

# Unregistration Rates for On-Road Vehicles in California

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## ABSTRACT

Motivated by the need to develop regional air pollution control strategies, a comprehensive field study was conducted throughout California to characterize the unregistration rate of light-duty vehicles in the state. Based on an analysis of more than 98,000 vehicle records, the average unregistered rate was found to be  $3.38 \pm 0.13\%$ . This included vehicles unregistered for a period of less than three months (2.41% of the total), vehicles unregistered between three months and two years (0.95% of the total), and vehicles unregistered for more than two years (0.03% of the total). About half of the counties had unregistration rates between 2% and 4%, with most counties' rates below 5%. The unregistered fleet was more heavily weighted toward older vehicles than the registered fleet. Department of Motor Vehicles (DMV) unregistration rates were compared with the field study rates. DMV estimates ranged from 6.2% to 7.5%, which were higher than those obtained in the field study. It was also found that 1.7% of the vehicles identified in the survey were registered outside the state or the country.

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## INTRODUCTION

Development of regional air pollution control strategies requires accurate estimation of the regional emissions inventory. Understanding and accurately portraying the in-use vehicle population is one of the most important aspects of obtaining accurate emissions inventory estimates. The registered vehicle population accounts for a majority of the vehicles on the road, however, unregistered and out-of-state vehicles represent an important proportion of the total inventory as well. Given that the unregistered vehicle population likely includes a higher percentage of older vehicles with emissions too high to meet Inspection and Maintenance (I&M) requirements, these vehicles may have a disproportionate effect on the emissions inventory.

To date, limited information is available on the contribution of unregistered vehicles to the emissions inventory. The California Air Resources Board's (CARB's) EMFAC<sup>1</sup> model provides estimates of current emissions for on-road motor vehicles in the state, based primarily on the population of vehicles registered with the Department of Motor Vehicles (DMV). Unregistered vehicle estimates are a recent addition to the EMFAC vehicle population. In making these estimates, CARB examined DMV records and found that approximately 7.4% of the total records for passenger cars were unregistered (CARB 2000). For the EMFAC2000 model, CARB added approximately 4.5 million vehicles to the in-use California vehicle population to account for vehicles in the process of being registered and those that were unregistered. CARB also estimated that 0.56% of the vehicle population that was chronically unregistered (unregistered for a period of more than 2 years) contribute 1% to the emissions inventory, depending on the pollutant and year being modeled (CARB 2000). CARB did not determine the total contribution from the unregistered vehicle population as a whole, however.

For modeling emissions inventories, states outside of California use the U.S. Environmental Protection Agency's MOBILE<sup>2</sup> model. MOBILE does not explicitly include the contribution of unregis-

tered vehicles in its emissions rate estimates, although provisions are made for states to incorporate unregistered vehicles in their calculations.

Most previous studies of the population of unregistered vehicles have focused on California. Hunstad (1999) conducted a study to characterize uninsured motorists and provide estimates of the number of uninsured and unregistered vehicles. Hunstad examined DMV records and other estimates of unregistration, including studies by the California Energy Commission, estimates based on California Highway Patrol violations, DMV driver's license records, estimates based on surveys, and fatal accident reports. Using these collective studies, Hunstad came up with average yearly estimates of between 8.5% and 11.7% for unregistered vehicles.

Dulla et al. (1992) examined license plate number (LPN) records of vehicles in parking lots in the late 1980s and found total unregistration rates ranging from 8.3% to 9.3% with chronically unregistered vehicles (i.e., greater than 2 years) representing about 0.56% of the in-use fleet. Although the impact of unregistered vehicles on emissions inventories in other states is important, limited information exists on unregistration rates outside of California. North Carolina is one state that has developed a database from accident reports to provide estimates of the vehicle-miles traveled in urban areas by vehicles registered outside of the area (Norowzi 2003).

Data that are available on the population of unregistered vehicles still have considerable limitations. DMV database sources do not, for example, provide a good indication of whether the vehicles travel on the road. The DMV files can contain vehicles that may have become inoperative or may be located outside of the county of record. Because these vehicles are not part of the in-use fleet that would be operated in the designated area, their inclusion would result in an overestimate of the actual on-road fleet's emissions.

The most recent on-road unregistered vehicle population study was conducted over a decade ago in California (Dulla et al. 1992). Since that time, California added a requirement that vehicle owners show proof of insurance before a vehicle's registration can be issued or renewed. Furthermore, I&M

<sup>1</sup> EMFAC is short for Emission FACtor.

<sup>2</sup> MOBILE = Mobile Source Emission Factor Model.

testing procedures have been increased from an idle to a dynamometer test at 15 mph and 25 mph in areas that do not meet air quality standards. The possibility exists that these two requirements may contribute to the increased number of unregistered vehicles in the state, especially poorly maintained vehicles that cannot pass a smog test.

Given the potentially significant emissions inventory impact and the limitations of the current unregistered vehicle population estimates, improving the understanding of both the number and types of unregistered vehicles on the road is important. The objective of this work was to obtain a better understanding of the population and characteristics of unregistered vehicles. As the primary component of this study, a statewide field survey was conducted to provide an estimate of the unregistered vehicle population. As part of the survey, a database of more than 98,000 vehicle LPNs was obtained. This survey represents the most comprehensive study of vehicle unregistration rates to date and encompasses all regions of California. In addition to the total unregistration rate, the following information was collected:

- a breakdown of the time period of unregistered status into instantaneous (less than 3 months), long term (3 months to 2 years) and chronic (more than 2 years) categories by county for California;
- characteristics of unregistered vehicles including, but not limited to, model year; and
- the percentage and identity in each county of non-California vehicles or vehicles that originated out of county.

Durbin et al. (2002) presents the detailed results of this survey.

## **METHODOLOGY**

A comprehensive field survey was conducted to determine the population of unregistered vehicles in California. The survey involved photographing license plates of vehicles that were parked in commercial parking lots to obtain registration and other information. Data were collected between June and December 2000.

A county-based stratified random sample of all California counties was conducted, with the sampling population and number of sites in each of the larger counties proportional to the county population. To ensure that the sample was demographically representative, each county was resolved to the zip code level, with zip codes selected randomly from the list of all zip codes in each county. Within the selected zip codes, as many commercial parking lots were surveyed as possible. Where security, sample team safety, or geographic size prevented complete sampling, locations were geographically balanced across the zip code. To ensure a reasonable distribution of destination types, a minimum number of sites in each county was sampled. In total, 409 zip codes were sampled during the field study, out of a total of 1,586 zip codes in California at the time of study. Because the zip codes included national parks and forests, sampling in those areas was performed as appropriate for a given county.

The sites for this study were restricted to destinations rather than residences. This provided a high probability that the vehicles captured in the survey were driven on a regular basis. Sites were also selected to represent a variety of different destinations. The primary collection sites were shopping malls, businesses, and retail stores, although the range of sites also included park and ride lots, medical facilities, and others. Overall, the different site types did not show significant variation in unregistration rates. In particular, all but one of the site types where at least 1,000 samples were collected had unregistration rates within 1% of the overall average (Durbin et al. 2002). It should be noted that this site selection and sampling methodology might not be fully representative of all vehicles distributed throughout the state. Families with multiple vehicles, for example, may use a specific vehicle for some applications such as shopping, while other vehicles may be used for longer trips or other tasks.

Consideration was given to sampling vehicles during actual driving on the road (i.e., with a license plate recorder) to obtain a broader cross section of vehicles. Because the primary purpose of this study was for support of development of the CARB EMFAC model, this approach was not chosen. In particular, it was thought that the fleet obtained

from sampling on the road would be more heavily weighted by vehicle-miles traveled and would be less consistent with the in-use population data presently used in CARB's EMFAC from the DMV.

To collect the data at each specific site, one to two photographers, using digital cameras with a reload time of less than a second between shots, took pictures while riding in a car as it slowly moved through a parking lot. Data from the photographic records were entered and compiled into a spreadsheet along with other information, such as the date and time of the site visit and a description of the site and its location (city, county, and zip code). The vehicle make and model were determined for roughly half of the vehicles photographed. The data were validated by double entry and cross-checking a 5% subsample as well as random spot checks of individual vehicles. The error rate for data entry of LPNs was consistently below 1%.

Given the nature of the rapid data collection in the field and the need to get large numbers of records, a percentage of the LPN photographs collected in the field were unreadable. The overall unreadable LPN rate averaged about 15% with a range from 1% or 2% to over 40% in some zip codes. Sites surveyed during rain events or near sundown made up the highest percentages of unreadable LPNs. Field teams generally attempted to collect 10% to 20% more photographs for each zip code to compensate for the expected unreadable percentage.

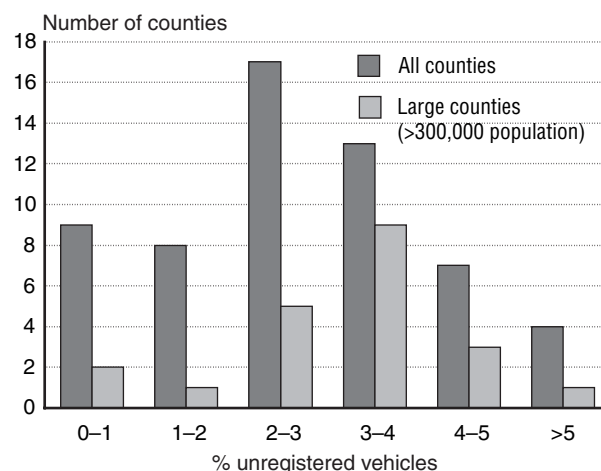
## RESULTS

### County Unregistration Rates

The field survey brought in more than 98,000 records. Table 1 presents data analysis for all counties with more than 1,000 samples and for the entire field survey sample population. (See Durbin et al. (2002) for detailed records for all counties).

Vehicles were considered to be unregistered if the year sticker was 1999 or older, regardless of the month, and registered if the year sticker was 2001. For vehicles with year 2000 stickers, the month of registration was evaluated against the time period when the vehicle was identified to determine the registration status. The percentage unregistered was calculated by dividing the number of unregistered

**FIGURE 1 Percentage of Unregistered Vehicles in Large and All Counties**



vehicles by the sum of registered vehicles, unregistered vehicles, and dealer plates (registration is paid at the time of vehicle purchase, so vehicles with dealer plates were considered registered).

The overall average unregistration rate for all surveyed vehicles was  $3.38 \pm 0.13\%$ , where the uncertainty represents the 95% confidence interval based on the sampling statistics (Vollset 1993). The unregistration rate ranged from 0% to 6.45% for different counties. Figure 1 presents the data for all the surveyed counties and for the most populous counties (population > 300,000). These data show that roughly 50% of the counties have unregistration rates ranging between 2% and 4%. Nearly all counties had unregistration rates below 5%. In general, larger counties had slightly higher unregistration rates than the overall distribution, with unregistration rates in larger counties generally ranging from 2% to 5%.

Counties with unregistration rates of less than 1% tended to be smaller, with sample sizes of fewer than 500 vehicles. In some small counties, the field data contained no unregistered vehicles. Alpine County has the highest rate of unregistered vehicles at 6.45%, but this figure may be due in part to the small sample size for that county. Data show that Calaveras, San Diego, and Madera counties have the next-highest unregistration rates of 5.22%, 4.99%, and 4.51%, respectively.

A one-way ANOVA test showed highly statistically significant differences in registration rates between different counties in the study ( $p < 0.0001$ ).

**TABLE 1 Registration Rates by County**

County	Total	Registered	Unregistered	Instantaneous	Long term	Chronic	Dealer	Front	No plate	Out of state	Out of country	Unknown	% unreg
Los Angeles	25,835	20,153	749	535	211	3	317	2,146	15	214	3	2,238	3.53
San Diego	9,584	7,226	385	300	83	2	110	708	3	230	22	900	4.99
Orange	9,468	7,421	251	171	76	4	169	665	18	138	4	802	3.20
San Bernardino	4,417	3,115	117	72	44	1	89	314	11	148	0	623	3.52
Riverside	4,262	3,026	144	83	60	1	94	238	6	123	0	631	4.41
Santa Clara	4,109	3,084	91	55	33	3	74	271	6	43	0	540	2.80
Alameda	3,529	2,688	72	54	18	0	52	238	1	38	0	440	2.56
Sacramento	3,337	2,573	90	50	37	3	53	233	12	37	0	339	3.31
San Francisco	2,840	2,154	100	74	25	1	33	226	3	85	0	239	4.37
San Mateo	2,705	2,112	75	54	19	2	35	144	8	60	0	271	3.38
Contra Costa	2,597	1,929	42	30	12	0	44	131	3	21	0	427	2.08
Ventura	2,073	1,574	61	48	13	0	43	120	1	22	0	252	3.64
Fresno	2,059	1,652	67	53	14	0	33	146	0	2	0	159	3.82
Santa Barbara	1,464	1,144	37	27	10	0	20	74	0	32	0	157	3.08
Sonoma	1,404	1,100	28	17	11	0	7	54	1	7	0	207	2.47
Kern	1,401	1,042	46	37	9	0	16	130	1	4	0	162	4.17
Stanislaus	1,329	1,076	40	29	11	0	2	94	1	8	0	108	3.58
<b>All counties</b>	<b>98,817</b>	<b>75,168</b>	<b>2,677</b>	<b>1,906</b>	<b>749</b>	<b>22</b>	<b>1,302</b>	<b>7,091</b>	<b>108</b>	<b>1,599</b>	<b>111</b>	<b>10,761</b>	<b>3.38</b>

Key: *County* = the county where the data was collected, not necessarily the county where the vehicle was registered.

*Registered* = vehicle had a current California registration.

*Unregistered* = vehicle had an expired California registration.

*Front* = vehicle's LPN was captured from the front of the vehicle. Because California vehicles only have registration tags for rear license plates, no registration information is available from the front plate.

*Dealer* = vehicle's LPN was a paper plate or a dealership plate of a newly purchased vehicle being used until the issued license plate is received.

*Unknown* = vehicles for which either the photographic quality prevented identification of the month if the vehicle had a registration year of 2000 or the year sticker was missing.

The individual zip code data contained a wider range of unregistration rates than the overall county data. Kern, San Diego, Santa Cruz, and San Benito counties each had one zip code with an unregistration rate above 20%, although most of these zip codes had limited sample sizes. Only the San Diego zip code contained a significant sample size (507).

In analyzing the data, correlations between the unregistered vehicle population percentage and demographic variables such as household income were examined. Using data obtained from the 2000 census, regression analyses revealed the influence of household income, total county population, and renter/owner percentage on unregistration rates at both the county and zip code level, using the unregistration rate as a dependent variable. Zip codes with fewer than 25 vehicles were removed from this analysis, because the small number of samples makes estimation of the rate of registration highly variable. A statistically significant regression ( $p = 0.004$ ,  $R^2 = 0.250$ ) for household income was found at the county level. This regression was not statistically significant on the zip code level, however, and the low  $R^2$  value of regression at the county level indicates that the relationship does not explain the majority of the variability observed in the unregistration rate. Statistically significant regressions of at least the 90% confidence level were found between unregistration rates and population at the county level ( $p = 0.096$ ,  $R^2 = 0.049$ ) and the registration zip code level ( $p = 0.007$ ,  $R^2 = 0.009$ ) but not the zip code where the vehicle was observed ( $p = 0.658$ ). Again, the low  $R^2$  values indicate that none of these relationships can account for most of the observed variability in unregistration status, although such research may be of interest in the future.

The overall 3.38% unregistered rate was broken down by the length of time a vehicle was unregistered. A total of 2.41% of the California licensed vehicles were classified as instantaneous (<3 months) unregistered. A total of 0.95% of the California licensed vehicles were classified as long-term (3 months to 2 years) unregistered. Chronic (>2 years) unregistered accounted for 0.03% of the California licensed vehicles.

A subset of vehicles operated in California were registered in other states or countries. As shown in table 1, this represents approximately 1.7% of the vehicles in this survey. In general, higher percentages of out-of-state vehicles were found in the border counties and in counties having zip codes with well-known tourist attractions. Border counties such as Del Norte, Sierra, Nevada, Alpine, Inyo, Imperial, and Kings County in the Central Valley all had relatively high proportions (>10%) of out-of-state vehicles. (Durbin et al. (2002) provide a map of out-of-state vehicle percentages by county.)

### Comparisons with DMV Data

The data obtained from the field study were cross-referenced with two different DMV databases to determine the DMV registration status of the vehicles identified in the field survey. Because the field survey included only vehicles used typically on the road, this should represent a more accurate estimate of the unregistered population than a straight DMV run that could include a mixture of vehicles used infrequently or not at all. The DMV databases used for this comparison correspond to late 1998 and 2001.

Table 2 provides a comparison of the DMV results and the field survey registration status for the April 2001 DMV database. The results for the 1998 DMV database were similar and are presented elsewhere (Durbin et al. 2002). Overall, the DMV database shows a similar profile of unregistered vehicles, with roughly half as many long-term unregistered vehicles in comparison with instantaneous unregistered vehicles and smaller numbers of chronically unregistered vehicles. Differences were observed, however, for the various registration categories between the DMV database and the field study. For example, a number of vehicles identified as registered in the field were unregistered in the DMV database and vice versa.

Several possible explanations exist for the vehicles observed to be registered in the field survey, but subsequently found to be unregistered. First, differences between the time of the field survey and the time of the DMV run may account for the discrepancy. In particular, vehicles registered at the time of the field study may have subsequently fallen out of

**TABLE 2 Cross-Tabulation of Registration Status with the 2001 DMV Database**

Field study status	Total	DMV registered	DMV unregistered	DMV instantaneous	DMV long term	DMV chronic
Registered	70,418	65,425	4,993	3,630	1,156	207
Unregistered	2,459	2,124	335	107	201	27
Instantaneous	1,771	1,636	135	20	106	9
Long term	670	480	190	86	93	11
Chronic	18	8	10	1	2	7
Front	6,627	6,092	535	307	193	35
Unknown	9,153	8,397	756	136	573	47
<b>Total</b>	<b>88,657</b>	<b>82,038</b>	<b>6,619</b>	<b>4,180</b>	<b>2,123</b>	<b>316</b>

registration. The fact that a majority of the vehicles in this category were found to be instantaneously unregistered supports this conclusion. A second possibility is that some vehicles identified as registered in the field had stolen tags or switched LPNs, although this probably represents a smaller fraction of the vehicles.

Interestingly, many of the vehicles found to be long-term or chronically unregistered in the field study were also found to be registered. For vehicles found to be unregistered in the field but registered with the DMV, it is probable that the vehicle was registered subsequent to the field study. This would account for the large percentage of instantaneously unregistered vehicles in the field study that were found to be subsequently registered with the DMV. Given the small number of vehicles in this category, it is possible that the owners of these vehicles simply did not adhere their registration stickers. Another subset of vehicles were long-term unregistered in the field study but instantaneously unregistered in the DMV. This subset of vehicles could be attributed to a combination of factors including an unattached or stolen sticker in conjunction with a subsequent late registration.

Differences also exist in the total unregistration rate between the two DMV databases and the field study results. For the 2001 DMV database run, for example, the unregistration rate was approximately 7.5% compared with the 3.38% obtained from the field results. The 1998 DMV database shows a higher estimated unregistration rate of 6.2%. It should be noted that since the data entry error rate for the field study records was typically below 1%,

we anticipate that this accounts for only a small portion of the observed discrepancy.

### **Unregistered Vehicle Model Year Distributions**

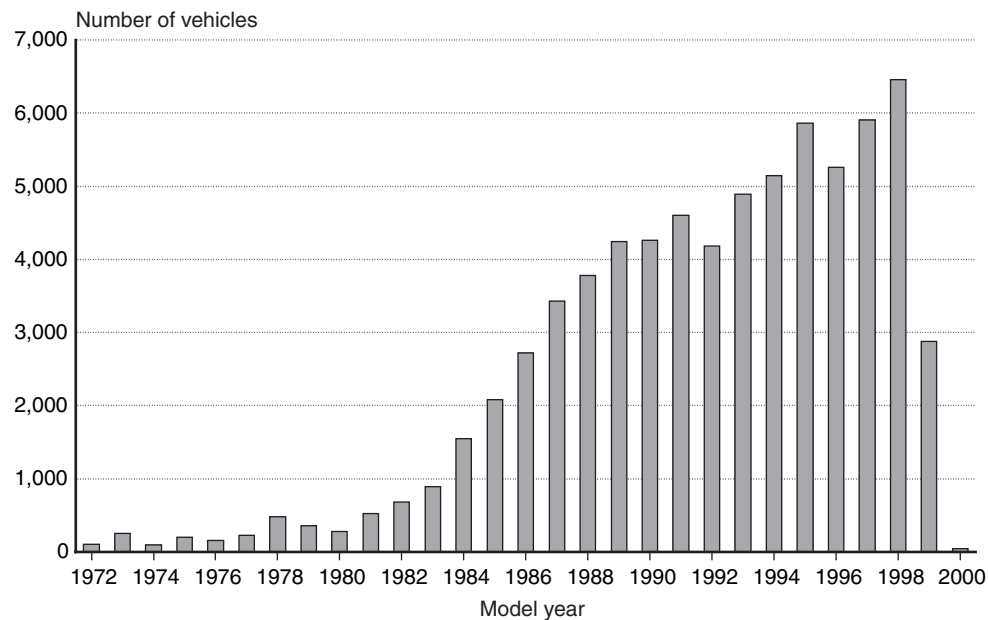
The observed LPNs from the field study were also cross-referenced with DMV records to obtain the model year for all vehicles having readable LPNs. Figure 2 presents a model year distribution for all observed vehicles. The model year distribution is heavily weighted to newer vehicles, as expected.

Figure 3 shows the model year for vehicles unregistered for more than 3 months (i.e., long-term and chronic unregistered vehicles), using data from the field study. Figure 4 shows the percentage unregistered for each model year category. For model year 2000 vehicles, 1 out of 10 had a long-term unregistered status, causing the percentage for that model year to be high. When compared with figure 2, the unregistered vehicle population is more heavily weighted to the older model years.

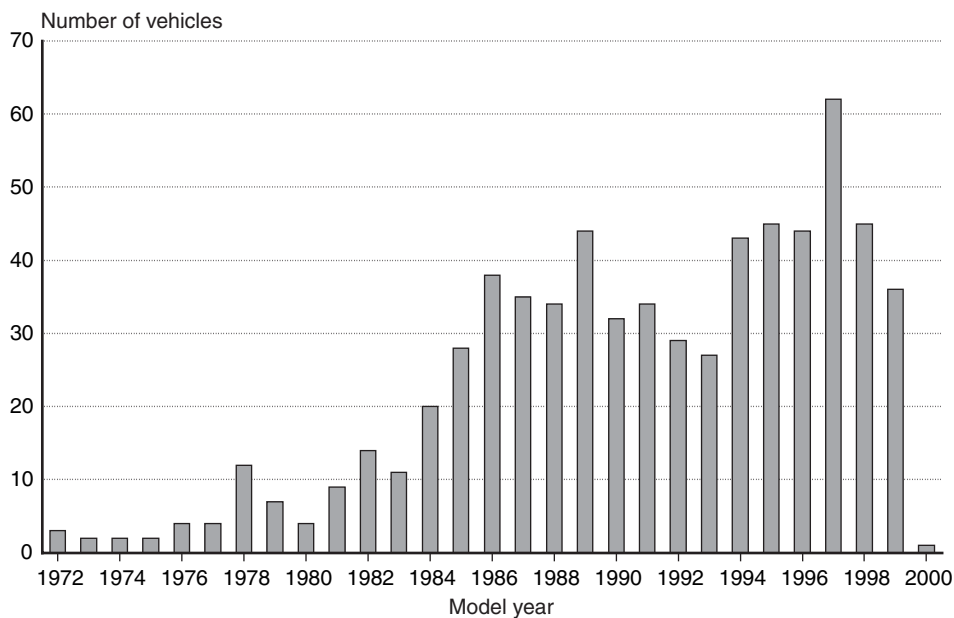
### **Comparison with Inspection and Maintenance Data**

To better understand the relationship between unregistration rates and the requirements that vehicles pass an I&M test for registration, field study records were cross-referenced with I&M records. To do this, the LPNs for all registered and unregistered vehicles (over 90,000) were sent to the Bureau of Automotive Repair (BAR). BAR provided I&M test results from mid-1996 to the present for all vehicles with a license plate match. The observed plates were matched with data from both the BAR90 and BAR97 programs.

**FIGURE 2 Model Year of all Observed Vehicles**



**FIGURE 3 Model Year of all Unregistered Vehicles for Less Than 3 Months**



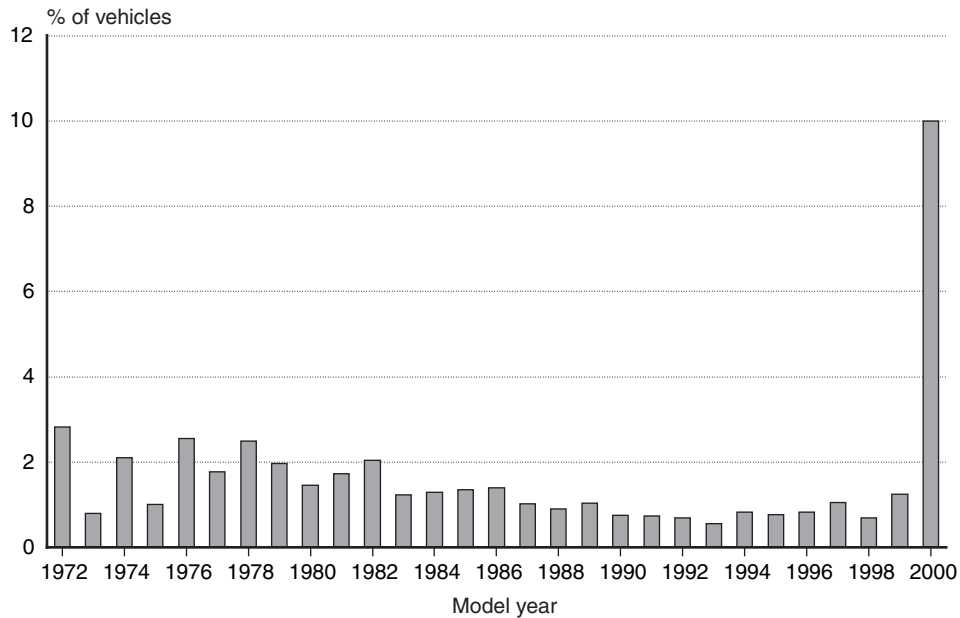
Note: An older version of the DMV database was used to determine the model year, hence, information on 1999 and 2000 model-year vehicles was limited.

The BAR90 and BAR97 programs represent two levels of I&M programs in California. The BAR90 program, an older emissions test, uses a two-speed idle test. The BAR90 program is used only in areas of California that do not require enhanced I&M. The BAR97 program, in use since 1998 in enhanced I&M areas of California, employs an accelerated simulation mode dynamometer test at 15 mph and 25 mph.

BAR rates data as “good” or “bad.” Bad files can indicate unknown or aborted tests or records with incorrect entries such as the vehicle identification number (VIN). Because the data were matched based on LPNs instead of VINs, these bad records were initially included and the aborted and unknown tests were subsequently separated out. The cross-tabulation of the I&M data and the observed data yielded 66,436 matching records.



**FIGURE 4 Percentage of Total Vehicles, by Model Year that are Unregistered for More Than 3 Months**



Bad data accounted for only 1,400 records out of the 66,436 BAR matches.

Table 3 presents a comparison of registration status and I&M test results. The I&M test results are broken into six categories: passed, failed, gross polluter, tampered, test aborted, and unknown (where no results were recorded). The results show the majority of the vehicles in all categories passed their last I&M. A large number of unknown and aborted I&M results come from the BAR-classified bad data. Overall, the percentage of vehicles passing the last I&M drops with the length of time since the vehicle was last registered. A chi-square test of independence between smog check results and unregistration status showed that the differences in the overall failure rate for the registered vehicles and instantaneous and long-term unregistered vehicles were statistically significant at the 0.0001 level. Chronically unregistered vehicles were not included in this chi-square test due to the small number of samples. The test indicates that smog check results are not independent of observed registration status, with a higher proportion of unregistered vehicles failing the smog check test. Interestingly, three vehicles that were chronically unregistered when observed by the survey team in 2000 had since taken and passed an I&M test in 2001. One vehicle identified as unregistered in the field study was

tested and found to be a gross polluter in 2000, indicating that the lack of registration for the vehicle may have been related to failing the I&M.

The I&M failures rates for the matched vehicles from the survey are less than the average failure rate for all vehicles taking the test in the state, which is slightly above 15% (CARB/BAR 2004). Because the fleet surveyed represents vehicles driven on a more regular basis, it is probable that the survey vehicles are newer than recorded during I&M. Furthermore, vehicles that are model years 1991 or newer have failure rates below the statewide average, while vehicles from the early 1980s have more than double the statewide average for failed inspections (CARB/BAR 2004). Vehicles that initially fail the I&M test can also pass a retest after repair to obtain registration.

## DISCUSSION AND CONCLUSIONS

Overall, the results of this study showed a generally consistent average statewide unregistration rate of between 3.4% to 7.5%, with an additional 1.7% of the vehicles registered out of state. The DMV and field studies also yielded similar distributions of largely instantaneous unregistered vehicles, with smaller numbers of chronic and long-term unregistered vehicles. Although differences were observed in the specific unregistered populations, both show

**TABLE 3 Cross-Tabulation of BAR Smog Check Test Results with Registration Status**

Field status	Number	Passed		Failed		Gross polluter		Tampered		Aborted		Unknown	
		#	%	#	%	#	%	#	%	#	%	#	%
Registered	51,974	50,423	97.0	682	1.3	250	0.48	25	0.1	391	0.8	203	0.4
Instantaneous	1,449	1,385	95.6	30	2.1	13	0.90	2	0.1	12	0.8	7	0.5
Long term	601	549	91.4	18	3.0	19	3.16	2	0.3	10	1.7	3	0.5
Chronic	13	11	84.6	1	7.7	1	7.69	0	0.0	0	0.0	0	0.0
Front	4,921	4,716	95.8	91	1.9	44	0.89	4	0.1	44	0.9	22	0.5
Unknown	7,387	7,015	95.0	157	2.1	66	0.89	13	0.2	83	1.1	53	0.7
<b>Total</b>	<b>66,346</b>	<b>64,100</b>		<b>979</b>		<b>393</b>		<b>46</b>		<b>540</b>		<b>288</b>	

Key: BAR = Bureau of Automotive Repair.

trends that, on a continuous basis, approximately 3% to 8% percent of the on-road vehicle population is unregistered and needs to be accounted for in emissions inventory models.

The results of this study can be compared with those from a limited number of other estimates. BAR has conducted some analyses of remote sensing device (RSD) data collected throughout the state as part of various studies over the years (Amlin 2002). From this data, BAR found that vehicles unregistered for a period of more than one year comprised approximately 0.6% to 0.7% of the on-road fleet. Because the RSD data would tend to be more heavily weighted toward vehicle-miles traveled (VMT), the BAR estimate includes an adjustment to compensate for older unregistered vehicles that would be driven fewer miles. The BAR study also found that the VMT for unregistered vehicles is significantly lower than the VMT for registered vehicles.

For comparison with these results, the percentage of vehicles unregistered for more than one year was determined using the present data. Of the vehicles in the field study, 0.15% were unregistered for a period of more than one year, which was less than the BAR estimates. BAR also examined the DMV database and found that between 5.1% and 5.5% of the DMV population had delinquent registration but renewed at some point in time.

Dulla et al. (1992) conducted an earlier parking lot survey of unregistered vehicles in the South Coast Air Basin of Southern California during 1989. In their field study, these researchers found that approximately 9.3% of vehicles had expired

license plates, with fewer than 2% of the vehicles unregistered for more than one year. These values are higher than the 3.38% overall unregistration with less than 1% unregistered for more than one year found in the present study.

In looking more specifically at the counties sampled in the Dulla et al. study, the unregistered rates in Los Angeles, Orange, Riverside, and San Bernardino Counties in this field study were 3.53%, 3.20%, 4.41%, and 3.52%, respectively; also lower than those found by Dulla et al. It is worth noting that the sample population in the Dulla et al. study was targeted more toward older vehicles, because the vehicles randomly sampled in parking lots are likely to be newer than the universe of vehicles found in the DMV database, and older vehicles are typically driven less. In fact, the sample population included a larger portion of older vehicles than the DMV population. Since the DMV data include a larger percentage of older vehicles than the on-road population, it is possible this estimate is biased high relative to the on-road population. In this regard, for vehicles less than 10 years of age, Dulla et al. (1992) found the unregistered population was 6.9%.

Hunstad (1999) also provided some estimates of unregistered vehicles based on available database sources including California Energy Commission data, California Highway Patrol (CHP) citations, driver's license records, surveys, and fatal accident reports. Estimates based on vehicle-not-at-fault in fatal accidents, CHP violations, and DMV records for vehicles unregistered less than one year were all in the range of 8% to 12% on an annual basis. Analysis of driver's license citations, on the other

hand, indicated a 3% to 4% unregistration rate. Citations appearing on driver's license records differ somewhat from other citation sources in that only convictions appear on an individual's driver's license record, not citations that are ruled unjustified by the court. In each of the categories examined by Hunstad, a number of factors could bias this estimate upward or downward. In general, these data should provide a rough estimate of the unregistered percentage. Not-at-fault fatal accident victims data are probably one of the less biased data sources, but include a large fraction of unknown license plates that had to be accounted for in the estimated unregistered percentage. This unknown category is for vehicles for which there is no identifying information, perhaps because the vehicle left the scene, or for which no DMV records could be found.

Surveys of unregistered ownership were also analyzed with unregistration rates found to be between 7% and 16%. For these surveys, it is important to note that estimates based on ownership of unregistered vehicles would be biased high relative to on-road population estimates if the vehicles are not driven on a regular basis. Data collected in surveys tend to support this hypothesis.

The results of the present study indicate that the population of unregistered vehicles was biased toward older vehicles relative to the total on-road fleet. To this extent, it is estimated that unregistered vehicles would make a disproportionate contribution to the emissions inventory on a population basis. Smog check records also indicate a higher percentage of failures for unregistered vehicles. The majority of the unregistered vehicles in all categories were found to pass their last smog check, however, indicating this is probably not the most significant contribution to the unregistered vehicle population.

Given the differences in unregistration rates found for various methodologies, further research should be conducted in this area. In particular, our results indicate there could be a range of as much as 3% to 8% for estimates of unregistered vehicles, with a wider range of estimates when other studies are also considered. With the higher emissions rates that can be assumed for the older unregistered vehicle fleet, this could represent a considerable uncertainty in emissions inventory estimates.

Within this study, more detailed analysis and comparison between the field study results and the DMV results could provide some important insights into this issue. In particular, for vehicles whose registration status does not match between the field study and the DMV results, the individual LPN records could be analyzed to better understand these differences. The analysis of the individual vehicle records would allow a better determination of whether the differences can be attributed to variations in the time period of the population snapshots, stolen stickers or license plates, errors in the database, or other factors.

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