

DEPARTMENT OF CONSUMER AFFAIRS

BAR

Bureau of Automotive Repair

Smog Check Performance Report

(An Analysis of Roadside Inspection Data)

2019



7/1/2019

Introduction and Summary

This report provides an update on California’s Smog Check Program. The annual reporting is required pursuant to Assembly Bill (AB) 2289.^a This legislation required the California Bureau of Automotive Repair (BAR) to implement both inspection-based performance standards^b for stations inspecting directed vehicles^c and On-Board Diagnostics (OBD II) focused inspections for newer vehicles.^{d,e} It also enhanced BAR’s ability to identify and take action against stations performing improper inspections.^f The 2019 Smog Check Performance Report (SCPR) satisfies the statutory reporting requirement for 2019.

BAR evaluates the Smog Check Program primarily by analyzing data collected through inspections performed at Smog Check stations and from BAR’s Roadside Inspection Program^g. In general, due to the inclusion of OBD systems in newer vehicles (1996 and newer), BAR’s roadside testing uses two different types of testing equipment, depending on the model year of the vehicle. Model year 1996 and newer vehicles are roadside tested using the OBD Inspection System (OIS)^h. For model years 1976-99 vehicles, roadside tailpipe testing is performed using a BAR-97 Emissions Inspection System (EIS)ⁱ. In addition, supplemental tailpipe tests have been collected for select vehicles, including model year 2000 and newer at the request of the California Air Resources Board (CARB) to better quantify emissions deterioration as the OBD vehicle fleet ages and to help evaluate excess emissions estimates.

Recent roadside test results from OIS tested vehicles are summarized in Table 1, including the corresponding OIS test results from the 2016-17 roadside sample. The table shows results only for model year 2000-06 vehicles, which represents the vast majority of OIS roadside vehicles tested in both sampling periods. 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

^a Eng, Chapter 258, Statutes of 2010.

^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 quarterly performance. In addition to performance, stations must also comply with the enforcement-related standards of the STAR Program.

^c “Directed vehicles” include all model year 1976-99 vehicles, and newer vehicles identified as having the greatest likelihood of failing their next inspection. These vehicles are required (“directed”) to be certified at STAR-certified stations. These vehicles are notified on their DMV renewal notice of this requirement.

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

^e For more information about OBD II, see CARB’s website: <https://www.arb.ca.gov/msprog/obdprog/obdprog.htm>.

^f As part of the implementation of the OIS, BAR developed, and has since continued to enhance, software that significantly improves detection of improper inspections on newer model year vehicles.

^g BAR’s Roadside Inspection Program provides data that is used to evaluate the effectiveness of the Smog Check Program. The Roadside inspection involves the California Highway Patrol (CHP) directing vehicles into an inspection lane where they are voluntarily tested by BAR using Smog Check equipment.

^h OIS is the Emission Inspection System for OBD tests of model year 2000 and newer gasoline-powered vehicles, all hybrids, and for model year 1998 and newer diesels.

ⁱ 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.

subsequently passed Smog Check), and those which initially passed the inspection.^a Since this is only the second annual SCPR in which OIS test results have been presented, these results are intended to help establish a baseline failure rate for older OIS tested vehicles. Overall, model years 2000-06 OIS-tested vehicles in the 2017-18 roadside sample failed at a model year weighted rate of about 19%, which compared to the 18% failure rate found for the similarly weighted (and partially overlapping) 2016-17 roadside sample.

Table 1
Roadside Failure Rates of OIS Tested Gasoline Vehicles, Model Years 2000-06

Initial Smog Check Result	Roadside OIS Failure Rates within One Year after Smog Check Certification* CY 2016-2017	Roadside OIS Failure Rates within One Year after Smog Check Certification* CY 2017-2018
Fail**	33% (701)	35% (732)
Pass***	16% (6,691)	17% (7,154)
Overall Failure Rate	18% (7,392)	19% (7,886)

* Roadside failure rate percentages are weighted by Model Year 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. "OIS Fail Rate" means OBD fail rates.

** 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.

For model year 1976-99 vehicles that are subject to tailpipe testing as part of their Smog Check, Table 2 summarizes the results from BAR's Roadside Inspection Program. As may be expected due to the greater age of the tailpipe tested fleet, overall weighted roadside failure rates for model year 1976-99 vehicles tended to be slightly higher (19% vs 20%) than for model year 2000-06 OIS tested vehicles.

Table 2
Roadside Emission Failure Rates of Tailpipe Tested Gasoline Vehicles, Model Years 1976-99

Initial Smog Check Result	Roadside Tailpipe Failure Rates within One Year after Smog Check Certification* CY 2016-2017	Roadside Tailpipe Failure Rates within One Year after Smog Check Certification* CY 2017-2018
Fail**	28% (701)	31% (612)
Pass***	17% (2,825)	18% (2,285)
Overall Failure Rate****	20% (3,526)	20% (2,897)

* Roadside failure rate percentages are weighted by model year 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. "Tailpipe Tested" is described earlier in this report.

** Vehicles failed initial Smog Check, were eventually certified as passing, but "re-failed" at roadside within one year.

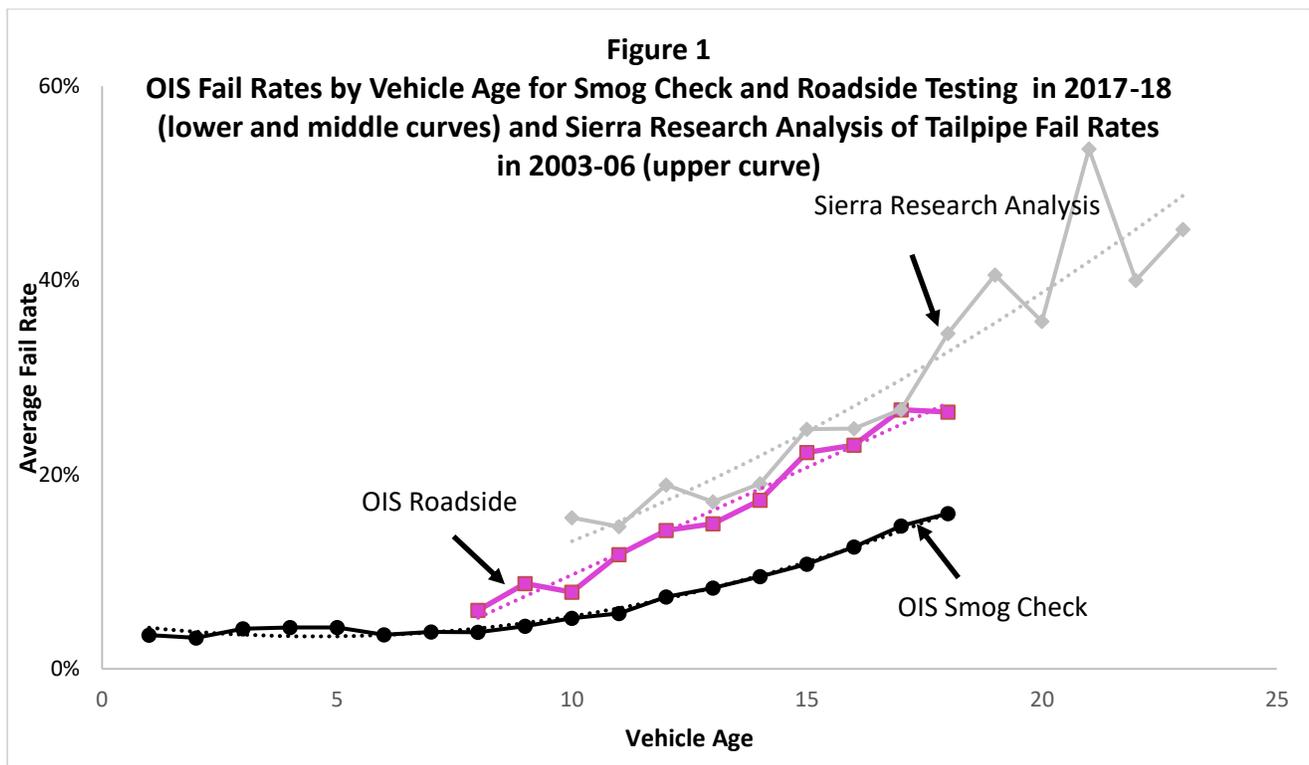
*** Vehicles passed initial Smog Check but failed at roadside within one year.

**** Rounding produced the overall failure for CY 2016-17 (rounded up from 19.522) and CY 2017-18 (rounded down from 20.305) to each be 20%. The accuracy of this result is to the whole number.

^a Historically, about 90% of vehicles overall pass initial inspection. The percentages in Table 1 are higher than that mainly because it's the older fraction of OIS tested vehicles.

As required by statute, BAR’s analyses of roadside data for this and prior SCPRs have attempted to identify and quantify the causes of excessive failures at roadside inspection. Two of the most important factors are vehicle age and the performance of the Smog Check station and inspector that certified each vehicle prior to roadside testing. Older model year vehicles tend to fail more at roadside than newer model years, and vehicles that were certified by high-performing Smog Check stations (those with an FPR score^a of 0.9 or greater) fail at a significantly lower rate than vehicles that were certified by low-performing stations (e.g., those with an FPR score less than 0.1).

Figure 1, shows failure rate vs. age for OIS tested model year 2000 and later gasoline vehicles. The figure shows the trend with age of both the initial failure rates at Smog Check (lower black line) and the OIS roadside fail rate (middle pink line). Both data sets cover the calendar years 2017-18, matching the latest roadside sample. We also show for comparison the average roadside tailpipe failure rate vs. vehicle age from the BAR roadside studies of 2003-06, which were analyzed by Sierra Research (upper gray line). Despite the many differences between the earlier tailpipe tested 1976-95 model year fleet studied and the OIS tested model year 1996 and newer fleet, the failure rate with age appears to be trending much the same. More specifically, beyond about age ten, newer vehicles tested on the OIS tend to be failing at a slightly lower rate than vehicles tested on the EIS were failing when they were at that same age (upper gray line). This could be attributed to greater durability of the emissions control system on newer vehicles.

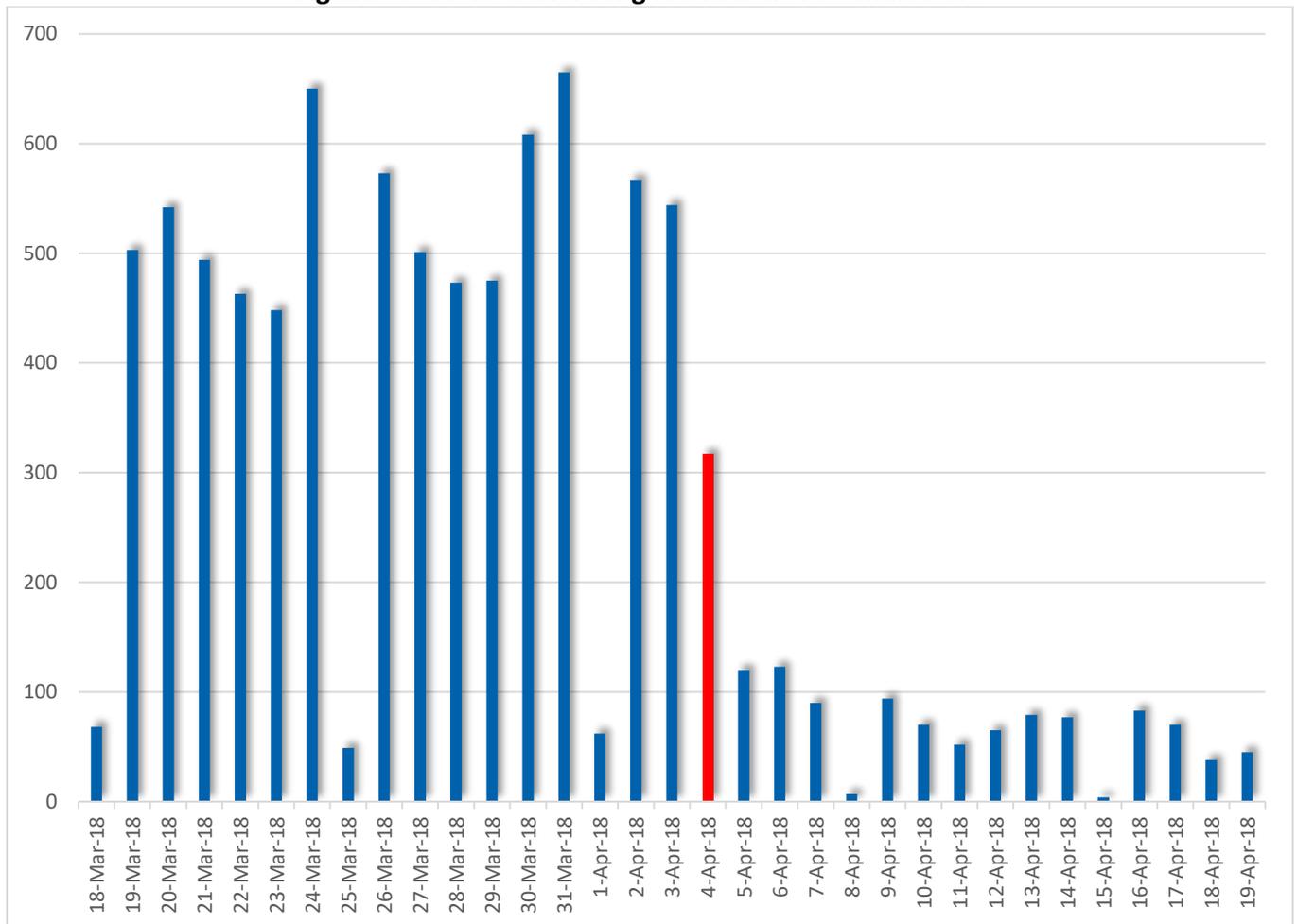


^a “Follow-up Pass Rate” (FPR) is, in brief, “...a performance measure that evaluates whether vehicles previously certified by each station or technician are passing, in their current cycle, at higher than expected rates.” CCR, Title 16, Division 33, Chapter 1, Article 5.5, §3340.1, “Follow-up Pass Rate”.

Regarding the quality of Smog Check inspections, California, like other states with decentralized inspection and maintenance programs, faces challenges from stations and inspectors who perform poor quality or fraudulent inspections. On April 4, 2018, BAR issued a press release informing the public about an enforcement operation at some 200 Smog Check stations. The action, which included unannounced Smog Check station inspections, was designed to address the suspected use of certain program defeat methods. Prior to the enforcement action, BAR data analysis identified an average of 452 fraudulent test indicators per day. Figure 2, below, shows the immediate effect of the coordinated enforcement action, indications of program defeat methods usage were reduced by 85%, to 68 fraudulent test indicators per day.

Other BAR enforcement actions against the usage of different types of program defeat methods used to conduct fraudulent Smog Checks have been used throughout the year. But, it's important to note, that none of these 'fixes' are all-encompassing or final. Tools and methods for conducting fraudulent Smog Checks continue to evolve, creating a threat to the integrity of California's Smog Check Program. As a result, BAR will continue to address fraudulent inspections, protect consumers and maximize the effectiveness of California's Smog Check Program.

Figure 2
Effect of BAR Enforcement Action on April 4, 2018,
Against Stations Generating Fraudulent Test Indicators



Summary of Findings

Analysis of 2017-18 roadside testing data, Smog Check inspection data, and related information presented, discussed and/or cited in this report leads BAR to conclude the following:

1. Model year 2000-06 vehicles OIS tested in the 2017-18 roadside sample failed at a weighted average rate of about 19%, compared to the 18% rate found for the 2016-17 roadside sample.
2. Model year 1976-99 tailpipe tested vehicles in the 2017-18 roadside sample failed for emissions at a weighted average rate of about 20%, which is the same as reported for the 2016-17 roadside sample.
3. Model year 2000-06 OIS tested vehicles tended to fail (for OBD) in the 2017-18 roadside sample at a similar but slightly lower rate than vehicles receiving an EIS tailpipe inspection at the same vehicle age in the 2003-06 roadside sample. This could be attributed to greater durability of the emissions control system on newer vehicles.
4. A coordinated surveillance/enforcement intervention, real-time certificate blocking with Referee direction, and new software tools to detect fraud, have had success in reducing fraud in the Smog Check Program. Continued efforts will be required to maintain the benefits and maximize the effectiveness of the Smog Check Program.
5. In roadside testing of model year 2000 and newer vehicles previously certified at a STAR station, each FPR drop of 0.4 points increased the odds of roadside failure by a factor of about 1.6, whereas for non-STAR stations, the odds increased by 2.4. For consumers, this means that certification by a STAR station will typically provide the greatest assurance that their vehicles' emissions control systems are operating properly.
6. Based on an updated methodology, BAR and CARB staff estimate that in calendar year 2018, Smog Check could have additionally provided emission reductions on the order of 60 - 70 tons per day of reactive organic gases and oxides of nitrogen (ROG + NO_x) from model year 1976 to 2012 light- and medium-duty gasoline vehicles if all Smog Check stations operated similar to the "high-performing" stations.

After a brief background review of BAR's Roadside Inspection Program, the remainder of this report describes the following:

- Recent changes to the Smog Check Program to improve station performance;
- Information about the effects of vehicle age, Smog Check station performance, and other factors on roadside failure rates;
- The excess emissions caused by poor station performance;
- An independent review of the 2018 SCPR by Saint Malo Solutions, LLC.^a The section of Saint Malo's report entitled "Specific Comments" has been excerpted and provided as Attachment A to this report, along with BAR's annotated answers to comments and questions from the review. The full review (without annotation) is available upon request at BAR.PRA@dca.gov.
- A report on what other states are doing to reduce emissions through vehicle inspection and maintenance. BAR worked with Saint Malo, to investigate the best practices of other vehicle inspection and maintenance programs.

^a In 2018, Saint Malo Solutions LLC was contracted to conduct an independent review of BAR's 2018 and 2019 SCPRs. The reviews, which are required by statute, are conducted to provide, "an independent validation of the evaluation methods, findings and conclusions presented in the report."

Background

The purpose of BAR's roadside testing is to provide data that can be used to evaluate the effectiveness of the Smog Check Program. Roadside tailpipe testing, which is voluntary for drivers, entails having law enforcement randomly pull over vehicles, allowing specially-equipped BAR survey teams to check their emission control systems. For certain model year 1976-99 gasoline-powered vehicles^a, the check is performed using an Acceleration Simulation Mode (ASM) test of tailpipe emissions, or for ASM incompatible vehicles, a Two-Speed Idle (TSI) tailpipe test. During the ASM test, the vehicle is placed on a chassis dynamometer and emissions tested using an EIS. This is the same type of tailpipe emission test that is performed by Smog Check stations in enhanced areas.^b In addition during a BAR roadside inspection, model year 1996-99 vehicles receive an OBD test using the OIS. Consistent with prior reports, this report focuses on data from tailpipe tests, not OBD tests. To minimize inconvenience to participating motorists, roadside testing does not include a visual or most functional inspection that would be performed during inspections at Smog Check stations. Neither type of roadside inspection impacts the Smog Check status of any participating vehicle; failed roadside inspection does not require the vehicle to undergo a Smog Check at a licensed station.

Roadside vehicles are selected at random using a fleet weighted stratified method that ensures a representative sample of vehicles subject to Smog Check. Just as with Smog Check inspections, a small percentage of vehicles pulled over at roadside with bald tires, liquid leaks, or other safety issues, are excluded from testing.^c 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).^d Therefore, ensuring these older vehicles are adequately sampled is important to accurately estimate their roadside failure rate and emissions impact.

Roadside inspection locations are selected from ZIP codes within the counties designated as Enhanced Smog Check Program areas. The number of vehicles sampled within these counties is proportional to the number of vehicles registered within them. Many of the analyses in this report, including the re-fail rates and the estimates for current excess emissions, use sample averages from the roadside data partitioned by model year group. These statistics are weighted to reflect the California vehicle populations being reported based on model year, vehicle type/class, Gross Vehicle Weight Rating (GVWR), and other factors. The latest roadside test data described in this report was collected between January 1, 2017, and December 31, 2018.

^a Light-, medium- and some heavy-duty vehicles (gross vehicle weight rating up to 9,999 lbs. GVWR) are included.

^b 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 model year gasoline-powered vehicles registered in enhanced areas require an ASM inspection.

^c See Attachment A page 25 for further detail.

^d 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 (SIP) to achieve and maintain federal clean air standards, as well as a measure needed to meet State air quality standards.

In March 2009, Sierra Research, Inc. (Sierra) released a report analyzing the effectiveness of the California Smog Check Program.^a The report found that for model year 1976-95 vehicles that initially failed, then passed the tailpipe (ASM) 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 model year 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, required 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 deployed the OIS in 2014. These and other changes are described in the annual SCPRs prepared and published by BAR in cooperation with the California Air Resources Board from 2012 through 2018.

In December 2018, there were 8,213 licensed Smog Check stations in California. 4,225 of these (51%) were “STAR” certified, meaning that they had elected voluntarily to meet higher standards of station performance and were authorized by BAR to test “directed vehicles.” 3,420 stations (42%) were classified as non-STAR. Fleet, Referee, and other stations made up the remaining 7%. STAR stations, on average, tend to operate at higher testing volumes. Of the roughly 11.4 million initial Smog Check tests performed in California in 2018, about 9.3 million (82%) were performed by STAR stations and 2.1 million (18%) by non-STAR stations.

BAR’s research and experience indicate that the vast majority of Smog Check stations conduct valid testing. However, a relatively small number of stations and technicians perform a disproportionate number of improper or fraudulent tests. In 2018, 84% of Smog Check tests were tested with the OIS. Accordingly, much of BAR’s efforts to prevent fraud are focused on that platform. The next section highlights a second BAR action, prior to the April 2018 enforcement action cited earlier, that also produced measurable benefits in improving Smog Check station performance in 2018.

Recent Changes to Smog Check to Improve Station Performance

The OIS equipment was required to be used for the Smog Check Program beginning March of 2015. Prior to the full-scale implementation of the program, there was over a year of beta testing at licensed stations where the OIS test was optional. A review of data generated during that early period in the program showed relatively little evidence of fraud when the program was new. However, by that summer, two different program defeat methods, simulators and surrogate vehicles began to be used at some Smog Check stations. A simulator is an electronic device that can be used to imitate a vehicle’s OBD data with or without the use of the actual vehicle.

While improper testing activity was performed in 2015, it was not fully recognized until 2017 when BAR developed a new software tool to flag improper tests “in real time” (i.e., before a Smog Check

^a *Ibid*, Sierra.

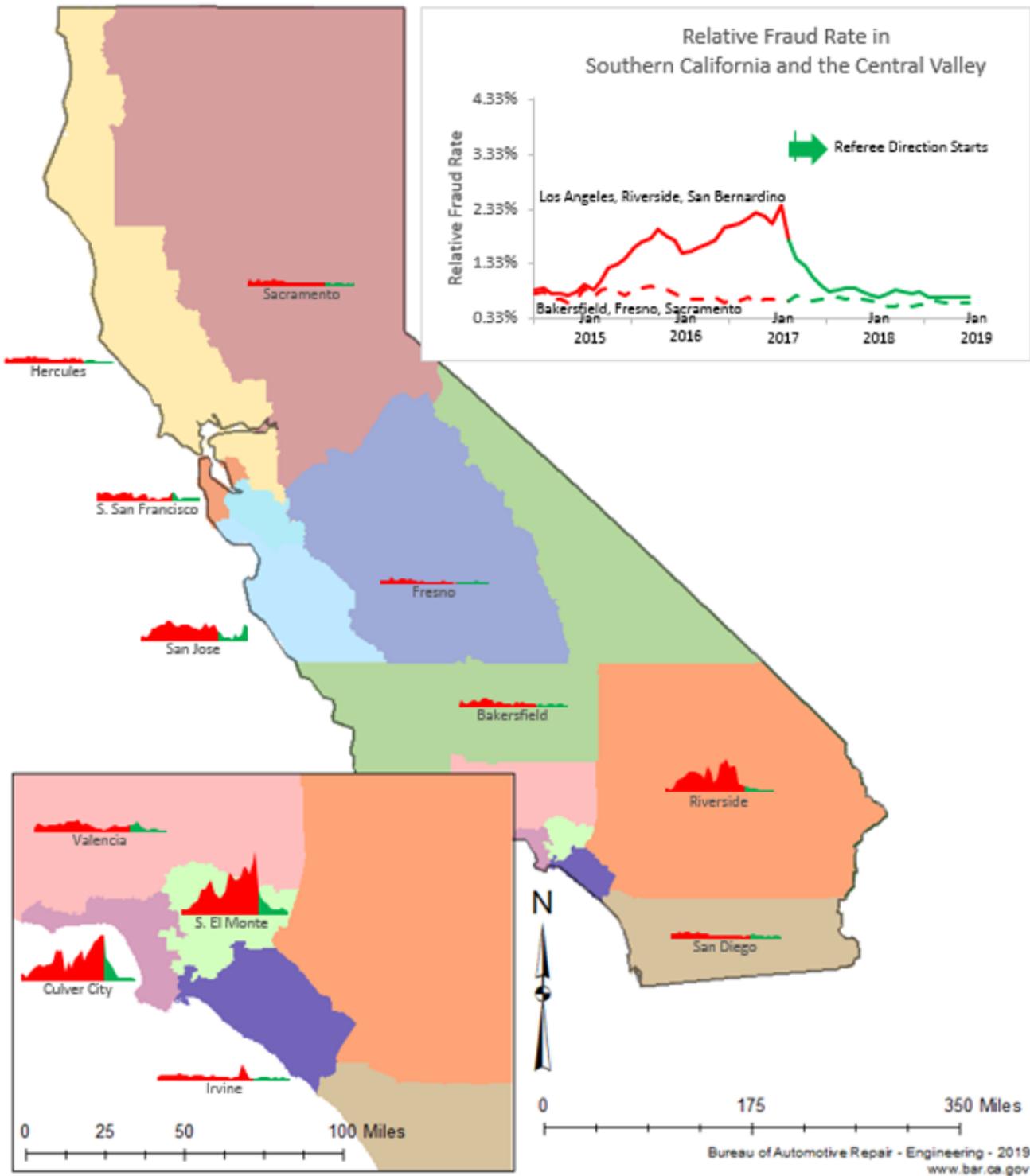
certificate is issued). Applying the new software tool to historical Smog Check data throughout the State revealed that some Smog Check stations were using program defeat methods. Beginning in 2017 BAR applied this automated software tool to perform data profiling checks to block a certificate from being issued when the test data did not match the expected data for the specific vehicle being tested. It also allowed BAR to block other stations from certifying that vehicle until it had been inspected by a Referee facility.^a

The magnitude of the reduction in fraudulent inspections throughout the state is shown in Figure 3 below. The graph in figure 3 shows the likely fraud indicator for Smog Check stations overseen by BAR's field offices in the Central Valley (lower curve) and in Southern California (upper curve). The rate of likely fraud of this type was low and relatively flat in the Central Valley, but in Southern California the rate was trending strongly upward (increasing fraud) over the first 2.5 years beginning in July 2014. Further, the graph in figure 3 shows the beginning in February 2017, BAR's certificate blocking and Referee redirection reduced the use of program defeat methods sharply. By June 2017, the fraud indicator levels for these methods returned to the levels seen when the OIS systems were newly introduced, and by the second half of 2018, the levels in Southern California were reduced to approximate the lower levels observed in the Central Valley.

Overall, between the first Referee redirection in February 2017 and the end of 2018, more than 14,000 vehicles that were about to be certified improperly by a Smog Check station were instead redirected to Referee stations. Subsequently, approximately 50% of the redirected vehicles, schedule and shown up for their Referee inspection appointment. In addition, the behavior that caused the Referee redirection has been drastically reduced. However, at the same time this success was playing out, indicators of new devices and strategies for conducting fraudulent inspections became apparent, requiring further investigative work by BAR. This fact reinforces BAR's experience that the problem of Smog Check fraud is ongoing and necessitates data-intensive analysis, surveillance and aggressive enforcement to maximize air quality benefits for Californians and protect the integrity of the program and shops that perform quality inspections.

^a The Smog Check Referee Program is a statewide network of stations that provide resources to consumers and Smog Check inspectors including, Smog Check inspection review, parts locator service, law enforcement citations (noise, emissions and smoke), verification of Smog Check exemption, inspections for unusual vehicles (specially constructed, grey market, engine changes), and repair cost waivers. Referee centers are centrally located within certain community colleges throughout California. To find a Referee center near you or to schedule an appointment, visit asktheref.org or call (800) 622-7733.

Figure 3
OBD Fraud Indications
July 2014 – December 2018



Effects of Vehicle Age, Smog Check Station Performance, and Other Factors upon the Roadside Failure Rate of Vehicles

Analysis for Tailpipe Tested Vehicles

Measuring vehicle failure rates during roadside inspections is important because it provides information about how well Smog Check stations are performing. However, interpreting the roadside results requires care because many factors can influence the roadside failure rate, including the following: vehicle age, performance of the Smog Check station that last certified the vehicle, time since the vehicle was last certified, and whether the vehicle failed and was repaired prior to the last certification. Considering these factors, BAR has modeled the emission failure rate for the 2017-18 roadside data from tailpipe (ASM) tested 1976-99 vehicles. The results are summarized in Figure 4, which shows how vehicle age and the pass or fail status prior to the last certification affect roadside fail rate. For this sample, model year 1996-99 vehicles are the youngest, with an age of 16-20 years, and vehicles from the 1970s are the oldest, with an age of 40-44 years. The width of the 95% confidence bands tends to be greatest for the older vehicles because the estimated fail rate becomes less certain as the population of vehicles in the fleet and the corresponding roadside sample diminish in size. The overlap of confidence bands in the upper right-hand quadrant of the graph shows that as vehicles age, not only do failure rates continue to rise for both previous passing and failing vehicles, but beyond about 35 years, a prior result of fail or pass becomes less important in determining roadside fail rate. This is due both to the relatively high failure rate at this age and to the sparse sample.

Figure 4

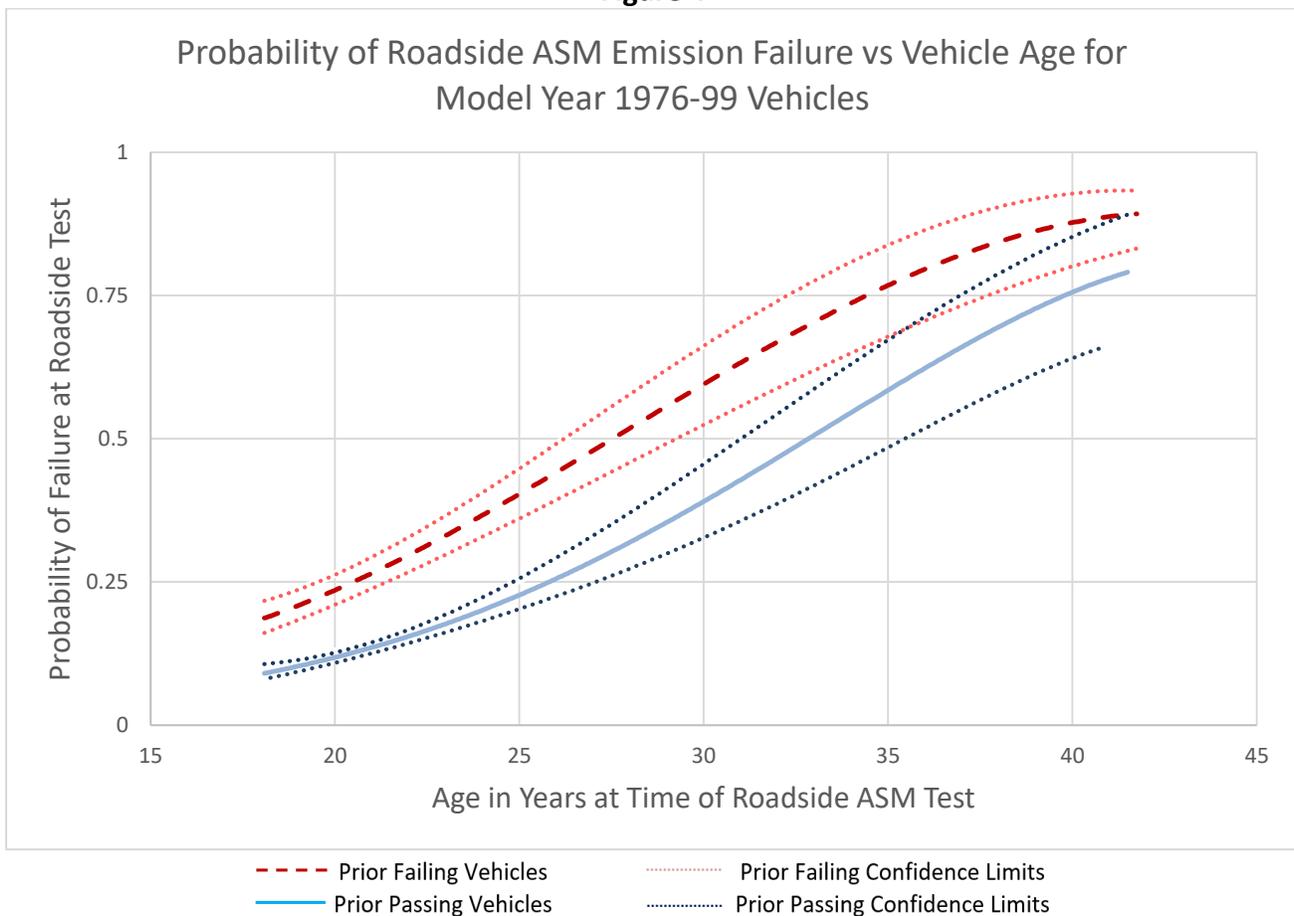
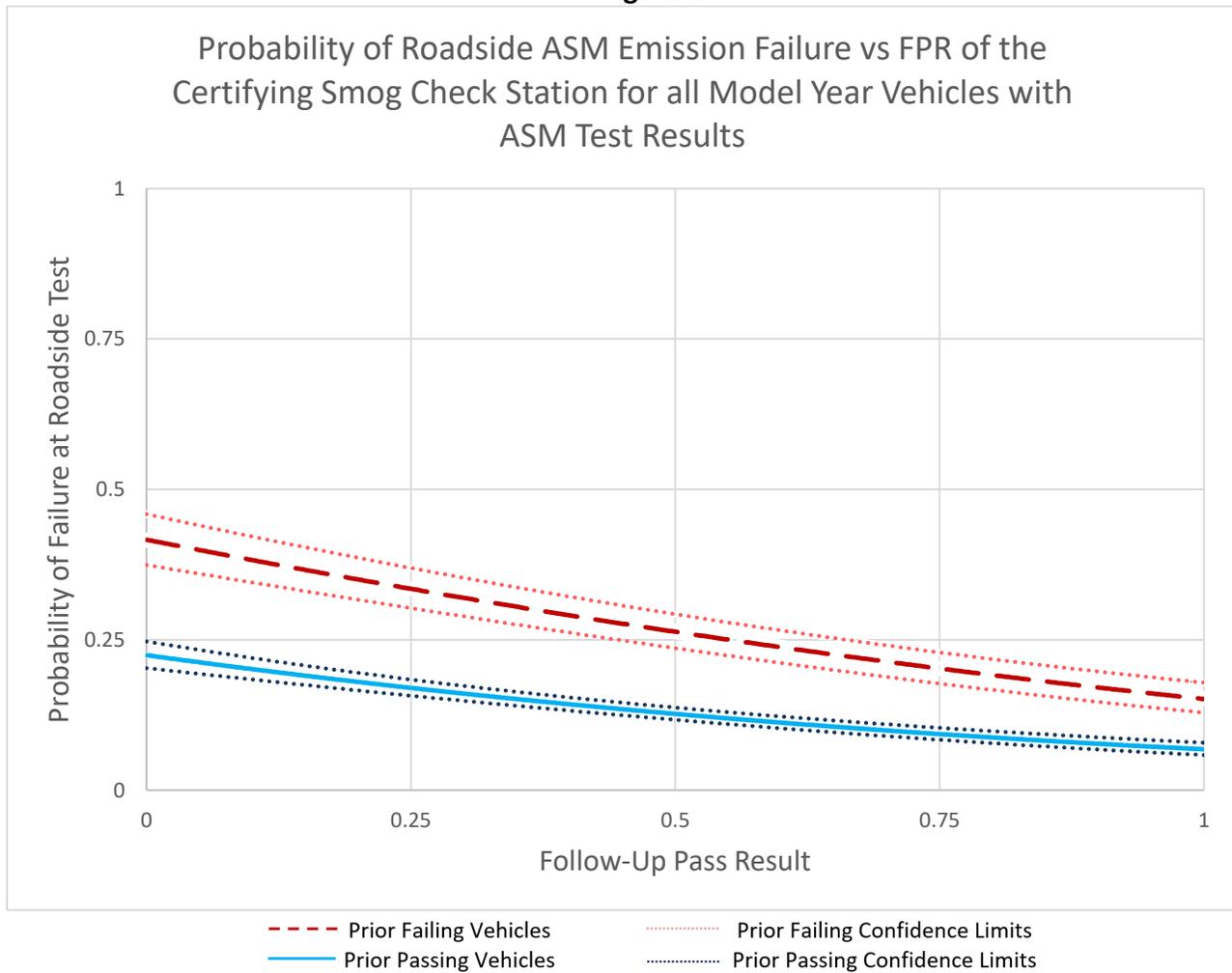


Figure 4 shows the effects of two of the factors that influence roadside failure rate, namely vehicle age and initial pass/fail status prior to certification. Results from the full model accounting for all five identified factors looks similar. Figure 5 shows how FPR affects the likelihood of roadside failure. One difference made to the Figure 5 model compared to Figure 4, is the inclusion of 2000-06 model years roadside data for which BAR has continued to collect both OIS^a and tailpipe data. This change increased the sample size by 44% (from 5,320 to 7,656 vehicles) and improved the model's performance, but there was no discernable change in the plot of roadside failure rate vs FPR (shown in Figure 5 for the larger dataset) or in how the certifying station's FPR score affects the probability of failing at roadside.^b

Figure 5



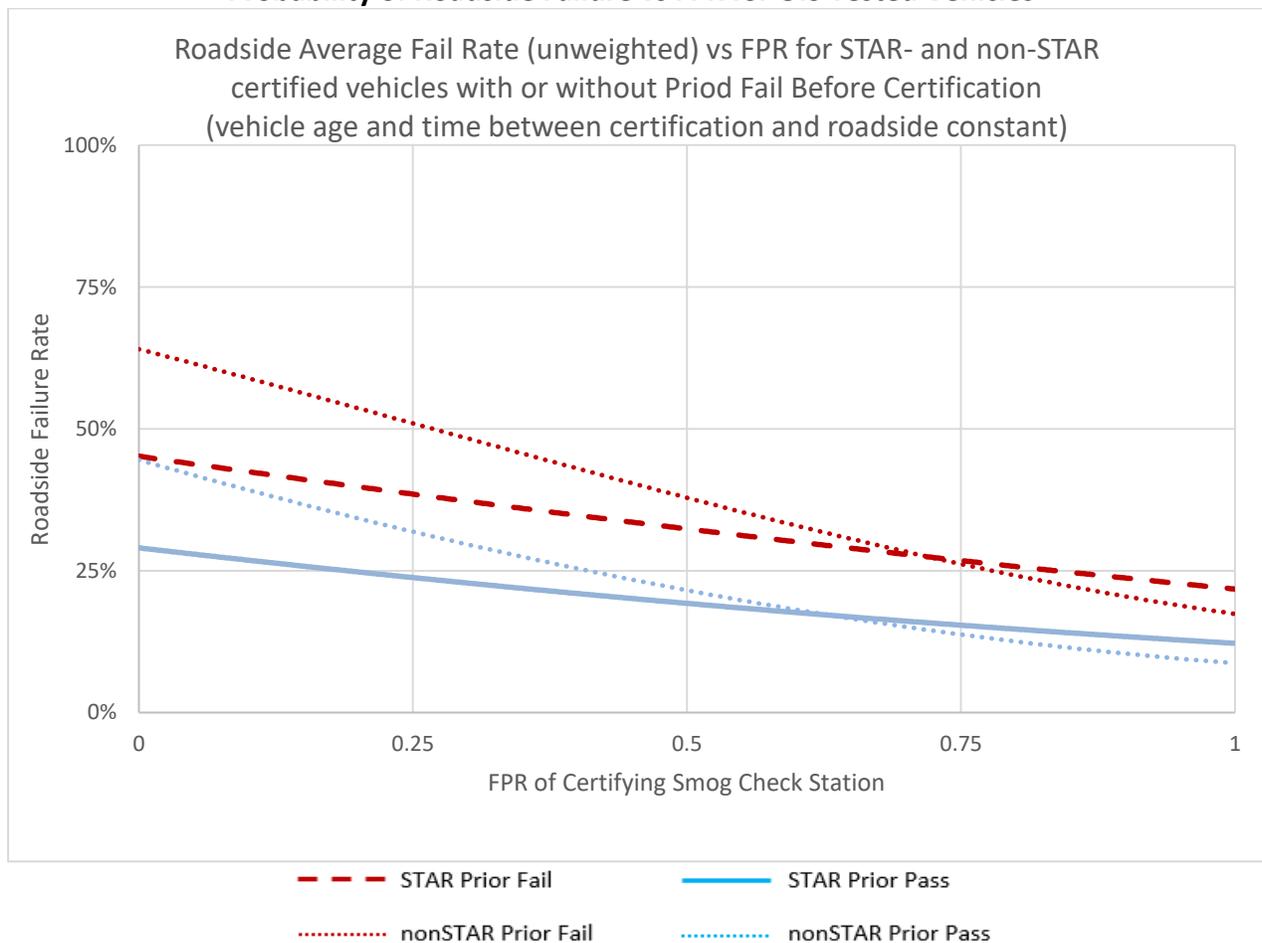
^a For Smog Check, model year 2000 and later gasoline vehicles are subject to OIS testing. However, in cooperation with CARB, BAR has continued both OIS and tailpipe testing for the 2000 and newer model years to better understand how OBD systems are performing and how the OBD fleet is responding to aging.

^b For both models, the odds of failing at roadside increased by a factor of 1.739 for each 0.4 increase in FPR.

Analysis for OIS Tested Vehicles

The analysis performed for the 2018 SCPR found that vehicles tested on the OIS and previously certified at STAR stations have lower first-year roadside fail rates than those certified by non-STAR stations. The latest (2017-18) roadside sample allows us to investigate further the relationship between STAR certification, FPR and roadside failure rates. Figure 6 compares the roadside failure rates of OIS tested vehicles that were previously certified at STAR and non-STAR Smog Check stations. The plot, which is similar in format to Figure 5, shows the probability of failure at roadside as a function of FPR for the certifying Smog Check station. The upper (red/pink) curves in the plot shows fails before certification and the lower (blue/light blue) curves shows prior passes. Comparing the curves, it is apparent that at the poor performing end of the FPR scale (left side of Figures 5 and 6) non-STAR station certifications of OIS tested vehicles result in markedly higher probabilities of failure later at roadside than certifications by STAR stations. For consumers, this means that certification by a STAR station will typically provide the greatest assurance that their vehicle will pass at roadside, pass their next Smog Check, and result in the vehicle’s cleanest emissions levels.

Figure 6
Probability of Roadside Failure vs FPR for OIS Tested Vehicles^a



^a Both figures show BAR modeling results for vehicles that previously failed (upper red bands) but were later certified at Smog Check and those which previously passed (lower blue bands).

Current Excess Emissions

This report defines excess emissions in terms of the emissions that could have been reduced if all vehicles were inspected at “high-performing” Smog Check stations. In part, the method relies on the CARB EMFAC2017 model as an estimate for current emissions from on-road gasoline-powered vehicles in California. The average roadside ASM concentration for vehicles certified as passing Smog Check at “high-performing” stations and subsequently tested at the roadside is compared to the average roadside ASM concentration for vehicles certified at either “high- or not-high-performing” stations combined. The ratio of the averages is used as a factor to apply to the current on-road emissions from the EMFAC model in order to estimate the emission reductions. This method is applied for each vehicle type and technology group. The following estimate was made using this methodology:

- The estimated additional achievable emission reductions for 1976 to 2012 model year light- and medium-duty gasoline-powered vehicles in the Smog Check Program is on the order of 60 - 70 tons per day of reactive organic gases and oxides of nitrogen (ROG + NOx) for CY 2018.

Evaluation of Best Practices of Other Vehicle Inspection Programs

The following is an evaluation of best practices and recommendations of other vehicle emissions inspection programs covering 32 states, plus Ontario, Canada. Other states have looked to California for guidance in optimizing the effectiveness and lowering the cost of vehicle inspections. Saint Malo Solutions, LLC provided the research and much of the language for BAR to use in this section of the report. One or more of the following tests are implemented in each of the involved states:

- OBD Test - Usually administered to 1996 and newer vehicles equipped with OBD II systems.
- ASM or Transient Dynamometer Test – (ASM 25/25 – ASM 50/15 - IM 147) Usually administered to pre-1996 model year vehicles weighing 14,000 lbs. GVWR or less.
- A Steady State or Two Speed Idle Test – Usually administered to older vehicles and/or vehicles that cannot be tested on a dynamometer.
- Opacity Test - For diesel vehicles, this test measures the level of opacity in the vehicle’s exhaust.
- A Gas Cap Seal Test.
- A visual Catalytic Converter Inspection.

Other highlights include:

- 27 states including California operate decentralized programs. Five oversee hybrid programs with both centralized and decentralized elements.
- 28 states tie compliance with registration renewal, the remainder issue windshield stickers.
- Like California, 12 other states require inspection upon vehicle resale.
- Unlike California, 14 states require periodic safety inspections.
- Like California, nine other states conduct statewide inspections while the remainder operate only in those areas of the state where air quality is adversely impacted due at least in part to vehicular emissions.
- California contracts with SGS Testcom, 15 others contract with Opus Inspection, 8 with Applus+ Technologies, 5 with Worldwide Environmental Products, and four each with Gordon Darby and Parsons. Two states use no contractor to assist in the conduct of their program.

- Test network sizes range from as few as two in the District of Columbia, to as many as 10,000 in the state of New York. California ranks second with 8,300 stations. Rounding out the top five networks are: #3 – Pennsylvania with 8,000 stations, #4 – Texas with 5,400 stations, and #5 – North Carolina with 4,500 stations.
- The average cost of inspection in California, is between \$50 and \$60 depending on the inspection type. The cost of inspection in other states ranged from free (state sponsored) to as much as \$90 per inspection in Vermont.
- Most states include hybrid vehicles to be inspected.
- 19 states require inspection every two years (biennial), 7 require annual inspection, and inspection frequency vary by vehicle type and age in 8 states.
- Many states defer the requirement for first emissions inspection (clean screen) for several years. The first required inspection for vehicle owners ranges from 0 years in the Northeast states (Maine, New Hampshire and Vermont), to 9 years of age in California and Wisconsin (where vehicle age = Calendar year – Vehicle Model Year).
- 7 states utilize remote sensing technologies (RSD) to screen the fleet to detect high emitting vehicles for inclusion (dirty screen) or clean vehicles for exemption from testing requirements (clean screening).
- Three states, including California, utilize remote OBD system checks (remote OBD or OBD III) in either as a part of their programs (Oregon) or as pilot programs (California /Ontario, Canada).

California has for many years conducted a remote OBD pilot, limited to government fleets. Utah and more recently Ontario, Canada have adopted remote OBD pilots. According to CARB, “OBD III strategies offer possibly the most cost effective options for OBD-based motor vehicle emission inspections....In fact, over a vehicle’s lifetime, it has been estimated that OBD III technology could reduce Smog Check testing costs by about 75% compared to station-based OBD inspection programs...the continuous nature of a remote OBD system and additional benefits from a reduced time from detection of a fail to repair may outweigh any additional losses.”^a Oregon’s Department of Environmental Quality (DEQ) Remote OBD program (DEQ TooTM) allows motorists to receive an emissions test using telematics (cellular data) and the internet.

^a Transitioning Away from Smog Check Tailpipe Emission Testing in California for OBD II Equipped Vehicles, CARB, March 2000

List of Attachments

A. Excerpted “Specific Comments” from “Review of the Bureau of Automotive Repair’s 2018 Smog Check Performance Report”, Saint Malo Solutions, LLC, February 1, 2019 with BAR annotations.

B. Acronyms

Attachment A

This attachment consists of the section entitled, “Specific Comments” from “Review of the Bureau of Automotive Repair’s 2018 Smog Check Performance Report”, by Saint Malo Solutions, LLC, February 1, 2019, with annotation (*in italics*) by BAR. Saint Malo’s comments on specific statements, tables, and page numbers refer to BAR’s 2018 SCPR. Citations in BAR’s responses refer to the current (2019) SCPR, unless stated otherwise. The entire independent review by Saint Malo of the 2018 SCPR (without annotation) is available upon request at BAR.PRA@dca.ca.gov.

Excerpt from 2018 SCPR:

Table 1 of the SCPR (recreated below) presents a comparison of the historic roadside results from the 2009 Sierra Research report to recently collected data as called for in HSC section 44024.5 (b) (7).

Table 1
Summary of Roadside Vehicle Failure Rates by Calendar Year (CY) and Model Years (MY) for ASM and OIS^a Testing compared with Historical Baseline

Roadside Fail Rates within one Year of Smog Check Certification

Initial Smog Check Results	(1) Historical Baseline CY 2003-06 ASM Fail Rate MYs 1976-95	(2) CY 2015-16 ASM Fail Rate MYs 1976-99	(3) CY 2016-17 ASM Fail Rate MYs 1976-99	(4) CY 2016-17 OIS Fail Rate MYs 2000-06
Fail***	49%	30% (813)	28% (701)	31% (702)
Pass*****	19%	14% (4956)	17% (2825)	16% (6685)
Overall Failure Rate	24%	16% (5769)	20% (3526)	17% (7387)

Saint Malo: “On page 2 the authors discuss using “data and models” of how various factors affect roadside fail rates to present the probability of roadside failure for both Acceleration Simulation Mode (ASM) Testing and On-Board Diagnostic Inspection System (OIS) tests (Figures 1 and 2 on page 3).”

“1. What is the point of this illustration other than to suggest that there is a relationship between failure rate and time between tests? If it is meant to be compared to the 2009 Sierra Research findings, perhaps the figures should include that trend line.”

BAR Response: *The plot was presented to show that there continues to be a relationship between when the roadside vehicles were previously certified and their likelihood of failing at roadside, and that the relationship depends on whether the vehicle previously failed. Included in the 2019 SCPR is a plot (Figure 1, pg. 4) which directly compares failure rates with age (based on model year) for OIS tested vehicles at Smog Check, OIS tested vehicles at roadside, and tailpipe vehicles analyzed by Sierra at roadside when those were of similar age to the OIS tested vehicles. The two trend lines (dashed lines) in the figure comparing roadside (OIS) failure rate in 2017-18 and the tailpipe emission failure rate roughly 15 years earlier in the 2003-06 data show similar trends, as noted earlier in this report.*

Saint Malo:

“2. Figures 1 and 2 appear to be very similar. Perhaps it would be more informative if the two figures were combined?”

BAR Response: *Good suggestion*

Saint Malo:

“3. Despite the fact that the two figures refer to different model year groups (Figure 1 – 1976-99 and Figure 2 – 2000-06), the modeled results appear quite similar. Should the reader conclude that the time between tests is the most significant predictor of failure regardless of test type?”

BAR Response: *No. We did not intend to imply that conclusion. The results to date from our efforts to model roadside failure rates suggest that ‘FPR of the certifying station’ and ‘vehicle age’ (based on model year) are probably the two most significant predictors of roadside fail rate. However, ‘time since last certification’ and ‘prior test result’ (among others) have also been found to help explain roadside failure rates. These latter two factors, which were introduced by Sierra Research in its 2009 report, have particular significance for BAR and for policy makers because of what they suggest about Smog Check station performance and, for re-failing vehicles, the durability of repairs, which is the reason BAR highlighted them.*

Saint Malo: BAR Conclusion 1 (page 4) states that “Roadside first-year fail rates in 2016-17 for both OIS testing and tailpipe based ASM testing were lower than the roadside tailpipe rates in 2003-06 (prior to AB 2289 and the STAR program).”

“While this conclusion may be true, it is not apparent that the failure rates in each of the four populations presented in the table are directly comparable. A statistically significant predictor of Smog Check failure is the age of the vehicle (or vehicle fleet) subjected to testing. That is, the older the vehicles, the higher the probability of failure. Given the different age ranges presented in Table 1 (1976-95, 1976-99 and 2000-06), it is not clear that the failure rates can be directly compared. It is the authors that state in Attachment A, that the odds of failure more than double for every four years increase in vehicle age.”

BAR Response: *In response to the reviewer’s suggestion, Figure 1 in has been added to the current (2019) SCPR to show a direct comparison (no modeling) of roadside failure rate and age for OIS fleet in 2017-18 and the Sierra-analyzed fleet when of similar age in 2003-06. There are 9 years of overlapping ages, and in 8 of those years the recent OIS failure rate is less than the Sierra-analyzed fleet’s failure rate at the same age (at age 17 years, the two fleets had equal failure rate). However, after controlling for other factors (discussed below) the probability of failure for the vehicles tested on the OIS is lower.*

Saint Malo:

BAR Conclusion 1:

“1. It is suggested, at a minimum, that the average age of each fleet be presented in Table 1 acknowledging that the older fleet is likely to have a higher failure rate regardless of test type.
2. As a further step, a comparison might be included that presents the failure rate by vehicle age for each of the four populations presented.”

BAR Response: *BAR finds that for complex variables like roadside failure rate that can be influenced by many factors, it's often more productive and efficient when comparisons like this are made to account for all the factors known to contribute to the odds of failure when trying to account for the effect of each factor individually. That is why BAR has employed multivariate regression in our analyses.*

Saint Malo:

BAR Conclusion 1:

"3. An analysis might be also performed to determine whether the apparent differences in failure rates are statistically significant after controlling for the differences in fleet ages."

BAR Response: *This is, in fact, how BAR performs its multivariate modeling analysis of age and all other variables with the option of stepwise regression in its multiple logistic regression analyses.*

Saint Malo: BAR Conclusion 3 compares the failure rates of vehicles tested both by ASM and OIS noting the higher OIS fail rates compared to tailpipe ASM testing for the same fleet. The authors go on to state that "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."

"1. Although agreed that a higher fail rate might be expected for vehicles tested by OIS, is the comparison being made to the ASM tailpipe results exclusively, or does the ASM fail rate include vehicles failing any reason (including visual or functional)?"

BAR Response: *The reviewer is correct that the reported roadside ASM testing is just that and, like all of BAR's current roadside testing, does not include functional or visual checks (except for MIL indicator light which is recorded if illuminated).*

Saint Malo:

BAR Conclusion 3:

"2. It is also important to note that the pass/fail criteria associated with the vehicle's OBD system tends to be much more stringent compared to those established for ASM. That is, OBD systems are designed, in general, to set a trouble code or illuminate the malfunction indicator light (MIL) when calibration drifts, or systems or components fail, which would likely result in emissions 1.5 times or more than the certification standard. In contrast, in order to minimize the probability of errors of commission or false failures, the tailpipe standards were derived to identify vehicles with emissions at two or more times the certification standard."

BAR Response: *BAR appreciates the additional factual and historical information provided to readers by the reviewer.*

Saint Malo: BAR Conclusion 4 points toward the fact that "the overall roadside fail rate increased from 16% in calendar years 2015-16 to 20% in 2016-17." The authors state that, "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 2016-17 vs. 21% from the 2015-16 roadside survey."

“1. The authors should be able to quantify what part of the increase is due to age in order to substantiate the claim that the larger cause is the difference between the fail rates for non-STAR stations.

2. The Footnote d on page 4 states that, “the 21% fail rate is from the last row in Table 1 from Reference 3,” however, it appears that the last row of Table 1 – Reference 3 is 20%.”

BAR Response: Footnote d is correct as written. The reviewer’s comment suggests confusion about which variable and which tables are being compared. BAR is comparing the non-STAR roadside ASM fail rate from the 2016-17 roadside sample (which is in Table 3 on page 10 of the 2018 SCPR) to the corresponding 2015-16 ASM value (in Table 1 on page 7 of the 2017 SCPR; the 2017 SCPR is correctly identified as Reference 3 in the 2018 SCPR.)

Excerpt from prior 2018 SCPR:

Table 3
2016-17 BAR Roadside Survey of OBD Failure Rates Using the OIS
Failure Rates of Model Year 1976-99 Vehicles

Initial Smog Check Result	All Station Types	STAR	Non-STAR
Fail***	28% (701)	28% (585)	30% (116)
Pass****	17% (2825)	15% (2404)	28% (421)
Overall Failure Rate	20% (3526)	18% (2989)	29% (537)

Saint Malo:

BAR Conclusion 4:

“3. Continuing with BAR Conclusion 4, the authors suggest that the increase in non-STAR failures is indicative of “relatively more vehicles being certified inappropriately by low-performing stations.” Is this point known or assumed?”

BAR Response: BAR believes that the facts support this statement. Regarding roadside vehicles previously certified at non-STAR stations, BAR has reported a 29% overall failure at roadside in 2016-17 compared to a 21% rate from the 2015-16 roadside sample. BAR has also reported that non-STAR stations overall have poorer FPR scores (i.e. they are lower performing) than STAR stations (see, for example, the 2017 SCPR, Figure A-1, pg18). From these facts, BAR concludes that “...relatively more vehicles are being certified inappropriately by low-performing stations and failing later at roadside...”

Saint Malo:

BAR Conclusion 4:

“3. (continued) Does this suggest the need to increase the population of “directed” vehicles to STAR stations?”

BAR Response: Currently, the vast majority of 1976-99 gasoline vehicles are directed to STAR stations.

Saint Malo:

BAR Conclusion 4:

“4. Can an analysis be performed which separates directed vehicles from the STAR station results?”

BAR Response: *BAR will consider this for future analyses.*

Saint Malo: “On page 6, the fact that vehicles with bald tires, liquid leaks, or other visible safety issues are excluded from roadside testing.

1. It would be helpful to quantify the percentage of vehicles that are not tested due to safety issues.”

BAR Response: *Out of 37,309 vehicles pulled over for the 2016-17 roadside sample, 97 vehicles (about 0.26%) had to be excluded or aborted from testing for safety reasons. We are not certain of the number of Smog Check test vehicles that are declined or aborted for the same reasons at Smog Check because that data entry may depend on the individual station and technician practice.*

Saint Malo:

“1. Are vehicles rejected for OIS testing for safety reasons? If not, this may make a comparison of OIS and ASM tests problematic. It may, however, highlight an advantage of OIS over ASM that may be worth mentioning (if not quantifying).”

BAR Response: *Essentially all the vehicles excluded for safety reasons were ASM test vehicles.*

Saint Malo:

“1. A percentage of vehicle operators selected for roadside testing refuse to participate for various reasons. Does a separate accounting of vehicles selected but not tested exist? If the population is significant, is there a way to assess the impact on the report’s conclusions?”

BAR Response: *BAR does keep a count of those who decline participation. If there is a way to assess the impact of the refusers on the report’s conclusion, BAR may consider attempting such an adjustment in the future.*

Saint Malo: “The pass/fail rates of ASM and OIS on the same fleet of over 4,000 vehicles was discussed on page 8 and illustrated on page 9.

1. The most important factor here is that 1.5% of vehicles that failed an ASM passed the OIS test. Some additional discussion (or additional analysis) should be included as this has implications on transitioning from ASM to OIS.”

BAR Response: *BAR will consider this for future analyses.*

Saint Malo: “Page 11 – Although the California Air Resources Board (CARB) may no longer provide EMFAC based estimates of emission reductions attributable to Smog Check, BAR has in the past, and I believe have enough roadside data currently, to at least estimate the percent reduction in emissions due to Smog Check. Further analyses could be performed to contrast STAR and non-STAR stations, and ASM compared to OIS.”

BAR Response: *BAR agrees with the reviewer that enough roadside data exist to estimate the percent reduction in emissions. As described elsewhere in the Report, CARB and BAR staffs have developed an alternative method of estimating the emissions reduction lost as a result of Smog Check stations operating at less than high-performance. The results from that analysis for calendar year 2018 are presented herein and for calendar year 2017 in an amended version of the 2018 SCPR (available at BAR’s website). The ASM to OIS comparisons suggested may be considered for a future report, although the data availability from ASM testing at non-STAR stations is limited because the vast majority of biennial ASM testing is directed to STAR stations.*

Saint Malo: *“In Attachment A, several factors are listed that are believed to contribute to roadside test failure. Has any consideration been given to the type of repair performed on vehicles that initially fail at a Smog Check station and subsequently pass only to fail at roadside? In a previous analysis of BAR’s Consumer Assistance Program (CAP), it was determined that some types of repairs are very effective in getting a vehicle to pass the test but the repairs do not last (i.e. catalyst replacement). These were legitimate repairs and the findings had implications on the length of warranty on aftermarket parts. Although this question is specific to ASM testing, it may have an impact as the fleet transitions to OIS testing.”*

BAR Response: *BAR does not have sufficient data on the repairs performed on vehicles that initially fail at Smog Check stations and subsequently pass Smog but fail at roadside to perform the analysis that is suggested. BAR will consider this for future analyses.*

As a final comment, BAR thanks our reviewer Saint Malo Solutions for the thoughtful and helpful comments.

Attachment B

Acronyms

ASM, Acceleration Simulation Mode

BAR, Bureau of Automotive Repair

BAR-97, BAR-certified EIS for testing model years 1976-99 vehicles

CARB, California Air Resources Board

CY, Calendar Year(s)

EIS, Emission Inspection System

FPR, Follow-up Pass Rate

GVWR, Gross Vehicle Weight Rating

OBD II, On-Board Diagnostics, 2nd generation, generally equipped on model year 1996 and newer light duty vehicles

OBD III, On-Board Diagnostics, theoretical 3rd generation, involves transmitting OBD data remotely.

OIS, OBD Inspection System for testing OBD-equipped vehicles including, gasoline model years 2000 and diesel 1998 and newer

SIP, State Implementation Plan, the state's commitments to the United States Environmental Protection Agency to achieve air quality standards

SCPR, Smog Check Performance Report

STAR, Classification of stations that can certify directed vehicles

TSI, Two-Speed Idle