

DEPARTMENT OF CONSUMER AFFAIRS

**BAR**

Bureau of Automotive Repair

# Smog Check Performance Report 2021



July 9, 2021

# Introduction and Summary

This report provides an update on California’s Smog Check Program pursuant to Assembly Bill (AB) 2289,<sup>a</sup> which required an annual evaluation of the program and the performance of Smog Check stations beginning no later than July 1, 2011. This legislation directed the California Bureau of Automotive Repair (BAR) to implement both inspection-based performance standards<sup>b</sup> for stations inspecting directed vehicles<sup>c</sup> and On-Board Diagnostics (OBD II) focused inspections for newer vehicles.<sup>d,e</sup> It also enhanced BAR’s ability to identify and take action against stations performing improper inspections.<sup>f</sup> The 2021 Smog Check Performance Report (SCPR) satisfies the statutory reporting requirement for 2021.

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 (see sidebar at the right).<sup>g</sup> The Roadside testing described in this report pairs Roadside-tested vehicles with their most recent Smog Check certification (i.e., a passing test). This is done to gain insight into the integrity of Smog Check testing. As in past SCPRs, vehicles whose most recent Smog Check does not result in the issuance of a certificate of compliance (i.e., certification) are excluded from the analyses. 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).<sup>h</sup> For model year 1976-1999 vehicles, Roadside tailpipe testing is performed using a BAR-97 Emissions Inspection System (EIS).<sup>i</sup> In addition, supplemental tailpipe tests have been collected for select vehicles, including model year 2000 and newer vehicles, to better quantify emissions deterioration as the OBD vehicle fleet ages and to help evaluate excess emissions.

## A Note About COVID-19 and the 2021 SCPR

Historically, BAR has almost exclusively relied on data from its Roadside Inspection Program to evaluate Smog Check performance for the annual SCPR required by AB 2289. Because of the COVID-19 pandemic, Roadside inspections were suspended in March of 2020. As a result, the analyses for this year’s report have been supplemented with Remote Sensing Device (RSD) data collected in the Los Angeles area from November 2020 to March 2021. While the RSD data provided supportive information for this year’s report, RSD is not a replacement for the Roadside Inspection Program as RSD data is not directly correlated with the inspections conducted in the Smog Check Program.

<sup>a</sup> Eng, Chapter 258, Statutes of 2010.

<sup>b</sup> 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 standards based on quarterly performance. In addition to performance, stations must also comply with the enforcement-related standards of the STAR Program.

<sup>c</sup> “Directed vehicles” include all model year 1976-1999 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. The owners of these vehicles are notified on their DMV renewal notice of this requirement.

<sup>d</sup> OBD II systems are self-diagnostic systems incorporated into the computers of vehicles beginning with the 1996 model year. 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.

<sup>e</sup> For more information about OBD II, see the California Air Resources Board website: <https://ww2.arb.ca.gov/resources/fact-sheets/board-diagnostic-ii-obd-ii-systems-fact-sheet>.

<sup>f</sup> 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.

<sup>g</sup> 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. Remote Sensing Device (RSD) data was also used in the 2021 SCPR to supplement the Roadside data. A description of the RSD data used in this report can be found on page 7.

<sup>h</sup> OIS is the Emission Inspection System used in the Smog Check Program for OBD tests of model year 2000 and newer gasoline-powered vehicles, all hybrids, and for model year 1998 and newer diesels.

<sup>i</sup> 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.

As noted above, BAR’s Roadside testing was halted in March of 2020. As a result, BAR did not have a full two years of data with which to assess Smog Check performance. Typically, Roadside data from calendar years 2019 and 2020 would have been used for this year’s evaluation, representing data from a complete biennial inspection cycle. For the 2021 SCPR, BAR evaluated Roadside data collected *during the first quarter* of each year from 2018 through 2020, which allowed for incorporation of 2020 Roadside data that was collected prior to halting inspections. The first-quarter data was analyzed for the 2018-2019 and 2019-2020 calendar years. The 2018-2019 data allows for a comparison to the full-year data analyzed for the 2020 SCPR.

Roadside test results from OIS tested vehicles are summarized in Table 1, which includes OIS test results from the full calendar year 2018-2019 Roadside sample analyzed for the 2020 SCPR, as well as the first-quarter data from 2018-2019 and 2019-2020. The table shows results only for model year 2000-2006 vehicles, which represents the 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 subsequently passed Smog Check), and those which initially passed the inspection.<sup>a</sup> Overall, model year 2000-2006 OIS-tested vehicles in the first-quarter 2019-2020 Roadside sample failed at a model year weighted rate of about 21%, which is the same failure rate found for the similarly weighted (and partially overlapping) first-quarter 2018-2019 Roadside sample.<sup>b</sup>

**Table 1  
Roadside Failure Rates of OIS Tested Gasoline Vehicles, Model Year 2000-2006**

<b>Initial Smog Check Result</b>	<b>Roadside OIS Failure Rates within One Year after Smog Check Certification* CY 2018-2019</b>	<b>Roadside OIS Failure Rates within One Year after Smog Check Certification* Quarter 1, 2018-2019</b>	<b>Roadside OIS Failure Rates within One Year after Smog Check Certification* Quarter 1, 2019-2020</b>
Fail**	33% (660)	39% (160)	31% (106)
Pass***	17% (6,535)	19% (1,775)	20% (1,041)
Overall Failure Rate	18% (7,195)	21% (1,935)	21% (1,147)

\* 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.

Table 2 summarizes the results from BAR’s Roadside Inspection Program for model year 1990-1999 vehicles that are subject to tailpipe testing as part of their Smog Check.<sup>c</sup> Failure rates are very similar among the three data sets (full year 2018-2019, Q1-2018 and Q1-2019, and Q1-2019 and Q1-2020), with an overall failure rate of 17% to 18%. Consistent with Table 1, vehicles that failed their initial Smog Check inspection and received a passing score on a retest were failing at a higher rate at the Roadside than initial test passing vehicles. It should be noted, however, that Roadside failure rates for initial test Smog Check failing vehicles have dropped dramatically relative to the analyses that supported the

<sup>a</sup> Historically, about 90% of vehicles overall pass initial inspection. The percentages in Table 1 are higher than that mainly because the vehicles tested represent the older fraction of OIS-tested vehicles.

<sup>b</sup> The roadside datasets used for the 2020 SCPR and the 2021 SCPR have one calendar year in common – 2019 – and hence are considered "partially overlapping."

<sup>c</sup> Because of the small sample size for 1976-1989 model year vehicles in the Roadside data sets when restricted to the first quarter of each calendar year, only 1990-1999 model years were included in Table 2.

passage of AB 2289 (Eng, Chapter 258) in 2010, from nearly one-half in the ~2005 timeframe to less than one-third now.

**Table 2  
Roadside Emission Failure Rates of Tailpipe Tested Gasoline Vehicles, Model Year 1990-1999**

<b>Initial Smog Check Result</b>	<b>Roadside ASM Failure Rates within One Year after Smog Check Certification* CY 2018-2019</b>	<b>Roadside ASM Failure Rates within One Year after Smog Check Certification* Quarter 1, 2018-2019</b>	<b>Roadside ASM Failure Rates within One Year after Smog Check Certification* Quarter 1, 2019-2020</b>
Fail**	27% (371)	26% (122)	24% (52)
Pass***	16% (1,706)	16% (597)	17% (296)
Overall Failure Rate	18% (2,077)	17% (719)	18% (348)

\* 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. "ASM" refers to the tailpipe emissions test.

\*\* 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.

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 who 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<sup>a</sup> of 0.9 or greater) fail at a significantly lower rate than vehicles that were certified by low-performing stations (those with an FPR score less than 0.1).

Figure 1 shows failure rate versus age for OIS-tested model year 2000 and later gasoline vehicles. The figure shows the trend with age of both the initial test failure rates at Smog Check (lower black line) and the OIS Roadside failure rate (upper red line). Both datasets cover calendar year 2019-2020, matching the latest Roadside sample (note that quarter 1 data from 2019 and 2020 was used for the Roadside sample, consistent with the analyses in Tables 1 and 2). Both datasets show that failure rates are a strong function of vehicle age.

Figure 2 shows the Roadside failure rates versus the performance of the Smog Check station that certified the vehicles prior to Roadside testing for two vehicle groups: (1) OBD-tested, 2000-2006 model year vehicles, and (2) ASM-tested, 1990-1999 model year vehicles. The same Q1-2019 and Q1-2020 datasets were used to construct Figure 2 as those reported in the right-hand columns of Tables 1 and 2 for the 2000-2006 and 1990-1999 model year vehicles, respectively. The results in Figure 2 show a very strong influence of station performance on Roadside failure rates, with low-performing stations having a Roadside failure rate 3 to 4-times greater than high-performing stations and 2-times greater than medium-performing stations (those with an FPR score between 0.1 and 0.9).

<sup>a</sup> "Follow-up Pass Rate" (FPR) is, "...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".

Figure 1

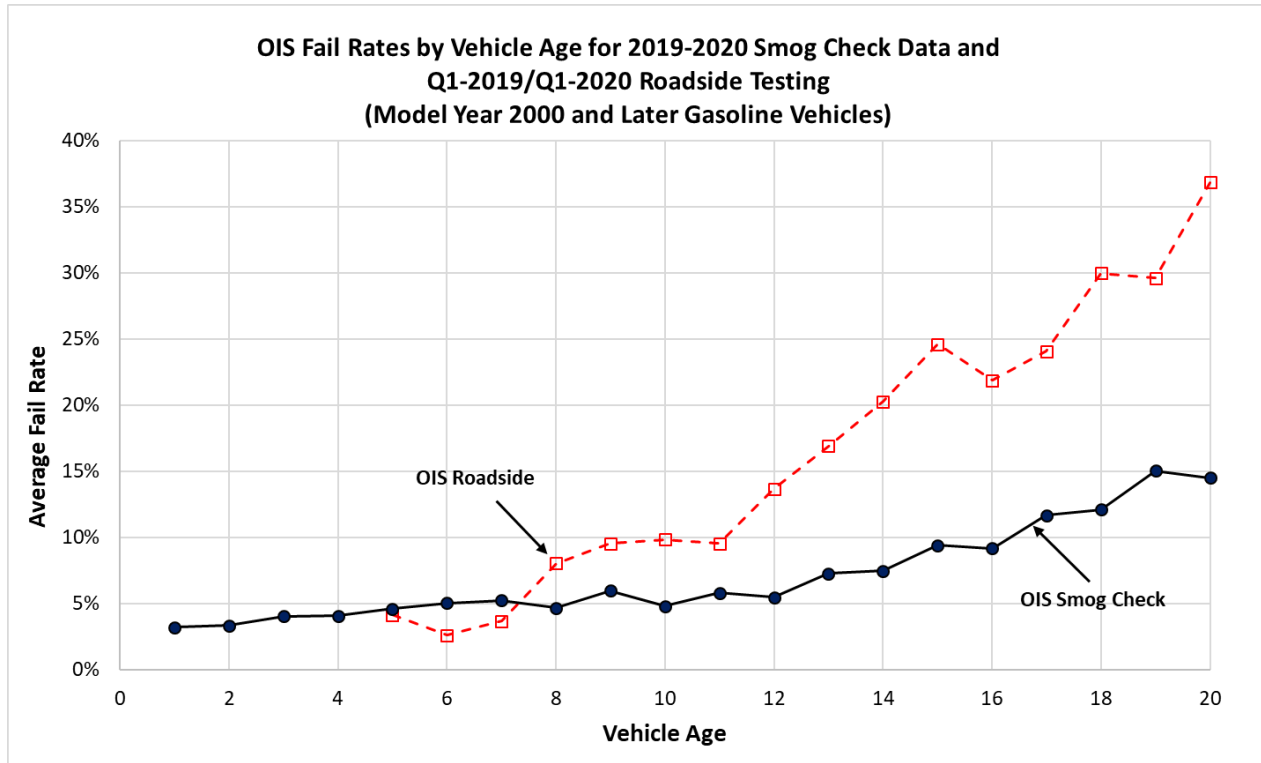
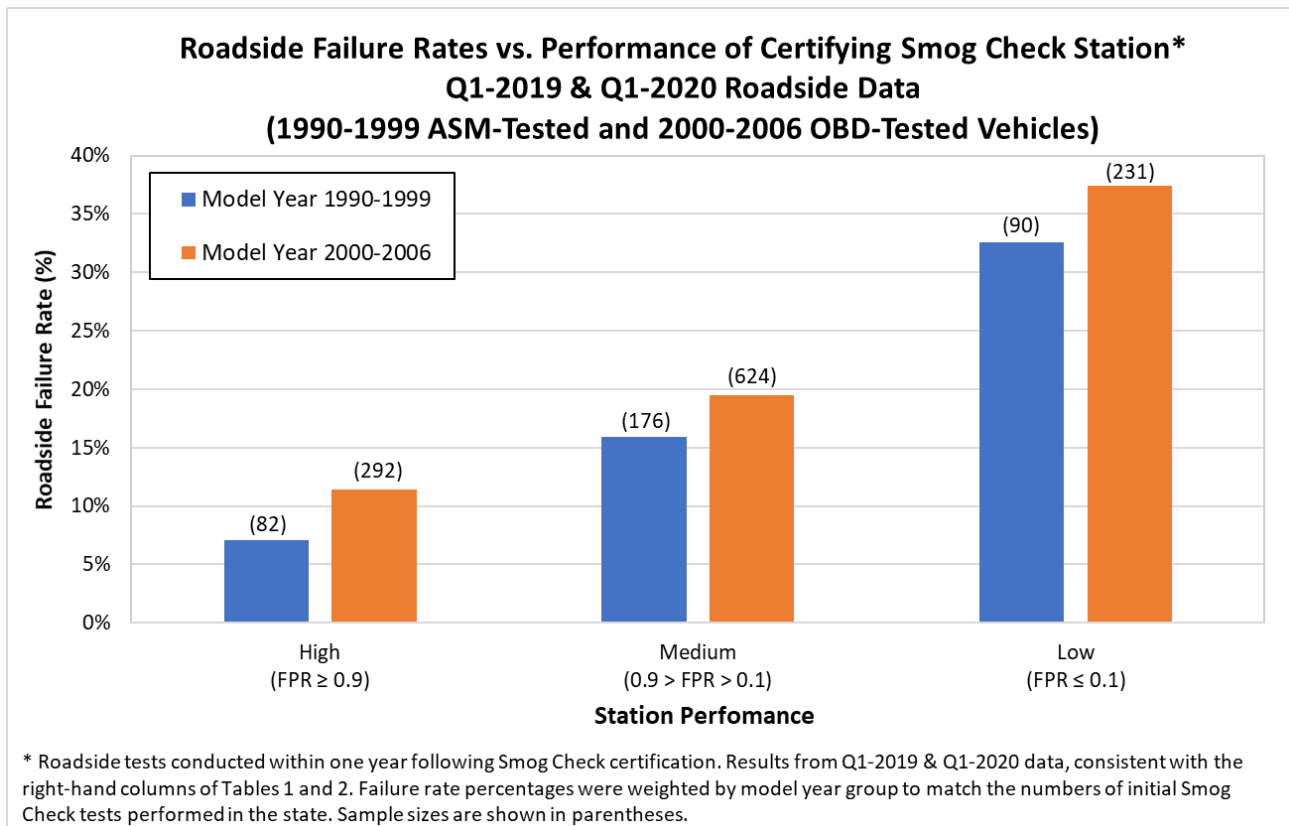


Figure 2



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 February 21, 2020, BAR issued a news release announcing actions against nine Smog Check stations charged with clean gassing.<sup>a,b</sup> As a result of BAR enforcement actions detailed later in this report, Smog Check licenses have been revoked at seven of the nine stations, and tailpipe Smog Checks are no longer permitted at the remaining two stations, pending further hearing. BAR has also actively pursued enforcement actions against stations performing fraudulent OIS tests. Between 2016 and 2020 BAR filed 1,083 cases with the California Office of the Attorney General (OAG), thus far resulting in 912 license revocations and 192 suspensions and/or probations. These actions have already begun to reduce emissions of the in-use fleet, as BAR's analysis of RSD data found that vehicles receiving a passing Smog Check from stations whose licenses were subsequently revoked had nitric oxide emissions over two-times higher than properly certified vehicles (i.e., vehicles certified by stations with licenses in good standing).

## Summary of Findings

Analysis of the 2019-2020 Roadside testing data, November 2020 to March 2021 RSD 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 2000-2006 vehicles OIS tested in the Q1 2019-2020 Roadside sample failed at a weighted average rate of about 21%, which is the same failure rate found for the Q1 2018-2019 Roadside sample.
2. Model year 1990-1999 tailpipe tested vehicles in the Q1 2019-2020 Roadside sample failed for emissions at a weighted average rate of about 18%, compared to a failure rate of 17% in the Q1 2018-2019 Roadside sample.
3. BAR's enforcement activities over the past five years are clearly reflected in the 2020-2021 RSD data collected in the Los Angeles area. Nitric oxide (NO) emission rates of vehicles that had been certified at stations whose licenses had subsequently been revoked are over two-times the NO emission rate of stations with licenses in good standing (5.5 g NO/kg fuel versus 2.6 g NO/kg fuel).
4. BAR and California Air Resources Board (CARB) staff estimate that in calendar year 2020, Smog Checks could have additionally provided emission reductions on the order of 20 - 40 tons per day (tpd) of reactive organic gases and oxides of nitrogen (ROG + NO<sub>x</sub>) from model year 1976-2016<sup>c</sup> light- and medium-duty gasoline vehicles if all Smog Check stations operated similar to "high-performing" stations.

After a brief background review of BAR's Roadside Inspection Program and the RSD data collection effort conducted for the 2021 SCPR, the remainder of this report describes the following:

- Efforts to improve station performance in the Smog Check Program.
- Information about the effects of vehicle age, Smog Check station performance, and other factors affecting on-road emissions as measured by RSD.
- The excess emissions caused by poor station performance.
- A report on what other states are doing to reduce emissions through vehicle inspection and maintenance. BAR worked with UC Riverside's Bourns College of Engineering, Center for

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a See: "Bureau-Of-Automotive-Repair-Initiates-Disciplinary-Action-Against-Nine-Smog-Check-Stations-Engaged-In-Fraud," at: <https://thedcapage.blog/news-releases/>

b "Clean gassing" refers to the act of introducing a surrogate gas into a test vehicle's exhaust emissions sample to fool the inspection system into passing that vehicle.

<sup>c</sup> As described later in this report, the emissions analysis accounted for model year 1976 to 2012 vehicles subject to biennial Smog Check inspections as well as a small impact from model year 2013 to 2016 vehicles subject to change-of-ownership Smog Check inspections.

Environmental Research & Technology (CE-CERT) to investigate the best practices of other vehicle inspection and maintenance programs.

- An independent review of the 2020 SCPR by Saint Malo Solutions, LLC.<sup>a</sup> 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.
- A brief summary of the RSD data collection efforts conducted to support the 2021 SCPR, which is included as Attachment B to this report.

## Background

### *Roadside Testing*

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 testing, which is voluntary for drivers, entails having CHP officers randomly pull over vehicles, allowing specially equipped BAR survey teams to check their emission control systems. For certain model year 1976-1999 gasoline-powered vehicles,<sup>b</sup> the check is performed using an 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 Smog Check Program areas.<sup>c</sup> In addition, during a BAR Roadside inspection model year 1996-1999 vehicles receive an OBD test using the OIS. To minimize inconvenience to participating motorists, Roadside testing does not include the visual and 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; a failed Roadside inspection does not require the vehicle to have a follow-up inspection at a licensed Smog Check station.

Roadside vehicles are selected at random using a fleet-weighted stratified sampling 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.<sup>d</sup> Older vehicles, while a smaller percentage of the fleet, continue to contribute disproportionately to overall smog-forming emissions of ROG + NOx.<sup>e</sup> 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 targeted for sampling 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 Roadside test data described in this report were

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<sup>a</sup> In 2018, Saint Malo Solutions, LLC was contracted to conduct an independent review of BAR's 2018 and 2019 SCPRs; efficient use of resources also allowed them to review the 2020 SCPR prior to contract expiration. 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."

<sup>b</sup> Light-, medium- and some heavy-duty vehicles (GVWR up to 9,999 lbs.) are included.

<sup>c</sup> 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.

<sup>d</sup> Very few vehicles are excluded from roadside testing based on safety issues, and those are almost exclusively EIS-related issues. The roadside crews use their discretion and automotive knowledge when determining which vehicles to reject from testing. The overriding concept is to be sure that no damage is done to the vehicle and that tests are conducted safely.

<sup>e</sup> 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.

collected between January 1, 2019, and March 31, 2019 (“Q1-2019” sample) and between January 1, 2020, and March 16, 2020 (“Q1-2020” sample).

### **Remote Sensing Device (RSD) Testing**

As noted above, BAR’s Roadside Inspection Program was suspended in March of 2020 because of the COVID-19 pandemic. To supplement the available Roadside test data, BAR contracted with Opus Inspection, Inc. (Opus) to collect RSD records in the Los Angeles area. Testing was conducted from November 20, 2020, to March 22, 2021. Opus collected 101,355 total RSD records over 44 sampling days at four locations. The final data set included over 76,500 unique vehicles and 71,100 California vehicles with a match to DMV records, which allows for determination of make, model, model year, etc. The RSD data was also merged with Smog Check records, which allowed for an assessment of Smog Check station performance and the influence of previous Smog Check result (initial test passing versus fail-then-pass) on tailpipe emissions.

RSD systems measure vehicle emissions ratios by passing a light source across a roadway and through an exhaust plume. Detectors measure how much light is absorbed by the exhaust plume, which is roughly proportional to emissions in the plume. More specifically, higher absorption equates to higher pollutant concentrations. However, to compensate for variations in plume capture, the RSD methodology computes pollutant concentration ratios (CO/CO<sub>2</sub>, HC/CO<sub>2</sub>, NO/CO<sub>2</sub>, etc.), which can be related to fuel-specific emission factors in grams of pollutant emitted per kilogram or gallon of fuel burned. More detailed descriptions of how RSD works can be found on the University of Denver’s Fuel Efficiency Automobile Test (FEAT) website,<sup>a</sup> and Attachment B to this report summarizes the data collected by Opus.

### **Assembly Bill 2289 Program Evaluations and Improvements**

In March 2009, Sierra Research, Inc. (Sierra) released a report analyzing the effectiveness of the California Smog Check Program.<sup>b</sup> The report found that for model year 1976-1995 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 1976-1995 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.

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 use of the OIS became mandatory in 2015. 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 2020.

In December 2020, there were 7,608 licensed Smog Check stations in California. Of these stations, 3,893 (51%) of these were “STAR” certified, meaning that they had elected to participate in the STAR program and maintain higher standards of station performance that authorizes them to test “directed vehicles.”<sup>c</sup> Another 3,138 stations (41%) were classified as non-STAR. Fleet, Referee, and other stations made up the remaining 8%. STAR stations, on average, tend to have higher testing volumes.

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<sup>a</sup> See, for example, [http://www.feat.biochem.du.edu/assets/publications/Passing%20Cars\\_acr\\_29\\_1996.pdf](http://www.feat.biochem.du.edu/assets/publications/Passing%20Cars_acr_29_1996.pdf). See also: “Measuring Emissions from the On-Road Vehicle Fleet in West Los Angeles,” prepared for the California Air Resources Board by Gary Bishop, University of Denver, November 5, 2019, at [http://www.feat.biochem.du.edu/assets/databases/Cal/Univ\\_Denver\\_ARB\\_17RD015\\_Final\\_Report\\_2018.pdf](http://www.feat.biochem.du.edu/assets/databases/Cal/Univ_Denver_ARB_17RD015_Final_Report_2018.pdf).

<sup>b</sup> “Evaluation of the California Smog Check Program Using Random Roadside Data,” prepared by Sierra Research for the California Air Resources Board and the California Bureau of Automotive Repair, Report No. SR09-03-01, March 12, 2009.

<sup>c</sup> Vehicles assessed to be more likely to fail a Smog Check inspection are directed to STAR stations as part of DMV registration renewal.



Of the roughly 10.3 million initial Smog Check tests performed in California in 2020, about 8.4 million (82%) were performed by STAR stations and 1.9 million (18%) by non-STAR stations.

BAR's research and experience indicate that most Smog Check stations conduct proper testing. However, a relatively small number of stations and technicians perform a disproportionate number of improper or fraudulent tests. In 2020, 86% of Smog Check inspections were performed with the OIS. Accordingly, much of BAR's efforts to prevent fraud are focused on that platform. The next section highlights BAR enforcement efforts for the OIS and EIS platforms, both of which produced measurable benefits in improving Smog Check station performance and reducing in-use emissions in 2020.

## **Efforts to Improve Station Performance**

Mandatory use of the OIS for model year 2000 and newer vehicles was required beginning in March of 2015. Prior to the full-scale deployment of the new equipment, it underwent over a year of beta testing at licensed Smog Check stations. 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 OIS defeat methods emerged: the use of simulators and the use of surrogate vehicles. A simulator is an electronic device that can be used to imitate a vehicle's OBD data with or without the presence of the actual vehicle. A surrogate vehicle is a known passing vehicle that is fraudulently substituted for a vehicle that the Smog Check technician has identified as being tested in order to deceive the OIS and allow the failing vehicle to pass.

In the 2020 SCPR, BAR presented statistics on its enforcement actions against Smog Check station owners and technicians suspected or found to be guilty of committing fraud in the Smog Check program, with an emphasis on OIS testing. Those statistics have been updated for the current report, and the impacts of those enforcement actions have been validated with RSD data as described later in this report.

### ***BAR Enforcement Efforts***

Station owners and technicians who commit Smog Check fraud are subject to revocation of their licenses to operate. Accordingly, formal accusations are filed against licensees committing fraud, and due process is afforded to them through hearings administered by the Office of Administrative Hearings (OAH) or, when appropriate, through criminal and/or civil proceedings in other courts. When conditions warrant, licenses may also be suspended or placed under probation through these processes.

Table 3 provides a summary by year of BAR's case filings with the California Office of the Attorney General (OAG), along with case outcomes for each year. (Note that case outcomes generally roll over across years, so they do not match yearly case filings.) The table reflects case filings that were based on assessment of Smog Check data only and excludes other Smog Check case filings that were based on more traditional BAR investigations. BAR sharply increased its case filings in 2017 in response to increased detection of fraudulent Smog Check activity. These and subsequent filings led to the substantial increase in Smog Check license revocations, suspensions, and probations that occurred in 2018 and 2019 and continued into 2020. In total for the 5-year period, BAR filed 1,083 data-only cases with the OAG, and there were 912 license revocations and 192 suspensions and/or probations.<sup>a</sup>

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<sup>a</sup> Note that the total number of license revocations, suspensions, and probations exceeds the number of case filings because multiple inspector licenses could have been revoked in a single case filing.

**Table 3**  
**Summary by Year of BAR Smog Check Data-Only Case Filings and Outcomes**  
**(Outcomes Still Pending on Some Filings as of this Writing)**

<b>Year</b>	<b>Case Filings to OAG</b>	<b>Outcome: Revocation</b>	<b>Outcome: Suspension</b>	<b>Outcome: Probation</b>
2016	117	2	0	0
2017	555	39	0	3
2018	252	280	9	9
2019	63	342	30	48
2020	96	249	24	69
<b>Total</b>	<b>1083</b>	<b>912</b>	<b>63</b>	<b>129</b>

The surge in case filings in 2017-2018 was a result of focused enforcement efforts to curtail the use of OBD simulators and surrogate vehicles. These efforts were facilitated by new analytical techniques that identified widespread OBD simulator usage and provided evidence to pursue administrative disciplinary cases based solely on data, without using traditional BAR investigative methods. These investigations were completed much more quickly, leading to many stations being served at the same time and producing a surge of cases through the administrative system. As these cases were filed and began filtering through the courts, four things happened. First, BAR implemented certificate blocking (described below), which interrupted stations from engaging in fraud using the first generation of simulators and surrogate vehicles. Second, most stations, now aware of BAR’s ability to detect and prosecute such behavior, backed away from using simulators. Third, BAR enforcement staff provided support for the cases now being heard in the courts. Finally, resources that had been allocated to investigate and prosecute the high volume of Smog Check fraud cases in 2017-2018 were re-allocated back to more traditional enforcement activities. The net result of these factors was a substantial drop in Smog Check (data-only) cases filed in 2019. With this type of fraudulent activity largely addressed, Smog Check enforcement cases have more recently been focused on advanced technologies and complex behavior that take far more time and effort to investigate and prosecute.

As described in the 2020 SCPR, BAR has implemented procedures to identify individual vehicles that are suspected of being fraudulently tested. In such cases, the Smog Check certification is blocked<sup>a</sup> and the vehicle is directed to a BAR Referee station<sup>b</sup> for a detailed inspection. During calendar year 2020, 3,600 vehicles had their certificates blocked because of potential fraud. Of those vehicles identified, less than half (43%) had completed the process to the point of receiving a Smog Check certificate as of May 15, 2021. The remaining vehicles are likely operating on an expired or improperly issued registration, have been removed from the road, or have moved out of state.

While investigation and prosecution of fraud by stations and technicians conducting OIS tests continues, there has also been renewed effort to investigate and prosecute fraud in tailpipe testing of the model year 1976-1999 vehicle fleet. In 2019, BAR undertook a major new effort to identify, prosecute, and shut down Smog Check stations and technicians performing a type of fraudulent tailpipe testing called “clean gassing.” Clean gassing is a method by which a surrogate gas is introduced into an EIS so that the analyzer will measure the surrogate gas or a mixture of surrogate gas and emissions and issue a passing test result based upon those readings, rather than actual vehicle emissions.

<sup>a</sup> This feature of the program was envisioned and is allowed under Health & Safety Code §44036(b)(3)(K).

<sup>b</sup> 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..

A news release issued by BAR in February 2020 announced administrative disciplinary action taken against nine Smog Check stations charged with clean gassing.<sup>a</sup> As of this writing, none of the original nine stations or technicians that conducted clean gassing are permitted to perform tailpipe Smog Check testing. For seven of the nine stations and technicians (plus one additional affiliated clean-gassing station that was identified during one hearing) the Smog Check station and technician licenses have been revoked. For the remaining two stations and technicians, performance of tailpipe-based Smog Checks has been prohibited by a court Interim Suspension Order pending a full evidentiary hearing.

Subsequent to the original nine clean gassing cases noted above, a series of additional clean gassing activities have been identified in 2019, 2020 and 2021, and additional clean gassing cases are in various stages of investigation and adjudication. Further details on these and hundreds of other BAR enforcement actions may be found at BAR's website.<sup>b</sup>

### ***Validation of Enforcement Activity with RSD Data***

In the 2020 SCPR, BAR analyzed the 2018-2019 Roadside data to determine if there were sufficient data with which to assess the impacts of its enforcement efforts. That analysis clearly showed an impact of the license revocations summarized in Table 3. Model year 2000-2012 vehicles previously certified at stations with licenses in good standing had a 14% failure rate,<sup>c</sup> while vehicles previously certified at stations with licenses that were subsequently revoked had a 28% failure rate.

For the 2021 SCPR, BAR was concerned that the smaller Q1-2019 and Q1-2020 Roadside data sets would make it difficult to identify a statistically significant impact of its enforcement efforts. Instead, the 2020-2021 RSD data collected in the Los Angeles area were merged with Smog Check records, and vehicles that had received a certificate of compliance within two years of the RSD collection date were analyzed. The results of this analysis are shown graphically for NO<sup>d</sup> emissions by model year in Figure 3, which again clearly illustrates the impacts that fraudulent Smog Check activity had on the on-road emission rates. It also shows that BAR's enforcement efforts are working to reduce on-road emissions by removing stations that are engaging in fraudulent activity. When the model year emission rates in Figure 3 are weighted by the fraction of travel associated with each model year based on CARB's EMFAC2021 model, NO emissions from stations with revoked licenses are over two-times NO emissions from stations with licenses in good standing (5.5 g NO/kg fuel versus 2.6 g NO/kg fuel).

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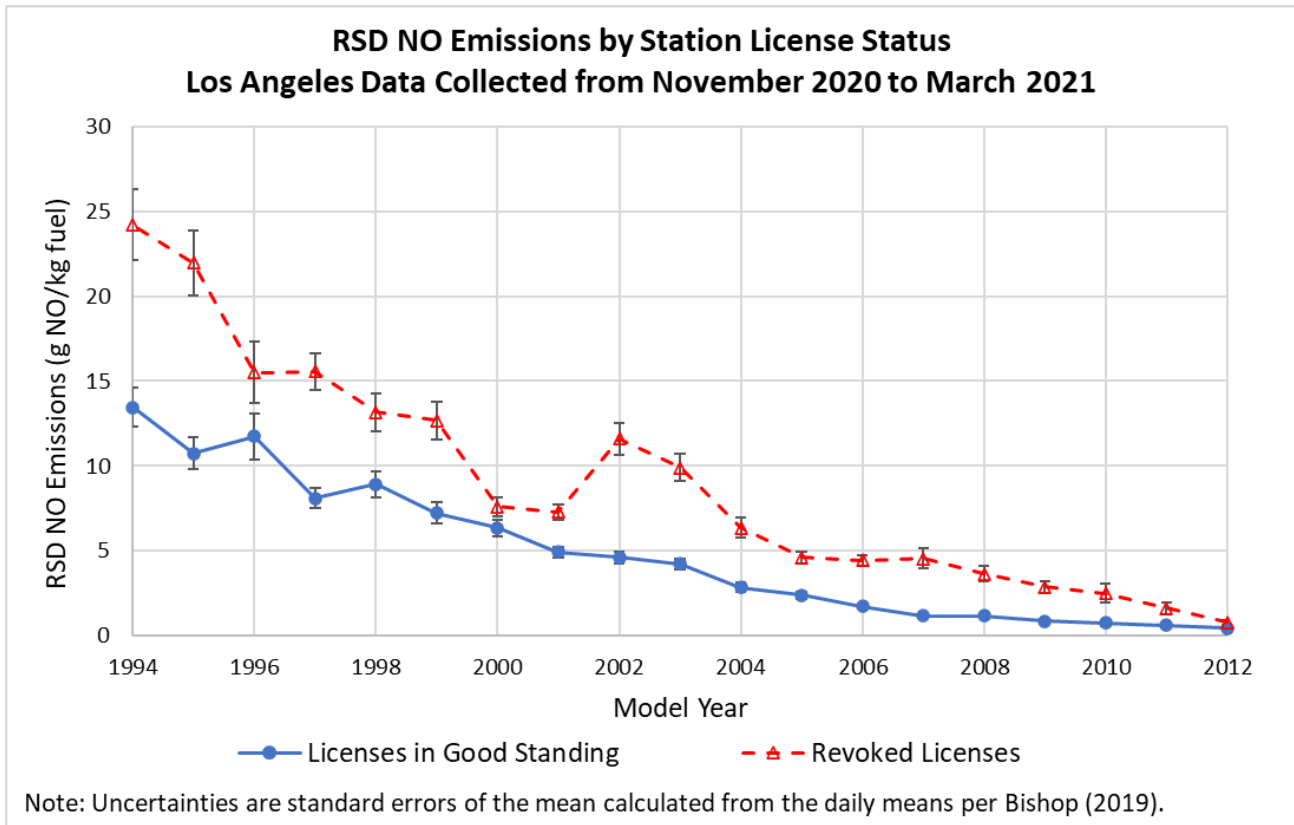
<sup>a</sup> See: "Bureau-Of-Automotive-Repair-Initiates-Disciplinary-Action-Against-Nine-Smog-Check-Stations-Engaged-In-Fraud," at: <https://thedcapage.blog/news-releases/>

<sup>b</sup> See: BAR's bi-annual Smog Check newsletter, "Automotive and Smog Check News" under "Disciplinary Actions" at <https://www.bar.ca.gov/ARSC>, and "License Search" at BAR's home page, <https://www.bar.ca.gov/>.

<sup>c</sup> Roadside failure rate percentages were weighted by model year to match the number of initial Smog Check tests performed in the state. The unweighted values were: 18% failure rate for vehicles previously certified at stations with valid licenses, and 40% for vehicles certified at stations that were subsequently revoked.

<sup>d</sup> Nitric oxide (NO) is the most abundant NO<sub>x</sub> species in vehicle exhaust, typically making up 90% or more of total NO<sub>x</sub> from gasoline vehicles.

Figure 3



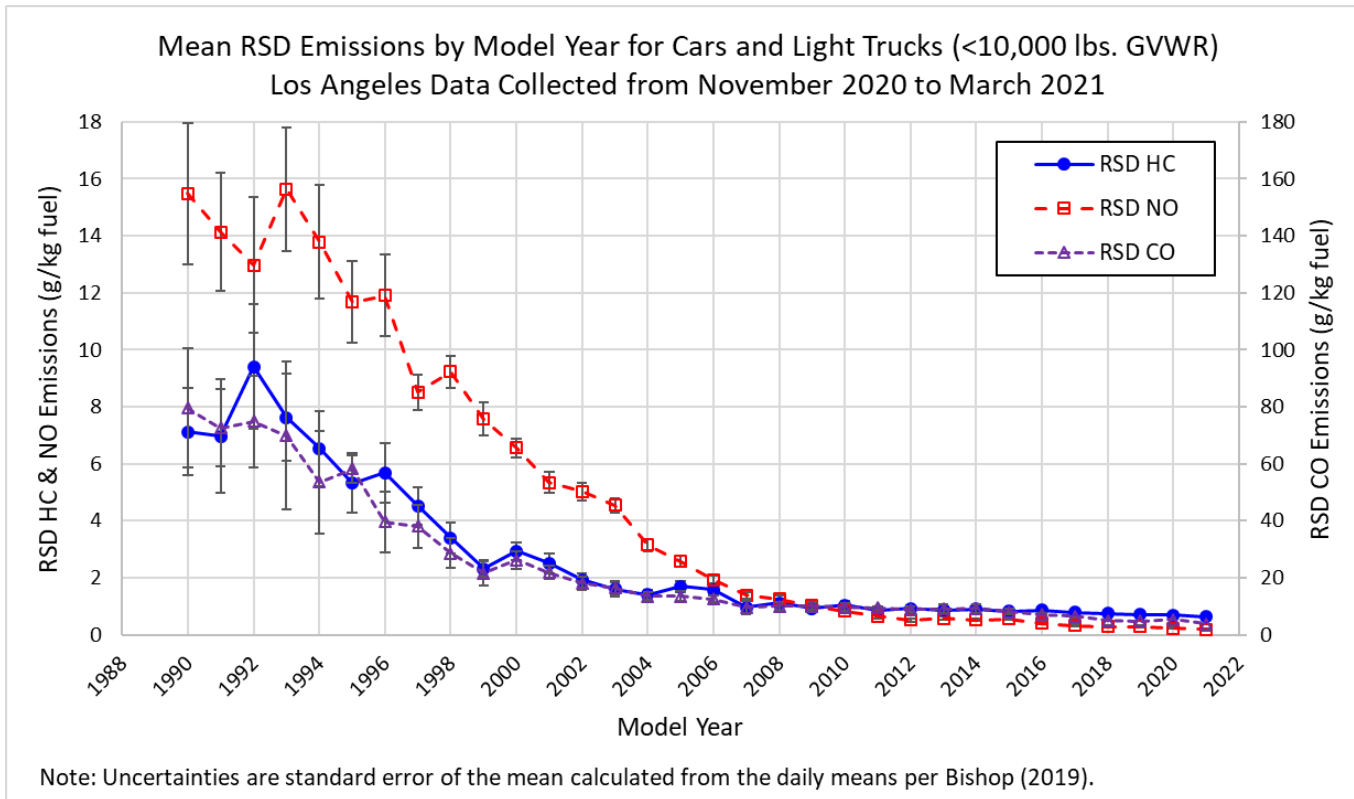
## Effects of Vehicle Age, Smog Check Station Performance, and Other Factors on Emissions Evaluated with RSD

In prior Smog Check Performance Reports, various factors that impact vehicle failure rates were evaluated using data from the Roadside Inspection Program. Those factors include: (1) vehicle age, (2) performance of the Smog Check station that last certified the vehicle, and (3) whether the vehicle failed and was repaired prior to its last certification. Because of the limited Roadside data set available for this year's SCPR, the RSD data collected in the Los Angeles area from November 2020 to March 2021 were used to assess some of these effects. The results of the RSD data analysis are summarized below.

### Effects of Vehicle Age/Model Year

Mean RSD HC, CO, and NO emissions in grams pollutant per kilogram of fuel by model year for gasoline passenger cars and light trucks (less than 10,000 lbs. GVWR) are shown in Figure 4. As observed in the figure, emissions are a strong function of model year (a surrogate for vehicle age in the figure), with older vehicles having much higher emissions than newer vehicles. The reduction in emissions over the 30 model years shown in the figure has been remarkable and is evidence of both an effective mobile source control strategy by California, including its Smog Check Program, and technological improvements by manufacturers of vehicles and their fuels. Figure 4 also illustrates the importance of continuing to test older vehicles as part of the Smog Check program as their emissions are many times greater than newer vehicle emission rates.

**Figure 4**



**Effects of Station Performance**

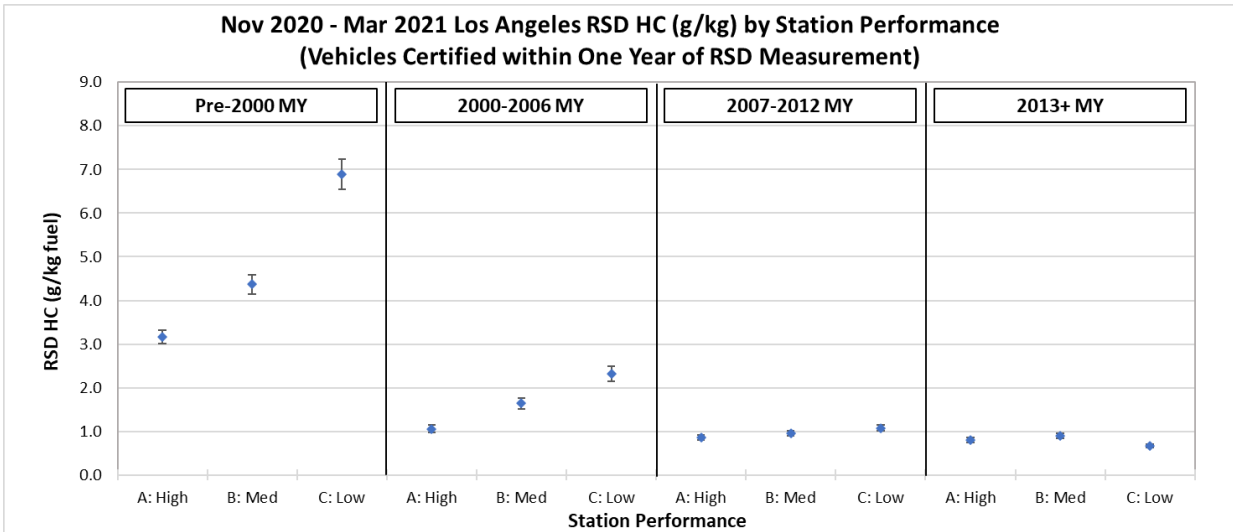
Figure 5 shows the impact of station performance, as measured by the FPR, on RSD HC, CO, and NO emissions for high-performing stations (FPR ≥ 0.9), medium-performing stations (0.1 < FPR < 0.9), and low-performing stations (FPR ≤ 0.1) for vehicles that had passed a Smog Check inspection within one year of the RSD measurement. The RSD data shows a very strong influence of station performance on in-use emissions performance for pre-2007 model year vehicles. This effect is very pronounced on the pre-2000 model year group, with HC and CO emissions being over 2-times greater and NO emissions being over 1.5-times greater for low-performing stations versus high-performing stations.

**Effects of Previous Smog Check Inspection Result**

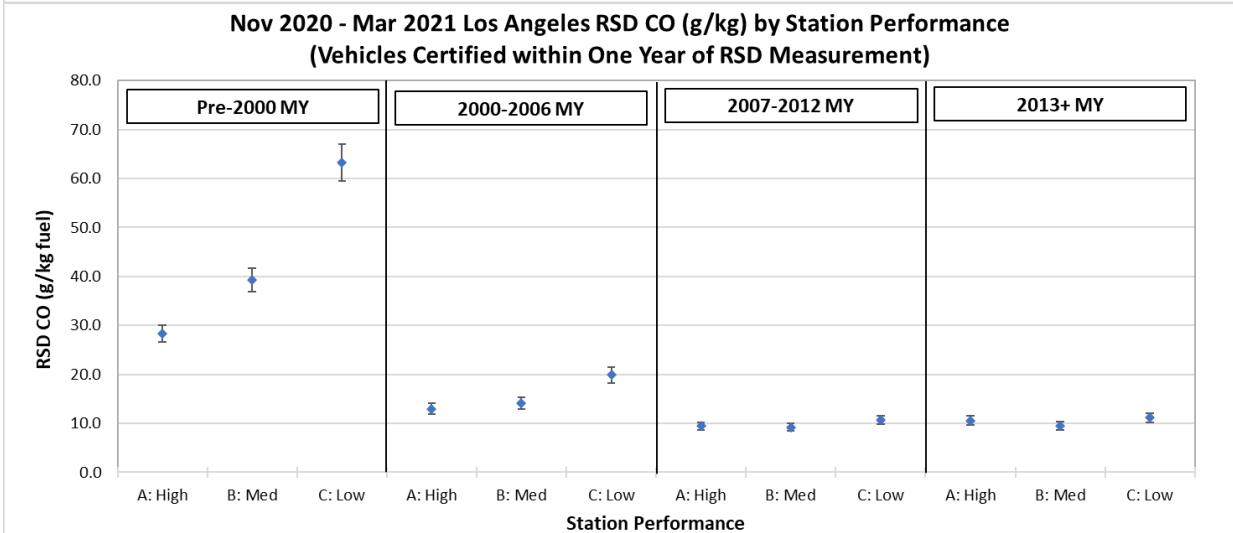
Figure 6 shows the impact of previous Smog Check inspection results on RSD HC, CO, and NO emissions. Mean RSD emissions from initial test passing vehicles versus initial test failing vehicles that pass on a retest are shown in the figure for pre-2000 model year vehicles. Vehicles that fail for readiness and subsequently pass are shown as a separate group for 2000 and later model years. The results in Figure 6 show a statistically significant increase in NO emissions for the fail-pass group versus the initial test passing vehicles for pre-2000 vehicles, while differences in HC and CO are not significant (i.e., the confidence intervals overlap). A statistically significant increase in emissions for the fail-pass group versus the initial pass group is observed for most model year groups and pollutants for 2000 and newer model year vehicles, while the results for the not ready-fail group are mixed.<sup>a</sup> Consistent with previous reports, the results in Figure 6 demonstrate that initial test failing vehicles have higher in-use emissions than initially passing vehicles.

<sup>a</sup> The OBD II system flags monitors as “not ready” when not enough time has elapsed since code clearing or a battery-disconnect event for the computer to conduct a self-check. This prevents vehicles with an illuminated check engine light from simply disconnecting the battery immediately before an inspection to pass the test.

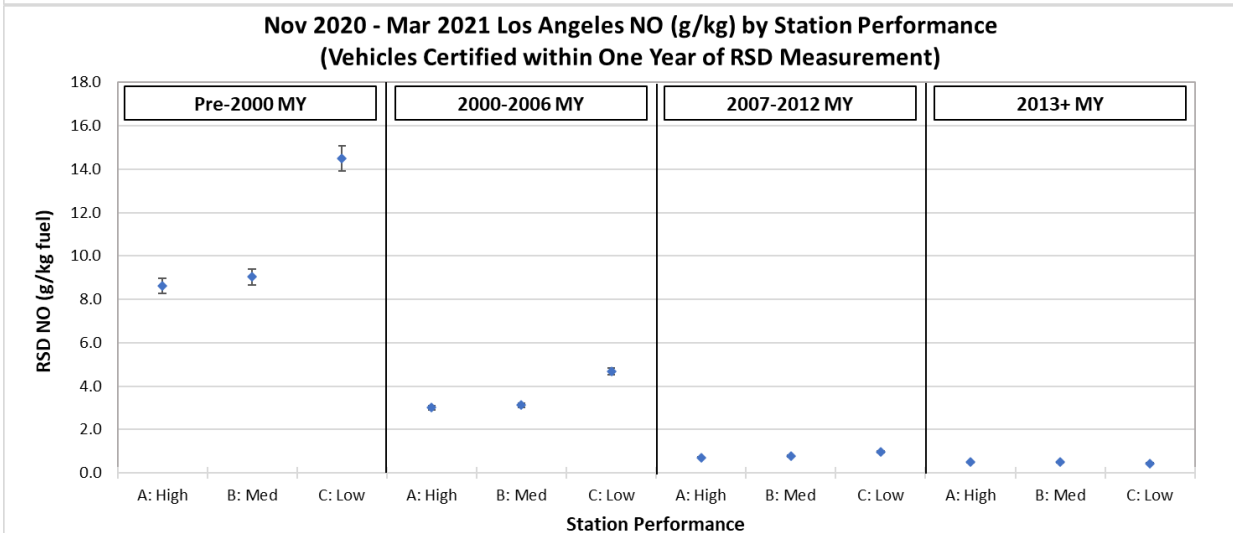
**Figure 5**  
**Effect of Station Performance on In-Use Emissions as Measured by RSD**



Note: Uncertainties are standard errors of the mean calculated from the daily means per Bishop (2019).

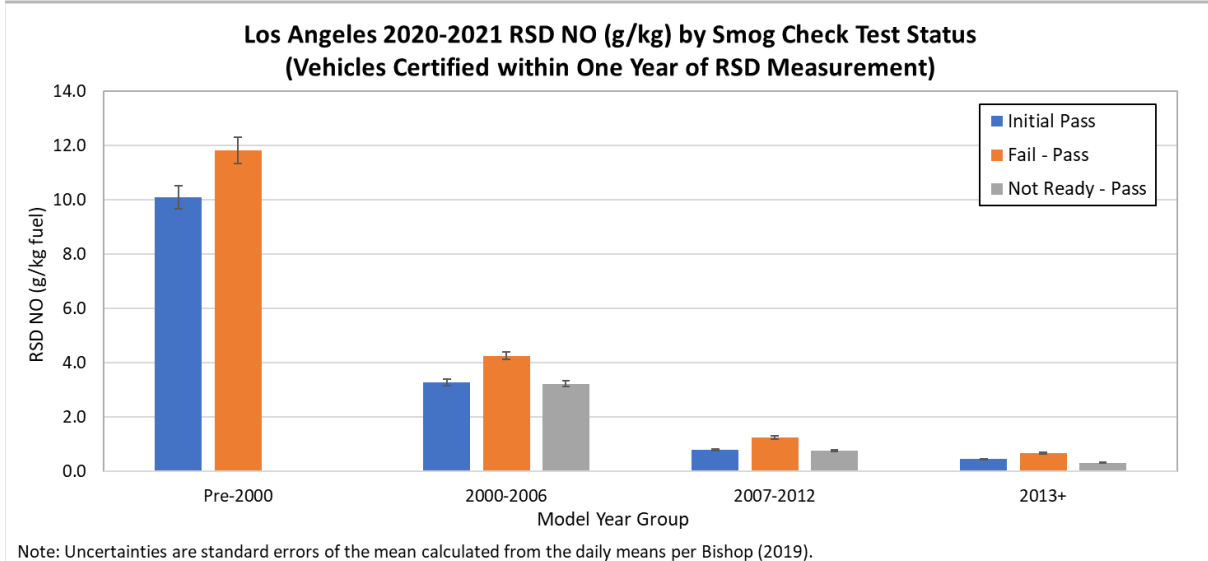
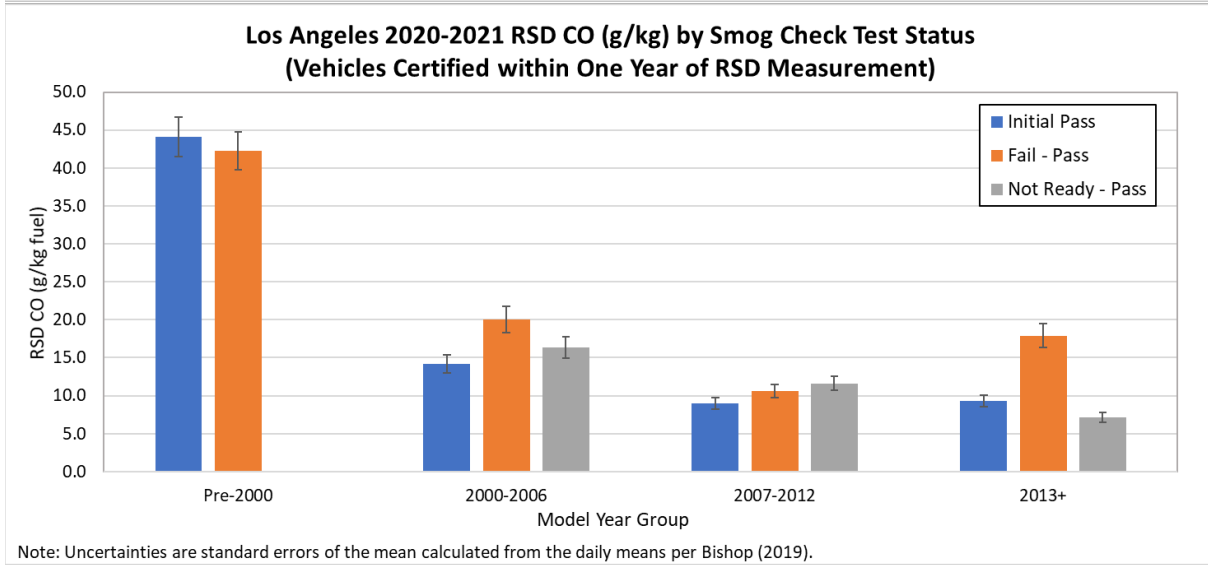
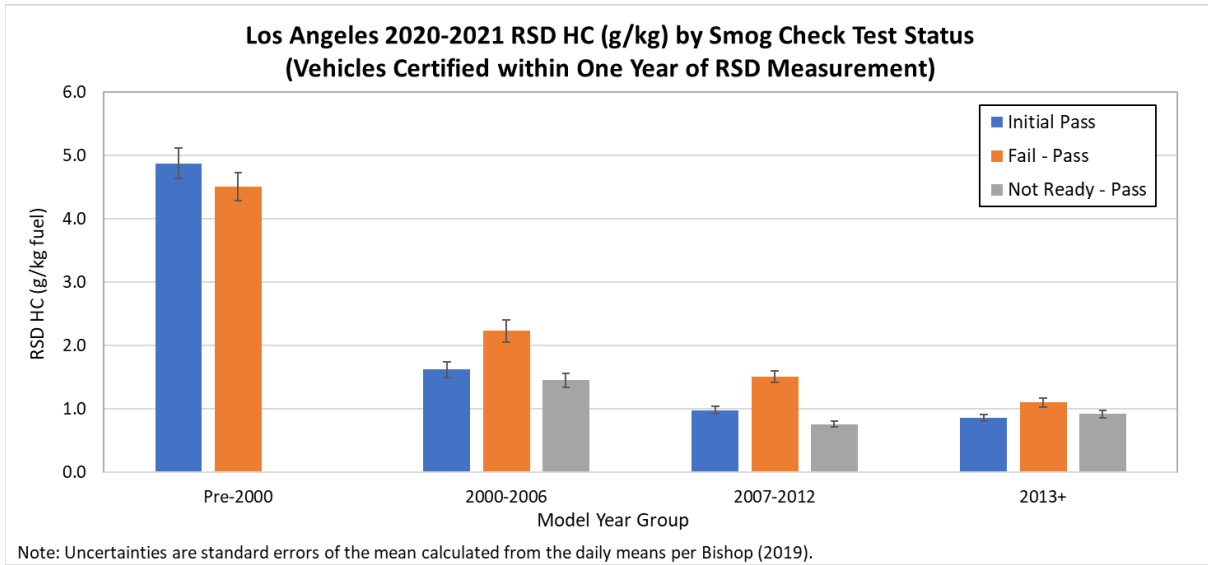


Note: Uncertainties are standard errors of the mean calculated from the daily means per Bishop (2019).



Note: Uncertainties are standard errors of the mean calculated from the daily means per Bishop (2019).

**Figure 6**  
**Effect of Previous Smog Check Result on In-Use Emissions as Measured by RSD**

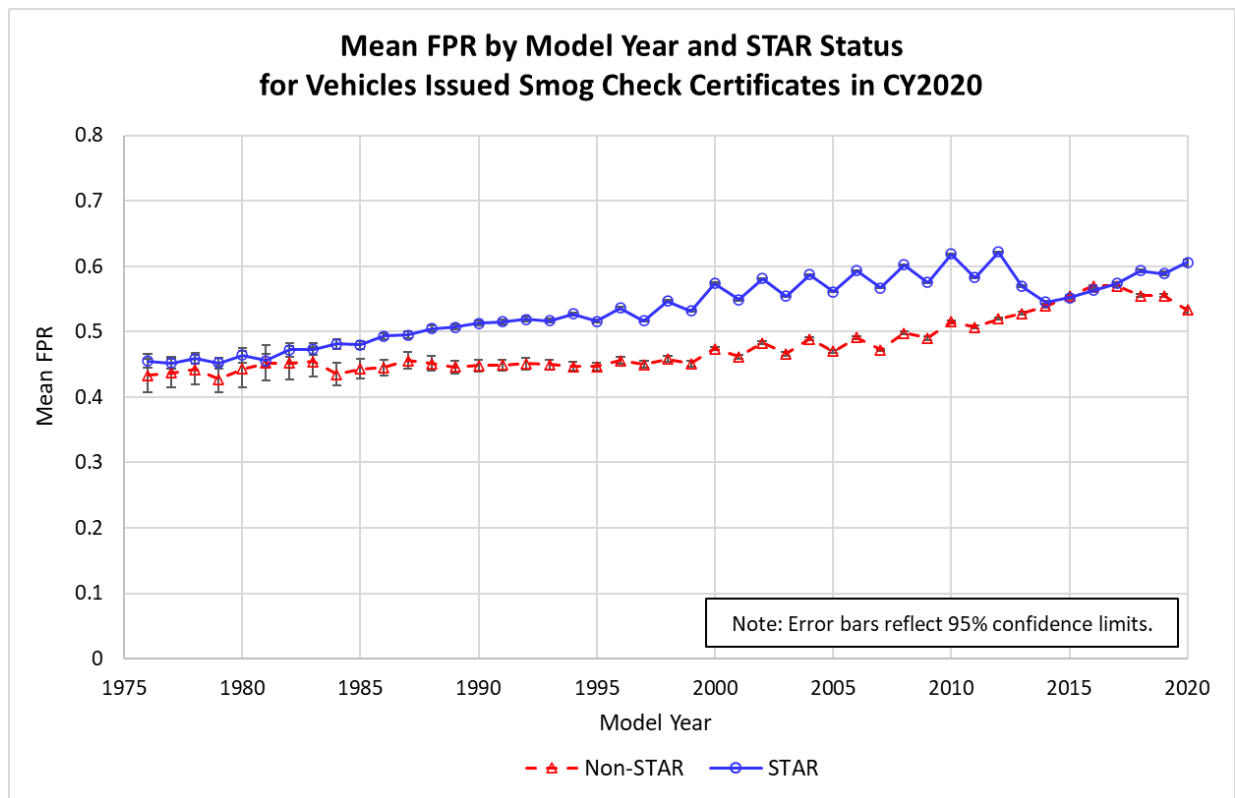


## STAR Station Performance

Analyses prepared for prior SCPRs have found that vehicles tested on the OIS and previously certified at STAR stations have lower first-year Roadside failure rates than those certified by non-STAR stations.<sup>a</sup> Because of the limited Roadside inspection data available for the 2021 SCPR, a follow-up analysis with Roadside data for this year's report could not be performed. While previous analyses of Roadside data have demonstrated a difference between STAR and non-STAR stations, analysis of the 2020-2021 Los Angeles area RSD data did not show a statistically significant difference between STAR and non-STAR stations.

Because the FPR has proven to be such a solid metric for assessing station performance, the Smog Check database was evaluated to determine the mean FPR score for STAR stations and non-STAR stations. The results of this analysis are presented in Figure 7 which shows that STAR stations have FPR scores that are 5 to 10 points higher than non-STAR stations, on average, for 1990 through 2012 model year vehicles. The figure clearly demonstrates better performance from STAR stations than from non-STAR stations.

Figure 7



BAR continues to pursue regulatory changes to certain aspects of the STAR Program to ensure that participating stations are of the highest quality and that they maintain that high quality well beyond initial STAR certification. Under the current rules, suspension of STAR certification is a lengthy process that can take up to two years to enforce, during which the station can continue to operate under the STAR banner. Three proposed revisions to the regulations would help to speed the process of suspending

<sup>a</sup> BAR implemented the STAR Program in January 2013. The program requires stations interested in inspecting directed vehicles to apply for STAR certification. BAR grants certification upon finding that the station meets inspection-based standards based on each calendar quarter's performance. In addition to performance, stations must also comply with the enforcement-related standards of the STAR Program.



STAR certification for poor performing stations, better ensuring that STAR stations are performing to elevated standards:

- (1) Reviewers of appeals would be able to assign penalties immediately, with less onerous penalties when warranted (e.g., a month suspension rather than complete decertification).
- (2) STAR inspection privileges for stations found to be out-of-compliance with STAR regulations would be maintained until the effective date of an informal hearing decision to suspend the privileges.
- (3) Stations with no previous FPR score would not be allowed to employ inspectors with no previous FPR score and become STAR certified. Either the station or inspector would need a passing FPR score to qualify the station for STAR certification.

## 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 to estimate these excess emissions relies on the CARB EMFAC2021 model to estimate 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 all stations. The ratio of the averages is used as a factor to apply to the current on-road emissions from the EMFAC model to estimate the emission reductions. This method is applied separately by vehicle type and model year group. The following estimate was made using this methodology:

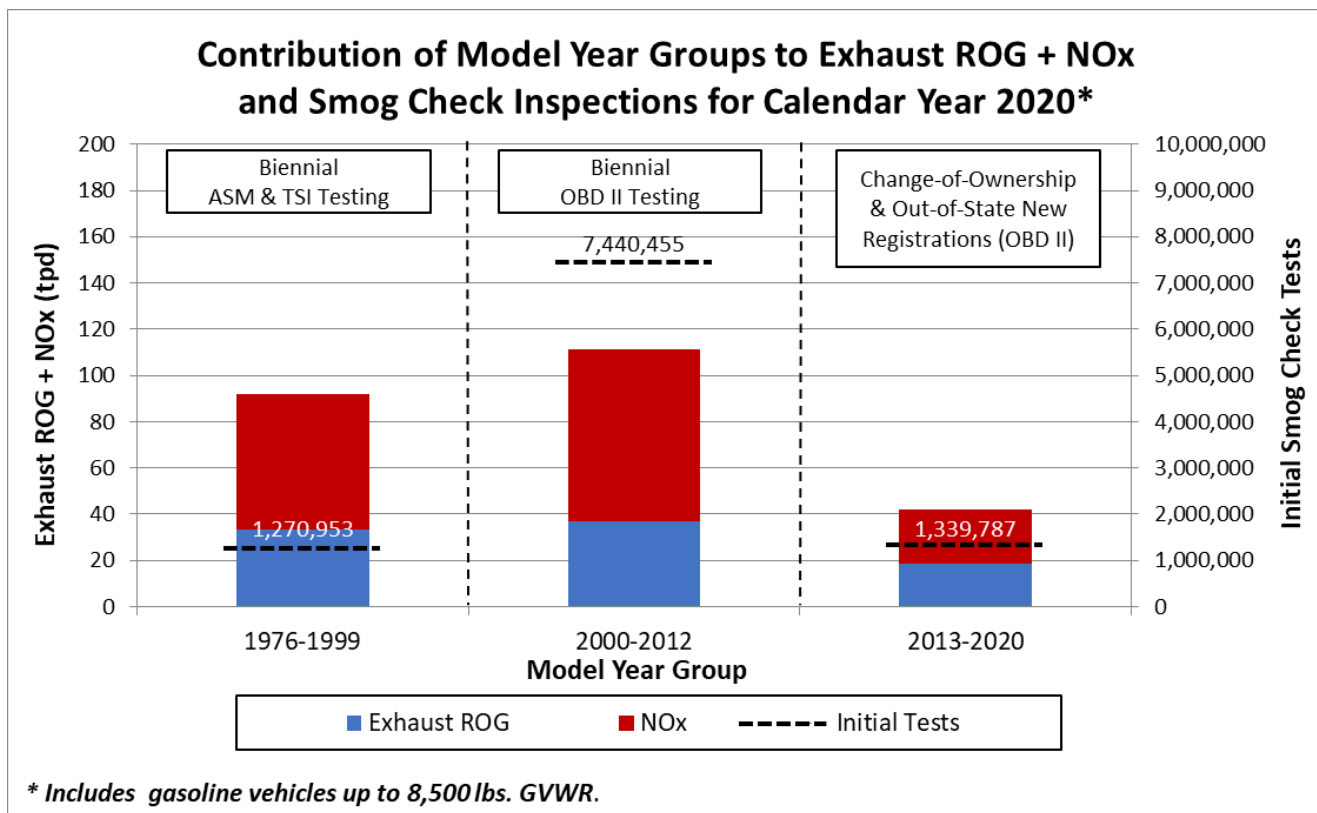
*The estimated additional achievable emission reductions for model year 1976 to 2016 light- and medium-duty gasoline-powered vehicles in the Smog Check Program is on the order of 20 to 40 tons per day of reactive organic gases and oxides of nitrogen (ROG + NOx) for 2020.<sup>a</sup>*

Of the 10.3 million initial Smog Check tests conducted in 2020, 14% were tailpipe tests (primarily ASM tests, but also including TSI tests) and 86% were OBD tests. However, about 60% of the excess emissions identified by Roadside testing coupled with the CARB EMFAC2021 model is attributable to the pre-2000 model year vehicles subject to tailpipe testing. Figure 8 shows the contribution of different model year groups to the 2020 exhaust ROG and NOx emissions inventory for gasoline vehicles up to 8,500 lbs. GVWR, along with their Smog Check test requirements. While the pre-2000 model year vehicles make up a relatively small fraction of the California fleet and Smog Check inspections, they contribute significantly to the on-road vehicle emissions inventory. This illustrates the importance of ensuring these vehicles are subject to high-quality inspections in the Smog Check Program.

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<sup>a</sup> In 2020, model year 1976 to 2012 vehicles were subject to biennial inspections, while model year 2013 to 2016 vehicles were subject to change-of-ownership inspections. Accordingly, the potential reduction from the model year 2013 to 2016 vehicles observed in the roadside data was scaled by the fraction of vehicles in these model years undergoing change-of-ownership inspections (~15%).

Figure 8



## Evaluation of Best Practices of Vehicle Inspection Programs

The following is an evaluation of best practices and specific elements of vehicle emissions inspection and maintenance (I/M) programs covering 30 states plus the District of Columbia. UC Riverside/CE-CERT 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 I/M programs in the U.S.:

- OBD Test: Usually administered to 1996 and newer vehicles equipped with OBD II systems.
- ASM or Transient Dynamometer Test (ASM5015, ASM2525, IM147, IM240): 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 and/or a pressure test of the evaporative emission control system.
- A visual inspection of the catalytic converter and other emission control components.

### Best Practices of I/M Programs

The following is considered best practice for I/M programs in the U.S.:

*OBD-equipped vehicles* – Scan of the on-board computer to ensure monitors have run and no diagnostic trouble codes (DTCs) are present; permanent DTCs need to be cleared by the vehicle running a self-check rather than simply clearing codes with a scan tool or via battery disconnect. In decentralized programs, procedures need to be in place to check for potential fraud.

*Tailpipe testing for pre-OBD vehicles and early-OBD systems* – Loaded-mode emissions testing via IM240, IM147, or ASM test procedures.

*Evaporative system check for pre-OBD vehicles* – Low-pressure evaporative system test to check for leaks; separate leak check of the fuel cap.

*Visual inspection of the emission control system* – Thorough inspection of the emission control system components (catalyst, EGR system, air injection, positive crankcase ventilation, etc.). Can also include an inspection for liquid fuel leaks.

*Opacity testing for diesel vehicles* – Diesel vehicles tested under load to identify high particulate emissions via an opacity check.

The California Smog Check Program has implemented all of the best practices identified above with the exception of opacity testing for diesel vehicles. Currently, only diesel vehicles under 14,000 lbs. GVWR are subject to Smog Check in California, and those are tested with a check of the OBD II system for 1998 and newer model years. Given the relatively small number of pre-1998 model year diesel vehicles under 14,000 lbs. GVWR in the state, adding opacity test capability to the BAR-97 equipment is not considered cost-effective. It should be noted, however, that CARB is in the process of developing an I/M program focused on diesel vehicles over 14,000 lbs. GVWR. It is anticipated that implementation of the heavy-duty I/M program will be phased-in beginning in 2023.

### ***I/M Program Summary***

The following summarizes I/M programs in the U.S. and changes that have occurred in the last year.

- With the acquisition of Gordon Darby by Opus Inspections in 2018, the number of contractors supporting state I/M programs has been reduced to five. Opus/Gordon Darby now administers I/M programs in 19 states and the District of Columbia. Applus+ Technologies supports seven states, Worldwide Environmental Products (WEP) holds contracts in four states, Parsons Engineering Science operates in three states, and OnCore Consulting supports a single program (California).
- In October 2020, Opus/Gordon Darby was awarded a four-year contract to perform the emission testing in Cache County, Utah, with an option for an additional four-year extension. That program was formerly administered by WEP.
- Fourteen states and the District of Columbia conduct safety inspections in addition to emissions testing. These states tend to conduct annual inspections and require the acquisition and display of window stickers as proof of compliance. The remaining states tie compliance with periodic emissions inspection directly to registration renewal.
- Eleven states and the District of Columbia require vehicles to be tested upon change of ownership. Two additional states, North Carolina and Rhode Island, require testing upon change of ownership only when the vehicle is sold by a dealer.
- California's program is conducted statewide, as are the programs in eight other states. The remaining states require testing only in those areas deemed to have air quality significantly and adversely impacted by on-road vehicles.
- The overall number of emissions testing stations has fallen over the past year. Some of the attrition can be attributed to the COVID-19 pandemic and some to the steadily diminishing population of pre-OBD vehicles.
- California had 7,600 licensed stations by year-end 2020, which is third in network size behind Pennsylvania (8,000 stations) and New York (10,000 stations). Other states range from as few as two stations in the District of Columbia, to as many as 5,700 in Texas.
- The average cost of inspection varies widely from state to state and by test type. The cost associated with annual inspections ranges from as little as \$9.00 in Tennessee to as much as \$52.50 in Missouri. For those biennial programs that charge an inspection fee, costs range from

a low of \$12.25 in Tucson, Arizona, to a high of \$75.00 in New Jersey. Delaware, Indiana, Ohio, and Wisconsin do not charge inspection fees.

- Except for Idaho, all states and the District of Columbia require periodic testing of hybrid-electric vehicles.
- Given the low failure rate among the newest vehicles in the fleet, most I/M programs exempt newer vehicles from testing. Maine, Massachusetts, and New Hampshire do not allow test exemptions based on vehicle age.

## **Attachments**

- A. Specific Comments from Saint Malo's "Review of the 2020 Smog Check Performance Report" and BAR Responses
- B. Summary of the RSD Data Collection Efforts to Support the 2021 Smog Check Performance Report
- C. List of Acronyms

## Attachment A

### Specific Comments from Saint Malo’s “Review of the 2020 Smog Check Performance Report” and BAR Responses

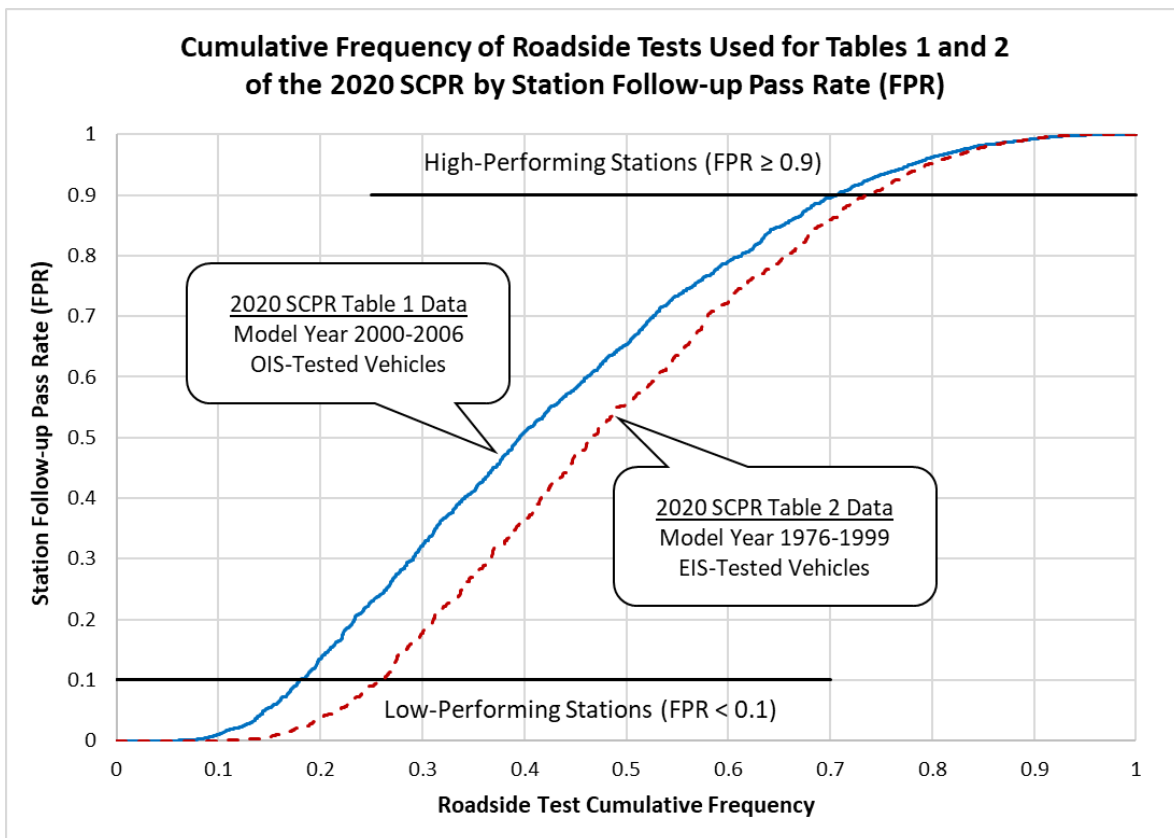
This attachment consists of specific comments from the *Review of the 2020 Smog Check Performance Report* by Saint Malo Solutions, LLC, August 21, 2020, with annotations (*in italics*) by BAR. Saint Malo’s comments on specific statements, tables, and page numbers refer to BAR’s 2020 SCPR. The entire independent review by Saint Malo of the 2020 SCPR (without annotation) is available upon request at [bar.pra@dca.ca.gov](mailto:bar.pra@dca.ca.gov).

**Saint Malo:** On Page 2 of the report the authors’ [*sic*] state: “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 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).”

Could the authors please explain the range of FPR scores? It is assumed that FPR scores range from “0” at the low end to “1.0” at the high end but this is unclear.

**BAR Response:** *The Follow-up Pass Rate (FPR) is a measure of station performance that ranges from 0 to 1. Low-performing stations are categorized as those with an FPR score of less than 0.1, and high-performing stations are those with an FPR score of 0.9 or more. Figure A-1 below is a cumulative frequency plot of FPR scores observed for a subset of vehicles in the 2018-2019 Roadside sample. For this figure, the data used to construct Tables 1 and 2 of the 2020 SCPR were analyzed and represent approximately 7,200 individual Roadside tests from model year 2000-2006 OIS-tested vehicles and 2,300 Roadside tests from 1976-1999 EIS-tested vehicles.*

**Figure A-1**



*For the data used in Figure A-1, 30% of the model year 2000-2006 OIS-tested vehicles had previously been tested and certified at high-performing stations, while 18% had been previously been tested and certified at low-performing stations. For the model year 1976-1999 EIS-tested vehicles, approximately 26% had been previously tested and certified at high-performing stations, and 26% had been previously tested and certified at low-performing stations.*

**Saint Malo:** On Page 6 the authors explain that: “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.”

Are the simulators to which the authors refer used for any other purpose? If not, perhaps the sentence could be reworded as, “A simulator is an electronic device used to imitate a vehicle’s OBD data with or without the presence and use of the actual vehicle.”

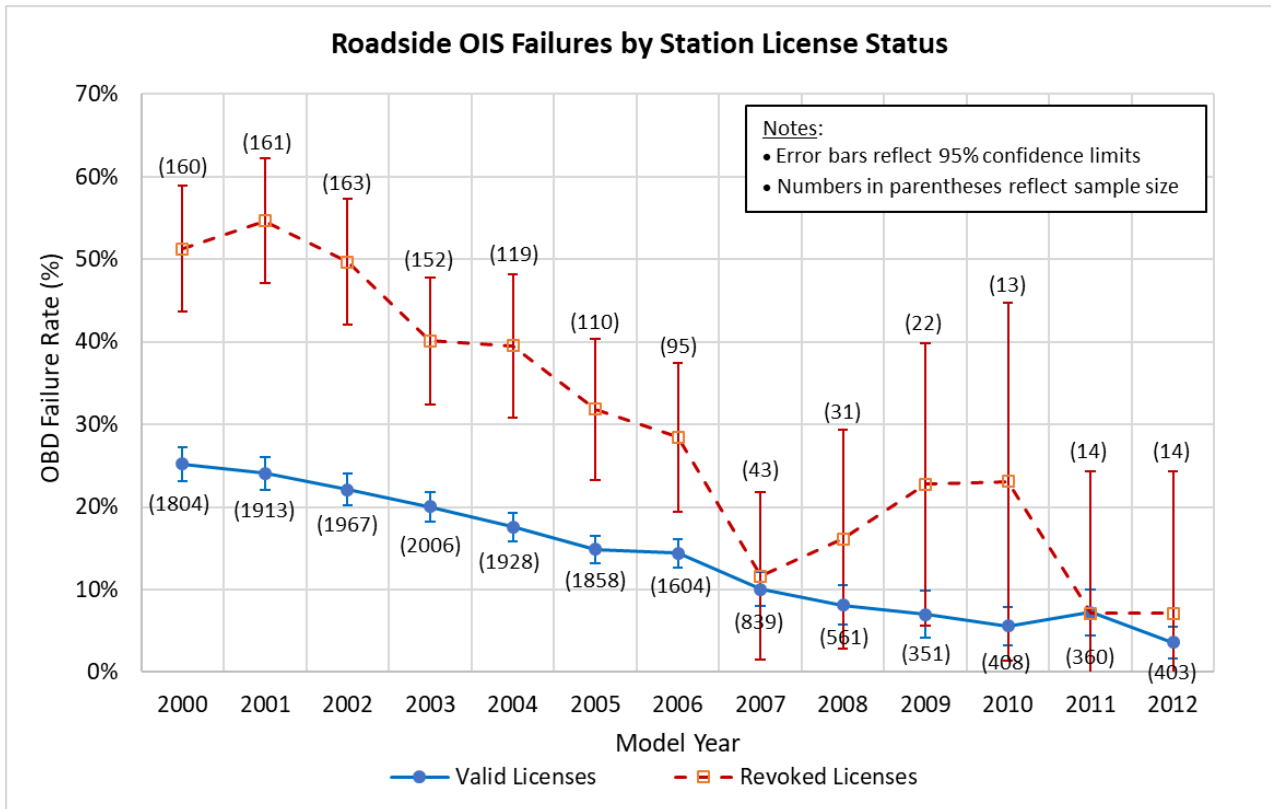
**BAR Response:** *All OBD simulators that BAR has identified, and in some cases recovered, at Smog Check stations are being used to perform fraudulent Smog Check inspections.*

**Saint Malo:** On Page 9, Figure 2 presents the Roadside Failure rates for stations with valid licenses and those that have had their licenses revoked. The figure shows that the failure rates of stations with revoked licenses are consistently higher than those with valid licenses except for model years 2007 and 2011.

Could the authors please provide some insight into why these model years might deviate from the apparent trend?

**BAR Response:** *Beyond model year 2006 the sample sizes for the revoked-license case begin to diminish, resulting in some scatter and uncertainty in the data. This was verbally explained when the 2020 SCPR results were presented to the BAR Advisory Group at their public meeting in July 2020. To more quantitatively address the reviewer’s question, Figure 2 from the 2020 SCPR is replicated as Figure A-2 below with 95% confidence limits around each model year failure rate estimate and sample size shown in parentheses. The valid-license case has very tight confidence limits around the model year failure rates because sample sizes are robust for all model years. The revoked-license case has wider confidence limits because of smaller sample sizes. Nonetheless, the results show statistically significant differences in failure rates through model year 2006 (i.e., non-overlapping confidence intervals), and although confidence intervals overlap for model year 2007 and later vehicles, there is no reason to expect a different trend for these vehicles between the revoked-license and valid-license cases.*

**Figure A-2**



**Saint Malo:** Footnote “a” on Page 11 reads: “While the majority of vehicles included in the matched Roadside-Smog Check data used for this report were tested at the Roadside within the two-year window of the biennial test cycle, there were 422 vehicles (2.6% of the OIS-tested sample) that exceeded two years between Smog Check certification and the Roadside inspection.

It is assumed that these 422 vehicles missed their scheduled Smog Check. If this is true, should these vehicles be considered atypical, analyzed separately, or excluded from the analysis?

**BAR Response:** *While these vehicles represent a small fraction of the Roadside-tested fleet, BAR does not consider them to be atypical precisely because they were observed in the Roadside data. The footnote refers to the data analyzed for Figure 5 of the 2020 SCPR, which shows the probability of failure versus time since Smog Check. Because data was available for vehicles that exceeded two years between Smog Checks, and those vehicles were randomly selected for testing at the Roadside, BAR decided to include them in the analysis.*

**Saint Malo:** On Page 13, Footnote \*\*\*\* below Table 5 reads: “Note that there are ten fewer total tests for 2018-2019 data in this table versus Table 1 because Referee stations were excluded in the analysis performed for Table 5.”

Could the authors either include these ten vehicles in Table 1 or exclude them from Table 5 in order to make the two comparable?



**BAR Response:** Because Table 5 of the report included a comparison of STAR versus non-STAR Smog Check stations, BAR did not think it appropriate to include Referee stations in that analysis. As a practical matter, the inclusion or exclusion of the Referee data and statistics in Tables 1 and 5 has little impact on the results. Ten vehicles out of a total of 7,195 model year 2000-2006 OIS-tested vehicles tested at the Roadside within a year of certification represents only 0.14% of the sample. Nonetheless, the failure rates shown in Table 1 of the 2020 SCPR were recalculated based on removal of the Referee tests, and the results are compared in Table A-1 below.

**Table A-1**  
**Roadside Failure Rates of OIS Tested Gasoline Vehicles, Model Year 2000-2006**  
**Calendar Year 2018-2019 Roadside Data with and without Referee Data**

<b>Initial Smog Check Result</b>	<b>Roadside OIS Failure Rates within One Year after Smog Check Certification * Referee Data Included (Original Analysis from Table 1 of the 2020 SCPR)</b>	<b>Roadside OIS Failure Rates within One Year after Smog Check Certification * Referee Data Excluded</b>
<i>Fail**</i>	32.9% (660)	33.2% (651)
<i>Pass***</i>	16.9% (6,535)	16.9% (6,534)
<b>Overall Failure Rate</b>	18.2% (7,195)	18.2% (7,185)

\* 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.

Nine of the ten vehicles in the Roadside sample that were certified at a Referee station were initial Smog Check failures, and eight of those nine vehicles were passing at the Roadside within a year of certification. Thus, when those vehicles were excluded from the analysis, the Roadside failure rate for initial Smog Check failures increased slightly from 32.9% to 33.2%.

**Saint Malo:** In "Summary of Findings – Finding 5," the first bullet point on Page 14 reads: "The estimated additional achievable emission reductions for model year 1976 to 2015 light- and medium-duty gasoline-powered vehicles in the Smog Check Program is on the order of 30 to 50 tons per day of reactive organic gases and oxides of nitrogen (ROG + NOx) for 2019."

Although the authors provide a brief summary of the analysis underlying the estimate of additional excess emissions achievable through test station improvement, could the authors provide additional information regarding how this number was estimated (i.e., show your math)? Could the authors put their estimate of additional excess emissions reductions into context? That is, 30 to 50 tons per day out of how many tons total?

**BAR Response:** The emissions estimates prepared for the 2020 SCPR followed a similar methodology as that utilized for the 2019 SCPR, which was developed in collaboration with the California Air Resources Board (CARB) mobile source emissions modeling staff. CARB staff reviewed the detailed calculations prepared for the 2020 SCPR, and comments from that review were incorporated into the analysis. This method relied on the Roadside ASM tests to determine the emissions difference between high-performing stations and all stations combined. The data was segregated by vehicle class (passenger cars, light-duty trucks, and medium-duty vehicles) and model year group, and the difference in emissions (calculated as a ratio of high-performing stations to all stations) was applied to the

*EMFAC2017 ton-per-day emissions. BAR intends to request a detailed review of the emissions analysis prepared for the 2021 SCPR as part of the independent review of that report.*

*The additional 30 to 50 tons per day of ROG + NOx excess emissions potentially reduced if all stations performed at the same level as “high-performing” stations amounts to 13% to 21% of the statewide light- and medium-duty vehicle exhaust ROG + NOx emissions inventory, or about 4% to 6% of the total on-road motor vehicle ROG + NOx inventory for 2019 based on the EMFAC2017 model.*

*As a final comment, BAR thanks Saint Malo Solutions for the thoughtful and helpful review and comments on the 2020 SCPR.*

## Attachment B

### Summary of the RSD Data Collection Efforts to Support the 2021 Smog Check Performance Report

This attachment provides a summary of the Remote Sensing Device (RSD) data collection efforts conducted in the Los Angeles area between November 2020 and March 2021. As noted in the body of this report, BAR's Roadside Inspection program was suspended in March of 2020 because of the COVID-19 pandemic. Normally, the 2021 Smog Check Performance Report (SCPR) would have used Roadside data from calendar years 2019 and 2020 to support the evaluation of the Smog Check Program. Because the 2020 Roadside inspections were suspended, BAR investigated alternative data sources to supplement analyses conducted for the 2021 SCPR. Collection of RSD data was considered the most appropriate path forward given the circumstances of 2020.

RSD systems measure vehicle emissions ratios by passing a light source across a roadway and through an exhaust plume. Detectors measure how much light is absorbed by the exhaust plume, which is roughly proportional to emissions in the plume. More specifically, higher absorption equates to higher pollutant concentrations. A typical RSD configuration is shown in Figure B-1.<sup>a</sup> Photographs of license plates are taken, and Automated License Plate Recognition (ALPR) software is used to convert those images to character values. For California vehicles, license plate data was merged with DMV records to determine make, model, model year, etc. of each vehicle, and the data was also merged with Smog Check records to determine the Smog Check history of the vehicles tested with RSD.

**Figure B-1**  
RSD System being Set Up on a Roadway



RSD measures pollutant ratios (CO/CO<sub>2</sub>, HC/CO<sub>2</sub>, NO/CO<sub>2</sub>, etc.) so that variations in plume capture and dilution are accounted for. Fuel-specific emissions in grams pollutant per kilogram or gallon of fuel are derived from these ratios by knowing how much CO<sub>2</sub> is formed from the combustion of gasoline or diesel fuel in an engine. In this report, emissions of HC, CO, and NO are presented in terms of grams of pollutant per kilogram of fuel.

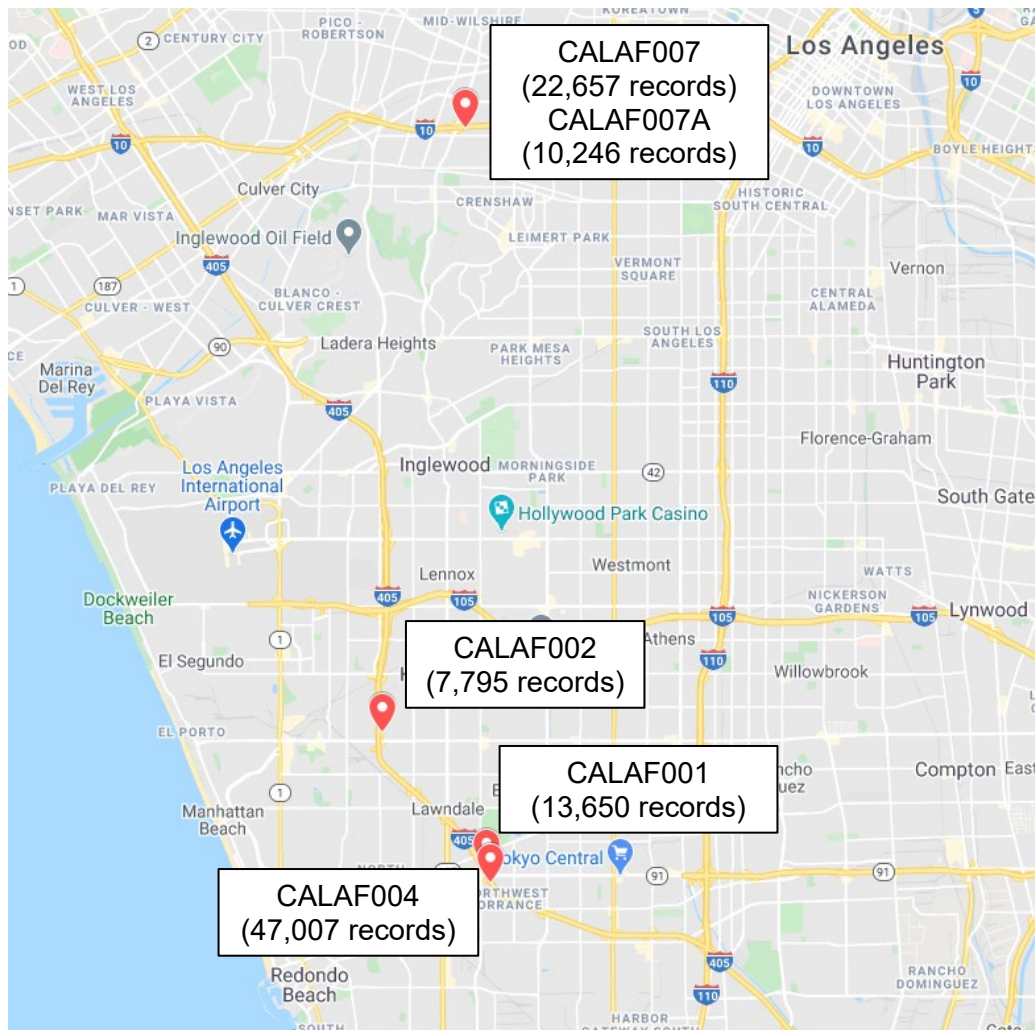
BAR contracted with Opus Inspection, Inc. to collect RSD records in the Los Angeles area. Testing was conducted from November 20, 2020, to March 22, 2021. Opus collected 101,355 total RSD records over 44 sampling days at four locations. Figure B-2 shows the locations of the 2020-2021 Los Angeles RSD sampling campaign, which are described below:

- CALAF001:<sup>b</sup> Entrance Ramp from Artesia Blvd. Westbound to I-405 Northbound
- CALAF002: Entrance Ramp from Rosecrans Ave. to I-405 Northbound
- CALAF004: Entrance Ramp from Artesia Blvd. Eastbound to I-405 Southbound
- CALAF007/7A: Entrance Ramp from South La Brea Ave. Northbound to I-10 Eastbound

<sup>a</sup> Photo from: "I/M Program Summary Report," UC Riverside, May 2021.

<sup>b</sup> Site references were assigned by Opus.

**Figure B-2  
Locations of RSD Sampling Sites in the Los Angeles Area**



Some general statistics of the data collected during the RSD sampling campaign are given below:

- 101,355 total RSD records were collected
- 76,538 unique vehicles were identified
- 74,113 unique California license plates
- 71,099 California vehicles with a DMV match<sup>a</sup>
- 36,766 California vehicles with historical Smog Check records
- 55 states/territories were identified; those with over 100 records are shown in Table B-1

Figure B-3 compares the model year distributions for gasoline passenger cars and light-duty trucks under 10,000 lbs. GVWR for the 2020-2021 Los Angeles RSD data, Smog Check data from 2020, and traditional Roadside Inspection Program data collected in 2018-2019 used to support the 2020 SCPR. As observed in Figure B-3, the three distributions are quite different: (1) the RSD data reflects the

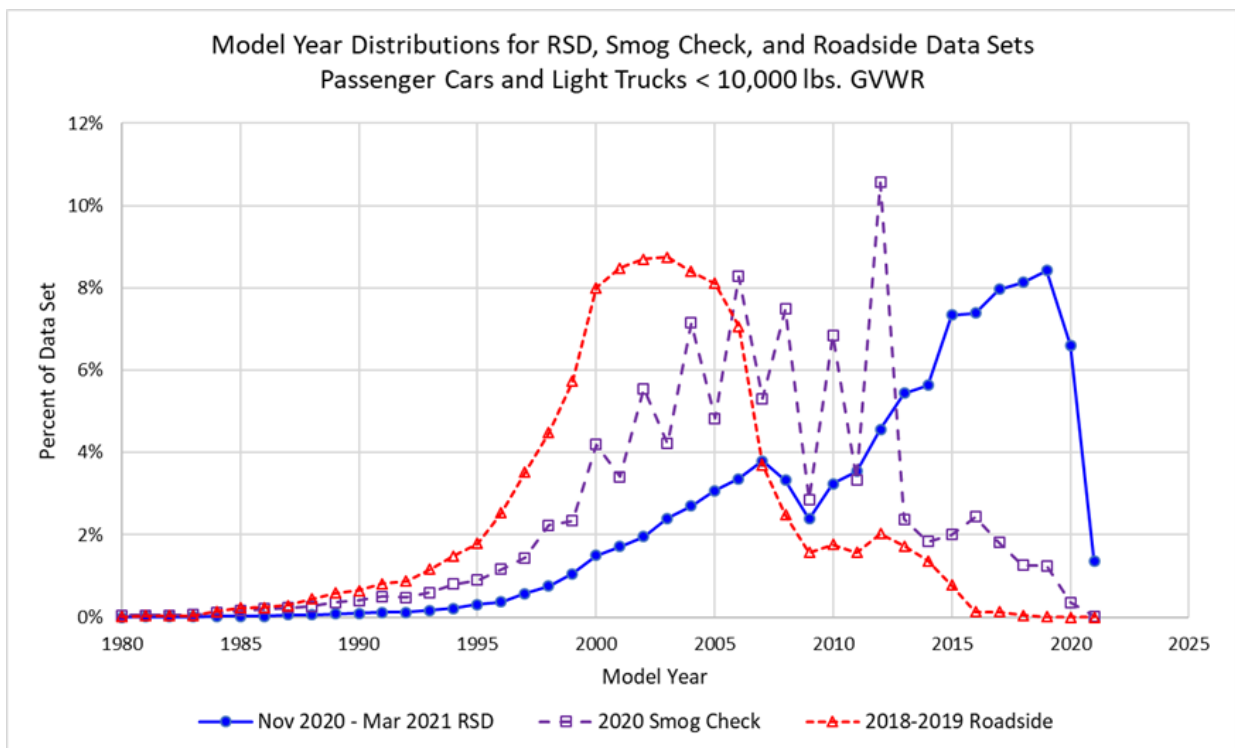
<sup>a</sup> Vehicles that could not be matched to the DMV database included new vehicles with paper plates and instances where translation of the license plate image to characters was uncertain (e.g., the license plate was obscured by a trailer hitch or a license plate frame covered the top or bottom characters on the plate).

distribution of vehicles currently being driven on the road, which is heavily skewed toward newer vehicles, (2) the Smog Check data shows a spike at model year 2012, which was the first model year required to be tested as part of routine biennial inspections in 2020, and (3) by design the Roadside data is heavily weighted toward 1996-2006 model years so that sufficient data is collected on older vehicles with which to assess program effectiveness. This feature of the Roadside data is impossible to replicate with an RSD data collection campaign, which is a significant limitation to the sole use of RSD data to evaluate Smog Check Program performance. In addition, an RSD measurement for an individual vehicle is an imperfect measure of how that vehicle would perform during a Smog Check inspection. Thus, the Roadside Inspection Program will remain an important element of Smog Check performance evaluation for the foreseeable future.

**Table B-1**  
**States with More than 100 RSD Records in the Los Angeles Sampling Campaign**

State	RSD Records	Unique Vehicles
California	98,564	74,113
Arizona	454	402
Texas	321	279
Nevada	271	239
Florida	167	152
Washington	160	137
Oregon	112	91
Illinois	103	99

**Figure B-3**  
**Comparison of Model Year Distributions of RSD Data, Smog Check Data, and Traditional Roadside Inspection Program Data**



## **Attachment C**

### **List of Acronyms**

AB, Assembly Bill

ALPR, Automated License Plate Recognition

ASM, Acceleration Simulation Mode

BAR, Bureau of Automotive Repair

BAR-97, BAR-certified EIS for testing model year 1976-1999 vehicles

CARB, California Air Resources Board

CCR, California Code of Regulations

CE-CERT, College of Engineering - Center for Environmental Research & Technology

CHP, California Highway Patrol

CO, Carbon Monoxide

CO<sub>2</sub>, Carbon Dioxide

CY, Calendar Year

DMV, Department of Motor Vehicles

DTC, Diagnostic Trouble Code identified by the OBD II system

EIS, Emission Inspection System

FEAT, Fuel Efficiency Automobile Test

FPR, Follow-up Pass Rate

g, grams

GVWR, Gross Vehicle Weight Rating

HC, Hydrocarbon

I/M, Inspection and Maintenance

kg, kilograms

lbs., pounds

LEV, Low Emission Vehicle

LEV II, Phase II of the Low Emission Vehicle program phased in between 2004 and 2010 model years

NO, Nitric Oxide, the primary NO<sub>x</sub> species emitted by motor vehicle engines

NO<sub>x</sub>, Oxides of Nitrogen

OAG, Office of the Attorney General

OAH, Office of Administrative Hearings

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

OBD III, On-Board Diagnostics, theoretical 3<sup>rd</sup> 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

ROG, Reactive Organic Gases, the portion of hydrocarbon emissions that are reactive in the atmosphere and participate in reactions that form ozone

RSD, Remote Sensing Device, an analyzer capable of measuring the concentration of HC, CO, and NO<sub>x</sub> from vehicles operating on the road

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

tpd, tons per day

TSI, Two-Speed Idle

U.S., United States