehicles-and-engines*

10. *https://iaspub.epa.gov/otaqpub/display_file.jsp?docid=16888&flag=1*

11. Harold M. Haskew and Thomas F. Liberty. "Evaporative Emissions from In-use Vehicles: Test Fleet Expansion," CRC E-77-2b, October 2010.

12. Harold M. Haskew and T. Liberty. "Study to Determine Evaporative Emission Breakdown, Including Permeation Effects and Diurnal Emissions Using E20 Fuels

on Aging Enhanced Evaporative Emissions Certified Vehicles," CRC E-77-2c, December 2010.

13. "Multi-Day Diurnal Testing," Assessment and Standards Division, Office of Transportation and Air Quality, EPA-420-R-14-006, U.S. Environmental Protection Agency, March 2014.

14. E-mail communication and data attachment between Hector Maldonado, California Air Resources Board and Sierra Research, June 2016.

15. Jeremy G. Heiken, M. Hixson and J. Lyons. "Review of EPA's MOVES2014 Model," CRC E-101, August 2016.

16. Harold M. Haskew, T. Liberty and D. McClement. "Fuel Permeation from Automotive Systems: E0, E6, E10 and E85, Interim Report," CRC Project No. E-65-3, August 2006.

17. Harold M. Haskew and T. Liberty. "Vehicle Evaporative Emission Mechanisms: A Pilot Study," CRC E-77, June 2008.

18. Harold M. Haskew and T. Liberty. "Enhanced Evaporative Emission Vehicles," CRC E-77-2, March 2010.

19. E-mail communication and data attachment between Ching-Shih Yang, U.S. Environmental Protection Agency and Sierra Research, June 2016.

20. Glen Passavant. "Onboard Refueling Vapor Recovery Widespread Use Assessment," memorandum from U.S. Environmental Protection Agency to Public Docket EPA-HQ-OAR-2010-1076, June 2011.

21. "Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Proposed Modifications to the LEV III Criteria Pollutant Requirements for Light- and Medium-Duty Vehicles, the Hybrid Electric Vehicle Test Procedures, and the Heavy-Duty Otto-Cycle and Heavy-Duty Diesel Test Procedures," California Air Resources Board, September 2014.

APPENDIX A

Federal and California Evaporative Emissions Standards

Federal and California Evaporative Emissions Standards

The engineering of vehicle evaporative control systems has occurred as certification standards and underlying test procedures have evolved. The details of these standards are germane to the study objectives completed and outline the difficulty in directly comparing numeric test results from different certification regimes. The underlying procedures are sufficiently distinct that numeric comparisons are not meaningful. For example, there are multiple instances of 2-gram certification standards, which are not equivalent in stringency.

Summarized below is the evolution of federal and California evaporative certification standards.

Federal Evaporative Certification Standards

Table A-1 summarizes the US federal evaporative certification standards from uncontrolled to the most recent Tier 3 standards. The pertinent details of the evolution of the federal certification standards summarized in the table are provided below.

- Early Control, Carbon Trap – Certification procedures included a 1-hour fuel heating "diurnal" (60°-84°F) and a 1-hour hot soak. Suspected vapor points were trapped in charcoal canisters that were weighed before and after testing. Allowed net gain was initially set at 6 grams followed by 2 grams as shown in Table A-1. Running losses were to be measured with carbon trap if engineering evaluation suspected a source. As a result, passenger cars were equipped with evaporative emissions control carbon canisters beginning with the 1971 model year.

- Early Control, Sealed Housing for Evaporative Determination (SHED) – Procedures retained the 1-hour fuel heating "diurnal" and 1-hour hot soak; however, the entire vehicle was measured in a SHED enclosure for the two parts. Recognizing increased stringency, the standard was initially set at 6 grams and subsequently lowered to 2 grams.

- Enhanced Evaporative – One-hour diurnal replaced by real time diurnal testing from 72° - 96°F in an enclosed variable temperature SHED (or VT-SHED). Variable volume or other mechanism was required to compensate for variable air temperature in sealed enclosure. The procedure includes two tracks (encompassing three-day and two-day diurnal tests). The primary track includes an FTP, followed by a running loss evaporative test (dynamometer enclosed by the SHED), a 1-hour hot soak test, and ending with a 72-hour (three-day) diurnal test. The 2 gram/test requirement equals the worst 24-hour diurnal plus hot soak.[*] The enhanced evaporative procedures were defined to better address permeation

[*] A second, "supplementary" track without the running loss test included an FTP, a hot soak, and a 48- hour (two-day) diurnal test. Both tracks include saturation of the canister with butane immediately before the FTP. The primary track purges the canister with the FTP and running loss test before the hot soak and diurnal. The supplemental track purges only with the FTP. The supplemental track (two-day diurnal test) was therefore deemed more stringent and was given a higher mass limit of 2.5 grams for passenger cars.

and running loss emissions.[*] A refueling test was added with the 2001 model year to monitor on-board refueling vapor recovery (ORVR) requirements that began with the 1998 model year vehicle.

Table A-1
US Federal Evaporative Certification Standards, Light-Duty Gasoline

Certification Regime	Model Years	Vehicle Class	Diurnal & Hot Soak Standard	Additional Standards
Uncontrolled	1970-and-earlier	N/A	N/A	N/A
Early Control, Carbon Trap	1971 - 1977	All	6 g/test (1971) 2 g/test (1972-1977)	N/A
Early Control, SHED	1978 - 1998	All	6 g/test (1978-1980) 2 g/test (1981-1998)	N/A
Enhanced Evaporative (aka Tier 1)	1996 - 2006	PC	2 g/test[a]	0.05 g/mi Running Loss 0.2 g/gal Refueling[e]
		LLDT HLDT[c]	2 g/test[a]	
		HLDT[d]	2.5 g/test[a]	
Tier 2 Evaporative	2004 - 2021	PC	0.95 g/test (2004-2008)[a] 0.50 g/test (2009-2021)[a]	0.05 g/mi Running Loss 0.2 g/gal Refueling
	2004 - 2021	LLDT	0.95 g/test (2004-2008)[a] 0.65 g/test (2009-2021)[a]	
	2004 - 2021	HLDT	1.20 g/test (2004-2008)[a] 0.90 g/test (2009-2021)[a]	
Tier 3 Evaporative	2016-and-later	PC, LDT1	0.30 g/test[b]	0.05 g/mi Running Loss 0.2 g/gal Refueling 0.02 g/test Canister Bleed
		LDT2	0.40 g/test[b]	
		LDT3, LDT4	0.50 g/test[b]	

a. Includes worst day of 3-day diurnal test.
b. Includes worst day over either three-day or two-day diurnal tests
c. HLDT < 30-gallon fuel tank.
d. HLDT ≥ 30-gallon fuel tank.
e. 0.2 g/gal applies to ORVR-equipped vehicles; for non-ORVR vehicles a separate spitback test of 1.0 g/test.

- Tier 2 Evaporative – The certification standard for the primary track (i.e., three-day diurnal) was reduced to 0.95 g/test under a worst-case fuel assumption (i.e., 10% ethanol blend) for 2004 model year passenger cars. This Tier 2 evaporative standard is also referred to as the “near-zero” evaporative standard (which is the nomenclature from the analogous California LEV II certification standard). Both

[*] A vehicle with 0.5 g/hour permeation could pass the one-hour diurnal plus one-hour hot soak procedure, but could have 12 grams permeation in a real-time diurnal measured over 24 hours. Permeation became apparent in late 80s and early 90s due in part with transition from metal to plastic fuel tanks. In same timeframe, with increased penetration of high pressure fuel injection fuel heating became a problem, resulting in noticeable running losses emissions (vehicle testers could smell fuel on the dynamometer during a test). A high-pressure pump delivered fuel to the pressure regulator under the hood; fuel not consumed by injectors (TBI and later PFI) was returned to the fuel tank. The fuel temperature in the tank could rise 20-30°F, resulting in running losses.

EPA and CARB promulgated harmonized evaporative test procedures commencing with the 2009 model year, after which the applicable three-day diurnal Tier 2 standard is 0.5 grams. The 2009 model year revised standard is not considered a change in stringency; the underlying fuel and temperature stipulations for the 0.95 and 0.5 gram/test standards differ and the numeric values are not directly comparable.

- Tier 3 Evaporative – The Tier 3 diurnal plus hot soak standard of 0.3 grams includes the worst-case 24-hour diurnal measured over either the three-day or two-day diurnal test. This standard is commonly known as the "zero" evaporative standard as it is largely a derivative of the CARB evaporative standard applicable to partial zero emission vehicles (or PZEVs) defined as part of the California LEV II program. A canister bleed procedure and accompanying standard were added.

California Evaporative Certification Standards

Beginning with the 1978 model year, California promulgated evaporative certification standards; prior to the 1978 model year, the federal EPA standards shown in Table A-1 were applicable in California. Table A-2 summarizes the California evaporative certification standards through to the most recent LEV III evaporative standards.

There is considerable overlap in California (Table A-2) and federal (Table A-1) evaporative certification standards and procedures. With that understood, distinctions in the California requirements, which differ from the federal case, are outlined below.

- Starting model year and phase-in schedules are specific to California (i.e., California started the 2-gram early control SHED and 2 gram enhanced evaporative standards one model year earlier than the federal requirement).

- Starting with enhanced evaporative standards, the diurnal temperature range is distinct (72°-96°F for federal, and 65°-105°F for California).

- With enhanced evaporative standards, there is no separate spitback refueling test. California implemented statewide Stage II refueling controls, and the spitback test was deemed unnecessary.

- Certification fuel is summer season California cleaner burning gasoline (which is lower RVP than federal certification fuel); ethanol-containing certification fuel (i.e., E10) is not required until LEV III standards.

- For LEV II standards, a portion of the fleet is certified to the optional "zero" evaporative standard in order to comply with the ZEV requirements specific to the California on-road emissions program.

Table A-2 California Evaporative Certification Standards, Light-Duty Gasoline				
Certification Regime	**Model Years**	**Vehicle Class**	**Diurnal & Hot Soak Standard**	**Additional Standards**
Early Control, SHED	1978 - 1998	All	6 g/test (1978-1979) 2 g/test (1980-1998)	N/A
Enhanced Evaporative	1995 - 2005	PC	2 g/test[a]	0.05 g/mi Running Loss 0.2 g/gal Refueling
		LLDT HLDT[c]	2 g/test[a]	
		HLDT[d]	2.5 g/test[a]	
LEV II Evaporative	2004 - 2021	PC	0.50 g/test (Near Zero)[a] 0.35 g/test (Zero)[a]	0.05 g/mi Running Loss 0.2 g/gal Refueling
		LLDT	0.65 g/test (Near Zero)[a] 0.50 g/test (Zero)[a]	
		HLDT	0.90 g/test (Near Zero)[a] 0.75 g/test (Zero)[a]	
LEV III Evaporative	2015-and-later	PC, LDT1	0.30 g/test (Option 2)[b]	0.05 g/mi Running Loss 0.2 g/gal Refueling 0.02 g/test Canister Bleed
		LDT2	0.40 g/test (Option 2)[b]	
		LDT3, LDT4	0.50 g/test (Option 2)[b]	

a. Includes worst day of three-day diurnal test.
b. Includes worst day over either two-day or two-day diurnal tests; Option 1 standards are nominally higher standards without the separate canister bleed test.
c. HLDT < 30-gallon fuel tank.
d. HLDT ≥ 30-gallon fuel tank

APPENDIX B

EPA Evaporative Certification Data Code Tables

TEST PROC	TEST PROC DESCRIPTION
13	CONSTANT TEMP. EVAP
14	VARIABLE TEMP. EVAP
15	Spitback
21	Federal fuel 2-day exhaust (w/can load)
23	2-day evap
24	Federal fuel refueling test (ORVR)
27	California fuel 2-day evap
32	Federal Fuel Running Loss
34	Federal fuel 3-day evap
37	California Fuel Running Loss
38	CA fuel 3-day evap.
43	Fed. fuel 2-day evap(Heat to load)
44	FED REFUEL (ORVR) (HEAT TO LOAD)
47	CA FUEL 2 DAY EVAP(HEAT TO LOAD)

TEST FUEL	TEST FUEL DESCRIPTION
1	Indolene 30
6	EPA Unleaded Gasoline
22	SPECIAL UNLEADED 91 RON
23	CARB Phase II Gasoline
37	E10 (10% Ethanol 90% EPA Unleaded Gasoline)
38	E85 (85% Ethanol 15% EPA Unleaded Gasoline)
41	CNG
42	LPG
43	E10 (10% Ethanol 90% CAL Phase II Gasoline)
46	CARB LEV3 E10 Regular Gasoline
47	CARB LEV3 E10 Premium Gasoline
61	Tier 2 Cert Gasoline

CERT REGION	CERT REGION DESCRIPTION
C	California + CAA Section 177 States
CA	California + CAA Section 177 States
CE	CALIF + NLEV (NE TRADING REGION)
CL	CALIF + NLEV (ALL STATES)
FC	Tier 2 Federal and California
NF	CLEAN FUEL VEH + NLEV(ASTR) + CA
NL	NLEV - ALL STATES
CF	CLEAN FUEL VEHICLE
F	Federal
FA	FEDERAL ALL ALTITUDE
NE	NLEV - (N.E. TRADING REGION)

STD LEVEL	STANDARD LEVEL DESCRIPTION
3Z	California LEV-III Zero Evap (Option 1)
4Z	California LEV-III Zero Evap (Option 2)
C2	California LEV-II Evap
F2	Federal LEV-II Evap
HD-2D	Federal Heavy-Duty 2-Day Evap (1.75 grams)
HD-3D	Federal Heavy-Duty 3-Day Evap (1.4 grams)
OT	Other
T0	TIER 0 (Pre-Enhanced)
T1	Federal Tier 1 Evap
T2	Federal Tier 2 Evap
ZZ	California LEV-II Zero Evap

APPENDIX C

Evaporative Certification Fleet Inventory Tabulations

Cal Year:	2014			Region:	F	FEDERAL					Vehicle Type:	PC
Col Num:	19	MYPvts	52	53	54	55	56	62	63	64	65	66
Col:	S	7	AZ	BA	BB	BC	BD	BJ	BK	BL	BM	BN
Model	Vehicle	Canister	Evap Cert Test Results (g/test, g/mi)					Evap Cert Standards (g/test, g/mi)				
Year	Population	Size (g)	3-Day	2-Day	1-Hour	RunLoss	Refuel	3-Day	2-Day	1-Hour	RunLoss	Refuel
2015	830,760	121.5	0.281	0.289	-	0.004	0.038	0.500	0.650	-	0.050	0.200
2014	4,264,349	121.6	0.273	0.310	-	0.003	0.031	0.500	0.650	-	0.050	0.200
2013	4,778,545	122.9	0.279	0.328	-	0.004	0.033	0.500	0.650	-	0.050	0.200
2012	4,340,787	124.5	0.274	0.328	-	0.003	0.031	0.501	0.650	-	0.050	0.200
2011	3,403,937	129.8	0.283	0.313	-	0.005	0.030	0.501	0.651	-	0.050	0.200
2010	3,643,483	127.0	0.275	0.295	-	0.003	0.027	0.501	0.650	-	0.050	0.200
2009	3,378,152	125.7	0.265	0.281	-	0.004	0.023	0.524	0.680	-	0.050	0.200
2008	4,777,381	125.6	0.265	0.296	-	0.003	0.024	0.950	1.200	-	0.050	0.200
2007	5,612,846	128.3	0.279	0.291	-	0.004	0.028	0.950	1.200	-	0.050	0.200
2006	5,251,145	131.4	0.307	0.314	-	0.004	0.033	0.988	1.245	-	0.050	0.200
2005	5,165,160	131.4	0.418	0.490	-	0.004	0.040	1.207	1.516	-	0.050	0.200
2004	4,776,275	127.6	0.754	0.792	-	0.005	0.052	1.575	2.073	-	0.050	0.200
2003	4,837,356	125.2	0.793	0.870	-	0.006	0.051	1.932	2.415	-	0.050	0.200
2002	4,710,282	123.8	0.900	0.972	-	0.007	0.054	2.000	2.500	-	0.050	0.200
2001	4,313,249	122.4	0.916	1.079	-	0.009	0.050	2.000	2.500	-	0.050	0.200
2000	4,365,371	121.3	0.962	1.099	-	0.007	0.050	2.000	2.491	-	0.066	0.200
1999	3,536,847	118.0	0.911	1.009	-	0.007	0.042	2.000	2.489	-	0.050	0.200
1998	2,923,342	114.6	0.860	1.052	0.619	0.007	0.065	2.002	2.488	2.000	0.050	0.200
1997	2,526,366	-	0.846	1.133	0.453	0.007	-	2.000	2.500	2.000	0.050	-
1996	1,908,312	-	0.942	1.000	0.479	0.006	-	2.000	2.500	2.000	0.050	-
1995	1,797,071	-	-	-	0.563	-	-	-	-	2.000	-	-
1994	1,344,284	-	-	-	0.646	-	-	-	-	2.000	-	-
1993	1,108,559	-	-	-	0.730	-	-	-	-	2.000	-	-
1992	894,413	-	-	-	-	-	-	-	-	-	-	-
1991	735,197	-	-	-	-	-	-	-	-	-	-	-
1990	596,205	-	-	-	-	-	-	-	-	-	-	-
1989	506,396	-	-	-	-	-	-	-	-	-	-	-
1988	422,521	-	-	-	-	-	-	-	-	-	-	-
1987	381,456	-	-	-	-	-	-	-	-	-	-	-
1986	337,915	-	-	-	-	-	-	-	-	-	-	-
1985	284,068	-	-	-	-	-	-	-	-	-	-	-
1984	242,711	-	-	-	-	-	-	-	-	-	-	-
1983	151,410	-	-	-	-	-	-	-	-	-	-	-
1982	114,377	-	-	-	-	-	-	-	-	-	-	-
1981	114,970	-	-	-	-	-	-	-	-	-	-	-
1980	118,333	-	-	-	-	-	-	-	-	-	-	-
1979	190,410	-	-	-	-	-	-	-	-	-	-	-
1978	170,067	-	-	-	-	-	-	-	-	-	-	-
1977	153,221	-	-	-	-	-	-	-	-	-	-	-
1976	125,111	-	-	-	-	-	-	-	-	-	-	-
1975	93,560	-	-	-	-	-	-	-	-	-	-	-
1974	125,858	-	-	-	-	-	-	-	-	-	-	-
1973	154,987	-	-	-	-	-	-	-	-	-	-	-
1972	172,100	-	-	-	-	-	-	-	-	-	-	-
1971	139,924	-	-	-	-	-	-	-	-	-	-	-
1970	180,384	-	-	-	-	-	-	-	-	-	-	-
1969	212,527	-	-	-	-	-	-	-	-	-	-	-
1968	187,260	-	-	-	-	-	-	-	-	-	-	-
1967	195,269	-	-	-	-	-	-	-	-	-	-	-
1966	195,061	-	-	-	-	-	-	-	-	-	-	-

Cal Year:	2009			Region:	F	FEDERAL					Vehicle Type:	PC
Col Num:	18	MYPvts	52	53	54	55	56	62	63	64	65	66
Col:	R	6	AZ	BA	BB	BC	BD	BJ	BK	BL	BM	BN
Model	Vehicle	Canister	Evap Cert Test Results (g/test, g/mi)					Evap Cert Standards (g/test, g/mi)				
Year	Population	Size (g)	3-Day	2-Day	1-Hour	RunLoss	Refuel	3-Day	2-Day	1-Hour	RunLoss	Refuel
2015	0	-	-	-	-	-	-	-	-	-	-	-
2014	0	-	-	-	-	-	-	-	-	-	-	-
2013	0	-	-	-	-	-	-	-	-	-	-	-
2012	0	-	-	-	-	-	-	-	-	-	-	-
2011	319	135.6	0.303	0.314	-	0.011	0.023	0.533	0.653	-	0.050	0.200
2010	1,077,132	128.3	0.264	0.280	-	0.003	0.027	0.500	0.650	-	0.050	0.200
2009	3,379,812	125.4	0.264	0.280	-	0.004	0.024	0.524	0.679	-	0.050	0.200
2008	5,015,169	125.3	0.265	0.297	-	0.003	0.024	0.950	1.200	-	0.050	0.200
2007	5,999,217	128.1	0.280	0.291	-	0.004	0.028	0.950	1.200	-	0.050	0.200
2006	5,739,540	131.3	0.307	0.314	-	0.004	0.033	0.989	1.246	-	0.050	0.200
2005	5,786,706	131.3	0.419	0.493	-	0.004	0.040	1.212	1.522	-	0.050	0.200
2004	5,522,692	127.6	0.753	0.792	-	0.006	0.051	1.575	2.082	-	0.050	0.200
2003	5,761,023	125.1	0.792	0.868	-	0.006	0.051	1.935	2.420	-	0.050	0.200
2002	5,913,517	123.4	0.896	0.964	-	0.007	0.054	2.000	2.500	-	0.050	0.200
2001	5,773,004	121.9	0.914	1.088	-	0.009	0.049	2.000	2.500	-	0.050	0.200
2000	6,226,777	120.4	0.963	1.117	-	0.007	0.049	2.000	2.491	-	0.069	0.200
1999	5,494,341	117.3	0.926	1.024	-	0.007	0.043	2.000	2.489	-	0.050	0.200
1998	4,813,203	113.3	0.882	1.092	0.612	0.006	0.065	2.002	2.485	2.000	0.050	0.200
1997	4,584,379	-	0.831	1.190	0.488	0.005	-	2.000	2.500	2.000	0.050	-
1996	3,845,894	-	1.000	1.036	0.486	0.006	-	2.000	2.500	2.000	0.050	-
1995	3,890,414	-	-	-	0.569	-	-	-	-	2.000	-	-
1994	3,100,845	-	-	-	0.652	-	-	-	-	2.000	-	-
1993	2,735,680	-	-	-	0.734	-	-	-	-	2.000	-	-
1992	2,240,954	-	-	-	-	-	-	-	-	-	-	-
1991	1,817,822	-	-	-	-	-	-	-	-	-	-	-
1990	1,493,271	-	-	-	-	-	-	-	-	-	-	-
1989	1,213,318	-	-	-	-	-	-	-	-	-	-	-
1988	953,935	-	-	-	-	-	-	-	-	-	-	-
1987	774,954	-	-	-	-	-	-	-	-	-	-	-
1986	653,452	-	-	-	-	-	-	-	-	-	-	-
1985	520,318	-	-	-	-	-	-	-	-	-	-	-
1984	416,906	-	-	-	-	-	-	-	-	-	-	-
1983	251,675	-	-	-	-	-	-	-	-	-	-	-
1982	172,401	-	-	-	-	-	-	-	-	-	-	-
1981	164,056	-	-	-	-	-	-	-	-	-	-	-
1980	169,981	-	-	-	-	-	-	-	-	-	-	-
1979	264,774	-	-	-	-	-	-	-	-	-	-	-
1978	230,861	-	-	-	-	-	-	-	-	-	-	-
1977	202,950	-	-	-	-	-	-	-	-	-	-	-
1976	161,326	-	-	-	-	-	-	-	-	-	-	-
1975	116,299	-	-	-	-	-	-	-	-	-	-	-
1974	156,479	-	-	-	-	-	-	-	-	-	-	-
1973	184,594	-	-	-	-	-	-	-	-	-	-	-
1972	200,544	-	-	-	-	-	-	-	-	-	-	-
1971	162,500	-	-	-	-	-	-	-	-	-	-	-
1970	203,539	-	-	-	-	-	-	-	-	-	-	-
1969	231,456	-	-	-	-	-	-	-	-	-	-	-
1968	201,805	-	-	-	-	-	-	-	-	-	-	-
1967	199,037	-	-	-	-	-	-	-	-	-	-	-
1966	203,114	-	-	-	-	-	-	-	-	-	-	-

Cal Year:	2004			Region:	F	FEDERAL				Vehicle Type:		PC
Col Num:	17	MYPvts	52	53	54	55	56	62	63	64	65	66
Col:	Q	5	AZ	BA	BB	BC	BD	BJ	BK	BL	BM	BN
Model	Vehicle	Canister	Evap Cert Test Results (g/test, g/mi)					Evap Cert Standards (g/test, g/mi)				
Year	Population	Size (g)	3-Day	2-Day	1-Hour	RunLoss	Refuel	3-Day	2-Day	1-Hour	RunLoss	Refuel
2015	0	-	-	-	-	-	-	-	-	-	-	-
2014	0	-	-	-	-	-	-	-	-	-	-	-
2013	0	-	-	-	-	-	-	-	-	-	-	-
2012	0	-	-	-	-	-	-	-	-	-	-	-
2011	0	-	-	-	-	-	-	-	-	-	-	-
2010	0	-	-	-	-	-	-	-	-	-	-	-
2009	0	-	-	-	-	-	-	-	-	-	-	-
2008	0	-	-	-	-	-	-	-	-	-	-	-
2007	0	-	-	-	-	-	-	-	-	-	-	-
2006	1,393	134.9	0.307	0.313	-	0.004	0.034	0.978	1.233	-	0.050	0.200
2005	1,585,606	133.2	0.411	0.488	-	0.003	0.046	1.222	1.535	-	0.050	0.200
2004	5,512,389	127.3	0.758	0.792	-	0.005	0.052	1.576	2.088	-	0.050	0.200
2003	6,037,831	124.8	0.792	0.867	-	0.006	0.051	1.937	2.422	-	0.050	0.200
2002	6,310,862	123.2	0.895	0.960	-	0.007	0.054	2.000	2.500	-	0.050	0.200
2001	6,378,404	121.4	0.914	1.087	-	0.009	0.049	2.000	2.500	-	0.050	0.200
2000	7,088,547	119.9	0.964	1.124	-	0.007	0.049	2.000	2.490	-	0.070	0.200
1999	6,543,721	116.9	0.929	1.024	-	0.006	0.043	2.000	2.488	-	0.050	0.200
1998	6,022,219	112.5	0.891	1.102	0.599	0.006	0.065	2.002	2.484	2.000	0.050	0.200
1997	6,199,773	-	0.827	1.216	0.504	0.005	-	2.000	2.500	2.000	0.050	-
1996	5,691,946	-	1.026	1.061	0.492	0.007	-	2.000	2.500	2.000	0.050	-
1995	6,386,070	-	-	-	0.576	-	-	-	-	2.000	-	-
1994	5,565,229	-	-	-	0.660	-	-	-	-	2.000	-	-
1993	5,561,667	-	-	-	0.744	-	-	-	-	2.000	-	-
1992	4,839,719	-	-	-	-	-	-	-	-	-	-	-
1991	4,313,458	-	-	-	-	-	-	-	-	-	-	-
1990	3,859,074	-	-	-	-	-	-	-	-	-	-	-
1989	3,412,527	-	-	-	-	-	-	-	-	-	-	-
1988	2,777,323	-	-	-	-	-	-	-	-	-	-	-
1987	2,179,434	-	-	-	-	-	-	-	-	-	-	-
1986	1,771,155	-	-	-	-	-	-	-	-	-	-	-
1985	1,357,329	-	-	-	-	-	-	-	-	-	-	-
1984	1,025,399	-	-	-	-	-	-	-	-	-	-	-
1983	604,063	-	-	-	-	-	-	-	-	-	-	-
1982	379,965	-	-	-	-	-	-	-	-	-	-	-
1981	331,092	-	-	-	-	-	-	-	-	-	-	-
1980	310,247	-	-	-	-	-	-	-	-	-	-	-
1979	449,107	-	-	-	-	-	-	-	-	-	-	-
1978	379,139	-	-	-	-	-	-	-	-	-	-	-
1977	315,567	-	-	-	-	-	-	-	-	-	-	-
1976	230,859	-	-	-	-	-	-	-	-	-	-	-
1975	159,181	-	-	-	-	-	-	-	-	-	-	-
1974	206,998	-	-	-	-	-	-	-	-	-	-	-
1973	238,534	-	-	-	-	-	-	-	-	-	-	-
1972	250,261	-	-	-	-	-	-	-	-	-	-	-
1971	200,713	-	-	-	-	-	-	-	-	-	-	-
1970	239,643	-	-	-	-	-	-	-	-	-	-	-
1969	265,745	-	-	-	-	-	-	-	-	-	-	-
1968	235,390	-	-	-	-	-	-	-	-	-	-	-
1967	229,687	-	-	-	-	-	-	-	-	-	-	-
1966	233,710	-	-	-	-	-	-	-	-	-	-	-

Cal Year:	2014			Region:	F	FEDERAL				Vehicle Type:		LDT
Col Num:	19	MYPvts	52	53	54	55	56	62	63	64	65	66
Col:	S	13	AZ	BA	BB	BC	BD	BJ	BK	BL	BM	BN
Model	Vehicle	Canister	Evap Cert Test Results (g/test, g/mi)					Evap Cert Standards (g/test, g/mi)				
Year	Population	Size (g)	3-Day	2-Day	1-Hour	RunLoss	Refuel	3-Day	2-Day	1-Hour	RunLoss	Refuel
2015	1,145,562	156.5	0.366	0.388	-	0.002	0.032	0.703	0.910	-	0.050	0.200
2014	5,384,594	161.7	0.360	0.423	-	0.001	0.041	0.729	0.934	-	0.050	0.200
2013	5,218,609	168.4	0.347	0.418	-	0.002	0.036	0.739	0.943	-	0.050	0.200
2012	4,525,539	170.2	0.348	0.420	-	0.002	0.046	0.764	0.986	-	0.050	0.200
2011	4,634,092	170.0	0.347	0.425	-	0.002	0.037	0.763	0.987	-	0.050	0.200
2010	3,858,718	171.0	0.368	0.406	-	0.001	0.037	0.780	1.010	-	0.050	0.200
2009	2,908,461	168.9	0.367	0.395	-	0.002	0.034	0.853	1.089	-	0.050	0.200
2008	5,414,202	172.8	0.399	0.404	-	0.002	0.037	1.082	1.358	-	0.050	0.200
2007	6,032,379	174.5	0.416	0.393	-	0.002	0.038	1.312	1.649	-	0.050	0.200
2006	6,006,450	172.8	0.438	0.462	-	0.002	0.050	1.329	1.665	-	0.050	0.200
2005	6,344,587	178.8	0.500	0.532	-	0.002	0.071	1.497	1.869	-	0.050	0.200
2004	6,380,251	164.4	0.772	0.738	-	0.004	0.067	1.769	2.213	-	0.050	0.200
2003	5,974,216	150.9	0.951	1.046	-	0.005	0.041	1.995	2.488	-	0.050	0.200
2002	5,772,810	138.7	1.098	1.193	-	0.005	0.038	2.010	2.510	-	0.050	0.200
2001	5,012,101	129.1	1.103	1.138	-	0.004	0.034	2.048	2.549	-	0.050	0.200
2000	4,726,209	113.6	1.023	1.094	-	0.003	0.039	2.025	2.525	-	0.050	0.200
1999	4,140,675	114.5	1.034	1.123	-	0.003	0.020	2.030	2.530	-	0.050	0.200
1998	3,320,769	125.9	0.987	1.200	1.123	0.004	0.060	2.043	2.541	2.000	0.050	0.200
1997	2,948,002	-	1.017	1.130	0.606	0.002	-	2.000	2.500	2.000	0.050	-
1996	2,105,983	-	0.703	0.812	0.724	0.001	-	2.000	2.500	2.000	0.050	-
1995	2,059,778	-	-	-	0.726	-	-	-	-	2.000	-	-
1994	1,772,301	-	-	-	0.728	-	-	-	-	2.000	-	-
1993	1,222,930	-	-	-	0.730	-	-	-	-	2.000	-	-
1992	911,524	-	-	-	-	-	-	-	-	-	-	-
1991	763,530	-	-	-	-	-	-	-	-	-	-	-
1990	693,614	-	-	-	-	-	-	-	-	-	-	-
1989	718,581	-	-	-	-	-	-	-	-	-	-	-
1988	613,952	-	-	-	-	-	-	-	-	-	-	-
1987	456,470	-	-	-	-	-	-	-	-	-	-	-
1986	450,275	-	-	-	-	-	-	-	-	-	-	-
1985	357,205	-	-	-	-	-	-	-	-	-	-	-
1984	295,468	-	-	-	-	-	-	-	-	-	-	-
1983	189,085	-	-	-	-	-	-	-	-	-	-	-
1982	145,772	-	-	-	-	-	-	-	-	-	-	-
1981	138,739	-	-	-	-	-	-	-	-	-	-	-
1980	123,705	-	-	-	-	-	-	-	-	-	-	-
1979	258,752	-	-	-	-	-	-	-	-	-	-	-
1978	231,238	-	-	-	-	-	-	-	-	-	-	-
1977	184,901	-	-	-	-	-	-	-	-	-	-	-
1976	138,263	-	-	-	-	-	-	-	-	-	-	-
1975	81,629	-	-	-	-	-	-	-	-	-	-	-
1974	96,015	-	-	-	-	-	-	-	-	-	-	-
1973	98,396	-	-	-	-	-	-	-	-	-	-	-
1972	130,382	-	-	-	-	-	-	-	-	-	-	-
1971	88,097	-	-	-	-	-	-	-	-	-	-	-
1970	79,910	-	-	-	-	-	-	-	-	-	-	-
1969	79,110	-	-	-	-	-	-	-	-	-	-	-
1968	56,016	-	-	-	-	-	-	-	-	-	-	-
1967	58,388	-	-	-	-	-	-	-	-	-	-	-
1966	60,832	-	-	-	-	-	-	-	-	-	-	-

Cal Year:	2009			Region:	F	FEDERAL					Vehicle Type:	LDT
Col Num:	18	MYPvts	52	53	54	55	56	62	63	64	65	66
Col:	R	12	AZ	BA	BB	BC	BD	BJ	BK	BL	BM	BN
Model	Vehicle	Canister	Evap Cert Test Results (g/test, g/mi)					Evap Cert Standards (g/test, g/mi)				
Year	Population	Size (g)	3-Day	2-Day	1-Hour	RunLoss	Refuel	3-Day	2-Day	1-Hour	RunLoss	Refuel
2015	0	-	-	-	-	-	-	-	-	-	-	-
2014	0	-	-	-	-	-	-	-	-	-	-	-
2013	0	-	-	-	-	-	-	-	-	-	-	-
2012	0	-	-	-	-	-	-	-	-	-	-	-
2011	585	171.9	0.350	0.398	-	0.007	0.025	0.771	0.931	-	0.050	0.200
2010	805,714	165.7	0.339	0.394	-	0.001	0.037	0.740	0.958	-	0.050	0.200
2009	2,836,015	168.7	0.365	0.393	-	0.002	0.035	0.849	1.085	-	0.050	0.200
2008	5,607,421	172.7	0.399	0.404	-	0.002	0.037	1.081	1.357	-	0.050	0.200
2007	6,315,712	174.3	0.416	0.394	-	0.002	0.038	1.310	1.647	-	0.050	0.200
2006	6,379,991	172.6	0.437	0.462	-	0.002	0.050	1.325	1.661	-	0.050	0.200
2005	6,834,307	178.5	0.501	0.532	-	0.002	0.071	1.492	1.864	-	0.050	0.200
2004	6,965,678	164.4	0.770	0.738	-	0.004	0.066	1.760	2.205	-	0.050	0.200
2003	6,701,297	151.3	0.948	1.044	-	0.005	0.042	1.995	2.488	-	0.050	0.200
2002	6,715,491	139.6	1.097	1.189	-	0.005	0.038	2.010	2.510	-	0.050	0.200
2001	6,073,875	130.5	1.102	1.134	-	0.004	0.035	2.045	2.546	-	0.050	0.200
2000	6,061,347	113.6	1.027	1.106	-	0.003	0.039	2.024	2.524	-	0.050	0.200
1999	5,571,982	114.6	1.041	1.136	-	0.003	0.020	2.029	2.529	-	0.050	0.200
1998	4,707,006	126.0	0.994	1.219	1.056	0.004	0.060	2.042	2.540	2.000	0.050	0.200
1997	4,244,729	-	1.030	1.143	0.606	0.001	-	2.000	2.500	2.000	0.050	-
1996	3,264,560	-	0.729	0.826	0.715	0.001	-	2.000	2.500	2.000	0.050	-
1995	3,308,990	-	-	-	0.721	-	-	-	-	2.000	-	-
1994	2,962,760	-	-	-	0.728	-	-	-	-	2.000	-	-
1993	2,204,887	-	-	-	0.734	-	-	-	-	2.000	-	-
1992	1,664,381	-	-	-	-	-	-	-	-	-	-	-
1991	1,419,231	-	-	-	-	-	-	-	-	-	-	-
1990	1,256,037	-	-	-	-	-	-	-	-	-	-	-
1989	1,311,600	-	-	-	-	-	-	-	-	-	-	-
1988	1,149,446	-	-	-	-	-	-	-	-	-	-	-
1987	845,013	-	-	-	-	-	-	-	-	-	-	-
1986	818,886	-	-	-	-	-	-	-	-	-	-	-
1985	648,735	-	-	-	-	-	-	-	-	-	-	-
1984	527,460	-	-	-	-	-	-	-	-	-	-	-
1983	331,053	-	-	-	-	-	-	-	-	-	-	-
1982	248,480	-	-	-	-	-	-	-	-	-	-	-
1981	229,673	-	-	-	-	-	-	-	-	-	-	-
1980	200,371	-	-	-	-	-	-	-	-	-	-	-
1979	400,881	-	-	-	-	-	-	-	-	-	-	-
1978	359,235	-	-	-	-	-	-	-	-	-	-	-
1977	276,340	-	-	-	-	-	-	-	-	-	-	-
1976	204,515	-	-	-	-	-	-	-	-	-	-	-
1975	118,840	-	-	-	-	-	-	-	-	-	-	-
1974	135,920	-	-	-	-	-	-	-	-	-	-	-
1973	137,615	-	-	-	-	-	-	-	-	-	-	-
1972	167,093	-	-	-	-	-	-	-	-	-	-	-
1971	113,206	-	-	-	-	-	-	-	-	-	-	-
1970	104,190	-	-	-	-	-	-	-	-	-	-	-
1969	100,655	-	-	-	-	-	-	-	-	-	-	-
1968	66,990	-	-	-	-	-	-	-	-	-	-	-
1967	85,876	-	-	-	-	-	-	-	-	-	-	-
1966	82,790	-	-	-	-	-	-	-	-	-	-	-

Cal Year:	2004			Region:	F	FEDERAL					Vehicle Type:	LDT
Col Num:	17	MYPvts	52	53	54	55	56	62	63	64	65	66
Col:	Q	11	AZ	BA	BB	BC	BD	BJ	BK	BL	BM	BN
Model	Vehicle	Canister	Evap Cert Test Results (g/test, g/mi)					Evap Cert Standards (g/test, g/mi)				
Year	Population	Size (g)	3-Day	2-Day	1-Hour	RunLoss	Refuel	3-Day	2-Day	1-Hour	RunLoss	Refuel
2015	0	-	-	-	-	-	-	-	-	-	-	-
2014	0	-	-	-	-	-	-	-	-	-	-	-
2013	0	-	-	-	-	-	-	-	-	-	-	-
2012	0	-	-	-	-	-	-	-	-	-	-	-
2011	0	-	-	-	-	-	-	-	-	-	-	-
2010	0	-	-	-	-	-	-	-	-	-	-	-
2009	0	-	-	-	-	-	-	-	-	-	-	-
2008	0	-	-	-	-	-	-	-	-	-	-	-
2007	0	-	-	-	-	-	-	-	-	-	-	-
2006	1,785	173.5	0.430	0.470	-	0.001	0.045	1.415	1.768	-	0.050	0.200
2005	1,359,342	174.2	0.560	0.567	-	0.002	0.072	1.386	1.735	-	0.050	0.200
2004	6,826,625	164.5	0.768	0.739	-	0.004	0.066	1.759	2.202	-	0.050	0.200
2003	6,955,924	151.3	0.948	1.044	-	0.005	0.042	1.995	2.488	-	0.050	0.200
2002	7,077,994	139.8	1.097	1.189	-	0.005	0.039	2.010	2.510	-	0.050	0.200
2001	6,548,296	130.8	1.101	1.136	-	0.005	0.035	2.045	2.546	-	0.050	0.200
2000	6,647,374	113.6	1.026	1.106	-	0.003	0.039	2.024	2.524	-	0.050	0.200
1999	6,322,019	114.6	1.042	1.137	-	0.003	0.020	2.028	2.528	-	0.050	0.200
1998	5,675,335	126.2	0.995	1.224	1.026	0.004	0.060	2.041	2.539	2.000	0.050	0.200
1997	5,309,696	-	1.033	1.145	0.613	0.001	-	2.000	2.500	2.000	0.050	-
1996	4,400,319	-	0.738	0.830	0.714	0.001	-	2.000	2.500	2.000	0.050	-
1995	4,672,562	-	-	-	0.724	-	-	-	-	2.000	-	-
1994	4,402,248	-	-	-	0.734	-	-	-	-	2.000	-	-
1993	3,598,738	-	-	-	0.744	-	-	-	-	2.000	-	-
1992	2,846,140	-	-	-	-	-	-	-	-	-	-	-
1991	2,559,495	-	-	-	-	-	-	-	-	-	-	-
1990	2,281,356	-	-	-	-	-	-	-	-	-	-	-
1989	2,453,180	-	-	-	-	-	-	-	-	-	-	-
1988	2,246,544	-	-	-	-	-	-	-	-	-	-	-
1987	1,714,603	-	-	-	-	-	-	-	-	-	-	-
1986	1,639,469	-	-	-	-	-	-	-	-	-	-	-
1985	1,307,662	-	-	-	-	-	-	-	-	-	-	-
1984	1,052,174	-	-	-	-	-	-	-	-	-	-	-
1983	646,799	-	-	-	-	-	-	-	-	-	-	-
1982	482,136	-	-	-	-	-	-	-	-	-	-	-
1981	436,358	-	-	-	-	-	-	-	-	-	-	-
1980	368,590	-	-	-	-	-	-	-	-	-	-	-
1979	710,765	-	-	-	-	-	-	-	-	-	-	-
1978	624,287	-	-	-	-	-	-	-	-	-	-	-
1977	472,634	-	-	-	-	-	-	-	-	-	-	-
1976	345,951	-	-	-	-	-	-	-	-	-	-	-
1975	198,046	-	-	-	-	-	-	-	-	-	-	-
1974	215,224	-	-	-	-	-	-	-	-	-	-	-
1973	221,220	-	-	-	-	-	-	-	-	-	-	-
1972	246,256	-	-	-	-	-	-	-	-	-	-	-
1971	164,930	-	-	-	-	-	-	-	-	-	-	-
1970	149,693	-	-	-	-	-	-	-	-	-	-	-
1969	143,821	-	-	-	-	-	-	-	-	-	-	-
1968	94,651	-	-	-	-	-	-	-	-	-	-	-
1967	114,167	-	-	-	-	-	-	-	-	-	-	-
1966	106,306	-	-	-	-	-	-	-	-	-	-	-

Cal Year:	2014			Region:	C	CA+177 STATES					Vehicle Type:	PC
Col Num:	16	MYPvts	47	48	49	50	51	57	58	59	60	61
Col:	P	4	AU	AV	AW	AX	AY	BE	BF	BG	BH	BI
Model	Vehicle	Canister	Evap Cert Test Results (g/test, g/mi)					Evap Cert Standards (g/test, g/mi)				
Year	Population	Size (g)	3-Day	2-Day	1-Hour	RunLoss	Refuel	3-Day	2-Day	1-Hour	RunLoss	Refuel
2015	440,427	123.3	0.274	0.291	-	0.004	0.033	0.466	0.592	-	0.050	0.200
2014	2,411,690	121.6	0.272	0.296	-	0.003	0.029	0.490	0.622	-	0.050	0.200
2013	2,827,231	122.7	0.280	0.314	-	0.005	0.032	0.468	0.572	-	0.050	0.200
2012	2,496,789	123.7	0.268	0.305	-	0.003	0.030	0.478	0.590	-	0.050	0.200
2011	1,848,108	129.7	0.265	0.307	-	0.006	0.028	0.474	0.600	-	0.050	0.200
2010	1,825,882	126.2	0.263	0.291	-	0.003	0.023	0.462	0.571	-	0.050	0.200
2009	1,662,648	124.6	0.266	0.280	-	0.004	0.023	0.477	0.602	-	0.050	0.200
2008	1,634,462	123.7	0.267	0.291	-	0.004	0.023	0.485	0.613	-	0.050	0.200
2007	1,432,013	125.1	0.268	0.281	-	0.004	0.026	0.483	0.611	-	0.050	0.200
2006	1,302,944	128.8	0.313	0.314	-	0.005	0.033	0.563	0.717	-	0.050	0.200
2005	1,322,470	127.7	0.388	0.445	-	0.005	0.036	0.866	1.085	-	0.050	0.200
2004	1,181,496	126.3	0.693	0.681	-	0.006	0.047	1.297	1.615	-	0.050	0.200
2003	1,220,932	126.4	0.751	0.835	-	0.008	0.049	1.776	2.218	-	0.050	0.200
2002	1,149,563	124.0	0.874	0.981	-	0.010	0.052	2.000	2.500	-	0.050	0.200
2001	1,071,181	122.2	0.885	1.008	-	0.011	0.048	1.979	2.472	-	0.050	0.200
2000	1,004,615	121.3	0.895	1.061	-	0.010	0.043	2.000	2.493	-	0.065	0.200
1999	775,469	119.4	0.814	0.958	-	0.010	0.039	2.000	2.496	-	0.050	0.200
1998	642,203	116.4	0.481	0.942	0.613	0.007	0.066	2.009	2.484	2.000	0.051	0.200
1997	521,420	-	0.789	0.997	0.387	0.014	-	2.000	2.500	2.000	0.050	-
1996	377,872	-	0.327	1.026	0.424	0.015	-	2.000	2.500	2.000	0.050	-
1995	353,577	-	-	-	0.415	-	-	-	-	2.000	-	-
1994	235,721	-	-	-	0.406	-	-	-	-	2.000	-	-
1993	143,557	-	-	-	0.397	-	-	-	-	2.000	-	-
1992	118,067	-	-	-	-	-	-	-	-	-	-	-
1991	113,526	-	-	-	-	-	-	-	-	-	-	-
1990	96,593	-	-	-	-	-	-	-	-	-	-	-
1989	83,729	-	-	-	-	-	-	-	-	-	-	-
1988	70,455	-	-	-	-	-	-	-	-	-	-	-
1987	66,840	-	-	-	-	-	-	-	-	-	-	-
1986	55,999	-	-	-	-	-	-	-	-	-	-	-
1985	17,710	-	-	-	-	-	-	-	-	-	-	-
1984	13,589	-	-	-	-	-	-	-	-	-	-	-
1983	7,816	-	-	-	-	-	-	-	-	-	-	-
1982	4,990	-	-	-	-	-	-	-	-	-	-	-
1981	4,310	-	-	-	-	-	-	-	-	-	-	-
1980	4,165	-	-	-	-	-	-	-	-	-	-	-
1979	5,523	-	-	-	-	-	-	-	-	-	-	-
1978	5,335	-	-	-	-	-	-	-	-	-	-	-
1977	4,868	-	-	-	-	-	-	-	-	-	-	-
1976	4,596	-	-	-	-	-	-	-	-	-	-	-
1975	3,643	-	-	-	-	-	-	-	-	-	-	-
1974	5,439	-	-	-	-	-	-	-	-	-	-	-
1973	8,538	-	-	-	-	-	-	-	-	-	-	-
1972	9,896	-	-	-	-	-	-	-	-	-	-	-
1971	8,871	-	-	-	-	-	-	-	-	-	-	-
1970	12,995	-	-	-	-	-	-	-	-	-	-	-
1969	14,349	-	-	-	-	-	-	-	-	-	-	-
1968	13,857	-	-	-	-	-	-	-	-	-	-	-
1967	14,968	-	-	-	-	-	-	-	-	-	-	-
1966	15,590	-	-	-	-	-	-	-	-	-	-	-

Cal Year:	2009			Region:	C	CA+177 STATES					Vehicle Type:	PC
Col Num:	15	MYPvts	47	48	49	50	51	57	58	59	60	61
Col:	O	3	AU	AV	AW	AX	AY	BE	BF	BG	BH	BI
Model	Vehicle	Canister	Evap Cert Test Results (g/test, g/mi)					Evap Cert Standards (g/test, g/mi)				
Year	Population	Size (g)	3-Day	2-Day	1-Hour	RunLoss	Refuel	3-Day	2-Day	1-Hour	RunLoss	Refuel
2015	0	-	-	-	-	-	-	-	-	-	-	-
2014	0	-	-	-	-	-	-	-	-	-	-	-
2013	0	-	-	-	-	-	-	-	-	-	-	-
2012	0	-	-	-	-	-	-	-	-	-	-	-
2011	2,335	137.8	0.287	0.330	-	0.014	0.025	0.484	0.631	-	0.050	0.200
2010	526,872	128.2	0.253	0.276	-	0.004	0.023	0.468	0.582	-	0.050	0.200
2009	1,815,299	125.1	0.266	0.279	-	0.004	0.023	0.476	0.601	-	0.050	0.200
2008	1,844,752	124.2	0.268	0.291	-	0.004	0.022	0.486	0.614	-	0.050	0.200
2007	1,620,175	125.6	0.268	0.282	-	0.004	0.026	0.484	0.612	-	0.050	0.200
2006	1,458,439	129.0	0.313	0.315	-	0.005	0.033	0.565	0.719	-	0.050	0.200
2005	1,493,706	127.8	0.389	0.446	-	0.005	0.036	0.870	1.091	-	0.050	0.200
2004	1,366,483	126.4	0.697	0.684	-	0.006	0.047	1.306	1.626	-	0.050	0.200
2003	1,454,791	126.3	0.755	0.836	-	0.008	0.049	1.783	2.228	-	0.050	0.200
2002	1,426,674	123.8	0.873	0.975	-	0.009	0.052	2.000	2.500	-	0.050	0.200
2001	1,428,588	121.9	0.890	1.019	-	0.011	0.047	1.979	2.472	-	0.050	0.200
2000	1,472,826	120.8	0.899	1.077	-	0.010	0.044	2.000	2.493	-	0.067	0.200
1999	1,211,680	118.6	0.838	0.979	-	0.009	0.040	2.000	2.496	-	0.050	0.200
1998	1,087,950	115.3	0.509	0.969	0.605	0.006	0.065	2.008	2.483	2.000	0.051	0.200
1997	1,001,437	-	0.757	1.028	0.396	0.010	-	2.000	2.500	2.000	0.050	-
1996	806,338	-	0.452	1.097	0.406	0.014	-	2.000	2.500	2.000	0.050	-
1995	797,692	-	-	-	0.447	-	-	-	-	2.000	-	-
1994	530,399	-	-	-	0.488	-	-	-	-	2.000	-	-
1993	307,787	-	-	-	0.529	-	-	-	-	2.000	-	-
1992	252,633	-	-	-	-	-	-	-	-	-	-	-
1991	241,605	-	-	-	-	-	-	-	-	-	-	-
1990	203,857	-	-	-	-	-	-	-	-	-	-	-
1989	166,070	-	-	-	-	-	-	-	-	-	-	-
1988	125,861	-	-	-	-	-	-	-	-	-	-	-
1987	103,743	-	-	-	-	-	-	-	-	-	-	-
1986	81,377	-	-	-	-	-	-	-	-	-	-	-
1985	35,900	-	-	-	-	-	-	-	-	-	-	-
1984	25,650	-	-	-	-	-	-	-	-	-	-	-
1983	15,725	-	-	-	-	-	-	-	-	-	-	-
1982	9,917	-	-	-	-	-	-	-	-	-	-	-
1981	9,514	-	-	-	-	-	-	-	-	-	-	-
1980	7,338	-	-	-	-	-	-	-	-	-	-	-
1979	8,611	-	-	-	-	-	-	-	-	-	-	-
1978	8,538	-	-	-	-	-	-	-	-	-	-	-
1977	7,993	-	-	-	-	-	-	-	-	-	-	-
1976	7,486	-	-	-	-	-	-	-	-	-	-	-
1975	5,720	-	-	-	-	-	-	-	-	-	-	-
1974	8,301	-	-	-	-	-	-	-	-	-	-	-
1973	11,455	-	-	-	-	-	-	-	-	-	-	-
1972	12,708	-	-	-	-	-	-	-	-	-	-	-
1971	11,446	-	-	-	-	-	-	-	-	-	-	-
1970	16,648	-	-	-	-	-	-	-	-	-	-	-
1969	18,502	-	-	-	-	-	-	-	-	-	-	-
1968	17,435	-	-	-	-	-	-	-	-	-	-	-
1967	18,154	-	-	-	-	-	-	-	-	-	-	-
1966	18,793	-	-	-	-	-	-	-	-	-	-	-

Cal Year:	2004			Region:	C	CA+177 STATES					Vehicle Type:	PC
Col Num:	14	MYPvts	47	48	49	50	51	57	58	59	60	61
Col:	N	2	AU	AV	AW	AX	AY	BE	BF	BG	BH	BI
Model	Vehicle	Canister	Evap Cert Test Results (g/test, g/mi)					Evap Cert Standards (g/test, g/mi)				
Year	Population	Size (g)	3-Day	2-Day	1-Hour	RunLoss	Refuel	3-Day	2-Day	1-Hour	RunLoss	Refuel
2015	0	-	-	-	-	-	-	-	-	-	-	-
2014	0	-	-	-	-	-	-	-	-	-	-	-
2013	0	-	-	-	-	-	-	-	-	-	-	-
2012	0	-	-	-	-	-	-	-	-	-	-	-
2011	0	-	-	-	-	-	-	-	-	-	-	-
2010	0	-	-	-	-	-	-	-	-	-	-	-
2009	0	-	-	-	-	-	-	-	-	-	-	-
2008	0	-	-	-	-	-	-	-	-	-	-	-
2007	0	-	-	-	-	-	-	-	-	-	-	-
2006	47	123.0	0.290	0.279	-	0.003	0.020	0.513	0.653	-	0.050	0.200
2005	408,646	130.2	0.383	0.447	-	0.004	0.040	0.889	1.118	-	0.050	0.200
2004	1,478,964	126.5	0.688	0.681	-	0.006	0.047	1.299	1.617	-	0.050	0.200
2003	1,650,661	126.7	0.755	0.835	-	0.008	0.048	1.778	2.221	-	0.050	0.200
2002	1,642,330	123.9	0.873	0.975	-	0.009	0.051	2.000	2.500	-	0.050	0.200
2001	1,672,850	121.8	0.891	1.020	-	0.011	0.048	1.978	2.472	-	0.050	0.200
2000	1,754,966	120.4	0.900	1.084	-	0.010	0.044	2.000	2.493	-	0.068	0.200
1999	1,500,869	118.3	0.843	0.983	-	0.009	0.040	2.000	2.496	-	0.050	0.200
1998	1,408,365	114.7	0.515	0.975	0.604	0.006	0.065	2.008	2.482	2.000	0.051	0.200
1997	1,405,592	-	0.745	1.037	0.397	0.009	-	2.000	2.500	2.000	0.050	-
1996	1,253,403	-	0.505	1.138	0.398	0.014	-	2.000	2.500	2.000	0.050	-
1995	1,423,677	-	-	-	0.445	-	-	-	-	2.000	-	-
1994	1,030,480	-	-	-	0.492	-	-	-	-	2.000	-	-
1993	645,459	-	-	-	0.539	-	-	-	-	2.000	-	-
1992	563,563	-	-	-	-	-	-	-	-	-	-	-
1991	596,224	-	-	-	-	-	-	-	-	-	-	-
1990	557,711	-	-	-	-	-	-	-	-	-	-	-
1989	515,145	-	-	-	-	-	-	-	-	-	-	-
1988	422,630	-	-	-	-	-	-	-	-	-	-	-
1987	364,807	-	-	-	-	-	-	-	-	-	-	-
1986	287,848	-	-	-	-	-	-	-	-	-	-	-
1985	90,304	-	-	-	-	-	-	-	-	-	-	-
1984	59,459	-	-	-	-	-	-	-	-	-	-	-
1983	33,400	-	-	-	-	-	-	-	-	-	-	-
1982	19,586	-	-	-	-	-	-	-	-	-	-	-
1981	15,533	-	-	-	-	-	-	-	-	-	-	-
1980	12,640	-	-	-	-	-	-	-	-	-	-	-
1979	16,368	-	-	-	-	-	-	-	-	-	-	-
1978	14,795	-	-	-	-	-	-	-	-	-	-	-
1977	13,099	-	-	-	-	-	-	-	-	-	-	-
1976	10,913	-	-	-	-	-	-	-	-	-	-	-
1975	7,638	-	-	-	-	-	-	-	-	-	-	-
1974	11,694	-	-	-	-	-	-	-	-	-	-	-
1973	16,267	-	-	-	-	-	-	-	-	-	-	-
1972	17,822	-	-	-	-	-	-	-	-	-	-	-
1971	16,210	-	-	-	-	-	-	-	-	-	-	-
1970	22,425	-	-	-	-	-	-	-	-	-	-	-
1969	24,958	-	-	-	-	-	-	-	-	-	-	-
1968	23,673	-	-	-	-	-	-	-	-	-	-	-
1967	24,231	-	-	-	-	-	-	-	-	-	-	-
1966	25,278	-	-	-	-	-	-	-	-	-	-	-

Cal Year:	2014			Region:	C	CA+177 STATES					Vehicle Type:	LDT
Col Num:	16	MYPvts	47	48	49	50	51	57	58	59	60	61
Col:	P	10	AU	AV	AW	AX	AY	BE	BF	BG	BH	BI
Model	Vehicle	Canister	Evap Cert Test Results (g/test, g/mi)					Evap Cert Standards (g/test, g/mi)				
Year	Population	Size (g)	3-Day	2-Day	1-Hour	RunLoss	Refuel	3-Day	2-Day	1-Hour	RunLoss	Refuel
2015	504,607	148.1	0.336	0.355	-	0.002	0.029	0.653	0.844	-	0.050	0.200
2014	2,196,048	149.4	0.348	0.382	-	0.001	0.038	0.660	0.848	-	0.051	0.200
2013	2,052,647	153.3	0.332	0.379	-	0.002	0.032	0.667	0.853	-	0.050	0.200
2012	1,763,807	155.0	0.324	0.379	-	0.002	0.045	0.675	0.858	-	0.050	0.200
2011	1,786,436	159.0	0.325	0.369	-	0.003	0.033	0.699	0.892	-	0.050	0.200
2010	1,323,517	157.0	0.326	0.374	-	0.002	0.033	0.674	0.868	-	0.050	0.200
2009	1,000,372	154.8	0.333	0.360	-	0.003	0.027	0.672	0.873	-	0.073	0.200
2008	1,382,677	162.4	0.367	0.385	-	0.002	0.033	0.739	0.947	-	0.050	0.200
2007	1,214,013	169.5	0.391	0.366	-	0.002	0.035	0.753	0.974	-	0.050	0.200
2006	1,305,025	168.0	0.401	0.433	-	0.003	0.043	0.835	1.068	-	0.050	0.200
2005	1,343,747	173.5	0.485	0.524	-	0.004	0.065	0.950	1.213	-	0.050	0.200
2004	1,377,052	161.0	0.731	0.716	-	0.005	0.059	1.500	1.888	-	0.050	0.200
2003	1,144,864	150.3	0.917	1.017	-	0.007	0.042	1.954	2.440	-	0.050	0.200
2002	1,032,326	140.9	1.034	1.130	-	0.007	0.037	2.005	2.505	-	0.050	0.194
2001	919,261	130.0	1.049	1.086	-	0.007	0.031	2.030	2.531	-	0.050	0.200
2000	812,525	114.4	0.926	1.034	-	0.005	0.039	2.018	2.518	-	0.050	0.200
1999	648,160	114.1	0.806	1.080	-	0.005	0.020	2.015	2.515	-	0.050	0.200
1998	523,982	122.7	0.605	1.044	0.522	0.007	-	2.000	2.500	2.000	0.050	-
1997	443,177	-	0.793	1.004	0.624	0.004	-	2.000	2.500	2.000	0.050	-
1996	299,796	-	0.755	0.940	0.311	0.018	-	2.000	2.500	2.000	0.050	-
1995	279,508	-	-	-	0.378	-	-	-	-	2.000	-	-
1994	221,389	-	-	-	0.445	-	-	-	-	2.000	-	-
1993	148,908	-	-	-	0.512	-	-	-	-	2.000	-	-
1992	112,200	-	-	-	-	-	-	-	-	-	-	-
1991	110,298	-	-	-	-	-	-	-	-	-	-	-
1990	100,264	-	-	-	-	-	-	-	-	-	-	-
1989	103,779	-	-	-	-	-	-	-	-	-	-	-
1988	79,297	-	-	-	-	-	-	-	-	-	-	-
1987	66,772	-	-	-	-	-	-	-	-	-	-	-
1986	66,993	-	-	-	-	-	-	-	-	-	-	-
1985	23,849	-	-	-	-	-	-	-	-	-	-	-
1984	19,110	-	-	-	-	-	-	-	-	-	-	-
1983	9,681	-	-	-	-	-	-	-	-	-	-	-
1982	8,197	-	-	-	-	-	-	-	-	-	-	-
1981	7,616	-	-	-	-	-	-	-	-	-	-	-
1980	6,543	-	-	-	-	-	-	-	-	-	-	-
1979	11,346	-	-	-	-	-	-	-	-	-	-	-
1978	10,326	-	-	-	-	-	-	-	-	-	-	-
1977	9,234	-	-	-	-	-	-	-	-	-	-	-
1976	6,328	-	-	-	-	-	-	-	-	-	-	-
1975	4,590	-	-	-	-	-	-	-	-	-	-	-
1974	5,483	-	-	-	-	-	-	-	-	-	-	-
1973	7,889	-	-	-	-	-	-	-	-	-	-	-
1972	10,170	-	-	-	-	-	-	-	-	-	-	-
1971	6,988	-	-	-	-	-	-	-	-	-	-	-
1970	5,864	-	-	-	-	-	-	-	-	-	-	-
1969	5,787	-	-	-	-	-	-	-	-	-	-	-
1968	3,880	-	-	-	-	-	-	-	-	-	-	-
1967	3,866	-	-	-	-	-	-	-	-	-	-	-
1966	4,206	-	-	-	-	-	-	-	-	-	-	-

Cal Year:	2009			Region:	C	CA+177 STATES					Vehicle Type:	LDT
Col Num:	15	MYPvts	47	48	49	50	51	57	58	59	60	61
Col:	O	9	AU	AV	AW	AX	AY	BE	BF	BG	BH	BI
Model	Vehicle	Canister	Evap Cert Test Results (g/test, g/mi)					Evap Cert Standards (g/test, g/mi)				
Year	Population	Size (g)	3-Day	2-Day	1-Hour	RunLoss	Refuel	3-Day	2-Day	1-Hour	RunLoss	Refuel
2015	0	-	-	-	-	-	-	-	-	-	-	-
2014	0	-	-	-	-	-	-	-	-	-	-	-
2013	0	-	-	-	-	-	-	-	-	-	-	-
2012	0	-	-	-	-	-	-	-	-	-	-	-
2011	1,576	166.6	0.331	0.373	-	0.004	0.025	0.711	0.921	-	0.050	0.200
2010	317,352	154.7	0.302	0.353	-	0.002	0.031	0.646	0.826	-	0.050	0.200
2009	1,043,074	154.5	0.330	0.358	-	0.002	0.027	0.671	0.871	-	0.074	0.200
2008	1,535,645	162.7	0.367	0.387	-	0.002	0.034	0.741	0.950	-	0.050	0.200
2007	1,355,380	169.3	0.391	0.368	-	0.002	0.035	0.753	0.974	-	0.050	0.200
2006	1,444,301	167.8	0.402	0.435	-	0.003	0.042	0.836	1.069	-	0.050	0.200
2005	1,496,558	173.2	0.485	0.525	-	0.004	0.064	0.950	1.213	-	0.050	0.200
2004	1,549,637	161.1	0.731	0.718	-	0.005	0.059	1.501	1.890	-	0.050	0.200
2003	1,317,954	150.6	0.910	1.013	-	0.007	0.042	1.953	2.439	-	0.050	0.200
2002	1,224,803	141.7	1.029	1.124	-	0.007	0.037	2.005	2.505	-	0.050	0.194
2001	1,143,557	131.1	1.044	1.082	-	0.007	0.032	2.027	2.527	-	0.050	0.200
2000	1,098,690	114.2	0.927	1.043	-	0.005	0.039	2.015	2.515	-	0.050	0.200
1999	923,556	113.7	0.813	1.095	-	0.005	0.020	2.013	2.513	-	0.050	0.200
1998	805,337	123.4	0.606	1.066	0.522	0.007	-	2.000	2.500	2.000	0.050	-
1997	700,515	-	0.772	1.018	0.639	0.004	-	2.000	2.500	2.000	0.050	-
1996	521,133	-	0.753	0.966	0.315	0.017	-	2.000	2.500	2.000	0.050	-
1995	512,953	-	-	-	0.386	-	-	-	-	2.000	-	-
1994	405,308	-	-	-	0.457	-	-	-	-	2.000	-	-
1993	273,149	-	-	-	0.529	-	-	-	-	2.000	-	-
1992	205,541	-	-	-	-	-	-	-	-	-	-	-
1991	199,548	-	-	-	-	-	-	-	-	-	-	-
1990	177,090	-	-	-	-	-	-	-	-	-	-	-
1989	182,322	-	-	-	-	-	-	-	-	-	-	-
1988	146,350	-	-	-	-	-	-	-	-	-	-	-
1987	117,104	-	-	-	-	-	-	-	-	-	-	-
1986	114,325	-	-	-	-	-	-	-	-	-	-	-
1985	44,158	-	-	-	-	-	-	-	-	-	-	-
1984	33,725	-	-	-	-	-	-	-	-	-	-	-
1983	17,882	-	-	-	-	-	-	-	-	-	-	-
1982	14,952	-	-	-	-	-	-	-	-	-	-	-
1981	13,388	-	-	-	-	-	-	-	-	-	-	-
1980	12,435	-	-	-	-	-	-	-	-	-	-	-
1979	17,633	-	-	-	-	-	-	-	-	-	-	-
1978	17,006	-	-	-	-	-	-	-	-	-	-	-
1977	14,547	-	-	-	-	-	-	-	-	-	-	-
1976	10,091	-	-	-	-	-	-	-	-	-	-	-
1975	7,344	-	-	-	-	-	-	-	-	-	-	-
1974	8,975	-	-	-	-	-	-	-	-	-	-	-
1973	12,119	-	-	-	-	-	-	-	-	-	-	-
1972	13,960	-	-	-	-	-	-	-	-	-	-	-
1971	9,684	-	-	-	-	-	-	-	-	-	-	-
1970	8,659	-	-	-	-	-	-	-	-	-	-	-
1969	7,915	-	-	-	-	-	-	-	-	-	-	-
1968	5,693	-	-	-	-	-	-	-	-	-	-	-
1967	5,870	-	-	-	-	-	-	-	-	-	-	-
1966	6,240	-	-	-	-	-	-	-	-	-	-	-

Cal Year:	2004			Region:	C	CA+177 STATES					Vehicle Type:	LDT
Col Num:	14	MYPvts	47	48	49	50	51	57	58	59	60	61
Col:	N	8	AU	AV	AW	AX	AY	BE	BF	BG	BH	BI
Model	Vehicle	Canister	Evap Cert Test Results (g/test, g/mi)					Evap Cert Standards (g/test, g/mi)				
Year	Population	Size (g)	3-Day	2-Day	1-Hour	RunLoss	Refuel	3-Day	2-Day	1-Hour	RunLoss	Refuel
2015	0	-	-	-	-	-	-	-	-	-	-	-
2014	0	-	-	-	-	-	-	-	-	-	-	-
2013	0	-	-	-	-	-	-	-	-	-	-	-
2012	0	-	-	-	-	-	-	-	-	-	-	-
2011	0	-	-	-	-	-	-	-	-	-	-	-
2010	0	-	-	-	-	-	-	-	-	-	-	-
2009	0	-	-	-	-	-	-	-	-	-	-	-
2008	0	-	-	-	-	-	-	-	-	-	-	-
2007	0	-	-	-	-	-	-	-	-	-	-	-
2006	82	190.0	0.461	0.395	-	0.001	0.047	0.815	1.046	-	0.050	0.200
2005	291,765	169.0	0.538	0.563	-	0.003	0.068	0.968	1.235	-	0.050	0.200
2004	1,644,572	161.1	0.734	0.723	-	0.005	0.059	1.499	1.887	-	0.050	0.200
2003	1,448,960	150.7	0.903	1.008	-	0.007	0.042	1.952	2.437	-	0.050	0.200
2002	1,357,864	142.0	1.022	1.117	-	0.007	0.037	2.004	2.504	-	0.050	0.194
2001	1,278,399	131.2	1.038	1.077	-	0.007	0.032	2.025	2.525	-	0.050	0.200
2000	1,227,248	113.9	0.922	1.040	-	0.005	0.039	2.014	2.514	-	0.050	0.200
1999	1,066,521	113.4	0.809	1.092	-	0.006	0.020	2.011	2.511	-	0.050	0.200
1998	985,113	123.3	0.607	1.069	0.513	0.007	-	2.000	2.500	2.000	0.050	-
1997	878,430	-	0.757	1.017	0.652	0.004	-	2.000	2.500	2.000	0.050	-
1996	725,749	-	0.746	0.970	0.315	0.017	-	2.000	2.500	2.000	0.050	-
1995	762,610	-	-	-	0.389	-	-	-	-	2.000	-	-
1994	621,613	-	-	-	0.464	-	-	-	-	2.000	-	-
1993	429,004	-	-	-	0.539	-	-	-	-	2.000	-	-
1992	346,224	-	-	-	-	-	-	-	-	-	-	-
1991	361,815	-	-	-	-	-	-	-	-	-	-	-
1990	330,686	-	-	-	-	-	-	-	-	-	-	-
1989	355,685	-	-	-	-	-	-	-	-	-	-	-
1988	296,223	-	-	-	-	-	-	-	-	-	-	-
1987	255,602	-	-	-	-	-	-	-	-	-	-	-
1986	247,462	-	-	-	-	-	-	-	-	-	-	-
1985	89,614	-	-	-	-	-	-	-	-	-	-	-
1984	68,422	-	-	-	-	-	-	-	-	-	-	-
1983	34,913	-	-	-	-	-	-	-	-	-	-	-
1982	28,253	-	-	-	-	-	-	-	-	-	-	-
1981	24,184	-	-	-	-	-	-	-	-	-	-	-
1980	21,574	-	-	-	-	-	-	-	-	-	-	-
1979	32,546	-	-	-	-	-	-	-	-	-	-	-
1978	30,804	-	-	-	-	-	-	-	-	-	-	-
1977	25,623	-	-	-	-	-	-	-	-	-	-	-
1976	17,719	-	-	-	-	-	-	-	-	-	-	-
1975	12,391	-	-	-	-	-	-	-	-	-	-	-
1974	14,075	-	-	-	-	-	-	-	-	-	-	-
1973	19,982	-	-	-	-	-	-	-	-	-	-	-
1972	22,115	-	-	-	-	-	-	-	-	-	-	-
1971	15,190	-	-	-	-	-	-	-	-	-	-	-
1970	13,251	-	-	-	-	-	-	-	-	-	-	-
1969	12,304	-	-	-	-	-	-	-	-	-	-	-
1968	8,882	-	-	-	-	-	-	-	-	-	-	-
1967	8,394	-	-	-	-	-	-	-	-	-	-	-
1966	8,929	-	-	-	-	-	-	-	-	-	-	-

APPENDIX D

Model Year Distribution of Evaporative Certification Standards for Gasoline-Powered Light-Duty Vehicles

Table D-1 Percentage of Model Year Fleet by Evaporative Standard, California Regulatory Region, Passenger Cars															
	2004 Registration Data					2009 Registration Data					2014 Registration Data				
Model Year	Tier 0	Tier 1 (Enhanced)	Tier 2 or LEV II Near Zero	LEV II Zero	Tier 3 or LEV III	Tier 0	Tier 1 (Enhanced)	Tier 2 or LEV II Near Zero	LEV II Zero	Tier 3 or LEV III	Tier 0	Tier 1 (Enhanced)	Tier 2 or LEV II Near Zero	LEV II Zero	Tier 3 or LEV III
1993	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
1996	61.1%	38.9%	0.0%	0.0%	0.0%	59.3%	40.7%	0.0%	0.0%	0.0%	55.3%	44.7%	0.0%	0.0%	0.0%
1997	38.2%	61.8%	0.0%	0.0%	0.0%	37.9%	62.1%	0.0%	0.0%	0.0%	37.8%	62.2%	0.0%	0.0%	0.0%
1998	13.4%	86.6%	0.0%	0.0%	0.0%	12.7%	87.3%	0.0%	0.0%	0.0%	10.9%	89.1%	0.0%	0.0%	0.0%
1999	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2000	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2001	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2002	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2003	0.0%	88.6%	9.8%	1.7%	0.0%	0.0%	88.8%	9.6%	1.7%	0.0%	0.0%	88.2%	10.1%	1.8%	0.0%
2004	0.0%	48.7%	37.1%	14.2%	0.0%	0.0%	49.3%	36.5%	14.1%	0.0%	0.0%	48.4%	37.4%	14.2%	0.0%
2005	0.0%	27.5%	63.5%	9.0%	0.0%	0.0%	26.4%	61.5%	12.1%	0.0%	0.0%	26.2%	61.4%	12.4%	0.0%
2006						0.0%	3.7%	87.5%	8.8%	0.0%	0.0%	3.7%	87.3%	9.0%	0.0%
2007						0.0%	0.0%	87.5%	12.5%	0.0%	0.0%	0.0%	87.1%	12.9%	0.0%
2008						0.0%	0.0%	86.5%	13.5%	0.0%	0.0%	0.0%	86.2%	13.8%	0.0%
2009						0.0%	0.0%	84.5%	15.5%	0.0%	0.0%	0.0%	84.8%	15.2%	0.0%
2010						0.0%	0.0%	83.7%	16.3%	0.0%	0.0%	0.0%	83.5%	16.5%	0.0%
2011											0.0%	0.0%	88.9%	11.1%	0.0%
2012											0.0%	0.0%	84.9%	15.1%	0.0%
2013											0.0%	0.0%	78.4%	21.6%	0.0%
2014											0.0%	0.0%	92.6%	7.3%	0.1%
2015											0.0%	0.0%	78.1%	13.9%	8.0%

Table D-2 Percentage of Model Year Fleet by Evaporative Standard, California Regulatory Region, Light-Duty Trucks															
	2004 Registration Data					2009 Registration Data					2014 Registration Data				
Model Year	Tier 0	Tier 1 (Enhanced)	Tier 2 or LEV II Near Zero	LEV II Zero	Tier 3 or LEV III	Tier 0	Tier 1 (Enhanced)	Tier 2 or LEV II Near Zero	LEV II Zero	Tier 3 or LEV III	Tier 0	Tier 1 (Enhanced)	Tier 2 or LEV II Near Zero	LEV II Zero	Tier 3 or LEV III
1993	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
1996	62.3%	37.7%	0.0%	0.0%	0.0%	64.0%	36.0%	0.0%	0.0%	0.0%	67.8%	32.2%	0.0%	0.0%	0.0%
1997	36.6%	63.4%	0.0%	0.0%	0.0%	37.4%	62.6%	0.0%	0.0%	0.0%	39.0%	61.0%	0.0%	0.0%	0.0%
1998	23.0%	77.0%	0.0%	0.0%	0.0%	24.0%	76.0%	0.0%	0.0%	0.0%	25.8%	74.2%	0.0%	0.0%	0.0%
1999	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2000	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2001	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2002	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2003	0.0%	95.2%	4.8%	0.0%	0.0%	0.0%	95.2%	4.8%	0.0%	0.0%	0.0%	95.2%	4.8%	0.0%	0.0%
2004	0.0%	60.0%	40.0%	0.0%	0.0%	0.0%	60.1%	39.9%	0.0%	0.0%	0.0%	59.8%	40.2%	0.0%	0.0%
2005	0.0%	20.5%	79.1%	0.4%	0.0%	0.0%	17.2%	82.5%	0.2%	0.0%	0.0%	17.2%	82.6%	0.2%	0.0%
2006						0.0%	8.3%	89.6%	2.1%	0.0%	0.0%	8.2%	89.7%	2.1%	0.0%
2007						0.0%	0.2%	98.1%	1.8%	0.0%	0.0%	0.2%	98.1%	1.7%	0.0%
2008						0.0%	0.1%	96.6%	3.3%	0.0%	0.0%	0.1%	96.5%	3.4%	0.0%
2009						0.0%	0.0%	99.4%	0.6%	0.0%	0.0%	0.0%	99.4%	0.6%	0.0%
2010						0.0%	0.0%	95.3%	4.7%	0.0%	0.0%	0.0%	97.0%	3.0%	0.0%
2011											0.0%	0.0%	93.6%	6.4%	0.0%
2012											0.0%	0.0%	94.4%	5.6%	0.0%
2013											0.0%	0.0%	99.4%	0.6%	0.0%
2014											0.0%	0.0%	97.6%	2.3%	0.1%
2015											0.0%	0.0%	97.4%	1.5%	1.1%

Table D-3 Percentage of Model Year Fleet by Evaporative Standard, Federal Regulatory Region, Passenger Cars															
	2004 Registration Data					2009 Registration Data					2014 Registration Data				
Model Year	Tier 0	Tier 1 (Enhanced)	Tier 2 or LEV II Near Zero	LEV II Zero	Tier 3 or LEV III	Tier 0	Tier 1 (Enhanced)	Tier 2 or LEV II Near Zero	LEV II Zero	Tier 3 or LEV III	Tier 0	Tier 1 (Enhanced)	Tier 2 or LEV II Near Zero	LEV II Zero	Tier 3 or LEV III
1993	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
1996	67.0%	33.0%	0.0%	0.0%	0.0%	64.5%	35.5%	0.0%	0.0%	0.0%	61.5%	38.5%	0.0%	0.0%	0.0%
1997	37.4%	62.6%	0.0%	0.0%	0.0%	37.2%	62.8%	0.0%	0.0%	0.0%	37.0%	63.0%	0.0%	0.0%	0.0%
1998	17.1%	82.9%	0.0%	0.0%	0.0%	16.8%	83.2%	0.0%	0.0%	0.0%	15.3%	84.7%	0.0%	0.0%	0.0%
1999	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2000	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2001	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2002	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2003	0.0%	92.5%	6.6%	0.8%	0.0%	0.0%	92.3%	6.8%	0.9%	0.0%	0.0%	91.9%	7.2%	1.0%	0.0%
2004	0.0%	63.0%	27.2%	9.9%	0.0%	0.0%	62.8%	27.6%	9.6%	0.0%	0.0%	61.9%	28.4%	9.7%	0.0%
2005	0.0%	35.0%	57.4%	7.6%	0.0%	0.0%	34.4%	56.4%	9.2%	0.0%	0.0%	34.2%	56.5%	9.4%	0.0%
2006						0.0%	2.3%	91.9%	5.8%	0.0%	0.0%	2.4%	91.7%	5.9%	0.0%
2007						0.0%	0.0%	90.4%	9.6%	0.0%	0.0%	0.0%	90.3%	9.7%	0.0%
2008						0.0%	0.0%	88.7%	11.3%	0.0%	0.0%	0.0%	88.7%	11.3%	0.0%
2009						0.0%	0.0%	85.2%	14.8%	0.0%	0.0%	0.0%	85.0%	15.0%	0.0%
2010						0.0%	0.0%	81.2%	18.8%	0.0%	0.0%	0.0%	82.9%	17.1%	0.0%
2011											0.0%	0.0%	90.7%	9.3%	0.0%
2012											0.0%	0.0%	85.8%	14.2%	0.0%
2013											0.0%	0.0%	82.4%	17.6%	0.0%
2014											0.0%	0.0%	94.2%	5.6%	0.1%
2015											0.0%	0.0%	78.8%	13.6%	7.6%

Table D-4 Percentage of Model Year Fleet by Evaporative Standard, Federal Regulatory Region, Light-Duty Trucks															
	2004 Registration Data					2009 Registration Data					2014 Registration Data				
Model Year	Tier 0	Tier 1 (Enhanced)	Tier 2 or LEV II Near Zero	LEV II Zero	Tier 3 or LEV III	Tier 0	Tier 1 (Enhanced)	Tier 2 or LEV II Near Zero	LEV II Zero	Tier 3 or LEV III	Tier 0	Tier 1 (Enhanced)	Tier 2 or LEV II Near Zero	LEV II Zero	Tier 3 or LEV III
1993	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
1996	66.8%	33.2%	0.0%	0.0%	0.0%	62.3%	37.7%	0.0%	0.0%	0.0%	72.4%	27.6%	0.0%	0.0%	0.0%
1997	37.2%	62.8%	0.0%	0.0%	0.0%	36.6%	63.4%	0.0%	0.0%	0.0%	39.2%	60.8%	0.0%	0.0%	0.0%
1998	29.8%	70.2%	0.0%	0.0%	0.0%	23.0%	77.0%	0.0%	0.0%	0.0%	33.6%	66.4%	0.0%	0.0%	0.0%
1999	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2000	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2001	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2002	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
2003	0.0%	96.9%	3.1%	0.0%	0.0%	0.0%	95.2%	4.8%	0.0%	0.0%	0.0%	96.9%	3.1%	0.0%	0.0%
2004	0.0%	61.3%	38.7%	0.0%	0.0%	0.0%	60.0%	40.0%	0.0%	0.0%	0.0%	61.4%	38.6%	0.0%	0.0%
2005	0.0%	21.6%	78.3%	0.1%	0.0%	0.0%	20.5%	79.1%	0.4%	0.0%	0.0%	17.0%	82.9%	0.1%	0.0%
2006						0.0%	2.5%	96.3%	1.3%	0.0%	0.0%	9.0%	89.9%	1.1%	0.0%
2007						0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	98.9%	0.9%	0.0%
2008						0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	97.8%	2.0%	0.0%
2009						0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	99.2%	0.8%	0.0%
2010						0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	98.5%	1.5%	0.0%
2011											0.0%	0.0%	96.4%	3.6%	0.0%
2012											0.0%	0.0%	94.1%	5.9%	0.0%
2013											0.0%	0.0%	99.7%	0.3%	0.0%
2014											0.0%	0.0%	99.0%	0.9%	0.1%
015											0.0%	0.0%	99.0%	0.5%	0.5%