Smog Check Performance Report
(An Analysis of Roadside Inspection Data)
Introduction and Summary

Assembly Bill (AB) 2289\(^a\) marked the first major update to the Smog Check Program since the mid-1990s. The law was a comprehensive effort to modernize California’s vehicle emissions inspection and maintenance program (Smog Check). The legislation required the Bureau of Automotive Repair (BAR) to implement both inspection-based performance standards\(^b\) for stations inspecting directed vehicles\(^c\) and improved On-Board Diagnostics (OBD II) inspections for newer vehicles.\(^d\,^2\) It also enhanced BAR’s ability to identify and take action against stations performing improper inspections.\(^e\) Lastly, the law requires BAR, in cooperation with the California Air Resources Board (CARB), to perform annual evaluations of the Smog Check Program using roadside inspection data. The 2018 Smog Check Performance Report (the “Report” or SCPR) satisfies the statutory reporting requirement for 2018.

BAR evaluates the Smog Check Program using data from a voluntary roadside pullover and testing program and data from inspections performed at Smog Check stations.\(^3\) While earlier SCPRs relied almost entirely on tailpipe testing\(^f\) of vehicles and evaluated the performance of tailpipe testing at Smog Check stations, this report also includes an evaluation of results from roadside OIS-based testing of vehicles which will continue to be used in the future to evaluate the performance of Smog Check stations. The OBD Inspection System (OIS) was devised and implemented by BAR pursuant to AB 2289, which intended to modernize and enhance the inspection of gasoline-powered vehicles of model years (MY) 2000 and newer. This report also presents results from tailpipe-based Smog Check testing, which is still required for MY 1976-99 vehicles. The latest roadside test results from OIS and tailpipe testing are summarized in Table 1, along with historical tailpipe testing results from 2003-06. Separate results are shown in the first and second rows of the table, respectively, for the vehicles that initially failed Smog Check (and presumably were repaired, since they subsequently passed Smog Check), and those which initially passed the inspection.

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\(^a\) Numbered superscripts are listed in Attachment C, References, at the end of this report.

\(^b\) BAR implemented the STAR Program in January 2013. The Program requires stations interested in inspecting directed vehicles to be STAR-certified. BAR grants certification upon finding that the station meets inspection-based performance standards based on each quarter performance. In addition to performance, stations must also comply with the enforcement-related standards of the STAR Program.

\(^c\) “Directed vehicles” must be smog checked at STAR-certified stations. All Model Year 1976-99 vehicles are directed, along with newer vehicles identified as having the greatest likelihood of failing their next inspection.

\(^d\) The California Air Resources Board describes On-Board Diagnostic (OBD) systems as self-diagnostic systems incorporated into the computers of new vehicles. BAR deployed statewide OIS (OBD II focused) testing on June 16, 2014, and mandated its use on March 9, 2015, for 2000 and newer gasoline-powered vehicles, 1998 and newer diesel-powered vehicles, and hybrids. These vehicles do not require a tailpipe emissions inspection.

\(^e\) As part of the implementation of the OIS, BAR developed software that significantly improved detection of improper inspections on newer MY vehicles.

\(^f\) As used herein, “Tailpipe” or “ASM” (Acceleration Simulation Mode) testing refers to placing a vehicle on a treadmill-like device to measure exhaust concentrations of pollutants under prescribed operating conditions.
Table 1
Summary of Roadside Vehicle Failure Rates by Calendar Years (CY) and MYs (MY) for ASM (Tailpipe) and OIS\textsuperscript{a} Testing Compared with Historical Baseline

<table>
<thead>
<tr>
<th>Initial Smog Check Result</th>
<th>Roadside Fail Rates within One Year of Smog Check Certification*</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Historical Baseline** CY 2003-06 ASM Fail Rate MYs 1976-95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fail***</td>
<td></td>
<td>49%</td>
<td>30%</td>
<td>28%</td>
<td>31%</td>
</tr>
<tr>
<td></td>
<td>(813)</td>
<td></td>
<td>(701)</td>
<td></td>
<td>(702)</td>
</tr>
<tr>
<td>Pass****</td>
<td></td>
<td>19%</td>
<td>14%</td>
<td>17%</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td>(4956)</td>
<td></td>
<td>(2825)</td>
<td></td>
<td>(6685)</td>
</tr>
<tr>
<td>Overall Failure Rate</td>
<td></td>
<td>24%</td>
<td>16%</td>
<td>20%</td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td>(5769)</td>
<td></td>
<td>(3526)</td>
<td></td>
<td>(7387)</td>
</tr>
</tbody>
</table>

* Roadside failure rate percentages are weighted by MY group to match the numbers of initial Smog Check tests performed in the State; sample sizes are shown in parentheses beneath the failure rate percentages. “ASM Fail Rate” means Acceleration Simulation Mode emission fail rates, and “OIS Fail Rate” means OBD fail rates.
** Calendar Year (CY) 2003-06 Tailpipe (ASM) Emission Fail Rates of MY (MY) 1976-95 vehicles; sources: BAR data, analysis by Sierra Research\textsuperscript{a}
*** Vehicles failed initial Smog Check, were eventually certified as passing, but “re-failed” at roadside within one year.
**** Vehicles passed initial Smog Check, but failed at roadside within one year.

Using 2016-17 roadside data and models of how various factors affect roadside fail rates, BAR has calculated the probability of roadside failure for both ASM emission tests of the 1976-99 MY fleet and OIS tests of the 2000-06 MY fleet as a function of the time since each vehicle was last certified at a Smog Check station. The on-road performance of the two respective fleets is summarized in Figures 1 and 2 (below) for average vehicles and stations. Each figure also shows how the roadside failure rate differs depending on whether the certifying station initially passed the vehicle (lower confidence band, in blue) or certified it after an initial failure, presumed repair, and follow-up passing test (upper confidence band, in red).\textsuperscript{b}

\textsuperscript{a} OIS is the Emission Inspection System for OBD tests of MY 2000 and later gasoline-powered vehicles, hybrids, and for MY 1998 and later diesels.
\textsuperscript{b} The probability of failure is plotted as both a line and a 95% confidence band to show the uncertainty in the model result; the lower band in each figure is narrower because far more vehicles initially pass than fail their initial Smog Check, and more data means less uncertainty in the estimate of the roadside failure rate.
Figure 1 - Probability of Roadside ASM Emission Failure vs Days Since Certification
For MY 1976-99 Vehicles

Figure 2 – Probability of Roadside OIS Failure vs. Days Since Certification
For MY 2000-06 Vehicles*

*Figure 2 is preliminary; see Attachment A for additional details.
Analysis of 2016-17 roadside testing data and associated Smog Check data leads us to conclude the following:

1. Roadside first-year fail rates\(^a\) in 2016-17 for both OIS testing and tailpipe based ASM testing were lower than the roadside tailpipe fail rates in 2003-06 (prior to AB 2289 and the STAR program).

2. For MY 2000 and newer vehicles, OIS test results confirm that vehicles previously certified at STAR stations have lower first-year roadside fail rates than those certified by non-STAR\(^b\) stations. The difference is most pronounced for vehicles that initially failed Smog Check, were presumably repaired, and were then certified. These vehicles re-failed at roadside inspection at a rate of 39% for non-STAR stations compared to 29% for STAR stations.\(^c\)

3. A roadside test method comparison of MY 2000-06 vehicles showed agreement between OIS and ASM test results for 80% of vehicles tested by both methods, but higher OIS fail rates overall compared to tailpipe ASM testing of the same fleet. This result is consistent with and confirms the more comprehensive nature of vehicle emission control system monitoring embodied in vehicles’ OBD systems inspected with the OIS.

4. For the MY 1976-99 vehicles that are subject to ASM testing, the overall roadside fail rate increased from 16% in calendar years 2015-16 to 20% in 2016-17. Part of this increase is likely due to vehicle age, but a larger cause is the substantially higher overall roadside fail rate for non-STAR stations of 29% in the 2016-17 survey vs. 21% from the 2015-16 roadside survey.\(^d\) This indicates relatively more vehicles being certified inappropriately by low-performing stations and failing later at roadside, continuing a pattern that was noted in the 2017 SCPR. It underscores the need to improve the performance of low-scoring stations and to prevent high- and moderately-performing stations from deteriorating into low-performers.

After a brief background on BAR’s roadside sampling, the remainder of this report provides a summary of the results from analysis of the 2016-2017 roadside OIS and tailpipe sampling data in accordance with the requirements of AB 2289.

\(^a\) “First-year fail rates” refers to the rate of OBD- or tailpipe-based failures for vehicles that were randomly tested at roadside in 2016-17 and previously passed Smog Check up to one year prior to the roadside test. Reducing first-year roadside fail rates (from the “Historical Baseline” shown in Table 1) was one of the key objectives of both AB 2289 and of the STAR Program that was developed and implemented by BAR in January 2013.

\(^b\) Stations which do not meet all requirements to be STAR-certified or who do not wish to participate in STAR (i.e., “non-STAR stations”) may still perform Smog Check inspections, but only for those vehicles which are least likely to fail, which excludes the large volume of “directed vehicles”.

\(^c\) The corresponding difference for initially-passing Smog Check vehicles at roadside was smaller at 19% fail rate for non-STAR station certifications and 16% for STAR certifications. However, the initially-passing vehicle roadside fail rate difference affects more vehicles because 93% of OIS vehicles pass their initial Smog Check.

\(^d\) The 29% fail rate is from the last row of Table 3 on page 10, and the 21% fail rate is from the last row in Table 1 from Reference 3. This compares the “overall” roadside fail rates (for both initially failing and initially passing vehicles) for non-STAR stations for the 2016-17 roadside sampling period to that for the 2015-16 period.
Background

The purpose of BAR’s Roadside Inspection Program is to provide data that can be used to evaluate the effectiveness of the Smog Check Program and to help assess the performance of Smog Check stations. Roadside tailpipe testing, which is voluntary for drivers, entails having law enforcement randomly pull over a vehicle, allowing a specially-equipped BAR survey team to check their emission control systems. For MY 1976-99 gasoline-powered light-duty vehicles, the check is performed using an Acceleration Simulation Mode (ASM) inspection of tailpipe emissions. In the ASM test, the vehicle is placed on a chassis dynamometer and emission-tested using a BAR-97 Emissions Inspection System (EIS). This is the same tailpipe emission test that is performed by Smog Check stations in enhanced areas. Other parts of a Smog Check test, such as the visual inspection and functional testing, are omitted from roadside inspections to minimize inconvenience to participating motorists. As with inspections performed at Smog Check stations, roadside inspections of MY 1996-99 vehicles equipped with second generation OBD systems (OBDII) are also subjected to an OBD test, in which the EIS is connected to the under-dash connector to review the status of fault codes and readiness monitors (this data is not included in the current analysis). For MY 2000 and newer gasoline-powered vehicles, the roadside ASM test has been replaced by an OIS test in which a Data Acquisition Device (DAD) is plugged into the vehicle to retrieve OBD II-based information about fault codes, readiness monitors, and other data that is required to document and ensure the validity of the test. However, in roadside OIS testing, like roadside ASM testing, other parts of the inspection procedure, such as the visual inspection, are not performed. Neither type of roadside inspection impacts the Smog Check status of any vehicle, meaning failing inspection results would not require the driver to undergo a Smog Check at a licensed station.

Roadside inspections are a stratified random sample that help to ensure a representative sample of the overall fleet of vehicles that are subject to Smog Check. Older vehicles, while a smaller percentage of the fleet, continue to contribute disproportionately to overall smog-forming emissions of hydrocarbons (HC) and nitrogen oxides (NOx). Therefore, ensuring they are adequately sampled is important for accurately estimating the roadside failure rate for the entire vehicle population.

Roadside inspection locations are selected based on vehicles registered in the zip code. The objective is to have a representative sample of vehicles by MY. It is also important to note the roadside inspection is done with the assistance of a California Highway Patrol officer who safely directs each candidate vehicle out of the traffic lane and into a temporary inspection lane.

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a Enhanced areas are California Smog Check Program areas within any part of an urbanized area of the state that is classified by the U.S. Environmental Protection Agency as not meeting air quality standards. Pre-2000 MY gasoline-powered vehicles registered in enhanced areas require an ASM inspection.

b Emission reduction measures, including Smog Check, have decreased air pollution levels in California significantly in the past few decades, but air pollution remains a serious health concern and Smog Check continues to be an essential element in California’s federally-mandated State Implementation Plan to achieve and maintain federal clean air standards, as well as a measure needed to meet State air quality standards.
Vehicles with bald tires, liquid leaks, or other visible safety issues are excluded from roadside testing.\textsuperscript{a}

In March 2009, Sierra Research, Inc. (Sierra) released a report analyzing the effectiveness of the California Smog Check Program.\textsuperscript{b} The report found that for MY 1976-95 vehicles that initially failed, then passed the ASM tailpipe test at a Smog Check station, 49\% failed an ASM roadside inspection within one year of certification (i.e., Fail-Pass-Roadside Fail vehicles). Based on its analysis, Sierra concluded that improper or falsified “passing” Smog Checks likely contributed to the re-fails. For MY 1976-95 vehicles that passed their initial ASM test at a Smog Check station, 19\% failed an ASM roadside inspection within one year of certification (i.e., Pass-Roadside Fail vehicles). The roadside inspections occurred, on average, about six months after the vehicle had been certified at a Smog Check station.

Assembly Bill (AB) 2289, which was adopted following release of the Sierra report, authorized BAR to address specified known issues, including the roadside fail rates of vehicles. In response to the bill and following a series of public workshops, BAR implemented the STAR Program in 2013 and in 2014 deployed the On-Board Diagnostics Inspection System (OIS). These and other changes are described in the annual SCPRs prepared and published from 2012 through 2017 by BAR in cooperation with the California Air Resources Board.\textsuperscript{c} As of December 31, 2017 there were 8,029 active stations, of which 4,767 (59\%) were STAR-certified.

In 2016, Revecorp, Inc. was contracted to conduct an independent review of BAR’s 2016 and 2017 SCPRs. The reviews, which are required by statute,\textsuperscript{d} are conducted to provide, “an independent validation of the evaluation methods, findings and conclusions presented in the report.”\textsuperscript{e} Revecorp’s review of the 2016 SCPR was included as part of BAR’s 2017 SCPR. Revecorp’s review of the 2017 SCPR, when finalized, will be made available by BAR.

**Analysis for MY 2000 and Newer Gasoline Vehicles Based on OIS Testing**

Statute requires that BAR perform an annual analysis of Smog Check inspection data. This SCPR, being the first to present OIS-based test results, offers an overview of roadside OBD data collected using the OIS from January 2016 to December 2017 and the associated Smog Check data from January 2014 to October 2017. BAR paired the roadside test results with the prior Smog Check certification records for each vehicle by matching their Vehicle Identification Numbers (VINs).\textsuperscript{f} The results are summarized in Table 2, which also distinguish the roadside fail rates for vehicles that were previously certified by STAR stations and non-STAR stations. As with the earlier table, separate results are shown by row for the vehicles that initially failed Smog

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\textsuperscript{a} This exclusion is consistent with BAR’s Smog Check Manual, which requires inspectors to, “Ensure the vehicle is safe to test,” as part of the Pre-Test Check List. Similarly, if a safety concern arises during either a roadside or Smog Check station test, the technician is instructed to abort the inspection.

\textsuperscript{b} The earliest and latest Smog Check tests associated with the 2016-17 roadside tests occurred in January 2014 and October 2017, respectively.
Check (and presumably were repaired, since they subsequently passed Smog Check) and those which initially passed the inspection.

The first column of data in Table 2 summarizes the first results from using the OIS to test roadside OBD fail rates for MY 2000-06 vehicles in calendar years 2016-17.\textsuperscript{a} Comparison of these OIS fail rates for All Station Types with the Historical Baseline (Table 1, column 1) shows that first-year roadside OIS fail rates (which are strictly OBD-based) in the 2016-17 survey period are lower than the earlier tailpipe (ASM) fail rates. Unavoidably, this comparison of current OBD data with historical ASM baseline data is crude, since the roadside OIS-tested fleet has no overlap with the earlier tailpipe tested fleet due to MY differences, and the two test methods differ greatly in their designs and capabilities. Furthermore, roadside testing does not include the full suite of tests that are performed at Smog Check stations. On the other hand, both fleets were at least ten years old at the time of their respective roadside testing. In future years, the 2016-17 roadside survey data of OIS-tested vehicles shown in column 1 of Table 2 should provide a more appropriate baseline for comparing future roadside OIS vehicle failure rates.

\textbf{Table 2}

\textbf{2016-17 BAR Roadside Survey of OBD Failure Rates Using the OIS}

<table>
<thead>
<tr>
<th>Initial Smog Check Result</th>
<th>Failure Rates of MY 2000-06 Vehicles within One Year of Smog Check Certification*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Station Types</td>
</tr>
<tr>
<td>Fail***</td>
<td>31% (702)</td>
</tr>
<tr>
<td>Pass***</td>
<td>16% (6685)</td>
</tr>
<tr>
<td>Overall Failure Rate</td>
<td>17% (7387)</td>
</tr>
</tbody>
</table>

* Failure rates are weighted by MY to match the numbers of initial Smog Check tests performed in the State; roadside sample sizes are shown in parentheses beneath the failure rates percentages.

** Alternative weighting was used due to limited sample size for certain non-STAR station tests of certain MYs

*** Vehicles failed initial Smog Check, were eventually passed, but failed at roadside ("re-fails") within 1 year.

**** Vehicles passed initial Smog Check, but failed at roadside within 1 year.

The data in the last two columns of Table 2 allow comparison of roadside OIS fail rates for vehicles that were previously certified at STAR stations to those previously certified by non-STAR stations. The comparison shows that vehicles certified at STAR stations failed at a much lower rate at roadside within one year than vehicles certified at non-STAR stations. The difference is most pronounced for roadside tests of vehicles that initially failed Smog Check,\textsuperscript{a}

\textsuperscript{a} The data in this column was also shown earlier in Table 1, column 4, to facilitate comparison with the Historical Baseline data.)
were presumably repaired, and were then certified at a Smog Check station. These vehicles re-
failed at roadside at a rate of 39% for non-STAR stations compared to 29% for STAR stations.
The corresponding differences for initially passing Smog Check vehicles at roadside was smaller,
with a 19% fail rate for non-STAR stations and 16% for STAR stations. However, the difference
between these failure rates affects a larger population of vehicles.

To gain a better understanding of the pass/fail effects of ASM and OIS testing and of the
emissions levels of newer vehicles, in calendar years 2016-17 BAR performed both types of
tests on each vehicle in a 4,000+ vehicle sample within the 2000-2006 MY range. Results from
that testing are summarized in Figure 3 below. The pie chart shows that 76.2% of the vehicle
sample passed both ASM and OIS with 3.4% failing both tests, indicating that the pass or fail
test results were identical for the OIS and ASM test methods for 80% of vehicles. For the
remaining 20% of vehicles, the pass/fail test results from the two test methods differed. These
are summarized in the bar chart to the right of Figure 3. It shows that 18.9% of vehicles failed
the OIS test but passed the ASM test, while 1.5% of vehicles failed the ASM but passed the OIS.
Figure 4 shows the total percentage failures for each of the two test methods for this roadside
sample. Technical differences between the two methods and the advantages of OBD-based
vehicle inspection and maintenance (for the OBDII vehicles that can support it) have been well
documented elsewhere. However, to provide additional insight, the figure also distinguishes
between OIS failures due to “MIL Illuminated” and “Not Ready” Failures, and between ASM
failures due to “Gross Polluter” and “Other Emissions” failures.

To further understand and explain roadside failure rates, Sierra included in its 2009 report a
plot of roadside failure rates as function of time since the last Smog Check certification. That
graphical analysis was intended to identify possible improper Smog Check tests by checking for
a roadside failure rate greater than zero shortly after a Smog Check certification. The analysis
also showed, as the slope of failure rate trend line with time, the rates of increase in roadside
failure over a period of about 2 years beyond Smog Check certification which, may reflect the
durability of repairs that were made to the initially failing vehicles. The parallel trend in failure
rates shown by Sierra appeared to suggest that repaired vehicles were deteriorating after
certification at the same rate as initially passing vehicles were deteriorating. The updated refail
plot shown in the 2017 SCPR no longer showed similar deterioration for initially passing and
repaired vehicles.

Results from the most recent modeling efforts to understand and explain roadside ASM tailpipe
test failures and OBD-based were highlighted earlier in Figures 1 and 2, respectively. This
modeling shows that roadside failures shortly after Smog Check certification have been reduced
and, for tailpipe tested vehicles, it confirms some of the main factors that are associated with
roadside failures. The factors include: time since last Smog Check certification, vehicle model
year (and age), Smog Check performance of the certifying station, whether the initial test was a
failure, and whether the certifying station was STAR. These and other results from the analysis
are described further in Attachment A.
Figure 3
Comparison of OIS (OBD-based) and ASM (Tailpipe-based) Pass/Fail Results for 4,157 MY 2000-06 Vehicles Tested at Roadside in CY 2016-2017 (source: BAR)

Figure 4
Comparison of OIS (OBD-based) and ASM (Tailpipe-based) Failure Rates\(^a\) for 4,157 MY 2000-06 Vehicles Tested at Roadside in CY 2016-17 (source: BAR)

\(^a\) For OIS tested vehicles, “MIL Illuminated Failures” are those in which the OBD system detects and signals the failure of an emissions-related component(s), while “Readiness Failures” indicate that a critical emission-related monitoring system(s) has failed to run to completion. For ASM tested vehicles, “Gross Polluter Failures” are those which cause a greater excess (typically several-fold) of HC, CO and/or NOx emissions, while “Other Emissions Failures” are all other emissions related failures.
Analysis for 1999 and Older Gasoline Vehicles Based on Tailpipe Testing

BAR analyzed roadside ASM (tailpipe emissions) test data collected from MY 1976-99 gasoline vehicles. The roadside data was collected from January 2016 to December 2017 along with the associated Smog Check data from December 2013 to August 2017. Results are shown in Table 3 for roadside failures occurring within one year of certification. This table is analogous to Table 2 (shown earlier) for OIS data. As in Table 2, results are also shown here in separate rows for the vehicles that initially failed Smog Check (and subsequently passed before their roadside test), and those which initially passed the inspection.

Table 3
2016-17 BAR Roadside Survey ASM Emission Failure Rates

<table>
<thead>
<tr>
<th>Initial Smog Check Result</th>
<th>Failure Rates of MY 1976-99 Vehicles within One Year of Smog Check Certification*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Station Types</td>
</tr>
<tr>
<td>Fail**</td>
<td>28% (701)</td>
</tr>
<tr>
<td>Pass***</td>
<td>17% (2825)</td>
</tr>
<tr>
<td>Overall Failure Rate</td>
<td>20% (3526)</td>
</tr>
</tbody>
</table>

* Roadside sample sizes are shown in parentheses beneath the roadside failure rate percentages.
** Vehicles failed initial Smog Check, were eventually certified as passing, but failed at roadside within 1 year.
*** Vehicles passed initial Smog Check, but failed at roadside within 1 year.

The overall ASM roadside fail rate increased from 16% in calendar years 2015-16 (see last row, Table 1), to 20% in 2016-17 the major cause of which is the substantially higher roadside fail rate for non-STAR stations of 29% vs. 21% from the 2015-16 roadside survey. This may be showing a pattern of deteriorated performance of low-performing stations as was initially reported in 2017\textsuperscript{12} and underscores the importance of proposed STAR regulatory improvements to enhance Smog Check performance at these stations.

The roadside re-fail rate and Follow-up Pass Rate (FPR) score for STAR stations are negatively impacted by the fact that some lower-performing stations can at least temporarily achieve STAR station certification under the current program. Some of these stations may perform low-quality inspections until their STAR certifications are invalidated. STAR regulatory changes are currently being pursued to address this issue.
Current Excess Emissions

The 2009 Sierra report included results from an analysis of emissions reductions lost due to poor Smog Check inspection performance. Sierra indicated that an additional 70 tons per day of reactive organic gases and oxides of nitrogen could have been prevented from entering the air statewide, provided all Smog Check stations performed on par with higher-performing stations when testing 1976-1995 MY vehicles.

Sierra’s ton per day estimate was based, in part, upon CARB’s emissions inventory modeling calculations. As BAR has reported in earlier SCPRs, a recalculation of emissions by CARB, resulted in revising Sierra’s lost emissions reduction to 50 tons per day. More recently, CARB has ceased performing separate emission calculation of the effect of Smog Check due to the condition created by the Smog Check program being a long-established program in California. In 2017-18 BAR began supporting research to produce a reliable, updated excess estimate of lost emissions as part of an ongoing contract effort, but more work is needed. CARB and BAR will amend the lost emissions estimate as soon as reliable results are obtained.

Evaluation of Best Practices of Other State Smog Inspection Programs

In response to HSC §44024.5 (b) (6), BAR has contracted with Revecorp, Inc. to provide a summary of the best practices of other states smog inspection programs. These results are available in Attachment B.

Recent Changes to California’s Smog Check Program

This Report has attempted to provide a summary of the results from changes to California’s Smog Check program that were made following the adoption of AB 2289, primarily as viewed by the objective measure of roadside failure rates. However, BAR has made several noteworthy changes to Smog Check in 2018 that have not yet been discussed because they did not affect the 2016-17 roadside data. These changes, which are expected to reduce roadside failure rates in 2018 and future years, include real-time Smog Check certificate blocking for fraudulent OIS tests, and the identification of and enforcement action against stations and technicians performing fraudulent testing.

Real-Time Certificate Blocking

AB 2289 (Eng, Chapter 258, Statutes of 2010) amended Health and Safety (H&S) Code section 44036(b)(3)(K) to authorize BAR to develop a real-time computer data program that prevents a certificate of compliance from being issued if a vehicle is identified as having an excessive variance from computer data for that vehicle, mismatched information, or other irregularities. In addition, the legislation foresaw the need for identified vehicles to be directed for further inspection, as described in H&S Code section 44015(a)(2), which prohibits a licensed Smog Check station from issuing a certificate of compliance to an identified vehicle. In February 2017,
BAR began implementation of a data check and certificate blocking/Referee direction program to fulfill these mandates. Since implementation in early 2018, approximately 500 stations have had vehicles blocked and redirected to a referee for inspection.

*Identification and Enforcement Against Stations and Technicians Performing Fraudulent Testing*

In conjunction with Certificate blocking, BAR has filed approximately 500 administrative cases against stations and inspectors found to have performed OBD clean-plugging inspections of vehicles. Certificate blocking has been effective in deterring fraudulent Smog Check activity. BAR will continue to protect consumers, improve California’s air quality, and ensure a fair and competitive business climate for stations and inspectors in California’s Smog Check Program.
**Conclusions**

Analysis of 2016-17 roadside testing data and associated Smog Check data leads us to conclude the following:

1. Roadside first-year fail rates in 2016-17 for both OIS testing and tailpipe based ASM testing were lower than the roadside tailpipe fail rates in 2003-06 (prior to AB 2289 and the STAR program).

2. For MY 2000 and newer vehicles, OIS test results confirm that vehicles previously certified at STAR stations have lower first-year roadside fail rates than those certified by non-STAR stations. The difference is most pronounced for vehicles that initially failed Smog Check, were presumably repaired, and were then certified. These vehicles re-failed at roadside inspection at a rate of 39% for non-STAR stations compared to 29% for STAR stations.

3. A roadside test method comparison of MY 2000-06 vehicles showed agreement between OIS and ASM test results for 80% of vehicles tested by both methods, but higher OIS fail rates overall compared to tailpipe acceleration simulation mode (ASM) testing of the same fleet. This result is consistent with and confirms the more comprehensive nature of vehicle emission control system monitoring embodied in vehicles’ OBD systems inspected with the OIS.

4. For the MY 1976-99 vehicles that are subject to ASM testing, the overall roadside fail rate increased from 16% in calendar years 2015-16 to 20% in 2016-17. Part of this increase is likely due to vehicle age, but a larger cause is the substantially higher overall roadside fail rate for non-STAR stations of 29% in the 2016-17 survey vs. 21% from the 2015-16 roadside survey. This indicates relatively more vehicles being certified inappropriately by low-performing stations and failing later at roadside, continuing a pattern that was noted in the 2017 SCPR. It underscores the need to improve the performance of low-scoring stations and to prevent high- and moderately-performing stations from deteriorating into low-performers.
Attachment A
Modeling Analysis of Roadside Fail Rates

*Roadside Emission Fail Rate of ASM Tested 1976-99 MY Vehicles*

To address the requirement of AB 2289 to explain roadside failure rates, BAR analyzed the roadside ASM tailpipe failure rate for 1976-99 MY vehicles and investigated what influences it. BAR’s analysis has identified several factors that affect the roadside ASM failure rates and attempted to quantify those effects through modeling. Several of the most significant factors are depicted in Figure A-1.

**Figure A-1**
Partial List of Factors Affecting the Odds of Roadside ASM Failure of MY 1976-99 Vehicles

The figure lists selected factors and shows a logistic regression-based model estimate of how each one affects the odds of failing emissions in the ASM test at roadside, along with the upper and lower bounds (at 95% confidence) of each estimate. As an example of how to interpret the
figure, the first factor indicates that for every year between when the previous initial Smog Check certification was made and when the vehicle was subsequently tested at roadside, the odds of failing emissions increased by a factor of 1.3 and, assuming the form of the model is correct, the 95% confidence bounds for this estimate range from about 1.2 to 1.5. Other factors show the following for odds of failing emissions at a subsequent roadside test:

- Each 4 years of vehicle age (i.e., decrease of 4 MYs) increases the odds of failure by 2.2 (i.e., the odds of failure more than doubles)
- Considering Follow-up Pass Rate (FPR) performance of Smog Check stations, each drop of 0.4 in FPR of the certifying station, increases the odds of failure by 1.6
- If the initial Smog Check test of the vehicle was a “PASS”, the odds of failure decline to a factor of about 0.4 (compared to initial “FAIL”); and
- If the certifying station was not STAR, the odds of failure increase by 1.2 (compared to STAR)

Figure A-2 shows how FPR and the prior initial pass/fail result of the certifying station affects the roadside emission failure rate for average vehicles. It is clear that roadside fail rate

Figure A-2
Probability of Roadside Emission Rate Failure vs. Certifying Station FPR
Showing Effect of Prior Initial Pass/Fail Results
increases significantly as the FPR score of the certifying station decreases to 0 (indicating poor station performance) as compared to a perfect FPR score of 1. The figure also shows that this result varies depending on whether the certifying station initially passed the vehicle (lower confidence band, in blue) or certified it after an initial failure (upper confidence band, in red).

Roadside Fail Rate of OIS-tested MY 2000+ Vehicles

Figure 2, shown earlier in this report, represents an initial attempt to model roadside OBD failure rates. Although this model result is preliminary, it is included here to emphasize one of the key findings (which is not preliminary) from this analysis about higher fail rates for OIS roadside testing of newer vehicles. BAR plans to continue investigating methods to more fully explain roadside fail rates.
Attachment B

Response to Health and Safety Code §44024.5(b)(6), Status of Vehicle Inspection Programs Nationwide and Inspection and Maintenance Trends
2018 Smog Check Performance Report

Response to Health and Safety Code §44024.5(b)(6), Status of Vehicle Inspection Programs Nationwide and Inspection and Maintenance Trends

PREPARED FOR:
THE CALIFORNIA DEPARTMENT OF CONSUMER AFFAIRS BUREAU OF AUTOMOTIVE REPAIR

Agreement 001546

June 20, 2018
2018 Smog Check Performance Report

Response to Health and Safety Code §44024.5(b)(6), Status of Vehicle Inspection Programs Nationwide and Inspection and Maintenance Trends

Prepared for:
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June 20, 2018

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The statements and conclusions in this report are those of the Contractor and not necessarily those of the Bureau of Automotive Repair (BAR) or the State of California. The mention of commercial products, their source, or their use in conjunction with material reported herein is not to be construed as actual or implied endorsement of such products.
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Response to Health and Safety Code §44024.5(b)(6), Status of Vehicle Inspection Programs
Nationwide and Inspection and Maintenance Trends

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2 INSPECTION AND MAINTENANCE TRENDS ................................................................. 2

3 IM PROGRAM SUMMARY AS OF JUNE 2018 ............................................................... 4
The following summary, requested by BAR, fulfills the requirements of HSC §44024.5 (b) (6).

1 STATUS OF VEHICLE INSPECTION PROGRAMS

For the analysis of other programs in the US and Canada, Revecorp relied upon data from the 2017 IM Solutions annual report\(^1\) and Revecorp’s knowledge and experience in working with state vehicle inspection programs across the US. There have been very few changes to the inspection and maintenance programs since the last report, however, for clarity in responding to the California Health and Safety Code requirements, the data is updated and repeated here.

The 2017 IM Solutions report includes data from 39 programs in 33 jurisdictions (some programs are managed at the county level), summarized in Section 3. Eleven programs inspect vehicles statewide with the remaining programs only inspecting vehicles for emissions in high population areas. In total, there were a reported 78,176,130 vehicle emissions inspections in 2016. California had the greatest number of inspections (11,500,000) with New York second (10,500,000) and Texas third (8,500,000). However, the New York vehicle inspection program had more decentralized inspection stations than California (about 10,000 and 7,300, respectively) indicating that the CA inspection program is the largest by inspection volume and the lower number of stations perform more inspections each. The number of inspections per year per program ranges from 12,000,000 to 45,000\(^2\) with the average number of inspections per year of 2,000,000, with 19 programs (half) having less than 1,000,000 tests per year. Additional program statistics are provided below, with the California values provided in parenthesis if available:

- Average exemption is 3.6 years (CA - 6 years; changing to 8 years in 2019 due to legislation)
- Overall average inspection cost is $24.70 (CA - $48.60, down from last year’s $57.33)
- Program Types and fees:
  - Centralized programs – 8. Average inspection cost is $19.35
  - Decentralized programs – 25. Average inspection cost is $27.70 (CA - $48.60)
  - Hybrid programs – 4. Average inspection cost is $16.81
- Remote sensing is used in six programs (CA - N/A)
  - Clean screen -- 2
  - Dirty screen -- 3
  - Both clean/dirty screen -- 1
- Self-service OBDII kiosks are operational in three programs, and being added in one program (CA – N/A)
- Remote OBDII is available in two programs (CA - government fleets only)
- Inspection frequencies:
  - Annual inspection programs – 12
  - Biennial inspection programs – 20 (CA – remote areas only upon change of ownership)
  - Mixed depending on the vehicle type – 6
  - Approximately one-third of the programs require tests at change of ownership (CA)
- Program enforcement method:
  - Registration denial – 28 (CA)
  - Registration revocation or suspension - 3
  - Sticker based enforcement – 6

---


\(^2\) In Idaho, two programs exist, Ada County and Canyon County which are operated independently. The Canyon county program has an annual inspection volume of 45,000 inspections a year.
A notable aspect of the California program compared to other programs is that California has one of the longest new model year exemptions (6 years) which is changing to eight years in 2019, with only Washington State and Colorado in the same range (7-8 years). Another notable aspect of the California program is it has the highest reported average inspection cost (market driven) of any program in the US or Canada, almost two times the overall average and slightly less than two times the average for other decentralized vehicle emissions inspection programs.

2 INSPECTION AND MAINTENANCE TRENDS

Programs continue to show an interest in moving to OBDII-only emissions inspections and the trend is to low cost, off-the-shelf OBDII scan tools combined with tablet based inspections. For example, the Vermont program has been operating for over a year using off-the-shelf OBDII scan tools that cost under $100, industrial tablets, wireless printers and a router for a total package cost under $2,000. A major concern with the program equipment is that the low-cost scan tools being used may have low communication rates with vehicles in the fleet. After well over a year of operation, there have been no technical difficulties with the equipment and the communication rates have been very high. Some of the feedback from the inspectors includes the equipment, although very mobile is not a theft risk (only one of 1150 has been stolen in over a year), heavy tablets become burdensome to use for long periods since they are frequently held in a single hand while the other hand is used to key in data, and ease of charging is important to technicians (a dock the tablet can be placed in is much preferred over having to plug in a power cable. Very few tablets have ended up being physically damaged from drops or impacts.

A new remote sensing technology (using downward looking laser technology, or “EDAR,” by Hager Environmental & Atmospheric Technologies “HEAT”) has been used in a few studies and is currently being implemented in Nashville to perform clean screening. Self-service OBDII kiosks have expanded to Oregon, Ohio and Maryland and are receiving public acceptance, but still only account for a few percent of OBDII tests in the programs. Remote OBDII continues to be pilot tested in Oregon, and an Ontario, Canada pilot program has been delayed temporarily due to a chance in administration. Some vehicle inspection programs still require safety inspections, limiting the use of remote sensing clean screening, remote OBDII inspections and self-service OBDII kiosks.

As noted, the trend is toward OBDII-only vehicle emissions inspection programs, to reduce inspection equipment and tests costs. Although the shrinking population of older vehicles requiring tailpipe testing are still significant contributors to air pollution, it is becoming less cost effective to have the necessary equipment in the field to test these vehicles. This is especially the case in locations with small vehicle populations or for programs where the need for emissions benefits from the IM Program is limited. States with persistent air quality problems (such as California) currently maintain tailpipe testing as the emissions reductions achieved from this small fraction of the fleet are critical. As more vehicles are OBDII equipped and air quality improves, states will likely convert to decentralized OBDII-only inspection programs, at lower costs. Although the inspection should also include a visual inspection to detect unapproved aftermarket parts or potential use of simulators and evaporative inspections, most programs which have converted to OBDII only testing only perform the OBDII test. A limited, but highly competitive number of vendors (only five vendors are assisting with the 39 programs), have been lowering the cost of inspection equipment, which may lead to lower inspection costs.

The major concern with decentralized inspections historically has been the financial incentive to conduct fraudulent testing of vehicles that should not pass inspection, or falsely fail a vehicle to gain repair revenue with stations which perform both testing and repairs. Inspectors may also be
motivated to falsely pass a vehicle which they unsuccessfully attempted to repair and charged a motorist for, so they can cover their lack of quality repairs.

In centralized testing facilities where vehicles are only inspected and there is less opportunity for fraud, effective oversight is more readily accomplished. This has been more important for the tailpipe type tests conducted on older vehicles as the electronic data supplied by the OBDII systems in model year 1996 and newer vehicles allows intensively monitored decentralized inspection programs to identify many types of potential fraudulent testing. California has adopted an OBDII-based approach for model year 2000 and newer gasoline vehicles and for model year 1998 and newer diesels. (Gasoline vehicles from model years 1996-99 include simple OBDII monitoring along with their required tailpipe testing.) Some programs, including California, can use the OBDII data to identify the use of electronic vehicle “simulators” and other devices to circumvent the OBDII inspection systems. The full extent of such fraudulent activity is largely unknown but it may become more prevalent in the future as more OBDII testable vehicles are added to the fleet.
### Summary of US and Canadian Vehicle Emissions Inspection Programs

<table>
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<tr>
<th>State</th>
<th>Location</th>
<th>Contractor</th>
<th>Type</th>
<th>Stations</th>
<th>Fee</th>
<th>Safety Testing</th>
<th>Remote Sensing</th>
<th>Kiosks</th>
<th>Remote OBD</th>
<th>Exemption Years</th>
<th>Frequency</th>
<th>Enforcement</th>
<th>Annual Tests</th>
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Attachment C
References

1 Eng, Chapter 258, Statutes of 2010.

2 For more information about OBD, see CARB’s website: https://www.arb.ca.gov/msprog/obdprog/obdprog.htm.

3 For additional details about BAR’s roadside inspection program, see “2017 Smog Check Performance Report (an Analysis of Roadside Inspection Data)”, California Bureau of Automotive Repair, June 30, 2017.


5 Ibid, 2017 SCPR, see Attachment A.

6 Ibid, Sierra.

7 See “AB 2289 Annual Reports” at BAR’s website: https://BAR.ca.gov/FormsPubs/index.html.

8 California Health and Safety Code Section 44024.5(b)(1).


10 Austin et al, Ibid, see Figure 4-1.

11 Ibid, 2017 SCPR, see Figure 1A

12 Ibid, 2017 SCPR.