Report No. SR09-03-01

Evaluation of the California Smog Check Program Using Random Roadside Data

prepared for:

California Air Resources Board and California Bureau of Automotive Repair

March 12, 2009

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1. EXECUTIVE SUMMARY

Under contract to the California Air Resources Board (ARB) and the Bureau of Automotive Repair (BAR), Sierra Research, Inc. (Sierra) analyzed data collected in BAR's Roadside Inspection Program to evaluate the effectiveness of the Smog Check program. Under the Roadside Inspection Program, vehicles are randomly recruited for inspection at checkpoints set up by the California Highway Patrol (CHP) using a stratified sampling protocol giving preference to older, higher emitting vehicles. BAR staff perform a visual inspection of each vehicle and use portable dynamometers and analyzers to measure emissions with the same Acceleration Simulation Mode (ASM) test procedure used in Smog Check stations. The data provide an independent measure of in-use emissions performance of California's fleet subject to the Smog Check program and can be compared to data being reported by Smog Check stations.

One objective of the evaluation was to compare the post-Smog Check performance of older, pre-1996 vehicles to the post-Smog Check performance determined from a previous evaluation of Roadside data collected in 2000-2002. Under the previous evaluation, it was found that:

> *For pre-1996 model year vehicles that fail their initial Smog Check inspection and receive a passing score on a re-test, 40% were failing again on the roadside within a year of the passing test.*

It should be noted that the 40% failure rate referenced above applies to the exhaust emissions standards and does not account for visual or functional inspection failures present in vehicles that passed the tailpipe standards. Based on Roadside data collected between February 2003 and April 2006, the percent of pre-1996 vehicles failing the emissions test at the roadside within one year of passing a re-test at a Smog Check station has increased from 40% to 49%. When visual and functional failures are included, the Roadside failure rate for vehicles that failed the initial inspection during their previous Smog Check increases to 59%.[1] Post-Smog Check deterioration contributes to the failure rate; however, our analysis of available data indicates that many of the vehicles that initially failed during the previous Smog Check cycle either were not actually repaired or were repaired only temporarily. The excess emissions associated with these vehicles are

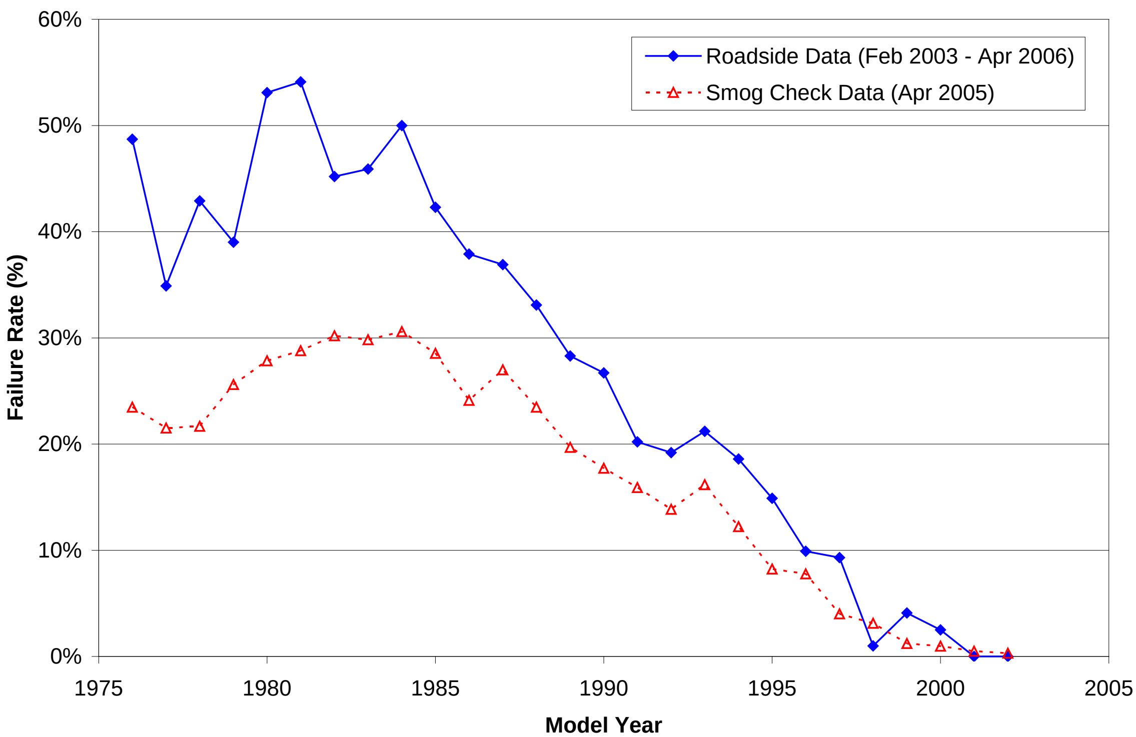
[1] The addition of visual and functional failures would increase the failure rate for vehicles in the 2000-2002 roadside sample also, but this calculation was not performed in the prior study.

estimated at 70 tons per day of hydrocarbons (HC) plus oxides of nitrogen (NOx).[2] Additional details regarding the analysis are set forth below.

Roadside Inspection Program Update

A comparison of model-year-specific tailpipe ASM failure rates from the Roadside data[3] to those observed in the Smog Check program (for April 2005) is shown in Figure 1-1. On average, the failure rate measured in the Roadside Inspection Program is about 1.5 times the failure rate reported on initial tests in the Smog Check program for pre-1996 model year vehicles. This is consistent with previous analyses and may be due in part to pre-inspection maintenance being performed in advance of the official Smog Check test, which is allowed under current law. However, further analysis is required to determine whether other factors are contributing to the difference in failure rates.

Figure 1-1
Roadside vs. Smog Check Program Initial Test ASM Failure Rates



[2] It should be noted that the 70 tons/day increment derived from roadside ASM data is a measure of station performance and the potential for program improvement, but cannot be compared to the I/M benefits in the State Implementation Plan (SIP). Roadside ASM data cannot be directly used in the EMFAC emissions model that is used for California SIPs.

[3] The Roadside data used for this analysis were collected between February 2003 and April 2006, with the bulk of the data collected between April 2005 and April 2006.

As noted above, previous analysis of Roadside data collected in 2000-2002 indicated that 40% of 1974-1995[4] model year Smog Check failures that had been re-tested and certified as passing in the program were failing at the roadside within a year. As shown in Table 1-1, our analysis of the newer (2003-2006) Roadside dataset indicates that 49% of 1976-1995 model year Smog Check failures are failing again within a year of a passing re-test. Thus, the "40%" failure rate has increased to 49% based on the newer Roadside dataset. It should be noted that the vehicles in the newer Roadside dataset are, on average, older than in the previous analysis, and therefore a higher failure rate would be expected. However, a greater concern are vehicles reported as passing the re-test at a Smog Check station that did not actually pass.

Table 1-1
Roadside ASM Tailpipe Failure Rates for Pre-1996 Model Year Vehicles Tested at the Roadside within One Year following a Passing Smog Check (2000-2002 vs. 2003-2006 Roadside Data)

Initial Smog Check Result	2000-2002 Roadside Results	2003-2006 Roadside Results
Fail*	40%	49%
Pass	10%	19%
Overall Roadside Fail Rate	15%	24%

*Note: Although these vehicles failed their initial Smog Check, they eventually were certified as passing the inspection, but subsequently failed a roadside inspection.

Also shown in Table 1-1 is the Roadside failure rate for vehicles that passed their initial inspection within a year prior to the Roadside test. The 2000-2002 Roadside data showed a 10% failure rate for 1974-1995 model year vehicles in this category. The 2003-2006 Roadside data showed a 9% increase in this failure rate (19% overall) for 1976-1995 model year vehicles. (When visual and functional failures are accounted for, the roadside failure rate for vehicles that passed their initial inspection during the prior Smog Check cycle increases to 31%.)

To understand the possible cause of the high ASM tailpipe emission failure rates shown in Table 1-1, roadside failure rates were also analyzed as a function of time following the Smog Check inspection. For this analysis, data were segregated into four time bins: (1) 0-6 months following a Smog Check inspection; (2) 6-12 months following inspection; (3) 12-18 months following inspection; and (4) 18-27 months following inspection. The last time bin was extended beyond two years to allow additional time for motorists that might delay the completion of their biennial inspection cycle.

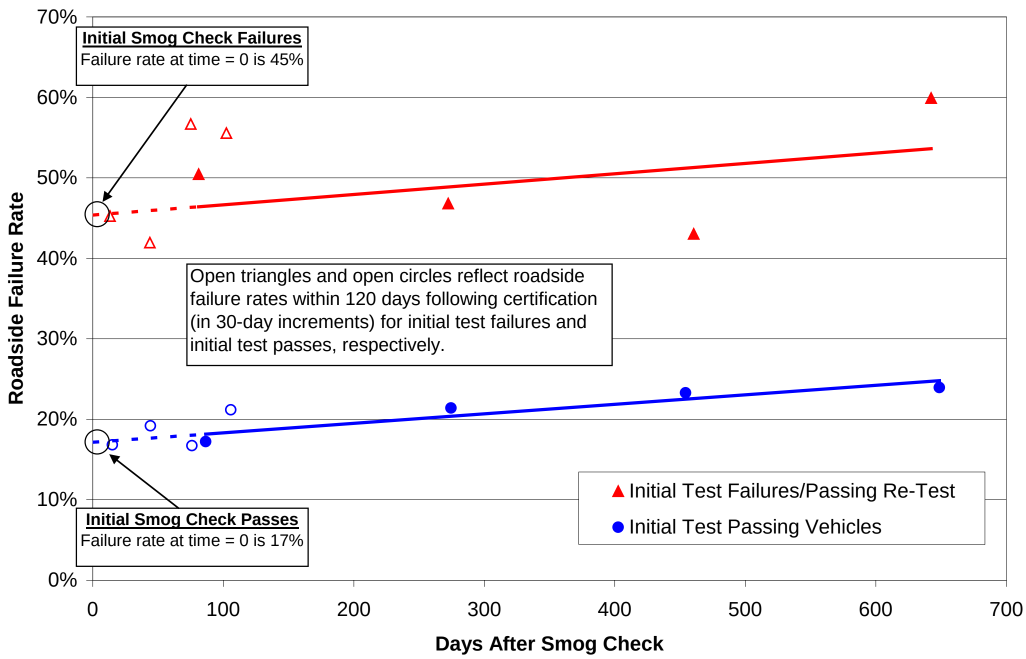
The results are presented in Figure 1-2 separately for vehicles that were initial test failures and initial test passes during their previous Smog Check cycle. The straight lines fit through the averages of the binned data cross the y-axis ("0" days after Smog Check)

[4] 1974 and 1975 model year vehicles are no longer subject to the Smog Check program as of April 2005.

at a relatively high failure rate of 17% for vehicles that passed their initial Smog Check and 45% for vehicles that initially failed. This indicates that there appears to be a high failure rate at the roadside immediately following a passing Smog Check inspection for both initially passing vehicles and initially failing vehicles. If all of the vehicles actually passed their last test at a Smog Check station, it would be expected that the lines should go through the origin (i.e., zero failures at time = 0 following certification), but they do not.

Figure 1-2

Roadside Tailpipe ASM Failure Rates for 1976-1995 Model Year Vehicles for Initial Smog Check Test Passing and Failing Vehicles Certified at Time = 0



The "hollow" data points shown on Figure 1-2 represents subsets of data from the 0-6 month bin. Each hollow point represents data from four 30-day periods following the official Smog Check inspection: 0-30 days, 31-60 days, 61-90 days, and 91-120 days. The fact that these data points fall along the same lines provides additional evidence that most vehicles observed to be failing at the roadside were failing immediately after having been reported as passing at a Smog Check station.

Further data analysis found that the high failure rates following the Smog Check inspection do not appear to be explained by owner tampering following a passing test. Considering all of the vehicles tested at the roadside test, the tampering rate for vehicles that initially failed during their previous Smog Check cycle was only 9%, which was not significantly different from the 8% tampering rate for vehicles that initially passed their Smog Check.

An analysis was also conducted to determine whether the higher roadside failure rates observed for vehicles that initially failed their last Smog Check might have been due to test-to-test variability. Vehicles that were marginally passing the test would be more likely to fail a subsequent test due to test-to-test variability. However, the average passing test results for vehicles that initially failed were almost identical to the average test results for vehicles that initially passed. In fact, on average, the HC and NOx emissions for both groups of vehicles were only 45% of the emissions standards. Carbon monoxide (CO) emissions were even lower.

Station Performance Analysis

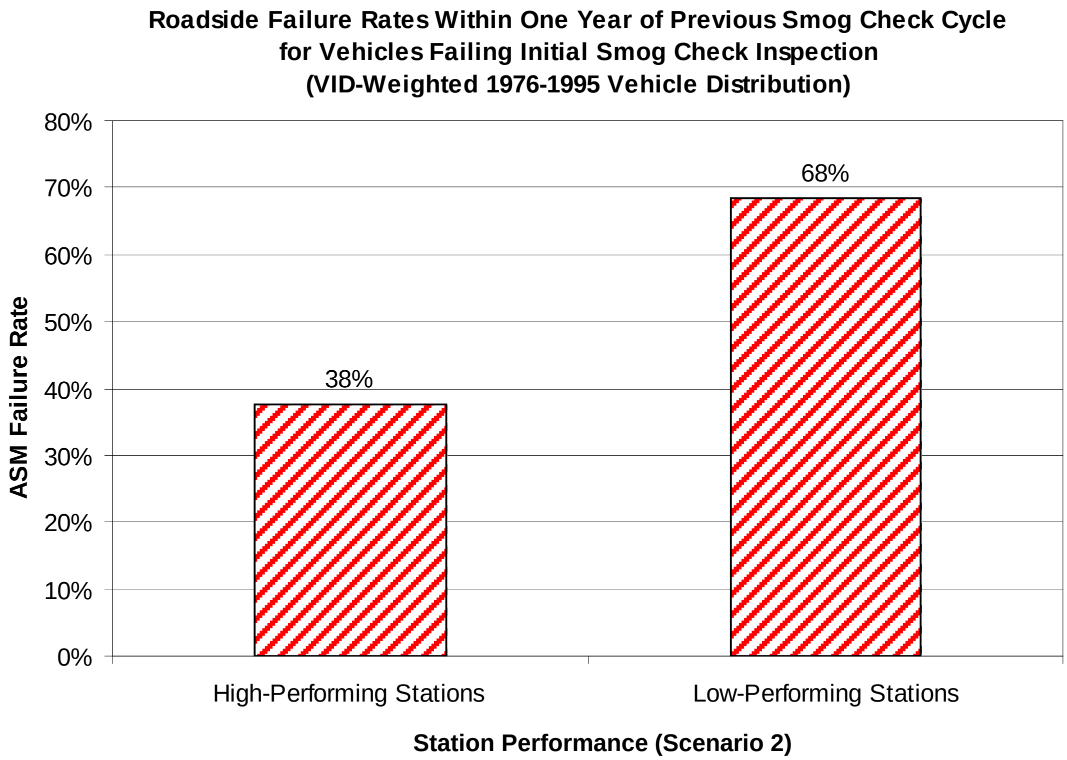
To gain further insight as to why almost half of the vehicles reported as passing Smog Check after initially failing are again failing when tested at the roadside, an analysis was conducted to determine whether the roadside test results of vehicles could be correlated with the performance of Smog Check stations. The analysis used a prototype Station Performance Algorithm developed by BAR in 2005 that ranked stations based on the percentage of vehicles that passed their next Smog Check inspection (accounting for station-to-station differences in model year, mileage, make, and other characteristics of tested vehicles). High-performing stations were considered those that certified vehicles in one inspection that passed at a higher rate in the next Smog Check inspection when compared with similar vehicles. Although development and evaluation of a formal station performance system is not complete, the roadside data analysis indicates that BAR's prototype algorithm appears to be effective in identifying the stations and technicians that ensure vehicles legitimately pass the Smog Check test prior to issuing a certificate of compliance. The analysis indicates that there are significant differences in the percent of vehicles that can be expected to pass a roadside test based on the ranking of the Smog Check station at which the passing test was obtained.

Figure 1-3 shows how the Roadside failure rates compare for stations with different scores using the Station Performance Algorithm. The results shown in the figure are for vehicles that failed the initial test during the previous Smog Check and should have received repairs to pass the test. Using the most stringent criteria (Scenario 2, as described in Section 5 of this report), the failure rate at the roadside was 38% for vehicles last certified by high-performing stations and 68% for the vehicles last certified by low-performing stations.

It should be noted that 79% of the Smog Check stations involved in this analysis (1,493 out of 1,886) were Test-Only stations. Because repairs are not performed at Test-Only stations, and because the high roadside failure rate for vehicles that failed the initial inspection in the previous Smog Check cycle shows up immediately after the re-test and does not appear to be related to owner tampering, Test-Only stations with a low rank sometimes appear to be inappropriately passing vehicles that should have failed.

The impact of station performance on the emission reductions achievable from the Smog Check program was estimated based on the assumption that the level of performance shown in Figure 1-3 for high performing stations could eventually be achieved for all stations. Based on this assumption, we estimate that there would be an additional 69.5 tons per day of ROG+NOx emissions reductions for 1976-1995 model year vehicles. This is nearly a 30% increase in Smog Check program benefits, which should bring the program close to reaching the target I/M benefits for this model year group of 315.8 tons per day.[5]

Figure 1-3



Additional Analyses

The Roadside results suggest that many of the vehicles initially failing Smog Check are not being repaired at all or are not being properly repaired. Additional analyses were conducted examining failure patterns by vehicle make, improper test type selection, mismatch of vehicle look-up information, and the frequency of aborted, training mode and pretests to determine if these factors could explain the high refail rate. With the exception of the frequency of aborted tests and pretests, no pattern could be found in the other areas that would explain the follow-up failure rate on the roadside.

The analysis did indicate that vehicles failing their subsequent roadside test within one year were more likely to have received an aborted test or a pretest than was the case for

[5] For the reasons noted previously, this estimate cannot be compared directly to the I/M benefits in the State Implementation Plan.

vehicles that passed at the roadside. Based on this analysis, it appears as though some Smog Check stations are attempting to determine whether a vehicle is likely to fail before they conduct the official test and that a vehicle's subsequent failure during a roadside test is somehow related to whether it received a pretest or an aborted test.

One possible explanation as to why vehicles with an aborted test or pretest are more likely to fail when subsequently tested at the roadside is that a technician is attempting to determine whether the official test needs to be altered in some way to generate a passing score. There are ways to falsify test results through the use of techniques such as "clean piping" (measuring the tailpipe emissions of a known clean vehicle instead of the vehicle identified in the Smog Check record), as well as falsifying visual or functional inspection results.

Focus Group Study Results

Five separate focus groups were also used to investigate reasons for the high roadside failure rate of vehicles that initially failed during the previous Smog Check cycle. These focus groups were intended to provide insight into future potential analysis topics. A focus group consisting of BAR personnel suggested several technical differences between the roadside testing and the tests conducted at Smog Check stations that could explain differences in test results (e.g., differences in test conditions, test equipment, and equipment maintenance). However, these suggestions explain only relatively small differences that would not change the results of this analysis.

In addition, BAR personnel, vehicle owners, Smog Check station managers, and technicians who participated in the focus groups all mentioned that the possibility of obtaining an illegal passing certificate through bribery, but it is unknown to what extent this occurs. BAR personnel and Smog Check station personnel also mentioned the failure of inspectors to perform adequate visual and functional checks as contributors to the problem, along with the use of cheap, aftermarket catalysts. (However, our analysis of available repair data does not indicate that the use of aftermarket catalysts is a significant factor.)

The focus groups also revealed that incentives exist that likely reward low performance, as it is more profitable for stations, and more affordable and convenient for motorists, when inspections are done quickly and cheaply, which often leads to improper and incomplete tests. Attachment 1 contains more details about the focus group study.

Recommendations

Based on the analysis described above, improper or falsified Smog Check results appear to be contributing to the 49% tailpipe failure rate at the roadside for vehicles that initially failed during the previous Smog Check cycle. While the existing BAR enforcement program has been successful in identifying some stations that produce falsified or incorrect test results, it cannot identify Smog Check stations that are willing to falsify a test result only for routine customers. None of the specially prepared vehicles used by BAR are taken to Smog Check stations by routine customers of the station.

To better address the extent to which improper and/or falsified test results may be factors in the Smog Check program, the following additional steps should be considered:

1. Further refine the Station Performance Algorithm and use it to target low-performing stations for increased enforcement and to create incentives for more stations to become high performing. Adding "fingerprint" analysis of OBD inspection results in Smog Check data is one of the approaches that could be included in the Station Performance Algorithm when the next generation of Test Analyzer Systems is deployed. If more detailed OBD results are collected by new analyzers, it should be possible to determine when a Smog Check station is reporting OBD inspection results that are inconsistent with the results that should have been generated for a particular make and model.

2. Perform inspections of vehicles immediately following certification at Smog Check stations. This would facilitate the inspection of vehicles owned by routine customers that may be treated differently than vehicles unknown to the station. The options for accomplishing such inspections include roadside inspections of vehicles leaving Smog Check stations or on-site inspections of vehicles that are preparing to leave a station.

3. Continue the Roadside Inspection Program. Using the results from this analysis as the baseline, continuation of the Roadside Inspection Program will enable the effectiveness of future Smog Check program improvements to be measured. Roadside data should also be used to target low performing stations for additional enforcement.

###

2. INTRODUCTION

Under contract to the California Air Resources Board (ARB) and the Bureau of Automotive Repair (BAR), Sierra Research, Inc. (Sierra) analyzed data collected in BAR's Roadside Inspection Program to evaluate the effectiveness of the Smog Check program. The Roadside Inspection Program has been used to provide ongoing information regarding the emissions and compliance status of vehicles subject to the enhanced Smog Check program. The program measures how effective the Smog Check program has been in providing a fleet of vehicles free from emissions-related defects.

This report summarizes the results of the 2003-2006 Roadside data analysis. It includes an analysis of how the roadside data correlate with Smog Check station performance as estimated using a prototype Station Performance Algorithm. It concludes with recommendations concerning future Smog Check projects and evaluations.

Organization of the Report

Following this introduction, Section 3 of the report provides a description of the Roadside Inspection Program. Section 4 summarizes the results of the roadside data analysis. Section 5 summarizes the Station Performance Algorithm and related analyses. Section 6 contains supplementary analyses of the roadside data. Section 7 contains recommendations for future work. Attachment 1 contains the results of the focus group study conducted by subcontractor Eastern Research Group (ERG).

###

3. BAR'S ROADSIDE INSPECTION PROGRAM

For many years, BAR has been collecting emissions data and visual inspection results through a Roadside Inspection Program conducted with the assistance of the California Highway Patrol. Vehicles are randomly selected using a stratified sampling protocol giving preference to older, higher emitting vehicles. Vehicles are given a Smog Check inspection using portable dynamometers and analytical equipment to measure emissions using full-duration two-mode Acceleration Simulation Mode (ASM) test procedures.

Equipment and Test Procedures

A complete description of the Roadside Inspection Program has been documented previously by BAR[6], and therefore only a brief overview is provided here.

- *Site Selection* – A rigorous random sampling protocol is used to select testing locations from the zip codes included in the enhanced Smog Check areas of the state. Test sites are limited to zip codes with more than 1,000 registered vehicles, and locations are physically limited to four-lane surface streets with a maximum speed limit of 45 mph.

- *Equipment* – The test equipment (Environment System Products' BAR97 EIS) complies with official Smog Check inspection requirements.

- *Vehicle Selection* – In a true random sample of California vehicles, older, higher emitting vehicles would be under-sampled relative to their contribution to fleet-average emissions while newer vehicles would be over-sampled. To ensure representation in proportion to fleet emissions, BAR uses a stratified random sampling procedure to increase the likelihood of older vehicles being proportionally represented.

- *Test Protocol* – Test vehicles are given a standard Smog Check inspection, including a visual, functional, and tailpipe test; however, ignition timing and EGR functional testing is omitted and the fast-pass algorithm, used to reduce test time in standard Smog Check program tests, is bypassed.

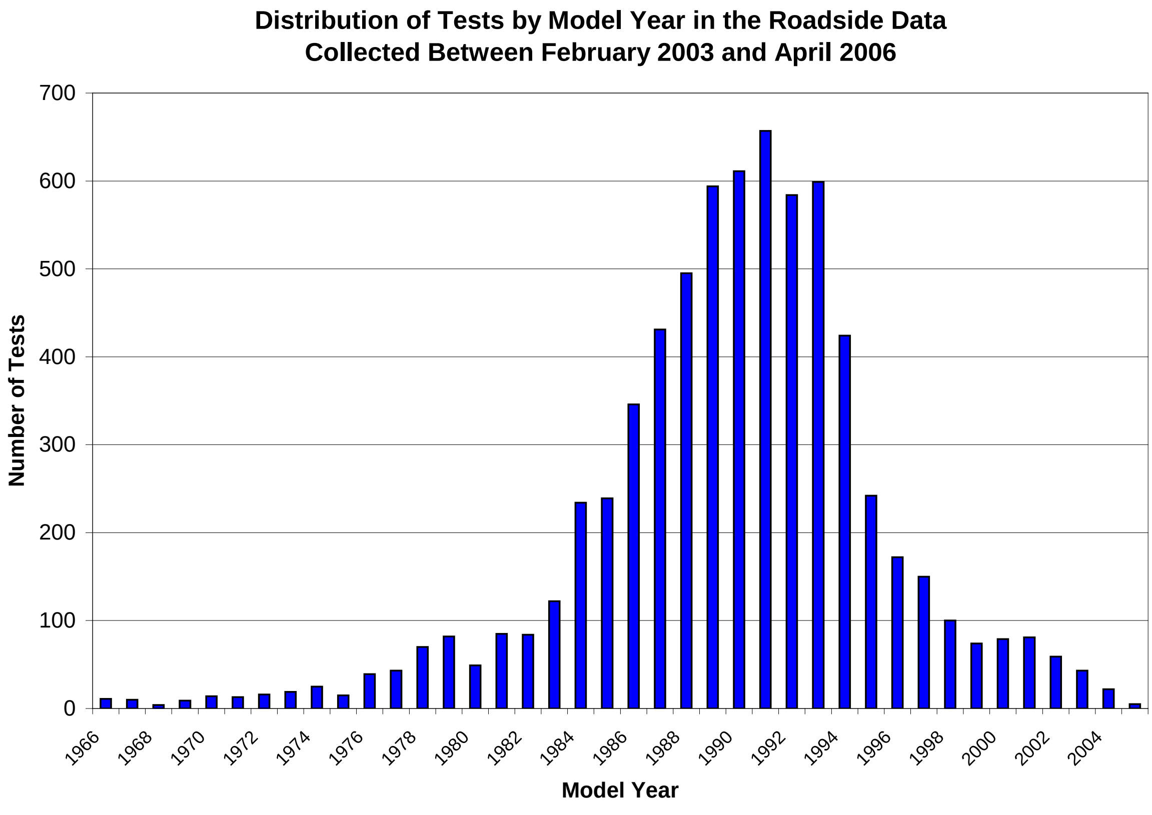
[6] "Roadside Inspection Program," Bureau of Automotive Repair, Report No. 2000-02, February 9, 2000. *http://www.epa.gov/otaq/regs/im/roadside.pdf*

- *Quality Control and Quality Assurance* – Quality Control checks meeting or exceeding standard Smog Check program requirements are made during roadside testing. These checks include calibration of the dynamometer every third day and audit calibration of all gases at least three times a day (immediately prior to inspection of the first vehicle, midway through the shift, and at the end of the shift).

Basic Roadside Population Statistics

The roadside data discussed in this report were collected between February 2003 and April 2006. Figure 3-1 summarizes the Model Year frequency distribution of the roadside sample. As noted above, a stratified random sampling technique is used to select vehicles for the vehicle pullover test program. Newer vehicles are deliberately under-sampled and older vehicles are over-sampled relative to their distribution in the fleet. This policy is reflected in the relatively low number of vehicles less than 10 model years old and disproportionately high number of vehicles more than 25 model years old.

Figure 3-1



Second-by-second results were retained for each roadside test performed in this program. This allowed the application of a “fast-pass” algorithm to the full duration roadside data to determine the passing or failing result. This was important in order to maintain comparability between the roadside results and Smog Check results recorded in the Vehicle Information Database (VID), which are based on a fast-pass algorithm to control test duration and to determine pass/fail status.

For many of the analyses presented later in this report, results were segregated into model year groups on the basis of similarities in emissions standards and emission control technology. The population of those model year groups in the roadside sample is summarized in Table 3-1. The impact of vehicle-miles-traveled (VMT) by each model year group was accounted for using CARB’s EMFAC model whenever estimates of fleetwide effects were made from the data. The 1966-1975 model year vehicles were included in the Roadside sample even though they are not subject to the program to obtain information regarding their contribution to total vehicle emissions. Also shown in Table 3-1 is the population distribution of those groups observed in the VID for calendar year 2005 (representing the 2003 to 2006 roadside sample period). The VID statistics were used to compute weighted averages.

Table 3-1
Model Year Distribution in the Roadside Data Versus the VID

Model Year	Roadside Distribution		VID Distribution
	Number	Percent	
1996+	785	11%	46%
1991-1995	2505	36%	30%
1986-1990	2477	36%	17%
1981-1985	764	11%	4%
1976-1980	283	4%	2%
1966-1975*	136	2%	--
Total	6950	100%	100%

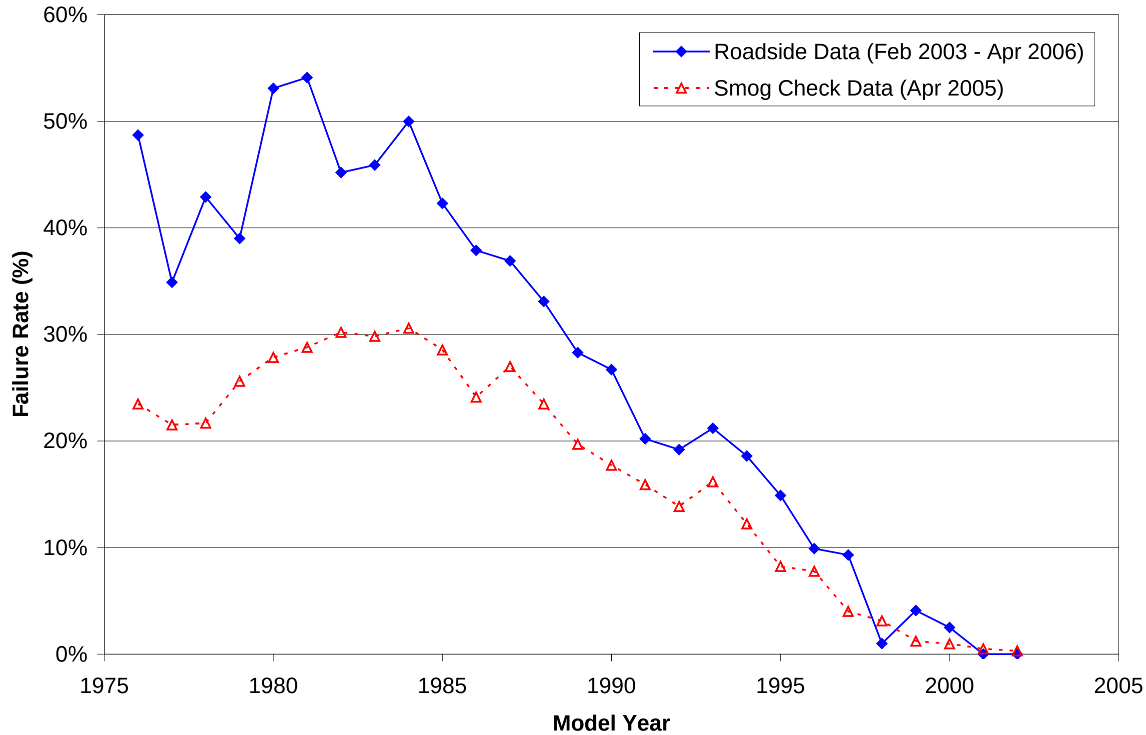
* Rolling 30 model year exemption was eliminated in 2005.

Comparison of Roadside and Smog Check Failure Rates

Figure 3-2 depicts the exhaust emission failure rates by model year observed in the 2003-2006 roadside dataset, with the initial test ASM tailpipe failure rates recorded in the April 2005 Smog Check VID displayed for comparison. The roadside failure rates are generally about 1.5 times the initial test failure rates seen in the Smog Check program for older vehicles.

Figure 3-2

Roadside vs. Smog Check Program Initial Test ASM Failure Rates



A much lower failure rate can be seen in the 1996 and newer vehicles in both the Roadside Inspection and Smog Check Programs. In addition, the actual emissions produced by a properly operating model year 2000 vehicle are much lower than those produced by an equivalent properly operating model year 1980 or older vehicle. The higher base emissions and higher failure rate combine to create much higher total emissions, even when the relative population and vehicle miles traveled (VMT) usage of the two groups are considered. For example, 1980 model year passenger cars that are free of emissions-related defects are only required to meet exhaust emissions standards of 0.39 grams per mile (g/mi) of non-methane hydrocarbons (NMHC) and 1.0 grams per mile NOx. In contrast, the emissions standards that apply to 2000 model year passenger cars are 80% lower: 0.073 g/mi NMHC and 0.2 g/mi NOx.[7]

Roadside and Smog Check Data

Additional processing of the second-by-second emissions data from Roadside Inspection Program was performed to provide a set of test results that could be directly compared to

[7] Individual 2000 model year passenger car models may be certified to meet standards associated with any of four "Low Emission Vehicle" categories. The NMHC and NOx values listed represent the average emissions for all models.

those obtained in the standard Smog Check program which uses a “fast-pass” algorithm to shorten testing time. The appropriate emission cutpoints were applied to the calculated scores to arrive at pass-fail results that would be expected during a standard Smog Check test.

Results from the standard Smog Check program are reported in BAR’s VID. VID results from calendar years 2000 through 2006 were included. Each result reported for each vehicle VIN included in the roadside testing was segregated from the VID for additional analysis.

###

4. ANALYSIS OF ROADSIDE AND SMOG CHECK DATA

During an evaluation of the Smog Check program conducted in 2002, results obtained on vehicles in the roadside program indicated that 40% of vehicles repaired after failing the initial test at a Smog Check station were failing a roadside test within one year. The BAR and the ARB staff directed Sierra to update the previous analysis[8] with more recent data and to attempt to determine the cause of the high percentage of vehicles failing at the roadside within one year of having passed a Smog Check.

The 2002 analysis was performed by Sierra under contract to ARB and BAR.[9] The following methodology was used:

- Roadside data collected from January 2000 through October 2002 were merged with earlier VID data to obtain the Smog Check history of vehicles in the roadside sample. The vehicle VIN was used to match results.

- Vehicles that had failed their initial Smog Check inspection (ASM only) and subsequently passed and received a Smog Check certificate within one year prior to the roadside inspection were identified. There were 735 vehicles in this group.

- Roadside ASM failure rates were calculated based on the fast-pass methodology for this sample of vehicles for model years 1974 through 1995.

- The model year specific average roadside failure rates were weighted by the distribution of initial tests observed in the VID (December 2000 through November 2001 data) for 1974[10] through 1995 model year vehicles to arrive at an overall roadside failure rate for this group of vehicles.

- The analysis found that 40.4% of the vehicles that failed their initial Smog Check inspection, then passed and received a certificate at a Smog Check station, were again failing in a roadside test performed within one year.

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[8] Refers to the "April 2005 Evaluation of the California Enhanced Vehicle Inspection and Maintenance (Smog Check) Program" dated September 2005.

[9] "Technical Support Document for Evaluation of the California Enhanced Vehicle Inspection and Maintenance (Smog Check) Program April 2004 Draft Report to the Inspection and Maintenance Review Committee -- Part 2," California Air Resources Board, Bureau of Automotive Repair, and Sierra Research, June 2004. *http://www.arb.ca.gov/msprog/smogcheck/jun04/tsd_part2.pdf*

[10] A 30-year rolling exemption was eliminated in 2005, making 1976 and newer vehicles subject to the Smog Check program.

A summary of roadside failure rates for this group of vehicles, by model year group, is provided in Table 4-1. Several additional analyses of the 2000-2002 roadside data were performed, including roadside results for initially passing vehicles, subsequent roadside failure rates by station type, and roadside failure rates within 90 days of Smog Check certification. The conclusion drawn from these additional analyses was that vehicle deterioration does not appear to explain the differences observed between the Smog Check results (i.e., a zero failure rate at the time of certification) and the roadside results.

Table 4-1
Roadside ASM Failure Rates for Initial Test Smog Check Failures
Tested at the Roadside Within One Year After Certification
(Based on January 2000 through October 2002 Roadside Data)

Model Year	Sample Size	Roadside Failure Rate
1974 – 1980	87	39%
1981 – 1985	272	47%
1986 – 1990	327	41%
1991 – 1995	49	36%
VID-Weighted 1974 – 1995	735	40%

Comparison of More Recent Roadside Data to the Previous Analysis

During kickoff meetings with ARB, BAR, Sierra, and other subcontractors (Eastern Research Group and de la Torre Klausmeir Consulting) involved in the 2005 Smog Check Evaluation Program, agreement was reached to repeat the analysis using the larger, more recent 2003-2006 Roadside dataset. Sierra also performed a number of additional analyses. The first such analysis was a direct comparison of the previous roadside "re-fail" rate to that observed in the 2003-2006 Roadside data. These results are summarized in Table 4-2.

Table 4-2
Roadside Failure Rates for Initial Test Smog Check Failures
Tested at the Roadside Within One Year After Certification
(Based on February 2003 through April 2006 Roadside Data)

Model Year	Sample Size	VID Distribution	ASM Failure Rate	Tailpipe (ASM) + Vis/Func Failure Rate
1976 – 1980	29	3.6%	62%	66%
1981 – 1985	103	8.3%	57%	79%
1986 – 1990	258	31.5%	47%	59%
1991 – 1995	186	56.6%	48%	56%
VID-Weighted 1976 – 1995	576	100%	49%	59%

Table 4-2 shows an even higher tailpipe (ASM) re-fail rate of 49% for the newer dataset. As shown in the last column of the table, the failure rate increases to 59% when visual and function failures are included. (As noted previously, the effect of visual and functional failures on the 2000-2002 roadside sample was not computed.) For the second analysis, results were limited to 1976-1995 model year vehicles because the 1974-1975 model year vehicles are no longer subject to testing in the Smog Check program. A higher re-fail rate for the newer roadside data would still be expected because the remaining vehicles are, on average, about four years older than they were during the previous analysis.

Analysis was also done on the performance of initial Smog Check passes during a subsequent roadside test. Table 4-3 presents both roadside ASM failure rates for initial test failures that subsequently passed Smog Check and initial test passes performed within one year prior to the roadside test. Results are presented for both the 2000-2002 roadside data and the 2003-2006 roadside data. The roadside failure rate for passing vehicles was also found to have increased about 9%.[11] Again, the age of the pre-1996 model year population was about four years older so a somewhat higher refail rate was expected.

Table 4-3
Roadside ASM Failure Rates for Pre-1996 Model Year Vehicles
Tested at the Roadside Within One Year After a Passing Smog Check
(2000-2002 vs. 2003-2006 Roadside Data)

Initial Smog Check Result	2000-2002 Roadside Data	2003-2006 Roadside Data
Fail*	40%	49%
Pass	10%	19%
Overall Fail Rate	15%	24%

*Note: Although these vehicles failed their initial Smog Check, they eventually were certified as passing the inspection prior to failing again at the roadside inspection.

Applying the above percentages to the number of initial tests conducted in 2005, it is estimated, based on the emissions portion of the test, that approximately 380,000 1976-1995 model year vehicles that failed their initial Smog Check inspection and were subsequently certified as passing, are in a failing condition again within a year ("Fail-Fail" vehicles). Similarly, roughly 750,000 1976-1995 model year vehicles that passed their initial Smog Check inspection are in a failing condition within a year ("Pass-Fail" vehicles). Because the Smog Check program has a biennial (2-year) cycle for testing all vehicles subject to the program, nearly double this number of vehicles (i.e., over 2

[11] It should be noted that the 19% failure rate shown in the table is based only on the tailpipe test. When visual and functional failures are included, the failure rate increases to 31%.

million vehicles) may be exceeding their allowable tailpipe emissions within one year of passing their Smog Check.

Estimated Federal Test Procedure-based HC and NOx emission rates (in g/mi) for vehicles in the Roadside dataset are summarized in Table 4-4. The table compares initial Smog Check test results of vehicles to their Roadside test results. Three points can be made with respect to this table:

- Initial Smog Check failures that are certified and subsequently pass on the roadside within one year ("Fail-Pass" vehicles) have emission rates similar to vehicles that initially pass Smog Check and continue to pass on the roadside ("Pass-Pass" vehicles). For example, Table 4-4 shows that the "Fail-Pass" vehicles average 0.70 g/mi HC compared to 0.62 g/mi HC for the "Pass-Pass" vehicles. The Smog Check program appears to be working to properly identify and ensure effective repairs for the "Fail-Pass" vehicles.

- Emission rates for "Fail-Fail" vehicles and "Pass-Fail" vehicles are similar (1.64 vs. 1.55 g/mi HC; 1.55 vs. 1.54 g/mi NOx), but the emission levels are nearly twice what they are for the "Pass-Pass" and "Fail-Pass" vehicles, which means that the Smog Check program is not resulting in the identification and effective repair of these vehicles.

- Because the number of "Pass-Fail" vehicles (750,000) is estimated to be twice as large as the number of "Fail-Fail" vehicles (380,000), the excess emissions from "Pass-Fail" vehicles may be twice that of "Fail-Fail" vehicles.

Table 4-4
Roadside FTP Emission Rates for Pre-1996 Vehicles with a Roadside Test Conducted within One Year After Passing Smog Check

Initial Smog Check Result	Roadside Result	HC (g/mi)	NOx (g/mi)
Fail*	Fail	1.64	1.55
	Pass	0.70	0.92
Pass	Fail	1.55	1.54
	Pass	0.62	0.83

*Note: Although these vehicles failed their initial Smog Check, they eventually were certified as passing the inspection.

Detailed Analysis of More Recent Data

Failures by Pollutant and Test Mode

Detailed analyses were performed using the new 2003-2006 roadside dataset. One analysis was performed to determine if the vehicles failing Smog Check were failing the roadside inspection for the same pollutant and ASM test mode. The results are shown in Table 4-5 for pre-1996 vehicles that were tested on the road within one year following a passing test after initially failing a Smog Check. That table indicates that the "re-fail" rate for individual pollutants and test modes ranges from a low of 58% (mode 1 CO) to a high of 76% (mode 1 NO). When either mode is considered, 74% of the vehicles initially failing for HC at a Smog Check station are again failing for HC at the roadside, 68% of the CO failures at a station are again failing for CO on the roadside, and 83% of the NO failures at a station are again failing for NO at the roadside within a year after passing the Smog Check. While this does not necessarily explain the high failure rate observed on the roadside, the similarity in failure patterns suggests that many vehicles were not actually repaired before they were recorded as passing the Smog Check retest.

Table 4-5
Percentage of Failures for the Same Pollutant/Test Mode for Pre-1996 Vehicles Failing Smog Check and Roadside Within a Year Following Certification

Pollutant	ASM Test Mode	Percentage Failing for Same Pollutant/Test Mode
HC	1	73%
	2	63%
	Either	74%
CO	1	58%
	2	60%
	Either	68%
NO	1	76%
	2	67%
	Either	83%

Failures Due to Deterioration

Vehicle deterioration was investigated by segregating results into the previously described model year groups, and computing weighted averages for four time periods prior to the roadside failure:

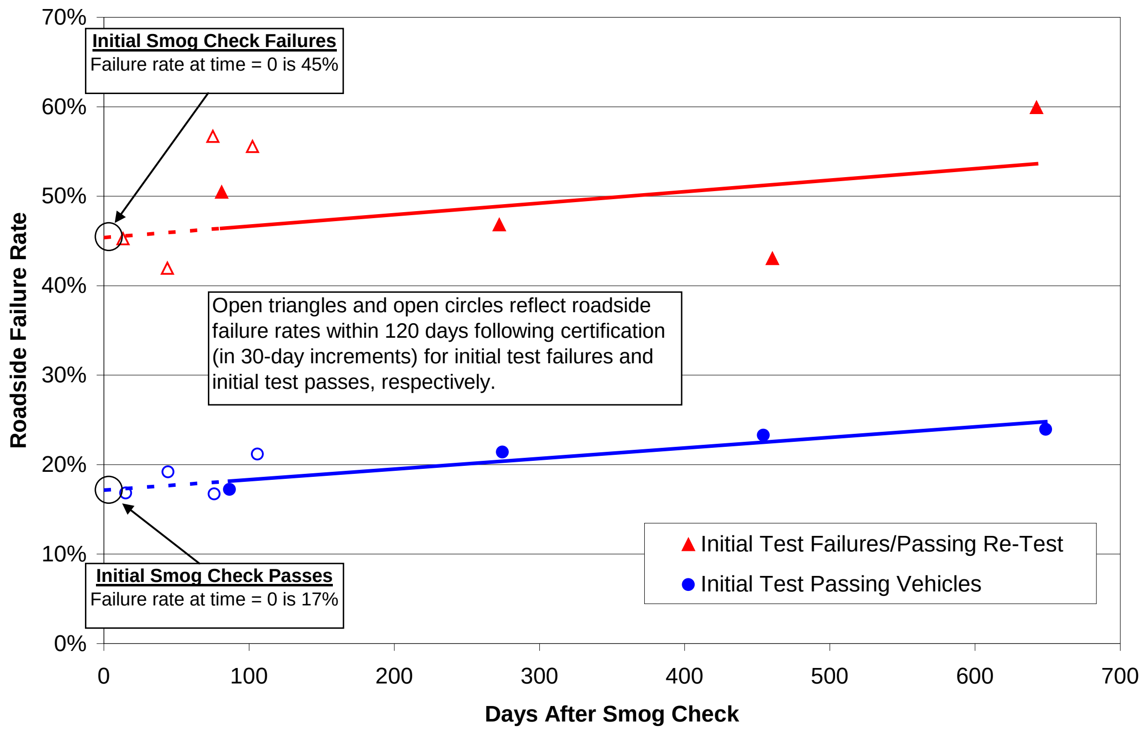
- 0-6 months following Smog Check (288 initial passes, 1,206 initial fails);
- 6-12 months following Smog Check (288 initial passes, 1,121 initial fails);

- 12-18 months following Smog Check (263 initial passes, 967 initial fails); and
- 18-27 months following Smog Check (247 initial passes, 903 initial fails).

The numbers in parentheses indicate the number of vehicles tested at the roadside during each period based on whether they passed or failed their initial inspection during their previous Smog Check. The last time bin was extended beyond two years to allow additional time for motorists that might delay the completion of their two-year biennial inspection cycle.

Within the 0-6 month period, the first 120-days were further divided into 30-day increments to examine the possible rapid deterioration of vehicles after having Smog Check repairs. Overall results are summarized in Figure 4-1.

Figure 4-1
Roadside Tailpipe ASM Failure Rates for 1976-1995 Model Year Vehicles for Initial Smog Check Test Passing and Failing Vehicles Certified at Time = 0



The results are presented in Figure 4-1 separately for initial test failures and initial test passes during the previous Smog Check. The straight lines fit through the averages of the binned data cross the y-axis ("0" days after Smog Check) at a relatively high failure rate of 17% for vehicles that passed their initial Smog Check and 45% for vehicles that initially failed. This indicates that there is a relatively high failure rate at the roadside immediately following a passing Smog Check inspection for both initially passing vehicles and initially failing vehicles. If all of the vehicles actually passed their last test at a Smog Check station, it would be expected that the lines should go through the origin (i.e., zero failures at time = 0 following certification), but they clearly do not.

In Figure 4-1, roadside results observed during the first 120 days following Smog Check certification validate the hypothesis that rapid deterioration of the vehicle likely did not occur. This is particularly apparent in the larger passing vehicle set where the data points are clustered closely around the linear trend line with a shallow slope. More scatter is observed with the failing vehicle set, which may be a result of the smaller sample size of those vehicles. Neither set of results shows a dramatic increase in roadside failure rates for vehicles in the four months immediately following their Smog Check inspection and only a slight increase in the failure rate over the entire 27-month period.

While the data presented in Figure 4-1 deal only with failure rates, an analysis of the average emission levels shows a similar trend. Figures 4-2, 4-3, and 4-4 show the trend in average HC, CO, and NOx emissions, respectively, estimated from the ASM test results. As shown in the figures, vehicles failing at the roadside within one year of passing Smog Check do not demonstrate a significantly different deterioration rate depending on whether their initial Smog Check test result was a pass or a fail, with the exception of one point in Figure 4-2.

Figure 4-2

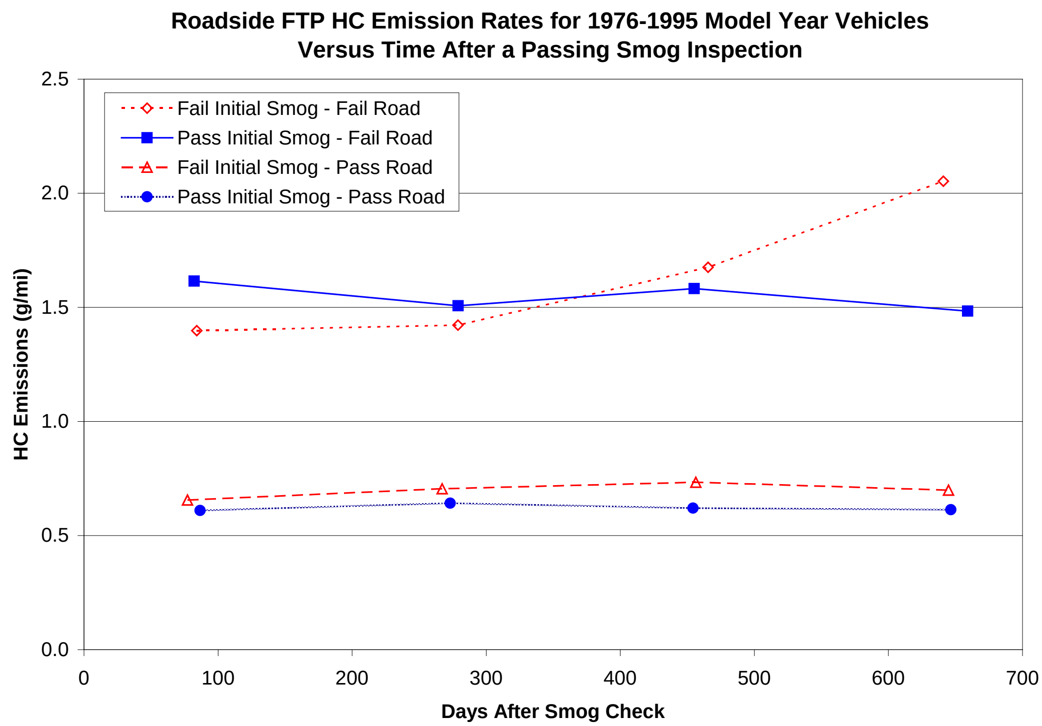


Figure 4-3

Roadside FTP CO Emission Rates for 1976-1995 Model Year Vehicles Versus Time After a Passing Smog Inspection

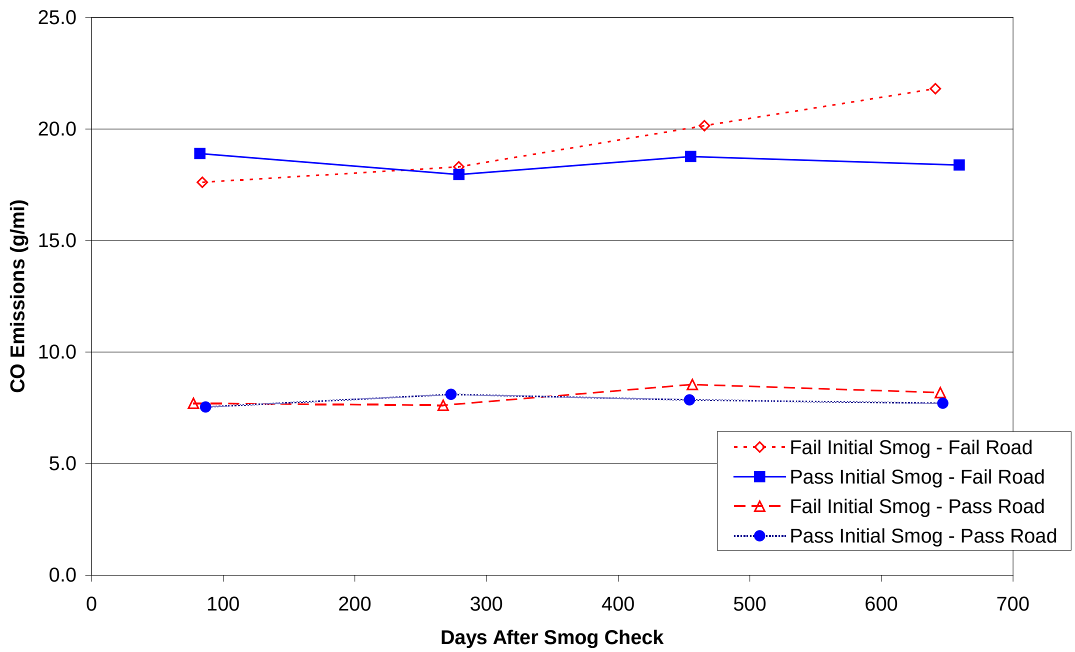
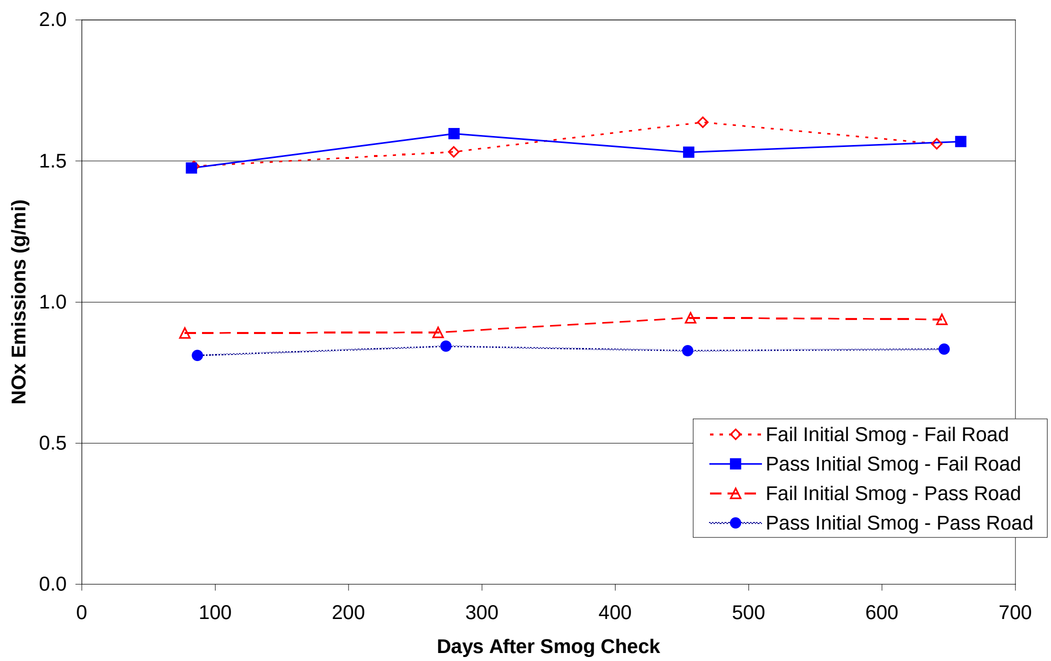


Figure 4-4

Roadside FTP NOx Emission Rates for 1976-1995 Model Year Vehicles Versus Time After a Passing Smog Inspection



The minimum sample size for the data points shown in Figures 4-2, 4-3, and 4-4 was 98 (for the "Fail Initial Smog – Pass Road" category in the 18-27 month time period). All other data points represent a minimum of 120 tests for vehicles that initially failed in the previous Smog Check cycle. There were a minimum of 225 tests at each data point for vehicles that initially passed in the previous Smog Check cycle and failed at the roadside. For vehicles that initially passed during the previous Smog Check cycle and passed at the roadside, the minimum sample size was 676.

Failures Due to Test-to-Test Variability

An analysis was also conducted to determine whether the higher roadside failure rates observed for vehicles that initially failed their last Smog Check might have been due to test-to-test variability. Test-to-test variability could be a factor if vehicles that initially failed their last Smog Check were closer to the standard when they ultimately passed the test. Vehicles that were marginally passing the test would be more likely to fail a subsequent test due to test-to-test variability. Test variability is especially a concern with older, carbureted vehicles without feedback control of fuel metering. However, as shown in Table 4-6, there was no significant difference in the average passing scores during the last Smog Check between vehicles that initially failed and vehicles that initially passed.

Table 4-6
Final Smog Check Emissions Prior to Roadside Test
(Percent of Applicable Standard)

	HC1	CO1	NO1	HC2	CO2	NO2
Initial Pass	56.8%	25.6%	46.5%	45.5%	18.5%	32.4%
Initial Fail	52.6%	21.6%	45.5%	45.7%	17.2%	37.3%

Note: "HC1" is the hydrocarbon standard for the ASM1 test; HC2 is the standard for the ASM2 test.

Failures Due to Tampering

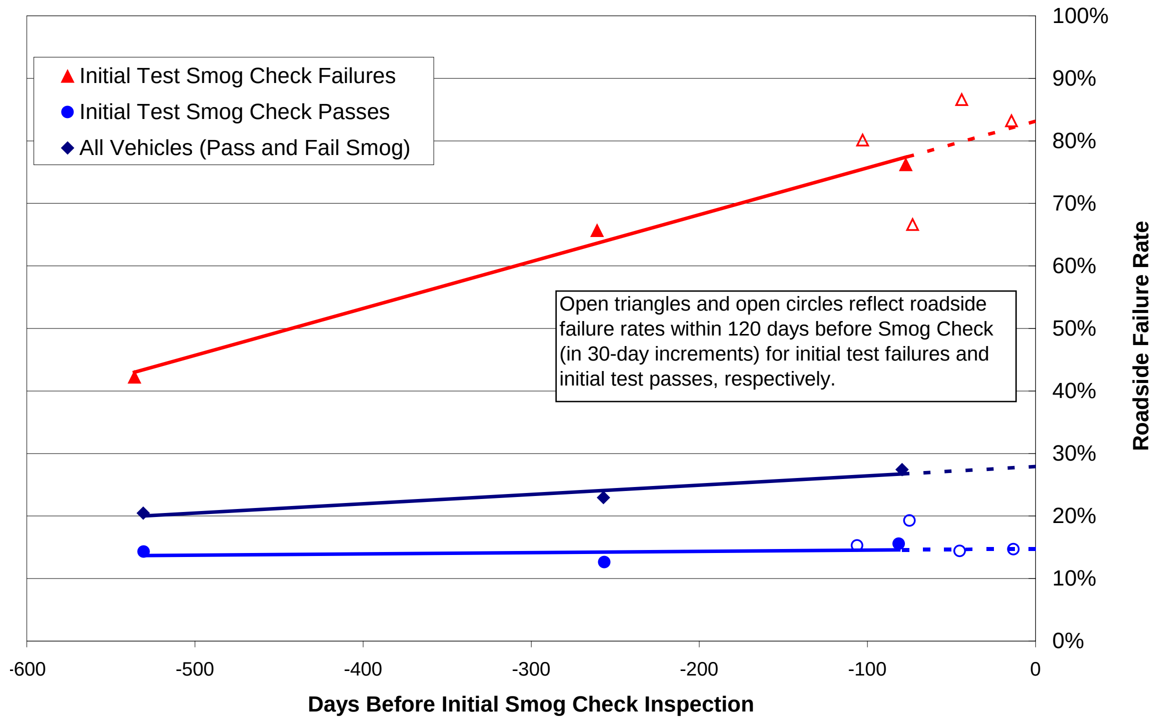
Further data analysis of vehicle inspections at the roadside indicated a tampering problem with only about 9% of the vehicles. (This is higher than the <5% tampering rate reported by Smog Check stations; however, under-reporting of tampering by Smog Check stations has been a problem since the beginning of the program.) Considering all of the vehicles that were tested at the roadside, the tampering rate for vehicles that initially failed during their previous Smog Check cycle (9%) was not significantly different from the tampering rate for vehicles that initially passed their Smog Check (8%). Therefore, the high failure rates immediately following the Smog Check inspection do not appear to be explained by owner tampering following a passing test.

Failures Prior to Smog Check

For comparison purposes, an analysis was also conducted of the initial Smog Check test performed subsequent to a roadside test. Figure 4-5 displays the roadside overall ASM failure rates for the 1976-1995 model year vehicles that received an initial Smog Check inspection within 27 months following participation in the roadside program. The minimum sample size for each data point was 121.

Figure 4-5

Roadside Tailpipe ASM Failure Rates for 1976-1995 Model Year Vehicles Leading Up to a Smog Check Inspection



The "Initial Test Smog Check Failures" line reflects the average roadside failure rate for vehicles at specified times prior to failing their next initial Smog Check inspection. Extrapolation of these results implies that only 83% of the vehicles would fail a roadside test if it were performed immediately prior to a failing Smog Check. Test-to-test variability may be contributing to why some vehicles that failed a subsequent Smog Check were previously recorded as passing during a roadside test.

The "Initial Test Smog Check Passes" line reflects the average roadside failure rate at specified times prior to passing their next initial Smog Check inspection. This line implies that 15% of the vehicles would fail a roadside test performed immediately prior to a passing Smog Check. It should be noted, however, that some of these vehicles likely would have received pre-inspection maintenance prior to the Smog Check test.

When comparing Figure 4-5 with Figure 4-1, it should be noted that the roadside failure rate for vehicles that fail their initial Smog Check is almost twice as high immediately before the Smog Check cycle as it is after the Smog Check cycle. Assuming that repairs were performed during the Smog Check process, the repair results would have been successful for about half of the failing vehicles.

In Figure 4-5, it is also interesting to compare the projected Smog Check failure rates of the passing and failing vehicle groups following a roadside inspection. The failing vehicles are approximately 15% below 100% on the vertical axis, while the passing vehicles are also 15% above 0%. This similarity may reflect undetermined differences between the two test protocols, the repeatability of the ASM test, or a combination of both.

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5. STATION PERFORMANCE ANALYSIS

Conceptually, the optimum method for measuring the effectiveness of a Smog Check station would be to measure the emissions of a random sample of vehicles before and after they have been tested and, if necessary, repaired at the station. To determine the durability of the repairs, vehicles would be recruited for off-cycle emissions testing periodically. It would also be necessary for the Smog Check station to be unaware of which vehicles were part of the random sample to ensure that vehicles were not receiving special treatment. One difficulty in conducting such a program is that there is no practical way to include vehicles owned by routine customers in the random sample.

Because of the logistical problems associated with using a routine testing program of the type described above, BAR has attempted to use more readily available information to determine the relative performance of Smog Check stations. Since the early days of the program, different performance metrics have been considered and tested by BAR, Sierra, and ERG staff, including a number of versions designed to identify stations that were performing fraudulent or improper testing. Details of the "Station Performance Algorithm" that BAR has developed are confidential, but they involve monitoring the performance of individual vehicles over multiple Smog Check cycles. The algorithm accounts for a number of factors such as vehicle age, make, model, previous inspection result, odometer, etc. These factors compensate for those vehicles that inherently fail at a higher rate without penalizing stations whose clientele comprises a significant portion of these vehicles.

Data were provided by BAR to Sierra in August 2006. As evaluated in this report, the data consisted of a list of stations and their performance using a prototype Station Performance Algorithm incorporating the above factors and research. Only higher volume stations were considered in the evaluation since the volume of data from these stations provided a large enough sample for statistical analysis. Subsequent to this analysis, BAR has continued to evaluate and refine the Station Performance Algorithm.

For this evaluation, station performance scores were assigned on a continuum from 0 to 1.0, with a score of 1.0 being the best. The Roadside Inspection Program results were used to independently evaluate station performance and the effectiveness of the score produced by the prototype Station Performance Algorithm. Since truly high-performing stations ensure that the vehicles they certify actually meet the applicable emissions standards and are free from visual and functional defects, vehicles certified by such stations should be more likely to pass during subsequent roadside inspections.

This analysis was performed using the previously described February 2003 through April 2006 roadside dataset. Below are the two scenarios evaluated in this analysis. Each scenario has different criteria to identify high-performing and low-performing stations:

- Scenario 1: High-Performing designation is based on a station performance score greater than or equal to 0.9 and Low-Performing designation is based on a score less than or equal to 0.1.

- Scenario 2: High-Performing designation is based on a station performance score greater than or equal to 0.975 and Low-Performing designation is based on a score less than or equal to 0.025

Everything between the high and low performance thresholds is considered to be medium-performing stations for this analysis.

The roadside data were placed into model year group bins as follows: 1976-1980; 1981-1984; 1985-1987; 1988-1991; and 1992-1995. Vehicle model years 1996 and newer were not evaluated because of their small sample size in the roadside data and relative low number of failures.

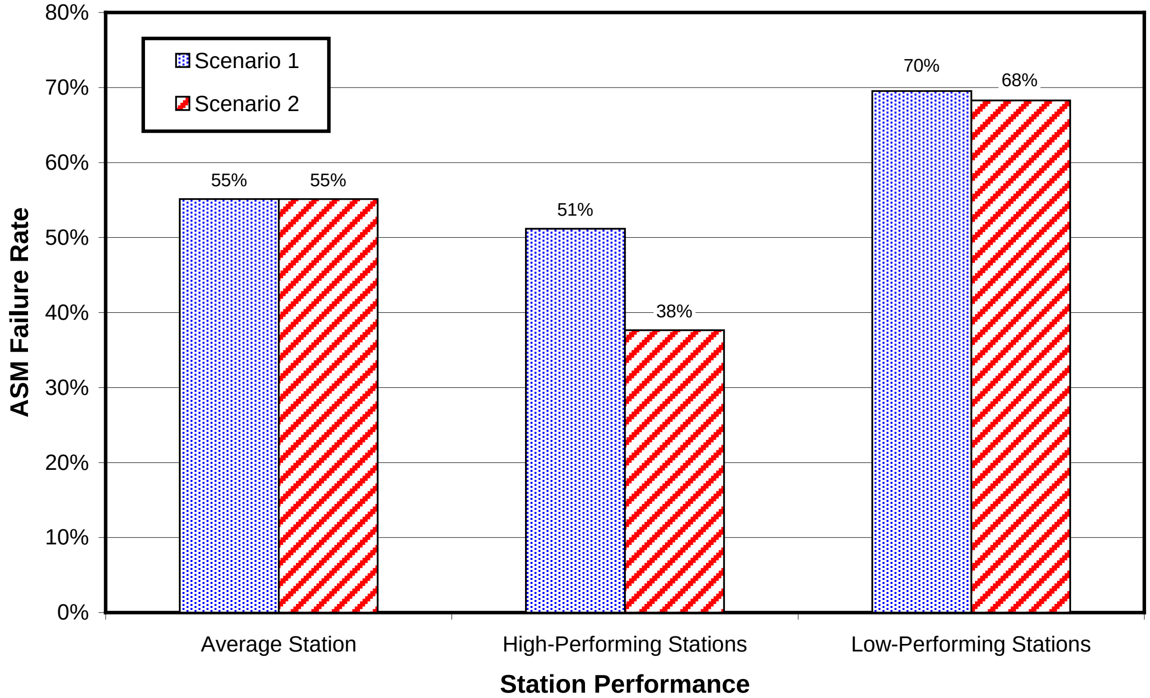
The percentage of roadside vehicles that were last certified by high-, medium-, and low-performing stations in this dataset is summarized below for the two scenarios. The numbers in parentheses under the "Performance" column are the number of Smog Check stations in each group. The numbers in parentheses under the "Roadside Tests" column are the number of vehicles in each group:

Scenario	Performance	Roadside Tests
1	High-Performing (306)	25% (1338)
	Medium-Performing (1103)	54% (2845)
	Low-Performing (323)	20% (1071)
2	High-Performing (118)	12% (655)
	Medium-Performing (1449)	76% (3972)
	Low-Performing (165)	12% (627)

Thus, under Scenario 1, the high-performing stations issued about 25% of the Smog certificates prior to the vehicles' roadside inspections, and the low-performing stations issued about 20%. Scenario 2 shows the high- and low-performing stations each issuing about 12% of the certificates prior to roadside inspections. The medium-performing stations make up the difference in both the scenarios.

Figure 5-1 displays VID-weighted 1976-1995 model year failure rates for these vehicles when tested in the Roadside Inspection Program. These particular vehicles failed their initial inspection and then passed Smog Check certification within a year prior to being

Figure 5-1
Roadside Failure Rates for Vehicles Failing Previous Initial Smog Inspection Prior to Certification within One Year of the Roadside Test (VID-Weighted 1976-1995 Vehicle Distribution)



Note: "Average Station" covers High-, Medium-, and Low-Performing stations. Failure rates are based on a subset of the Roadside sample for which station rankings were available and VID-weighting does not precisely match that used in other calculations.

tested in the Roadside Inspection Program. The ability of the Station Performance Algorithm to identify high-performing stations is evident when comparing the two scenarios. In Scenario 1, the roadside failure rate was 51% for the high-performing stations and was 38% in Scenario 2.[12]

At the other end of the spectrum, relatively little difference was noted for the low-performing stations under both scenarios. Vehicles that had been tested at these stations exhibited a failure rate of 68-70% when tested at the roadside.

It should be noted that 79% of the Smog Check stations involved in this analysis (1,493 out of 1,886) were Test-Only stations. Because repairs are not performed at Test-Only stations, Test-Only stations with a low rank sometimes appear to be inappropriately passing vehicles that should have failed.

[12] It should be noted that the overall failure rates from this analysis do not match the failure rates in the entire roadside sample because the station performance was not available for all of the vehicles tested at the roadside.

Using the two performance scenarios above, several calculations were performed, as described below.

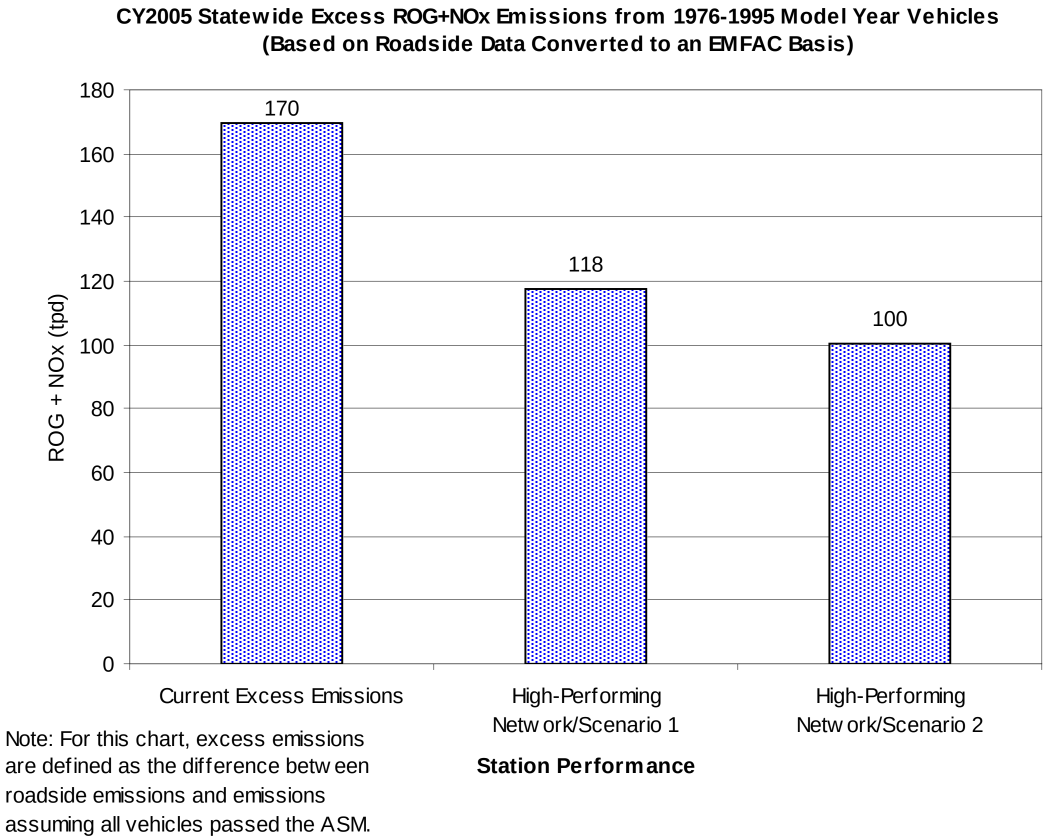
Table 5-1 presents the potential emissions benefits of sending all 1976-1995 model year vehicles to high-performing stations under this analysis. The impact of Station Performance on the emission reductions achievable from the Smog Check program was estimated based on the assumption that the level of performance achieved by high-performing stations could be achieved by all stations. The results show that sending all 1976-1995 vehicles to the top 25% of the stations (Scenario 1) could achieve as much as 51.9 tpd statewide ROG+NOx emission benefit, and sending all 1976-1995 vehicles to the top performing 12% of the stations (Scenario 2) could achieve as much as 69.5 tpd ROG+NOx benefit (both on an EMFAC basis). This is nearly a 30% increase in Smog Check program benefits for this model year group.

Table 5-1
CY2005 Statewide Emissions Benefits if All 1976-1995 Model Year Vehicles Were Tested at High Performing Stations
(tons per day)

Scenario	ROG	CO	NOx	ROG+NOx
1	22.4	415.5	29.5	51.9
2	32.2	536.8	37.3	69.5

Figure 5-2 shows the excess emissions associated with 1976-1995 model year vehicles under the current Smog Check program as well as the excess emissions that would be expected if all 1976-1995 model year vehicles were tested at the highest-performing stations based on a best case scenario. For this analysis, excess emissions were calculated as the difference between the roadside data (converted to an FTP and then EMFAC basis) and the emissions if all of the vehicles passed the roadside ASM test. The difference between the current excess emissions of 170 tons per day ROG + NOx and the potential excess emissions of 100 tons per day ROG + NOx if all vehicles were inspected at “high-performing” stations as they are defined under Scenario 2 is the 69.5 tons per day shown in the last column of Table 5-1. The remaining 100 tons per day of excess emissions is approximately equal to the expected performance of the Smog Check program estimated by the EMFAC model (i.e., the Smog Check program was never expected to eliminate all excess emissions). Based on EMFAC, the Smog Check program is capable of reducing emissions from this model year group by 315.8 tons per day using relatively high-performing stations.

Figure 5-2



Station Performance and Repair Data Analysis

Repairs performed during the Smog Check process are reported to BAR through the VID. A repair dataset analyzed in conjunction with the Roadside data (February 2003 to April 2006) and station performance data were provided by BAR.

The repair dataset provided by BAR included more than 4 million repair records, primarily dated between January 1998 and August 2005. A total of 1,859 repair records were identified for vehicles in the Roadside dataset. Of these, 1,038 were repair records for vehicles repaired by stations included in the August 2006 station performance dataset. The 1,038 records were further segregated into two bins, one for repairs performed within one year prior to the roadside inspection (147 tests found) and two years prior to the roadside inspection (342 tests found). The sample size of these two bins was considered insufficient for determining if patterns could be detected in the repairs performed on vehicles that received both a Roadside and station inspection by a station included in the station performance dataset. Thus, the repair datasets were augmented to include all repair records after January 1, 2000, resulting in a total of 870 repair records being used for this analysis.

The Smog Check program records repairs for 13 major categories that are broken into 76 subcategories. The following 10 major categories and some of their subcategories were used for this initial analysis:

Ignition	Spark plugs, ignition wires, cap, rotor, timing, coil
EGR	Vacuum, valve, clean passage, controls
Sensors	O_2 sensor, temperature, throttle position, MAP, MAF, crank position, cam position
Carburetor	Fuel filter, air filter, adjust, rebuild/replace
Catalyst	Catalyst
Fuel Injection	Fuel filter, air filter, pressure regulator, throttle body, fuel distributor, injectors, cold start
Mechanical	Vacuum leaks, cylinder, top end, valve train, lower end, intake manifold, turbo
AIR	Air pump, pulse valve, diverter valve, belt, plumbing, check valve
Controls	Mixture control, spark control, purge solenoid, idle speed, EGR solenoid, diverter valve
ECM	Engine control module (computer)

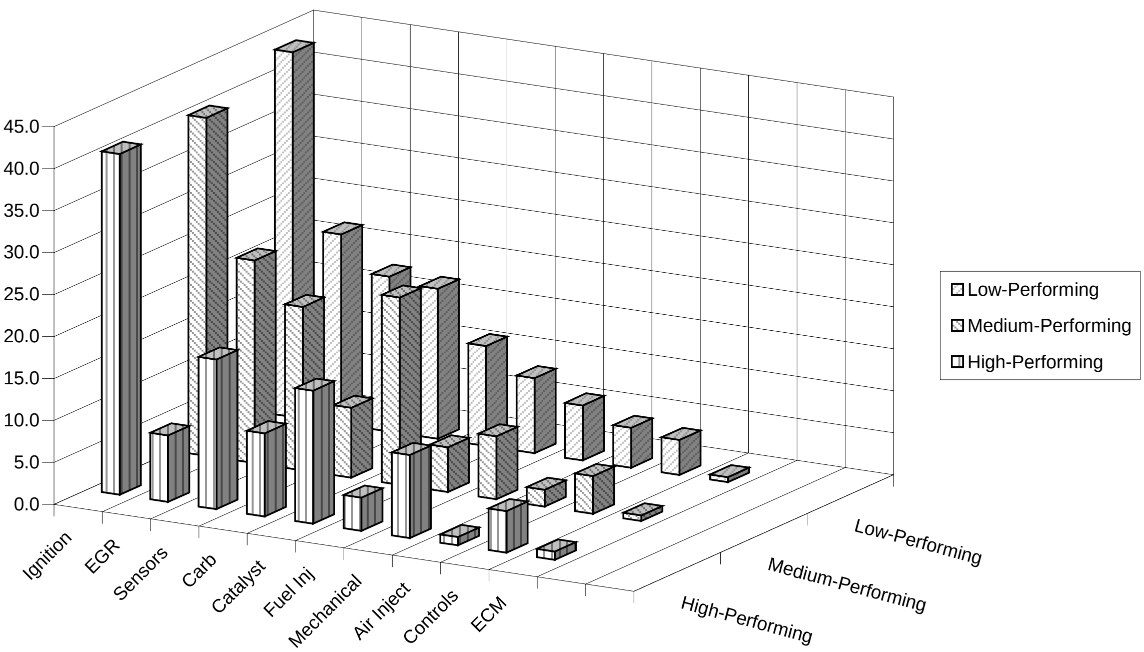
The stations performing repairs were divided into three previously defined groups: high-, medium-, and low-performing stations. This initial analysis was performed to determine whether there is a pattern in the types of repairs performed based on the station's performance.

Table 5-2 compares, on a percentage basis, the type of repair reported for vehicles later inspected on the roadside, with the numbers in bold type highlighting some of the more notable results.

Figure 5-3 displays the results graphically. It is possible (even likely) for multiple repair groups to be reported for a given vehicle. In this sample of 870 vehicle repair records, more than 40% of the records indicate a repair or adjustment to the ignition system, including plugs, wires, and associated components.

Table 5-2 **Percentage of Repairs Performed by Stations in Different Performance Groups**			
	Performance Group		
Repair Categories	Low-Performing	Medium-Performing	High-Performing
Ignition	43.5	40.3	40.6
EGR	22.6	24.1	**7.9**
Sensors	18.5	19.5	17.8
Carburetor	**17.9**	8.3	9.9
Catalyst	11.9	22.3	15.8
Fuel Injection	**8.9**	5.3	4.0
Mechanical	6.6	7.5	9.9
Air Injection	**4.8**	2.0	1.0
Controls	4.2	4.5	5.0
ECM	0.6	0.7	1.0

Figure 5-3
Comparison of Repairs Performed by Stations in Different Performance Groups



In this limited sample, some results are questionable. For example, it is surprising to see that the higher performing stations performed substantially fewer EGR repairs than the medium and lower performing stations. Also surprising is that lower performing stations performed repairs more frequently in the categories of Carburetor, Fuel Injection, and Air Injection, which are generally considered to be more difficult and time-consuming repairs. Given these results, the accuracy of the repair data are questionable. While BAR wants technicians to enter data for all repairs, it is clear that they do not. From these results, it appears that low-quality repairs, in particular, are not being entered.

Of particular interest, the lower performing stations in this group performed the fewest catalyst replacements, which is counterintuitive and contradicts a common theory regarding use of a cheap aftermarket catalyst to temporarily mask a problem without repairing the root cause.

It may be useful to obtain all of the repair information for a larger vehicle population to which the Station Performance Algorithm could be applied. The limited available sample size prevents drilling down for the more detailed information in the repair subcategories, as only one or two repairs were reported in some of the categories. However, based on the sample analyzed here, it is uncertain whether the repair data are sufficiently accurate for an expanded analysis to be meaningful.

Repair data are recorded by a vehicle's VIN and date of repair. It is common for multiple tests to be performed on vehicles needing repairs, but the repair record is not linked to any specific test. It is likely that many repair records were not properly matched with the appropriate test record. Improving that link might improve the usefulness of this type of investigation.

It would be useful to analyze repair records for a large sample of vehicles that failed a Smog Check in 2006, were subsequently repaired and certified, and then received a biennial test in 2008. A larger sample size might provide additional insight as to the type of repair associated with the failure of different pollutants. Information gathered by such analysis, incorporating repair durability as measured by "Pass/Fail" results during the next test cycle, might also be of interest to service technicians and station owners. However, the value of such an analysis will ultimately depend on whether the repair data are sufficiently accurate.

Repairs are reported in the Emission Inspection System under the following categories: "Tampered and Repaired"; "Repaired"; "Diagnosed OK"; and "Estimated to Need Repair." For this analysis, emission control systems reported as "Tampered and Repaired" were combined with systems that were "Repaired" to evaluate emissions performance. Additional analysis of the other repair categories, such as the "Estimated to Need Repair" category, might also be of interest.

In summary, although the repair analysis in this section provides some interesting information, the small dataset prevents drawing any meaningful conclusions. Further analysis of station performance based on a larger repair dataset may provide additional insight into the reasons behind the roadside failure rate.

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6. ADDITIONAL ANALYSES

As previously described, the Roadside Inspection Program data included tests performed between February 2003 and April 2006. Standard Smog Check program results for the vehicles included in the Roadside dataset were merged by VIN for additional analysis. Smog Check results from January 2000 through April 2006 were available at the time these analyses were performed. Additional data were made available in December 2007, extending the available Smog Check results through October 2007. These additional results were merged with the previous datasets. Spot checking the additional Smog Check results showed that these additional data had no impact on previous analyses discussed in this report. The new data were used in the more recent analyses described in this section of the report.

This section also includes a brief summary of the focus group study conducted by subcontractor Eastern Research Group (ERG) during the summer of 2007. Attachment 1 contains more detailed results of the focus group study.

Significant Rates of Aborted Tests, Training Mode Tests, and Pretests

An analysis was done to determine whether a significant number of vehicles failing a roadside inspection were also subject to a high number of aborted tests, training mode tests, or pretests during the Smog Check inspection cycle. It should be noted that a pretest does not necessarily indicate a pattern of misbehavior. In addition, there are legitimate reasons for aborting tests, many of which are related to safety or some of the BAR 97 software features that ensure accuracy of the analyzer.

As with the previous analyses, the merged Roadside/Smog Check datasets were used as a starting point for this analysis. Initially, all Smog Check records for vehicles failing the roadside test were retained. All tests performed prior to the previous passing Smog Check cycle were removed. The remaining records in the final cycle were then scanned for Aborted Tests, Training Mode Tests, and Pretests, and each category was summed by vehicle type. Results are displayed in Table 6-1.

Table 6-2 presents the same information for vehicles that passed the roadside test. Aborted tests accounted for only 5.83% of the Smog Check tests for these vehicles, which compares to 13.56% aborted tests for vehicles failing at the roadside. Although pretests do not necessarily indicate that a technician has done something wrong, pretests were 8.95% of the Smog Check tests of roadside passing vehicles, which compares to

Table 6-1 Total Count of Previous Smog Check Test Result Outcome Types Vehicles Failing Roadside Tailpipe Inspection									
Body Type*	Total Gross Polluter	Total Tamper	Total Abort	Total Hands-On	Total Training	Total Pretest	Total Pass	Total Fail	Total Fail -w-Pretest
0	0	0	1	0	1	0	4	0	0
1	216	27	160	0	16	213	1096	461	65
2	14	3	7	0	0	16	77	31	3
3	104	18	50	0	5	78	406	121	21
4	30	6	10	0	2	12	119	28	2
5	24	3	17	0	1	24	150	46	7
6	11	5	10	0	0	17	75	15	6
Total	**399**	**62**	**255**	**0**	**25**	**360**	**1927**	**702**	**104**
%**	**21.22**	**3.30**	**13.56**	**0.00**	**1.33**	**19.15**	**102.50**	**37.34**	**5.53**

* 1=sedan, 2=station wagon, 3=pickup, 4=SUV, 5=minivan, 6=larger van, 0=other
** Percentage based on category sum divided by number of unique VINs contained in sample = 1880

Table 6-2 Total Count of Previous Smog Check Test Result Outcome Types Vehicles Passing Roadside Tailpipe Inspection									
Body Type	Total Gross Polluter	Total Tamper	Total Abort	Total Hands-On	Total Training	Total Pretest	Total Pass	Total Fail	Total Fail -w-Pretest
0	1	0	0	0	1	0	9	0	0
1	138	44	188	2	34	261	3322	536	64
2	12	1	13	0	2	19	172	35	6
3	51	21	61	0	4	92	959	150	25
4	17	2	20	0	0	26	425	60	9
5	18	7	9	0	3	45	398	65	14
6	11	2	8	0	2	16	104	18	4
Total	**248**	**77**	**299**	**2**	**46**	**459**	**5389**	**864**	**122**
%*	**4.83**	**1.50**	**5.83**	**0.04**	**0.90**	**8.95**	**105.03**	**16.84**	**2.38**

* Percentage based on category sum divided by number of unique VINs contained in sample = 5131

19.15% pretests for roadside failing vehicles. Training mode tests were also lower for roadside passing vehicles. As the tables show, the frequency of Smog Check aborted tests, training mode tests, and pretests for roadside failing vehicles are more than double those observed in roadside passing vehicles. For comparison, a similar analysis was performed using a single recent month of Smog Check Program data. The frequency of each category fell between the results shown for roadside passing and roadside failing vehicles.

In summary, the frequency of these test activities could indicate, in some cases, questionable station performance needing further review.

Vehicle Manufacturer Failure Rate – Roadside Versus Smog Check

The failure rate for vehicles in the 2003-2006 Roadside dataset was compared to Smog Check results for April 2004.[13] Only valid test results were used so both the Roadside and Smog Check datasets were purged of all "Abort," "Pretest," and "Training" inspection records prior to the analysis. To maintain consistency with the earlier analyses, only results for model years 1974-1995 were considered. To account for the stratified sampling protocol used in the Roadside Inspection Program, the results were further weighted to match the April 2004 VID Model Year distribution. The results were then segregated into vehicle manufacturer group, and the individual vehicle manufacturer's roadside failure rate was divided by the Smog Check failure for comparison. These results are displayed in Table 6-3.

The results shown in Table 6-3 were sorted by test volume per vehicle manufacturer, and only the higher volume vehicle manufacturers are shown. Lower volume vehicle manufacturers were grouped together under the heading of "Other." As previously observed, the roadside failure rate was generally double that observed in the Smog Check program.

There do not appear to be significant differences in the ratio of roadside to Smog Check failure rates by vehicle manufacturer.

Table 6-3
Smog Check versus Roadsides Failure Rate by Vehicle Manufacturer
(Weighted to April 2004 VID)

	Roadside	Smog Check	Roadside	Road/VID
Manufacturer	Sample	Failure %	Failure %	Ratio
GM	1340	14%	26%	1.89
Toyota	1218	12%	22%	1.9
Ford	1155	10%	21%	2.11
Honda	812	13%	26%	1.96
Nissan	520	11%	20%	1.87
Chrysler	453	14%	32%	2.2
Other	621	15%	31%	2.07

[13] Smog Check data for 2004 were used so that the average vehicle age and vehicle-miles-traveled (VMT) of the fleet would remain consistent with the 2004 Roadside dataset.

Vehicles Receiving Improper Test Type Prior to Roadside Inspection

An analysis was performed to identify whether a significant number of vehicles tested during the Roadside Inspection Program received and passed a less stringent two-speed idle (TSI) test rather than the ASM test as part of their previous Smog Check inspection cycle. The vehicles contained in the 2003-2006 Roadside Inspection Program dataset were matched (by VIN) with Smog Check data from 2000-2007 to include all Smog Check tests performed within one biennial cycle of the roadside inspection. Once matched, all Smog Check records that occurred after the vehicle's roadside inspection date were removed from the dataset. The remaining vehicles were then examined by inspection type.

Vehicles that require an ASM test are identified in the VID. Certain vehicles cannot be ASM tested, including vehicles equipped with full-time All Wheel Drive (AWD), vehicles equipped with Traction Control (TC) that cannot be disabled, and vehicles that are physically too large to fit on the ASM test dynamometer.

The Smog Check technician's responsibilities include determining whether the vehicle is testable. When an inspection is initiated, the analyzer gets the registration zip code and determines the test type based on the zip code. For trucks and motor homes, the analyzer then prompts the technician to enter the gross vehicle weight rating (GVWR) or other information that would result in the replacement of the ASM test with a TSI test. The information in Table 6-4 shows where the GVWR exceeds the 8,500 maximum weight for ASM prior to May 1, 2003. After that date, the maximum was raised to 9,999 pounds to determine which vehicles get a Two Speed Idle (TSI) test. The table shows 21 out of 45 vehicles that exceed the earlier weight limit for the ASM and 4 vehicles that exceed the later weight cap. It appears that these vehicles were correctly tested with the TSI test even though they received an ASM test at the roadside.

Vehicles that the Smog Check station indicated could not be tested because of their weight, size, or drive configuration are identified with an entry in the column entitled "Reason" in Table 6-4. Since these vehicles were ASM tested at the roadside, the reason given for TSI testing by the Smog Check station appears to be invalid. Still other vehicles received a TSI test without a reason being given.

As indicated by boldface type, 20 of the 45 vehicles listed in Table 6-4 appear to have been improperly given a TSI test. However, they account for much less than 1% of the Roadside Inspection Program population and therefore do not explain the much higher failure rate observed in the Roadside program.

Table 6-4
Vehicles Receiving Two Speed Idle Tests in Smog Check Program
(**Bold Type** Indicates Apparently Incorrect Selection of TSI Test)

Model Year	Make	Smog Check Model	Roadside Model	Reason	Smog GVWR
1993	FORD	EXPLORER 4-DR	EXPLORER 4-DR	AWD	5280
1992	FORD	CLUB WAGON	E350 CLUB WAGON		8700
1992	**CADIL**	**STS**	**DEVILLE**	**AWD**	**n.a.**
1986	CHEVY	C20	C20 SUBURBAN		8600
1987	**GMC**	**SAFARI**	**SAFARI**	**Trac. Control**	**6000**
1985	CHEVR	C20 PICKUP	CAB CHASSIS	Too Heavy	8600
1991	**GMC**	**SAFARI AWD**	**SAFARI**	**AWD**	**6100**
1989	**CHEVR**	**ASTRO**	**ASTRO**	**Trac. Control**	**5600**
1976	CHEVR	G30 CHEVY VAN	G30 CHEVY VAN		10000
1979	FORD	F250 PICKUP	F250 PICKUP		10000
1997	MITSU	MONTERO	MONTERO SPORT		5000
1987	**NISSA**	**MAXIMA**	**MAXIMA**	**Trac. Control**	**n.a.**
1984	TOYOT	FLATBED	PICKUP		8600
1986	TOYOT	1 TON DUALEY	PICKUP		8601
1990	TOYOT	CAB/CHASSIS	CAB/CHASSIS	Too Big	8600
1991	TOYOT	PICKUP	CAB/CHASSIS	Too Big	8499
1992	**FORD**	**EXPLORER 4-DR**	**EXPLORER 4-DR**	**AWD**	**5240**
1991	**FORD**	**EXPLORER**	**EXPLORER**	**AWD**	**5180**
1993	**FORD**	**EXPLORER 4-DR**	**EXPLORER 4-DR**	**AWD**	**5280**
2000	FORD	EXCURSION	EXCURSION		8600
1994	**FORD**	**F150 SUPER CAB/SHORT**	**F150 REG CAB/ LONG**	**Too Heavy**	**6250**
1989	FORD	F250 PICKUP	F250 PICKUP	Too Heavy	8600
1991	FORD	F250	F250 PICKUP		8600
1993	FORD	F250 REG CAB – LONG	F250 PICKUP		8600
1985	FORD	TRUCK	F250 PICKUP		8600
1993	**CADIL**	**FLEETWOOD**	**FLEETWOOD**		**n.a.**
1982	CHEVR	G20 CHEVY VAN	G20 CHEVY VAN		8600
1981	CHEVR	C20 PICKUP	C20 PICKUP		8600
1988	CHEVR	CHEYENN	C3500 PICK UP		8600
1993	CHEVR	TRUCK	C3500 PICKUP		10000
1993	CHEVR	G30 CHEVY VAN	G30 CHEVY VAN		8600
1993	**GMC**	**S15 JIMMY 4WD**	**S15 JIMMY 2WD**	**AWD**	**5100**
1991	CHEVY	SUBURBAN 2500	K2500 SUBURBAN		8501
1984	CHEVR	C30 PICKUP	C3500 PICKUP		10000
1987	GMC	G3500 RALLY WAGON	C3500 PICKUP	Too Heavy	8600
1998	**JEEP**	**GRAND CHEROKEE**	**GRAND CHEROKEE**	**AWD**	**5000**
1990	FORD	F150 PICKUP	F150 PICKUP		5250
1997	**MERCU**	**GRAND MARQUIS**	**GRAND MARQUIS**	**Trac. Control**	**n.a.**
1991	**TOYOT**	**CAMRY**	**CAMRY**		**n.a.**
1989	**NISSA**	**240SX**	**240SX**		**n.a.**
1991	**TOYOT**	**CAMRY**	**CAMRY**		**n.a.**
1991	**TOYOT**	**PICKUP**	**PICKUP**	**Too Big**	**5820**
1993	**TOYOT**	**UTILITY**	**CAB/CHASSIS**	**Too Big**	**6500**
1978	**FORD**	**F250 PICKUP**	**F250 PICKUP**	**Too Big**	**7600**
2000	**VOLVO**	**C70 COUPE**	**C70**	**Trac. Control**	**n.a.**

Vehicles With Lookup Table ID Number Mismatches

The Vehicle Lookup Table (VLT) is used to identify the proper dynamometer loading for a vehicle based on such characteristics as Make, Model, Model Year, Engine, Transmission, and Body. Each unique combination is identified with a VLT row identification (ID) number. The previously described Roadside Inspection/Smog Check dataset was analyzed to determine how frequently the VLT row ID differed between the Smog Check and Roadside Inspection tests, and to identify the source of the differences. When technicians have to enter information manually, mistakes can occur; therefore, all of the discrepancies observed based on this analysis are not necessarily due to intentional data entry errors intended to affect the outcome of the test. Another source of error is misinformation in older look-up tables that were corrected by BAR around 2003. Nevertheless, the analysis provides an indication of the extent to which data entry errors are affecting test results.

Only the vehicle's roadside inspection and the settings used for the vehicle's most recent passing Smog Check inspection were examined. Smog Check inspections not resulting in a passing certificate, including pretest, training, and aborted tests, were removed. Smog Check results following the vehicle's Roadside Inspection date were also removed.

Of the 6,667 remaining roadside tests used for this analysis, 605 of the corresponding final Smog Check tests used a different VLT version. These were removed for this analysis, leaving 6,062 tests. Of the 6,062 remaining roadside/Smog Check test pairs, 799 (13.2%) reported use of different VLT row IDs.

Table 6-5 identifies the differences observed in the vehicle characteristics recorded for the 799 Roadside and Smog Check tests with differing VLT row IDs. The total number of mismatches (993) is greater than the number of tests because some vehicles had more than one mismatch.

Table 6-5
Mismatches in Vehicle Characteristics
Comparing Roadside and Smog Check Station Data

Characteristic	Mismatch	% of Total Mismatches
Model	347	43%
Engine Displacement	253	32%
Model Year	136	17%
Body Type	112	14%
Number of Cylinders	50	6%
Transmission Type	42	5%
Make	31	4%
Type (Pass or Truck)	22	3%

Initially, the Model names of all tests with mismatching VLT row numbers were inspected. It was apparent that a more productive approach would be to first segregate Body Types (sedans, wagons, pickups, SUVs, and vans), and then to examine Models within individual types.

The 799 row identification mismatches were compared with regards to the Body Type reported for the two tests. The results are displayed in Table 6-6.

Table 6-6
VLT Mismatch – Roadside versus Smog Check
By Vehicle Body Type

Body Type	Mismatch	Match	Mismatch (%)
Sedan	398	3319	11%
Station Wagon	49	133	27%
Pickup	215	912	19%
Sport/Utility	66	375	15%
Minivan	24	428	5%
Full-size Van	47	96	33%

Individual test results were then examined. For example, 49 Station Wagons with a mismatch between roadside and Smog Check VLT row number were identified. The only unusual pattern noted was a number of subcompacts, such as the Honda Civic, that were identified as either a sedan or a station wagon. This was attributed to confusion regarding how to classify a "hatchback" design.

The differences found in pickups, SUVs, and Vans were more significant. A common difference between the two datasets was the assignment of ½ Ton, ¾ Ton and 1 Ton models, as indicated by such names as F150, F250, and F350 or C1500 and C2500. The heavy-duty models can require substantially heavier test weight than the base models. A more subtle difference noted was the difference between two-wheel-drive and four-wheel-drive assignments. The four-wheel-drive versions of the full size vehicles frequently have assigned dynamometer test weights between 500 and 1000 pounds heavier than the two-wheel-drive versions.

The assigned test weights of all pickups, SUVs, and vans with mismatched VLT row numbers in the Smog Check and roadside datasets were averaged to determine if there was a bias between the datasets. The average weights of the two groups were within 10 pounds, indicating there was no systematic offset.

The next most common row ID discrepancies as shown in Table 6-5 include Engine Displacement, Model Year, Number of Cylinders, Transmission Type, and Make. Again, individual tests with discrepancies were segregated and manually reviewed. The source of most of the differences appeared to be carelessness, where a technician in one program reported a four cylinder engine while a different technician reported a six cylinder engine. More significant was the number of times a vehicle would be tested in one program as a Camry, for example, and a Corolla in the other. However, no consistent bias in assigned test weight was found between the two datasets. Most of the issues resulting from these discrepancies should be addressed in the design of the BAR 2010 analyzer.

In summary, although there were cases where VLT mismatches occurred, none of these situations impacted the refail rate at the roadside.

Focus Group Study Results

Five separate focus groups were also used to investigate reasons for the high roadside failure rate of vehicles that initially failed during the previous Smog Check cycle. These focus groups were intended to provide insight into future potential areas of analysis.

A focus group consisting of BAR personnel suggested several technical differences between the roadside testing and the tests conducted at Smog Check stations that could explain differences in test results (e.g., differences in test conditions, test equipment, and equipment maintenance). However, these suggestions explain only relatively small differences that would not change the results of this analysis. In addition, BAR personnel and Smog Check station personnel mentioned the failure of inspectors to perform adequate visual and functional checks as contributors to the problem, along with the use of cheap, aftermarket catalysts.

BAR personnel, vehicle owners, Smog Check station managers, and technicians who participated in the focus groups all mentioned the possibility that some technicians might accept bribes to produce a falsified passing test result, but no one offered any real evidence of the extent to which bribery or illegal activities result in falsified test results.

The focus groups also revealed that incentives exist that likely reward low performance as it is more profitable for stations, and more affordable and convenient for motorists, when inspections are done quickly and cheaply, which often leads to improper and incomplete tests.

Attachment 1 contains more details about the focus group study.

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7. RECOMMENDATIONS

Based on the analysis described above, improper or falsified Smog Check results appear to be contributing to the 49% tailpipe failure rate at the roadside for vehicles that initially failed during the previous Smog Check cycle. While the existing BAR program has been successful in identifying some stations that produce falsified or incorrect test results, it cannot identify Smog Check stations that are willing to falsify a test result only for routine customers. None of the specially prepared vehicles used by BAR are taken to Smog Check stations by routine customers of the station.

To better address the extent to which improper and/or falsified test results may be factors in the Smog Check program, the following additional steps should be considered:

1. Further refine the Station Performance Algorithm and use it to target low-performing stations for increased enforcement and to create incentives for more stations to become high performing. Adding "fingerprint" analysis of OBD inspection results in Smog Check data is one of the approaches that could be included in the Station Performance Algorithm when the next generation of Test Analyzer Systems is deployed. If more detailed OBD results are collected by new analyzers, it should be possible to determine when a Smog Check station is reporting OBD inspection results that are inconsistent with the results that should have been generated for a particular make and model.[14]

2. Perform inspections of vehicles immediately following certification at Smog Check stations. This would facilitate the inspection of vehicles owned by routine customers that may be treated differently than vehicles unknown to the station. The options for accomplishing such inspections include roadside inspections of vehicles leaving Smog Check stations or on-site inspections of vehicles that are preparing to leave a station.

[14] A detailed explanation of how OBD "fingerprint" analysis might be performed is not considered appropriate for a report that may receive widespread distribution, but has been discussed with BAR and ARB privately.

3. Continue the Roadside Inspection Program. Using the results from this analysis as the baseline, continuation of the Roadside Inspection Program will enable the effectiveness of future Smog Check program improvements to be measured. Roadside data should also be used to target low performing stations for additional enforcement.

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Attachment 1

Summary of Smog Check Focus Group Study

Summary of Smog Check Focus Group Study

August 20, 2007

Prepared for:

California Air Resources Board
California Bureau of Automotive Repair

Prepared by:

Eastern Research Group

Table of Contents

Introduction

Based upon results from the random roadside inspection program, high emitting vehicles are passing at Smog Check stations at a high rate. In other words, vehicles that passed their regular Smog Check inspection were found later (by roadside inspection) to have probably passed by error or fraud. The goals of this task are to obtain information on the motivations for non-compliant behavior (“Why” questions), and to identify the different ways in which a high-emitting vehicle may receive a Smog Check certificate (“How” questions).

ARB and BAR wanted to collect information to identify possible causes for the observed problem. A well-run focus group is an ideal tool for gaining new insights into real world program operation. Synergy between focus group participants can drive discoveries and insights far more quickly than is possible with individual interviews. However, focus groups must be well-run by a facilitator who prevents group domination by just one or two participants or by the force of individual agendas.

Eastern Research Group (ERG) led this task by helping design and prepare the focus group materials, identify participant groups of interest, arrange facilities, pay incentives, and report the results. ERG was aided by SDV/ACCI, who performed the recruiting and provided a focus group facilitator, Brian Fowler.

Participant Groups of Interest

ERG consulted with ARB and BAR to determine the best persons to target for these focus groups. There are both legitimate and illegitimate reasons for the discrepancy between Smog Check inspections and roadside inspections results. To best identify and understand these reasons, we felt it would be important to talk not only to technical experts, such as BAR personnel, inspectors, and repair technicians; but also to vehicle owners themselves, who probably can have a significant role in the outcome of an inspection.

Vehicle owners eligible to participate were identified by their experience with the program. The two types of vehicle owners we recruited had all been through the Smog Check program, and then received a roadside inspection within a year that they ‘failed.’ Some of them had passed their regular Smog Check on the first try and some had failed and then passed Smog Check (presumably after being repaired).

ARB and BAR expressed a desire to understand if inspectors and repair technicians had different opinions about how to improve Smog Check, based upon how competent they appear to be. To determine if a significant knowledge gap existed between experts thought to be competent and those thought to be incompetent, we broke this group into four categories: ‘hands-on’ personnel with BAR (enforcement technicians, field representatives, roadside technicians, etc.); station managers and technicians thought to be ‘high-performing’ (based upon the experience of BAR), those thought to be ‘lowperforming,’ and those who had either received citations or had their licenses revoked.

Focus Group Questions

ERG worked with ARB and BAR to develop a list of questions for each focus group. Vehicles owners were to be asked about their experience with the program, things they see wrong with it, and ways they see to improve it. BAR personnel, station managers, and technicians were to be asked primarily about things they see wrong with the program and ways they believe it could be improved.

The lists are in the form of a script. They begin with an introduction of the reasons for the focus groups. Then they touch on each of the following subjects.

- Legitimate ways vehicles can pass the inspection when they should have failed it.
- Opinions on ‘gaming’ the test process
- The roles of repairs in the high re-fail rate during roadside inspections
- How motorists could be responsible
- Opinions on how Smog Check could be improved

We have attached the questions as appendices for the reader’s reference. The script of questions used for vehicle owners is reproduced in Appendix A and the scripts used for station managers, technicians, and BAR personnel are reproduced in Appendix B.

Recruiting

Recruiting participants for each focus group was a case of identifying persons who fit the criteria for each group, determining the best location to recruit near, then randomly contacting all qualifying persons in that area until enough volunteers had been obtained. This necessarily involved handling confidential consumer information, so protecting identities from unauthorized use was extremely important.

Data Security

Since deciding upon focus group recruits would involve handling personal information of consumers, confidentiality was of serious concern. Therefore, any person who was to handle private information was required to sign several agreements with the state. The first agreement was a memorandum of understanding (MOU) with the BAR. In summary, the MOU required that persons with confidential information follow applicable state and federal laws, and that they follow certain documentation procedures. The second agreement was with the Department of Motor Vehicles (DMV). It was their Information Security Agreement, and it limited the sharing of personal information and stipulated security procedures for handling the information.

Identifying and Recruiting Participants

A focus group for this type of study typically contains 3 to 6 participants. Any more will discourage some from participation, which is a waste of incentives budget. Any less becomes more of a one-on-one interview. A standard ‘rule of thumb’ when recruiting focus groups of this size is to obtain commitments from 8 recruits, with the idea that about 2 out of the 8 will typically not show up at the appointed time and place. A further assumption is that a typical response rate to telephone recruiting (at an incentive of $100 for 1.5 hours) is about 10%, so one in ten persons called will agree to participate. Therefore, we figured that approximately 80 persons would have to be called for each focus group to obtain commitments from 8 persons.

ERG worked with BAR engineering to identify potential recruits fitting the criteria for each focus group (as described previously). For the BAR personnel group, ERG relied upon BAR alone to provide a list of recruits from their own staff and to recruit those individuals. With approval of ARB and BAR, we decided to conduct the focus group for BAR personnel first, in Sacramento. This would allow training our moderator and could serve as a test of the questions with a group of professionals. A further advantage of conducting the first group with BAR personnel was that any information needed after the focus group could be reliably obtained through written, follow-up questions.

For vehicle owners ERG first produced a list of license plates that fit the criteria for participation (i.e., that the vehicle had gone through a Smog Check cycle soon before a roadside inspection). BAR then matched the list to the registration database at DMV and provided ERG the names and addresses of the vehicle owners. This produced a list from which to recruit vehicle owners. For the manager/technician groups, BAR provided a list of all stations and technicians in the state and a list of stations and technicians that fit the criteria for the three focus groups (i.e., identified as high-performing, low performing, or having received a citation or revocation of license). ERG then matched the names, addresses, and phone numbers from the master list of the stations and technicians to the focus group qualifying lists provided by BAR. This produced three more lists from which to recruit the three remaining focus groups.

After filtering the vehicle owner database and the station manager/technician databases, we looked for areas of the state within which we could recruit the required numbers of individuals for each focus group. A reasonable distance to ask people to travel for a focus group (with an incentive in the $100 range) is about 20 miles or 30 minutes. After applying this distance criterion to the search, we quickly realized that the only area of the state with sufficient potential participants in a 20 mile radius of each other was the Los Angeles basin. After locating several possible focus group locations in the South Coast area, we settled upon a location in the Burbank/Hollywood area. The facility is run by Schlesinger Associates, a well-respected firm in marketing research and qualitative analysis. Their website is at www.schlesingerassociates.com.

The Schlesigner Associates facility is located in the 90068 zip code. ERG used geographical information software to identify zip codes within a 20-mile radius of the 90068 zip code. Figure 1 is a map of the applicable zip code boundaries. Any potential participant within these zip codes was a candidate for recruitment.

ERG developed scripts for our subcontractor to use in recruiting participants. The scripts provided a standardized check list for recruiters to help decrease misunderstandings during the process. Recruits who volunteered to participate were send a confirmation letter with information on the time and place of their focus group and whom they should contact with questions.

The groups in southern California were held at Schlesinger Associates. They are located in the Panasonic building on 3330 Cahuenga Boulevard West, in Los Angeles. This is across U.S. highway 101 from Universal City. All focus groups at this facility took place on July 24, 2007. Vehicle owners were interviewed at 8:00 am, high performing managers and technicians at 11 am, low performing managers and technicians were at 3:00 pm, and cited/revoked managers and technicians were at 6:00 pm.

Figure 1. Map of Zip Codes Participants Were Recruited From

Results

The first of the five focus groups was done in Sacramento with BAR personnel. The last four were all performed in southern California on July 24.

Recruiting Results

Recruiting for the BAR Personnel focus group was a special case of having BAR managers decide who they considered best for the focus group, having ERG review BAR suggestions, then having the BAR managers arrange for their personnel to participate in the focus group. No monetary incentives were offered for that focus group. Six personnel were suggested by BAR and agreed to by ERG. All six of those personnel participated in the focus group in Sacramento.

Recruiting for the vehicle owner and station manager/technician focus groups was a more normal type of focus group recruiting, in that the recruits were offered monetary incentives and were required to participate during their normal work day, but not necessarily with the cooperation of their employer. An added complication was that the recruiter had to overcome a level of suspicion as a 'representative' of the state. This suspicion is understandable considering the fact that these focus groups often targeted groups with a high likelihood of having 'skirted' the letter of Smog Check rules. For example, many of the vehicle owners had failed their Smog Check, then passes a later Smog Check (presumably after having the vehicle repaired), then gone on to fail a roadside inspection and many of the technicians were labeled as 'low performing' by BAR enforcement.

Table 1 summarizes recruiting results for all focus groups. The previously discussed results for the BAR focus group are on the top row. Results for the other groups are in the bottom 4 rows. All recruiting for the focus groups in Los Angeles was done by telephone. In the case of vehicle owners, ERG subcontractor SDV/ACCI searched for the phone numbers based upon names and addresses obtained from the DMV database. Of the 314 possible candidates within 20-miles of the facility, 65 valid phone numbers were found. While this was not the desired number of possible recruits (i.e., 80), it was sufficient to obtain commitments from 5 individuals to participate in the vehicle owner focus group. Unfortunately, only two of those individuals actually participated in the focus group at 8 am.

Similar results were seen for the manager/technician focus groups. Of the approximately 80 to 100 individuals recruited, between 6 and 8 volunteered to participate in each focus group. Interestingly, the volunteer rate seemed significantly higher for the groups labeled by BAR enforcement as 'lower performing.' This may indicate that the volunteer rate is influenced by the focus group's dissatisfaction level with the system. Unfortunately, as was the case with the vehicle owners, only two or three individuals actually participated in each focus group. Even though SDV/ACCI was authorized to call all afternoon volunteers on the morning of the focus group, and offer them a 50% increased incentive of $150, the participation rate did not rise for the later focus groups.

Table 1. Summary of Recruiting Results for All Focus Groups

Group	City	Date/Time	Within 20-mile Radius	Recruited	Volunteered	Participated	Final Incentive
BAR Personnel	Sacramento	Jun. 1 at 8:30 am	n/a	6	6	6	$0
Vehicle Owners	Los Angeles	Jul. 24 at 8 am	314	65	5	2	$100
High Performing	Los Angeles	Jul. 24 at 11 am	78	78	6	3	$100
Low Performing	Los Angeles	Jul. 24 at 3 pm	97	97	7	2	$150
Cited/Revoked	Los Angeles	Jul. 24 at 6 pm	99	84	8	2	$150

Focus Group Results

All focus groups were conducted at facilities expressly designed for that purpose. Each facility had a meeting room with a two-way mirror to an adjacent observation room, where expert observers took notes. All focus groups were recorded on DVD as well. First we discuss the recruiting results, then the focus group results.

Mr. Andrew Burnette of ERG and Brian Fowler, ERG's subcontracted through SDV/ACCI were present in the BAR personnel focus group session. Mr. Fowler facilitated the meeting and Mr. Burnette answered technical questions as needed. Observers from both ARB and BAR were present in the observation room. Only Mr. Fowler was present for the rest of the focus groups. Mr. Burnette observed all of these sessions from the observation room. Some ARB and BAR personnel were also present during some of these focus groups.

The first focus group, with BAR personnel, produced the most findings, opinions, and suggestions. Not only was this group larger than the others, it also consisted only of professionals who were expert in their areas of the program. BAR personnel suggested several reasons why vehicles may legitimately pass a Smog Check inspection, then go on to fail a roadside inspection. The following bullets summarize these reasons.

- The roadside crew always uses a fan to help cool the vehicle but stations only use fans when the temperature is over 72F. Use of the fan can influence emissions.
- Being in the sun or fog may have an impact because ambient conditions influence the vehicle emissions. Temperatures change pretty drastically during the day in inspection lanes. These may be quite different than for the roadside systems.
- All roadside units use the ESP BAR97 system, and there are systematic differences between the BAR97 systems (ESP, Sun, Worldwide, etc.).
- Roadside equipment is better maintained that station equipment. For example, stations perform calibrations and leak checks about every three-days, but Roadside crews do them every day.
- Cutpoint changes may have occurred between the roadside inspection and the Smog Check inspection it is being compared to. It wouldn't be a fair comparison if vehicles are failed at roadside using a stricter standard than they were repaired to.
- Roadside vehicles are all being driven on surface streets. So vehicles that are mainly driven on the highway, which are in better shape, are not included as much in the roadside sample.

The BAR personnel further mentioned that, as compared to typical Smog Check technicians, there is a different level of competence and incentives in the roadside crew. Different fail rates are to be expected. Referee technicians have a level of competence similar to roadside crews, so referee stations probably have a fail rate much closer to that of roadside crews.

BAR personnel generally agreed that more could be done to improve the program. Their suggestions are summarized in Table 2.

The station manager and technician focus groups were also quite fruitful in providing suggestions and opinions for Smog Check. Although there was a discernable difference in the attitudes and experiences of these last three focus groups, their opinions and suggestions were strikingly similar. They are also summarized in Table 2.

The vehicle owner focus group was important mainly to give the customer's viewpoint and to add weight to some of the more important findings. Their suggestions are likewise summarized in Table 2.

Conclusions and Recommendations

All significant findings are listed in Table 2 at the end of the previous section. In this section we discuss what we consider the most important of those findings.

After considering the information gathered in these focus groups, ERG has several conclusions and recommendations for the Smog Check program. Most of these suggestions will implicitly require some further research, which should be designed after ARB and BAR have decided upon priorities for possible program changes.

Table 2. Summary of Focus Group Findings

Finding	BAR Personnel	Vehicle Owners	Managers & Techs	Notes
Cheap catalysts are common and cause temporary 'repairs'.	X	X	X	This was the most mentioned problem. $150 catalyst replacements are of low quality. A good quality catalyst replacement is about 10-times more expensive.
Technician certification and renewal should include hands-on diagnostic tests	X		X	Written tests allow incompetent technicians to be certified.
Attempted bribery is fairly common.	X	X	X	All who mentioned it said $100 to $150 is the going rate.
Vehicle owners cheat too, so enforcement should include them			X	Maybe this could include better public education.
Time of day (i.e., ambient conditions) influences vehicle emissions	X		X	Perhaps temperature correction factors should be incorporated.
If a vehicle fails at test-only, require a Smog Check immediately after repair at the repair shop.			X	The inspection in the VID will record the repair result and the shop, increase revenue to the repair shop, and allow free re-test at original inspection station (if desired). Or sometimes the state could reimburse this to get more post repair data.
Fast pass encourages skipping the visual and functional tests	X		X	When techs see a fast pass, they often assume the visual and functional are okay. It makes the test go faster.
CAP Program is not as well known as it should be		X	X	Example of low-income owner who gave up vehicle that could not pass. Now taking the bus (takes 3-times longer), and looking for another cheap car.
6-year exemption from Smog Check is too long	X		X	Some cars may be out of warranty by then.
Truck cutpoints are manipulated by entering the wrong GVWR	X		X	Not seen as a big problem, but frequent enough to be noticed.
Test-only stations get several directed (to test-only) vehicles each day. This causes tense situations.	X		X	Some how vehicle owners are not understanding they should go to test-only if directed. Causes them inconvenience and bad feelings about the program.
Low concentration calibration gas should be even lower now	X			Some cutpoints are now in the 50 ppm [HC?] range, which is much lower than the calibration range.
Inadequate preconditioning is a problem due to customer waiting	X			Pretty common to fail for NOx at station, then pass at Gold Shield (CAP).
idle	X			Some cars look like they will fail in manual mode (idle), but pass ASM.
There is significant pressure on techs to insepct quickly and pass vehicles.	X			Managers want 6 Smogs per hour and it is hard to tell owners they failed the inspection. Techs with higher fail rates are fired first.
Comprehensive 'end of warranty' inspection should be required for vehicles	X			Dealer/manufacturer should fix any warrantied items at end of warranty.
shops	X			
Tech training should emphasize diagnosis and ethics	X			This is in addition to the hands-on test mentioned above.
Service writers should be held accountable for fraud at their shop	X			This would encourage oversight of technicians
Better technicians should be rewarded somehow	X			Money or recocgnition of some kind would work.
A NOx 'hangup' test is needed because of lazy NOx electrochemical cells	X			This would allow lazy cells to come back to zero before the next test. This would be less important when the UV method replaces electrochemical method.
Cars could be given grades when they are certified. This might increase the value of low emitting used cars.	X			Cars with an 'A' would be more reliable, likely to pass, fuel efficient, etc.
Enforcement personnel would benefit from more time doing their Intranet research.	X			The intranet tools are valuable for finding 'bad players', but there is not enough research time available to effectively use them.
Enforcement personnel would benefit from more 'one-on-one' tech time during field audits. Some personnel felt VID data was not shared with enforcement well enough.	X			This will allow better communication/training with lower quality techs. One person felt that anayzer data was not readily available to enforcement.
Automatic consumer survey cards (post inspection) could help identify stations needing improvement.	X			This could be used to both get and give information. Were the told about CAP? Were they given a written estimate? A web based option could be offered.
Better repairs should be encouraged with monetary incentives. Or not.	X			One idea was to charge higher certificate fees to low performing stations. One person felt strongly that incentives are wrong. Techs should do their job right without new incentives.
1976 and older vehicles should be inspected at change of ownership.	X			This would encourage more rapid turn-over of older vehicles.

Inferior catalytic converters are a major cause of ineffective repairs:
The most important finding stems from a legitimate repair that should probably be disallowed in California. All groups agreed that low-cost catalytic converters are a prevalent repair item for failing vehicles. At about $100 to $150 installed, commonly used replacement catalytic converters cost as little as 10% of a high-quality 'OEM' catalytic converter. This cost difference is largely driven by the content of precious-metal catalysts that make the catalytic converter work. Participants with relevant technical expertise all agreed these catalytic converters are inferior and are a major cause of rapidly rising emissions after repair. *This finding supports the current efforts of ARB and BAR in determining the impact of disallowing the use of inferior catalytic converters.*

The fast-pass feature 'encourages' technicians to skip the visual and functional portions of the inspection:
When a vehicle 'fast-passes' the emissions portion of the inspection, the technician knows there will be little suspicion aroused if the vehicle passes the visual and functional portions of the inspection as well. Therefore, after a 'fast-pass' they feel safe skipping the visual and functional portions by entering a 'pass' or 'not applicable' response (as appropriate) when prompted by the analyzer software. These parts of the inspection are time-consuming and considered irrelevant by some technicians when the emissions are low enough to pass the test. *BAR should consider turning off the fast-pass feature for at least certain classes of vehicle (e.g., older vehicles with a high tendency to fail the visual or functional inspection). These vehicle classes could probably be identified from roadside and referee inspection records. [Would this change require a software modification?]*

The CAP program is not as well-known as it should be:
Both technicians and vehicle owners mentioned that the CAP program is not as well known as it should be. Managers and technicians agreed that the program is well-run and useful. Although most of them routinely mention the program to failing customers, they said most people were unaware of the program when they do mention it. One vehicle owner had a low-income friend who had given up her vehicle because she could not afford to repair it and was never aware of her option to apply for assistance through the CAP program. *BAR should consider ways to encourage all technicians to sell the CAP program. Perhaps a referral system could be set up where the referring technician receives discounts on professional expenses, profit-sharing with the station that performs the repairs, or some other pro-active incentive for referring vehicles that qualify and participate in the CAP program.*

An on-going consumer feedback/education program should be implemented:
BAR personnel felt that consumer feedback is a source of information that could be put to better use. Current feedback is complaint driven. A program that methodically encourages feedback, while providing education at the same time would help Enforcement target stations needing improvement and discover what parts of the program consumers are not sufficiently aware of. *BAR should consider a program that randomly solicits feedback by mail (consumers without access to the World Wide Web) and should encourage feedback via BAR's website on an electronic survey form.*

Appendix A

Scripted Questions for Vehicle Owner Focus Group

Discussion Guide for Motorist Focus Groups

Introduction

To begin, we want to be sure that everyone understands this is a confidential focus group. We emphasize this because we want everyone to speak freely regarding your previous experiences and your opinions. If it makes you more comfortable, feel free to attribute actions to a third, unnamed party. For example, you could say, "I know someone who did this," Instead of saying, "I did this."

Recent studies have shown that a large number of vehicles pass their Smog Check test and then fail a roadside test conducted immediately afterward. The group here this morning may include several people that have experienced this problem with their vehicles. Try to remember your last Smog Check. It should have been since October of last year. Try to remember if you failed or passed on the first attempt. It's not critical, but may be helpful in answering some of my questions this morning.

Based on your personal experience, we would like to investigate why so many vehicles certified by the Smog Check program subsequently fail a roadside test. This problem is particularly relevant as the State grapples with revising its plan to meet air quality standards.

To answer this question, we are looking for insight from people such as you, who are most likely to understand what is happening in the real world. Consequently, you may be able to help identify new, innovative ways to address these problems. Such insights are best discovered through an open, exploratory discussion.

Again, we encourage full participation from the group. Be assured that everyone's identity will be held confidential, and will not be provided released publicly to anyone.

I.

[The following questions may be asked of all motorists.]

1. Did you prepare for your initial test before going to the Smog Check station? How?
2. Did a Smog Check technician give your vehicle a preliminary inspection or test before performing the actual Smog Check test?
3. Did a Smog Check technician recommend any repairs or maintenance prior to your initial test? If so,
   - What repairs were recommended?
   - Did you make those repairs?
   - Did the technician recommend a specific type of repair station for the work?
4. How much money did you spend on repairs or maintenance prior to your initial inspection?

II.

[The following questions are for vehicles that failed their initial inspection].

5. After you failed the test, did station personnel provide you with adequate information on what to do to your vehicle before returning for a retest?
6. After your vehicle failed the test, which one of the following things did you do?
   - Took the vehicle to a professional mechanic to have it repaired
   - Repaired the vehicle yourself or had it repaired by a family member or friend
   - Figure out a way to pass the test without any repairs (including going to another station that would pass it).
   - Did nothing and:
     - sold or traded-in the vehicle
     - quit driving the vehicle
     - scrapped the vehicle
     - continued driving the vehicle without re-registering it
     - figured out a way to re-register the vehicle anyway
     - other
7. How much money did you spend, if any, on your vehicle to get it to pass the test?
8. Did the technician offer an option for “higher end” and “lower cost” parts?
   - If so, which did you choose?
   - Did he explain the advantages of high-end repairs?
   - Do you think the high-end repairs were a good idea?
   - What was the price difference?
9. What repairs, if any, were made to get your vehicle to pass the test?
   - If parts were purchased, were they new or aftermarket parts?

III.

[The following questions may be asked of all motorists.]

10. Do you have any ideas why your vehicle failed its roadside inspection so soon after receiving a Smog Check certificate?
    - Did you notice any change in vehicle performance between your Smog Check test and the roadside test? Please elaborate.
    - Did you have any additional work done on your vehicle between the Smog Check and roadside tests? If so, please describe.
11. We have heard of motorists making “temporary adjustments” to their vehicles in order to pass their Smog Check test. Do you believe this is feasible, and if so, how might this be done?
12. What other ways might motorists with high emitting vehicles obtain a passing Smog Check certificate?
    - How common are these approaches?

- How much do you think they cost (in terms of time and money)? [Ask about bribes and the required size of the bribe if it doesn't come up.]

13. Please tell me if you are very familiar, somewhat familiar, or not familiar with the following options for failing vehicles:
    - Waiver option
    - Consumer Assistance Program
14. Some people have told us that they have managed to avoid the vehicle emissions test requirements when they expected their vehicle to fail. Would you say this practice is common or uncommon in your area? If a motorist does not comply with the Smog Check requirements, how likely do you feel it is that they will get caught and fined:
    - extremely likely
    - very likely
    - somewhat likely
    - not very likely
    - not at all likely
15. What could be done to encourage motorists to have their vehicles fully repaired after they fail a vehicle emissions test (i.e., not just enough to pass)?
16. What could be done to encourage motorists to fully comply with the emissions testing program?

Appendix B

Scripted Questions for Station Manager, Technician, and BAR Personnel Focus Groups

Discussion Guide for Focus Groups of Technicians, Station Owners/Managers, and BAR Personnel

Introduction (technicians/station owners/enforcement personnel)

Recent analyses performed under contract to both California BAR and the California ARB show that too many of the vehicles that were certified after having failed an initial smog inspection subsequently fail a roadside test conducted immediately afterward. In addition, too many of the initially passing vehicles were in a high-emitting condition at the time they were granted a certificate. Analysis also shows that this high re-failure rate is not a consequence of rapid deterioration of emissions control equipment. Instead, it appears that many of the vehicles may not have been in a passing condition at the time of certification. This is the problem we want to investigate today: Why are so many vehicles certified by Smog Check technicians failing roadside tests immediately after passing their Smog Check test? This problem is particularly relevant as the State grapples with revising its plan to meet its air quality standards.

Understanding the Issues (both groups)

So how do we improve the rate at which vehicles are properly tested and repaired prior to certification? To answer this question, we are looking for insight from people such as you, who are most likely to understand what is really happening on the ground.

Technicians/Station Owners[15]

As agents licensed through the Bureau, technicians are the gatekeepers of the Smog Check certification. As such, they bear particular responsibility for ensuring that only compliant vehicles are certified. Technicians and station operators are well positioned to understand both the motivations for improper testing, repair, and for motorist noncompliance, as well as the specific actions that lead to the high re-fail rates observed. In other words, you understand the "How" and the "Why" associated with this problem better than anyone else. Consequently, you may be able to help identify new, innovative ways to address these problems. Such insights are best discovered through an open, exploratory discussion.

We encourage full participation from the group. Be assured that the identity of all respondents will be held confidential, and will not be provided released publicly to anyone.

I.

Let's begin by discussing how high emitters may be *legitimately* slipping through the Smog Check test.

[15] The wording in this section should be altered for the de-certified owner/technician group to reflect past-tense where appropriate.

1. *Is it common for vehicles to fail, get retested immediately without additional preconditioning, and then pass without any adjustments or repairs? Do you think the change from fail to pass is the result of the analyzer or vehicle performance? Why?*
2. *Do you know any legitimate reasons a vehicle would pass when it normally would fail the test?* …[If no one brings them up, here are some suggestions…]
   a. *Technicians preconditioning vehicles differently than others? What could be done to improve the consistency of preconditioning?*
   b. *Motorists fail at one shop and then go to another to get a second opinion?*
   c. *Inconsistent results between stations? What are the likely causes of the inconsistencies?*

II.

I'd like your opinions on "gaming" the test process

- *How common is it?* [If they say it doesn't happen, ask the next question.]
- *Is it technically feasible?*

Now I'm going to read a list of possible ways of "gaming" the test process. [Read the following together in groups, allowing the participants to respond to each group, then proceed to the next. Put each group on white board or easel for reference. Run through these quickly.]

3. *Altering Emission Reading/Data Stream*
   - Clean piping
   - Clean plug/scan (OBD)
   - Dilute exhaust sample

4. *Temporary Vehicle Modifications*
   - Retard timing
   - Induce vacuum leak
   - Alter idle speed (TSI only)
   - Alter engine load (A/C, lights on…)

5. Fraudulent Test Sequence/Execution
   - Incomplete/abort emissions test
   - Incomplete visual/functional
   - Gear Shifting

6. *Altered Preconditioning*
   - Over condition vehicle
   - "I/M lotto"

7. *VID Manipulation*
   - Change vehicle description to select less stringent cutpoints
   - Select different vehicle or fuel type

- Select older model year
- ASM to TSI
- Incorrect entry to select default test settings

8. *Test Equipment Manipulation*
    - Analyzer tampering
    - Dirty "zero air" to set false zero

9. *Has anything else come to mind as we discussed these?*

III.

Next, let's discuss the possible role of repairs.

10. *Do most consumers generally authorize the repairs you suggest? If not, why not?*

11. *To what extent do technicians feel pressured to perform inexpensive repairs that will cause the vehicle to pass the retest (but not necessarily fix the underlying problem)? Why?*
    - *Pressure from motorists*
    - *Financial and/or time pressure*

12. *Are there drawbacks to ensuring vehicles are completely repaired prior to being granted a certificate? What are they?*

IV.

Now, I'd like to discuss how the motorists themselves may be influencing test results.

13. *Is it common for motorists to offer bribes to pass their vehicle? For how much?*

14. *Do you believe that motorists know how to find shops that will certify their vehicle, regardless of condition?*

15. *Do you believe replacement part quality is a significant factor in determining retest results? If so, for which parts?*

16. *Do repairs by unlicensed stations and/or unqualified technicians substantially impact repair quality?*

17. *What other means do motorists use to obtain a certification for a high-emitting vehicle, or otherwise avoid program requirements?*

V.

I'd like to conclude by discussing how the Smog Check program could be made more effective at ensuring proper testing and repair of high emitting vehicles.

18. *For a "typical" gross emitter, please estimate the repair cost at which motorists would prefer to simply scrap their vehicles.*

19. *Are consumers generally aware of the options available under the CAP program? Is it effective?*

20. *Are there other ways BAR, technicians, or stations can improve motorist compliance with the Smog Check program?*

21. *Are the current audit and enforcement policies effective at ensuring high station performance? If not, what do you think would make them more effective?*

22. *What could BAR do to help stations identify more polluting vehicles? (Training? Incentives?)*

23. *What could BAR do to help stations repair more polluting vehicles? (Training? Incentives?)*

BAR Enforcement Staff

As representatives of the Bureau, the audit and enforcement staff provides the foundation for ensuring the integrity and effectiveness of the Smog Check certification process. As such, you are well positioned to understand both the motivations for improper testing, repair, and motorist non-compliance, as well as the specific actions that lead to the high re-fail rates observed. In other words, you understand the "How " and the "Why" associated with this problem as well as anyone. Consequently, you may be able to help identify new, innovative ways to address these problems. Such insights are best discovered through an open, exploratory discussion.

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I'd like to conclude by discussing how the Smog Check program could be made more effective at ensuring proper testing and repair of high emitting vehicles.

17. *Are there other ways BAR, technicians, or stations can improve motorist compliance with the Smog Check program?*

18. *Are the current audit and enforcement policies effective at ensuring high station performance? If not, what do you think would make them more effective?*

19. *What could BAR do to help stations identify more polluting vehicles? (Training? Incentives?)*

20. *What could BAR do to help stations repair more polluting vehicles? (Training? Incentives?)*