DEPARTMENT OF CONSUMER AFFAIRS

BAR

Bureau of Automotive Repair

Smog Check Performance Report

2023

July 1, 2023

Introduction and Summary

This report provides an update on California's Smog Check Program (Program) pursuant to Assembly Bill (AB) 2289 (Eng, Chapter 258, Statutes of 2010), which requires an annual evaluation of the Program and the performance of Smog Check stations. This legislation directed the California Bureau of Automotive Repair (BAR) to implement both inspection-based performance standards for stations inspecting directed vehicles[1] and On-Board Diagnostics II (OBD)-focused inspections for newer vehicles. It also enhanced BAR's ability to identify and take action against stations performing improper inspections. The 2023 Smog Check Performance Report (SCPR) satisfies the statutory reporting requirement for 2022.

AB 2289 requires that BAR, in cooperation with the California Air Resources Board (CARB), perform certain analyses of Smog Check-related data and annually report the results of these analyses to the public. Specific information required to be presented in this report include:

- The percentage of vehicles initially passing a Smog Check that subsequently fail a roadside inspection.
- The percentage of vehicles that initially fail (and later pass) Smog Check that fail a subsequent roadside inspection.
- An estimate of the excess emissions associated with these vehicles.
- A best-effort explanation of the reasons why these vehicles may have been inappropriately passed or failed within Smog Check.
- A comparison of current findings to those included in the 2009 report entitled "Evaluation of the California Smog Check Program Using Random Roadside Data" (the "2009 Report").

In addition to the above, AB 2289 requires BAR to offer recommendations for modifications to the existing program geared toward reducing "excess emissions" to a minimum and to consider those best practices implemented by other states or provinces. The term "excess emissions" is traditionally used to describe levels of pollutants that are over and above those to which a vehicle has been certified, however the term is used in this report to describe those additional benefits that could be realized if all vehicles subject to the program were inspected at "high performing" Smog Check stations.

California's Smog Check is a biennial program requiring the inspection of vehicles' emission control components and systems every other year. The analyses included in this report are based upon data collected during calendar years (CY) 2021 and 2022, representing the latest complete test cycle for the entire fleet. For purposes of these analyses, the fleet was subdivided into two broad groups; pre-2000 model year (MY) vehicles that receive an Acceleration Simulation Mode (ASM) or Two Speed Idle (TSI) exhaust emissions test; and those 2000 and newer MY vehicles equipped with OBD that receive an OBD-focused inspection using the BAR OBD Inspection System (OIS). While diesel-powered vehicles are inspected at roadside, related data are considered too scarce to draw separate conclusions.

[1] "Directed vehicles" include most 1976-1999 MY vehicles, and those newer vehicles identified as having the greatest likelihood of failing their next inspection. These vehicles are required (i.e., "directed") to be certified at STAR-certified stations.

A summary of the test results for 1976 to 2022 MY vehicles inspected in CYs 2020-2021 and 2021-2022 are presented in Table 1 below. Separate results are shown for vehicles that initially failed Smog Check and subsequently received certification (FAIL), and those that initially passed Smog Check (PASS). Overall, vehicles failed roadside inspection at a statewide fleet-weighted rate[2] of about 14%, which can be directly compared to the 16% overall failure rate found in the CY 2020-2021 roadside sample. For reasons explained later in this report, sufficient data was not available to present separate results for pre-2000 MY tailpipe tested vehicles for each of the analyses performed.

Table 1
Roadside Failure Rates of Tested Gasoline-Powered Vehicles, MY 1976-2022*

Initial Smog Check Results	Roadside Failure Rates Within One Year after Smog Check (CY 2020-2021)	Roadside Failure Rates Within One Year after Smog Check (CY 2021-2022)
FAIL	22% (263)	30% (345)
PASS	15% (2497)	13% (6167)
Overall	**16% (2760)**	**14% (6512)**

* Sample sizes are shown in parentheses beside the failure rate percentages.

Figure 1 presents the age specific initial failure rates for the OIS tested fleet in addition to the results of roadside inspections. Both the roadside and Smog Check datasets reflect a strong relationship between vehicle age and failure rate. Vehicle age is determined by subtracting the vehicle MY from the CY (Vehicle Age=CY-MY). It is important to note that vehicles eight years old and newer are currently exempt from biennial inspection. However, these vehicles are required to undergo inspection upon initial registration in California and upon change of ownership (COO). As can be seen in Figure 1, the Smog Check failure rate (SCFR) increases by a factor of 3.2 from vehicles aged 10 to 23 years (from 5% to 16%), while the roadside failure rate (RFR) increased by a factor of 6.8, more than twice the SCFR, over the same period (from 4% to 27%). It is reasonable to ask why this difference exists.

As vehicles age, their emission control components become less effective or fail outright and it is the objective of the Program to identify these vehicles for repair. However, the observed difference between the age specific SCFRs and RFRs suggests that at least a portion of the difference can be attributed to the fact that Smog Check stations pass vehicles that would have failed if properly inspected or fail at roadside because lasting repairs were not made. If all Smog Check stations performed proper inspections and made effective and lasting repairs, the failure rates observed at roadside would more closely match the overall Smog Check results. Table 2 (below) presents the relative failure rates by inspection category observed during Smog Check and at roadside.

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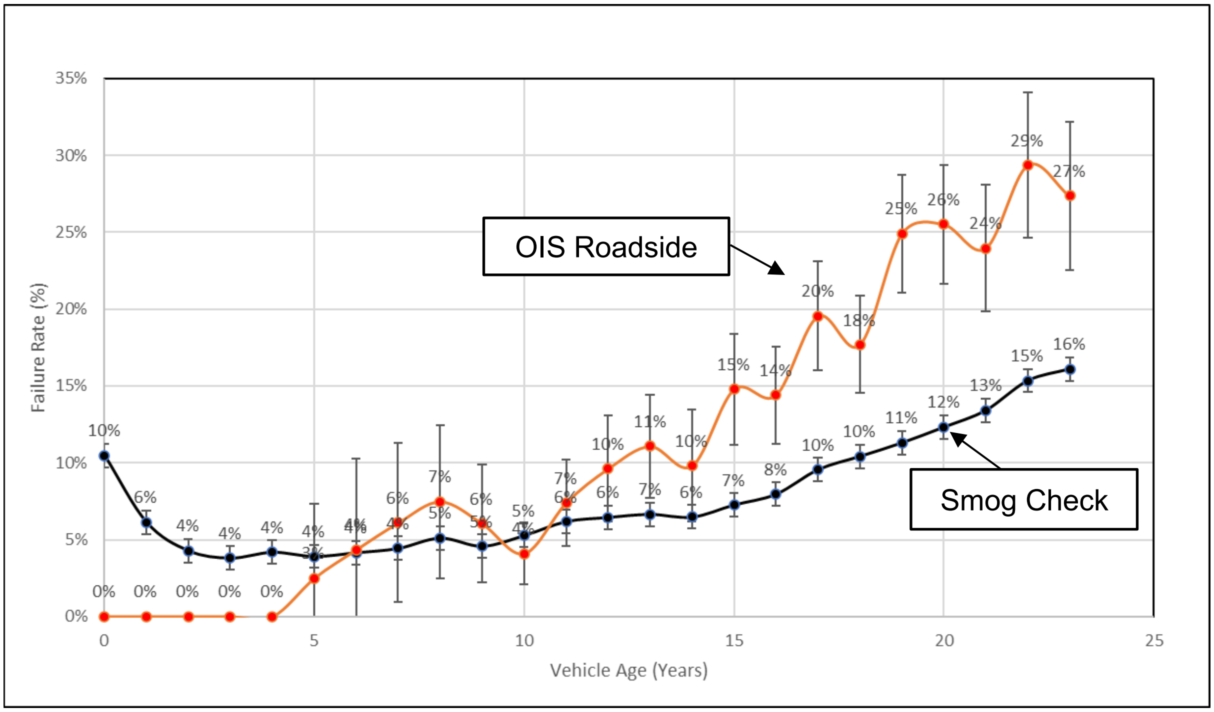
[2] Roadside failure rate percentages are weighted by MY population to match the number of initial Smog Check tests performed in the State.

Figure 1
OIS Fail Rates by Vehicle Age using Smog Check and Roadside Testing Data
(CY 2021-2022, MY 2022 and Older Gasoline-Powered Vehicles) *



*Error bars reflect the 95% confidence levels. The greater the sample size, the smaller the variation around the mean.

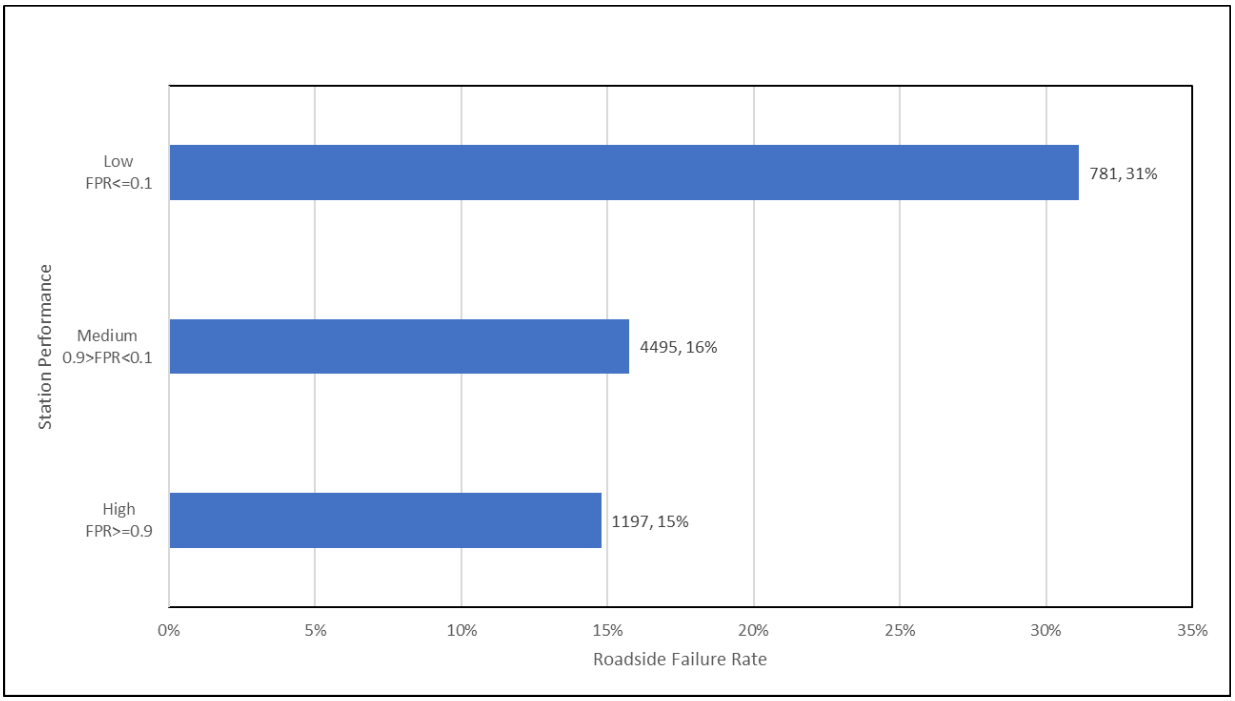
Table 2
Smog Check and Roadside Failure Rates by Inspection Category*

Inspection Category	Pre-2000 MY (ASM/TSI) Smog Check	Pre-2000 MY (ASM/TSI) Roadside	2000+ MY (OIS) Smog Check	2000+ MY (OIS) Roadside
Fail Emissions	10.5%	26.2%	-	-
Fail Gross Polluter	2.4%	6.7%	-	-
Fail Functional	9.9%	-	7.1%	-
Fail Visual	3.3%	-	1.2%	-
Fail OBD	-	-	7.0%	13.5%
Fail Readiness	-	-	4.5%	6.6%
Fail Smoke/Liquid Leak	-	-	0.1%	-

*Emissions are not measured for 2000+ MY vehicles; visual and functional inspections are not performed at roadside.

BAR has taken steps to improve station and technician performance through effective education, incentives, and administrative discipline. Individuals and entities licensed by BAR are subject to a process of progressive discipline beginning with reminders and warnings but will, in the extreme case of fraudulent testing, result in license revocation as required by State law. Evidence for the efficacy of BAR's enforcement approach can be seen in the roadside data shown in Figure 2 (below) where vehicles certified by "high performing" Smog Check stations, those with a Follow-up Pass Rate (FPR)[3] score of 0.9 or above, were found to have consistently lower failures compared to those certified by lower-performing stations.

Figure 2
Performance of Certifying Smog Check Station vs. Roadside Failure Rates
CY 2021-2022 Roadside Data*



*The terms "Low"," Medium," and "High" represent the station performance based on FPR score. The numbers to the right of the bars reflect the number of stations included in the analysis and the roadside failure rate (# of stations, % fail).

3 "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."

Summary of Findings

Analysis of the CY 2021-2022 roadside test data, Smog Check inspection data, and related information presented, discussed, and/or cited in this report lead BAR to conclude the following:

1. MY 1976-2022 vehicles included in the CY 2021-2022 roadside sample failed at a MY weighted rate of about 14% which is significantly lower statistically, than the 16% for the CY 2020-2021 roadside sample.
2. Vehicles certified by “high performing” Smog Check stations failed at a lower rate during roadside inspections compared to vehicles certified by Smog Check Stations with lower FPR scores.
3. Incremental improvements to the Program are evidenced through declining overall failure rate, declining differences between roadside and Smog Check failure rates, and an increase in enforcement actions against stations and technicians engaging in fraudulent practices.
4. BAR and CARB staff estimate that in CY 2022, Smog Check could have provided approximately 56 additional tons per day (tpd) of exhaust emission reductions of reactive organic gases (ROG) and oxides of nitrogen (NOx) from vehicles subject to the program if all stations operated as effectively as high-performing stations.

After a review of BAR’s Roadside Inspection Program data collection efforts conducted in support of the 2023 SCPR, this report discusses the following:

- BAR’s efforts to improve station performance in the Program;
- Information about the relationships between vehicle age, Smog Check station performance, and other factors that affect on-road emissions;
- An assesment of excess emissions associated with sub-optimal station performance;
- An update on what other states are doing to reduce emissions through inspection and maintenance (I/M);
- Specific recommendations for Program improvement.

Background

A comprehensive program evaluation report[4] prepared for CARB and BAR (“2009 Report”), Austin, *et. al.,* examined the differences between failure rates at the roadside and the initial test results from Smog Check. The significantly higher failure rates observed during roadside inspections led the authors to conclude that:

“…many of the vehicles that initially failed during the previous Smog Check cycle were not actually repaired or were repaired only temporarily.”

4 Austin, T., McClement, D., and Roeschen, J.D., 2009, “Evaluation of the California Smog Check Program Using Random Roadside Data”, Report No. SR09-03-01, March 12, 2009, Sierra Research, http://www.calautoteachers.com/PDF/FINAL_RoadsideReport_031209.pdf

Further investigation into prior Smog Check histories showed that many of the excess and premature failures seen at roadside were due to vehicles that had previously failed Smog Check that were subsequently certified, presumably having been repaired. The authors estimated that the Smog Check Program could have achieved an additional reduction of 70 tons per day (tpd) of excess emissions of hydrocarbon (HC) and NOx had these vehicles been properly inspected and repaired.

To address this issue, the authors suggested that BAR:

- Further refine the station performance algorithm for increased enforcement
- Create incentives for more stations to become high performing
- Perform inspections of vehicles immediately following certification at Smog Check stations through either roadside or on-site testing
- Continue roadside inspections to provide data for Smog Check performance assessment and to target low performing stations for additional enforcement

Roadside Inspection Program

BAR, with the assistance of the California Highway Patrol (CHP), conducts roadside inspections in “enhanced areas” of the state, those urbanized areas experiencing serious, severe, or extreme air quality problems. During these inspections, vehicles are directed by a CHP officer to a roadside inspection area where they are tested in a manner similar to what is required by Smog Check.

To minimize inconvenience, participation in roadside inspection is voluntary, and participation does not affect the Smog Check pass/fail status of any of the vehicles tested. The objective of this program is to gather data that can be used to independently audit the performance of the Program as a whole.

The voluntary nature of the roadside testing program coupled with the impacts of the pandemic and a shift in CHP priorities, resulted in fewer tests being performed in CY 2020 and 2021 compared to earlier years. Approximately 12,000 vehicles, roughly divided into 90% 2000 and newer MY OIS tested vehicles, and 10% 1999 and older tailpipe tested vehicles, were used to support the findings in this report (See Table 3 below).

Table 3
Roadside Inspection Datasets - Vehicles Tested

Model Year Group	CY 2019	CY 2020	CY 2021	CY 2022
1976-1995	877	124	175	276
1996-1999	1,576	264	446	571
2000-2003	3,152	538	1,080	1,289
2004-2006	2,310	452	1,015	1,306
2007+	2,925	712	2,038	3,408
Total	**10,840**	**2,090**	**4,754**	**6,850**

Figure 3 presents the MY distribution of the CY 2021-2022 roadside dataset, as well as the distribution of initial tests performed within Smog Check for the same period. Given that newer vehicles are exempt from biennial inspection and understanding that older vehicles are more likely to develop problems with their emission control systems, older vehicles are purposefully oversampled at roadside compared to Smog Check. As can be seen in Figure 3, the resulting average age of the roadside dataset is two MYs older (16.5 yrs.) compared to the Smog Check dataset (14.2 yrs.) To account for the difference in the average age of the stratified random roadside sample, BAR weights the roadside sample results by the number of initial Smog Check tests, i.e., the number of unique vehicles of each MY or MY group in the overall California fleet before computing the actual statistics for the fleet.

Figure 3
Population Distributions by MY for Roadside and Smog Check Tested Vehicles

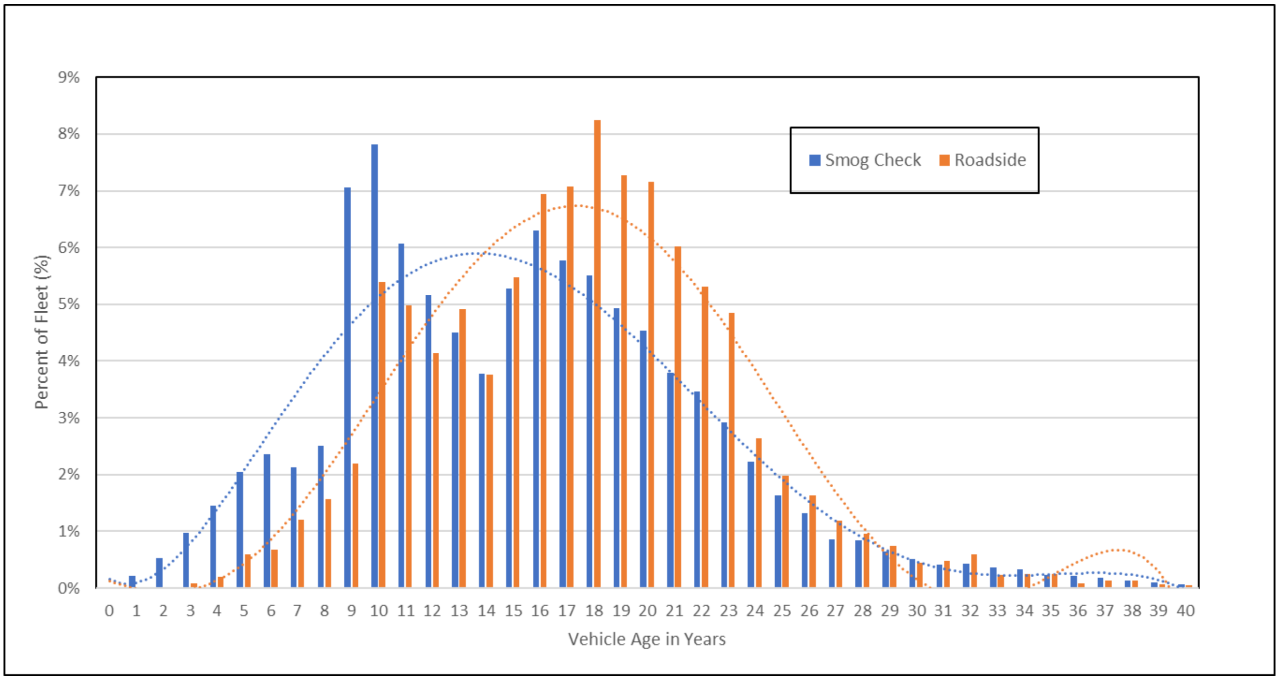
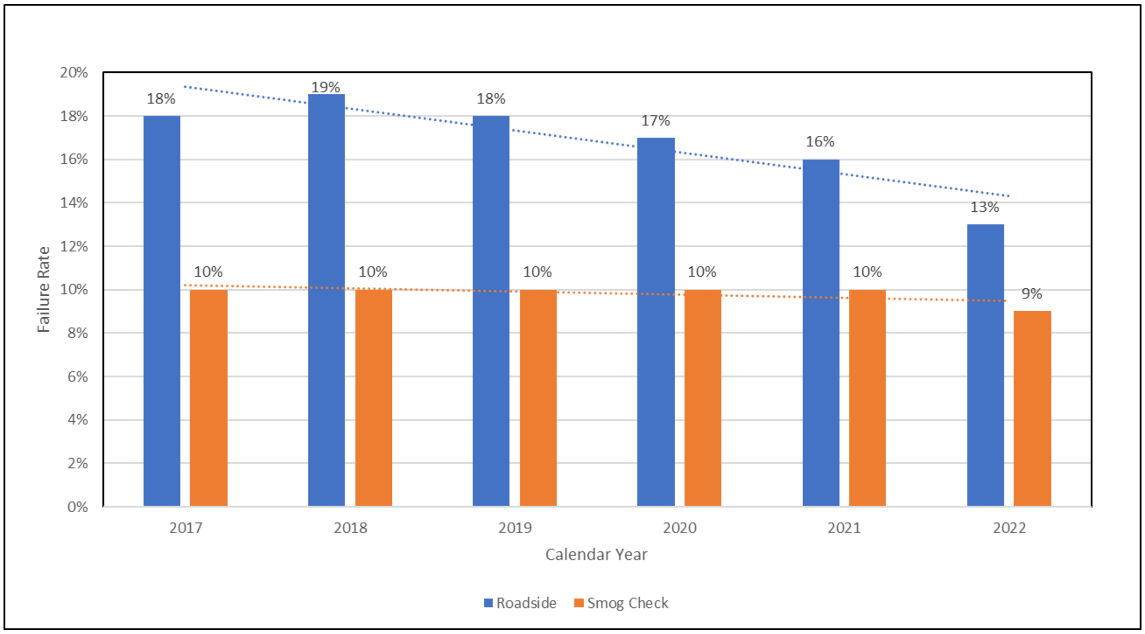


Figure 4 (below) presents the current and historic RFR and SCFR for CYs 2017 to 2022. While the SCFR remained relatively constant, the RFR has declined significantly from a fleet adjusted high of 19% in 2018, to a low of 14% in 2022. Perhaps of more significance is the narrowing of the difference between the SCFR and RFR. The reduction in the RFR and the closing of the gap between the two failure rates are evidence of incremental improvement of the overall Program.

Figure 4
Current and Historic Random Roadside and Smog Check Failure Rates



Efforts to Improve Station Performance

The voluntary STAR program was established by BAR in 2013 for Smog Check stations seeking to test directed vehicles. Stations and inspectors participating in the STAR program have their performance assessed against other stations and inspectors within the Program. As an incentive for more stations to become high performing, each year BAR directs a portion of the enhanced area fleet, including vehicles designated as “gross polluters,”[5] to those stations that meet all STAR requirements. The effectiveness of the STAR program is evidenced by the consistently higher median FPR scores for STAR stations compared to those of non-STAR stations (See Figure 5 below). As previously shown, Smog Check stations with higher FPR scores have lower RFRs compared to stations with lower FPR scores.

BAR has also acted aggressively to identify and take corrective action against those suspected of fraudulently certifying vehicles. Individuals and entities suspected of performing fraudulent Smog Checks risk suspension or revocation of their license(s) if found guilty. This process involves formal accusations that are filed by BAR against the licensees who committed the alleged fraud, and due process is afforded to them through hearings conducted by the Office of Administrative Hearings (OAH) or, when appropriate, through civil or even criminal proceedings in other courts.

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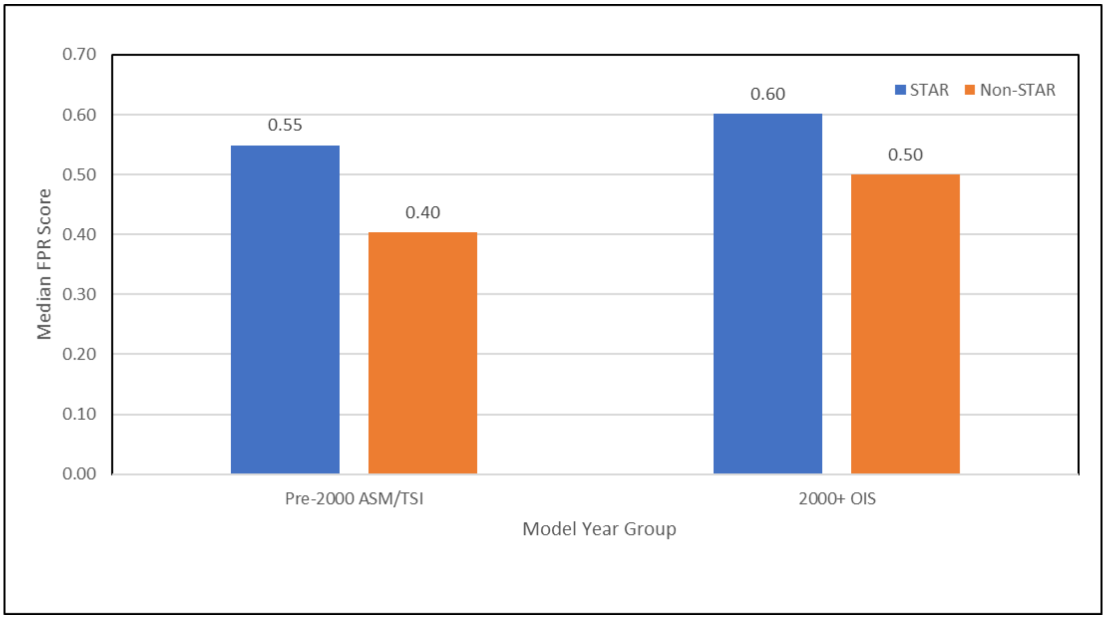
5 “Gross Polluters” pollute much more than typical vehicles that fail a Smog Check. The emission levels associated with Gross Polluters varies according to vehicle type and MY, however, they typically exceed at least one or more of the gross polluter standards (twice the minimum emissions limit).

Figure 5
Median FPR Score as a Function of Station Type
Where Vehicle was Last Certified



The most prevalent fraudulent techniques used within Smog Check or to circumvent Smog Check requirements are:

- Clean Piping (pre-2000 MY vehicles)
- Clean Gassing (pre-1996 MY vehicles)
- Clean Plugging (2000+ MY vehicles)
- Clean Tanking (pre-2000 MY vehicles), and
- Registration-based fraud (all vehicles)

"Clean piping" involves fraudulently obtaining an emissions sample from a vehicle that is known to pass a Smog Check and representing the results as having been taken from a vehicle that is the actual subject of the test.

"Clean gassing" is a method by which a surrogate gas is introduced into an Emission Inspection System (EIS)[6], so that the EIS will measure the surrogate gas or a mixture of surrogate gas and exhaust emissions and issue a passing test result based upon those readings rather than the actual emissions of the vehicle.

Newer vehicles (MY 2000+) are not subject to tailpipe testing, instead the vehicles' OBD systems are queried electronically to determine compliance with Smog Check requirements. The practice of "clean plugging" then, is the modern equivalent to clean piping in that the

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6 The BAR 97 Emission Inspection System (EIS) inspects vehicles under simulated driving conditions to detect HC, CO, and NOx.

electronic data reportedly collected from the vehicle being inspected is actually obtained from a completely different vehicle or from a vehicle simulator, designed to generate passing readings.

"Clean Tanking" involves reporting fraudulent evaporative control system test results that are actually derived from a calibration tank or another surrogate tank rather than the fuel tank of the vehicle being tested.

Finally, registration-based fraud involves providing false information to the Department of Motor Vehicles (DMV) to obtain or renew registration without a required Smog Check. Some motorists present counterfeit Vehicle Inspection Reports (VIR) to DMV, some falsely claim that their vehicles are registered in "attainment areas" of the state in order to avoid inspection, while others falsely report that their vehicles have been converted and are no longer powered by either gasoline or diesel fuel.

In response to these and other highly improper and/or illegal acts, BAR developed and continues to refine its ability to identify suspicious activities and to gather data and other related evidence to support administrative and legal actions to combat and deter fraud and other illegal Smog Check related activities. Table 4 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.[7] It should be noted that filings may take more than a year to resolve, therefore the number of outcomes may not match the number of case filings on a year-to-year basis. Table 4 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 or those investigations and actions by DMV.[8]

Table 4
Summary by Year of BAR Smog Check Data-Only Case Filings and Outcomes (Outcomes Still Pending on Some Filings as of this Writing)

Year	Case Filings to OAG	Outcome: Revocation	Outcome: Suspension	Outcome: Probation
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
2021	99	124	36	47
2022	71	100	22	26
Total	**1253**	**1136**	**121**	**202**

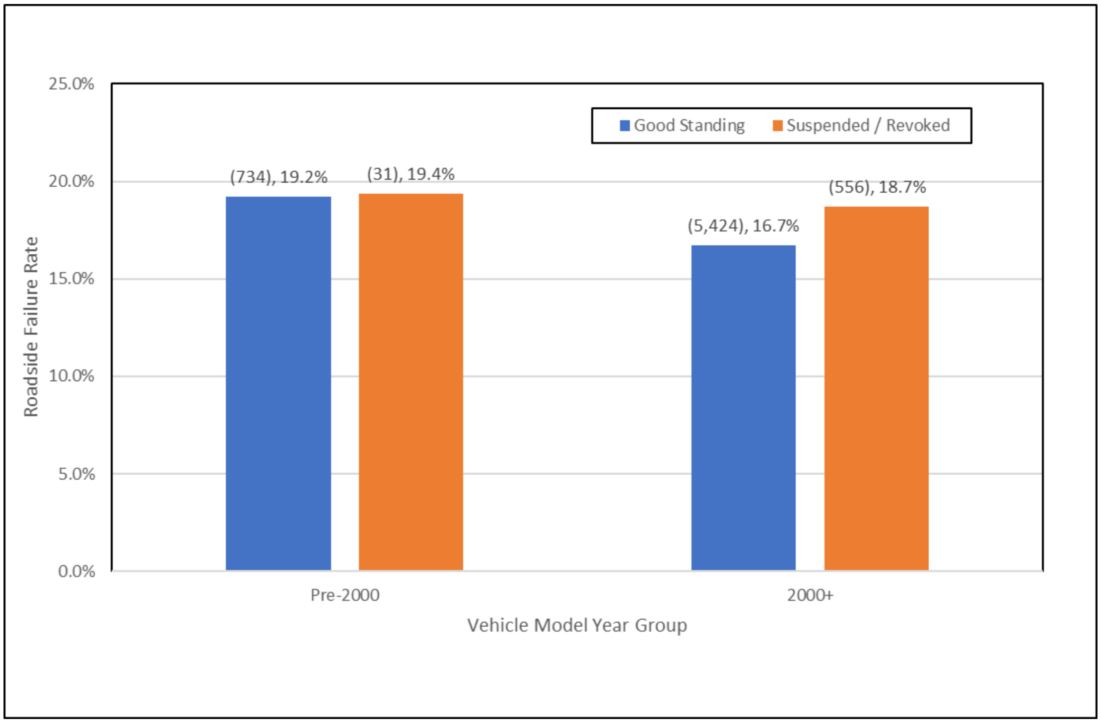
Figure 6 illustrates the superior performance of stations in good standing compared to those that have had their licenses suspended or revoked, again using the roadside failure rates as a

7 Enforcement actions are published on BAR's website in a searchable format at Enforcement Actions - Bureau of Automotive Repair (ca.gov)

8 "Traditional" investigations conducted by BAR include, but are not limited to, the use of undercover vehicles with implanted defects and station surveillance.

metric of station performance. Figure 6 clearly shows the benefit of reduced RFRs when stations that commit fraud have their licenses suspended and/or revoked.

Figure 6
Roadside Failure Rate by MY Group and Station License Status Where Vehicle was Last Certified



The DMV's Business Partner Automation (BPA) program authorizes qualified partners to process vehicle related transactions, including vehicle registration and titling, from their remote locations. In recent years, BAR and DMV have identified certain DMV Business Partners with questionable transaction activity. In response, BAR and DMV developed an Application Programming Interface (API), a programming interface between the two agencies that allows DMV and DMV Business Partners to verify in real time that a valid Smog Check certificate exists prior to processing a registration renewal transaction. Prior to the implementation of BAR's API, DMV Business Partners accounted for over 52% of questionable renewal transactions coming out of all DMV service locations from 1/1/2022 to 2/15/2022. After the implementation of BAR's API on the evening of 2/15/2022, the number of questionable DMV Business Partner transactions from 2/16/2022 to 7/5/2022 dropped to less than 10%. BAR's API has been a huge success in reducing the amount of questionable DMV Business Partner transactions, which started with 4,131 transactions on 1/1/2022 and ended with 374 transactions on 7/5/2022 resulting in a 91% drop of potential questionable renewal transactions.

In an effort to further increase overall security of the program and to prevent fraud, the Office of Administrative Law (OAL) approved BAR's regulatory action requiring Smog Check inspectors to use biometric palm scanners instead of a password to log in to test systems and perform OIS tests. This regulation went into effect October 1, 2022 and BAR is currently working to implement this change.

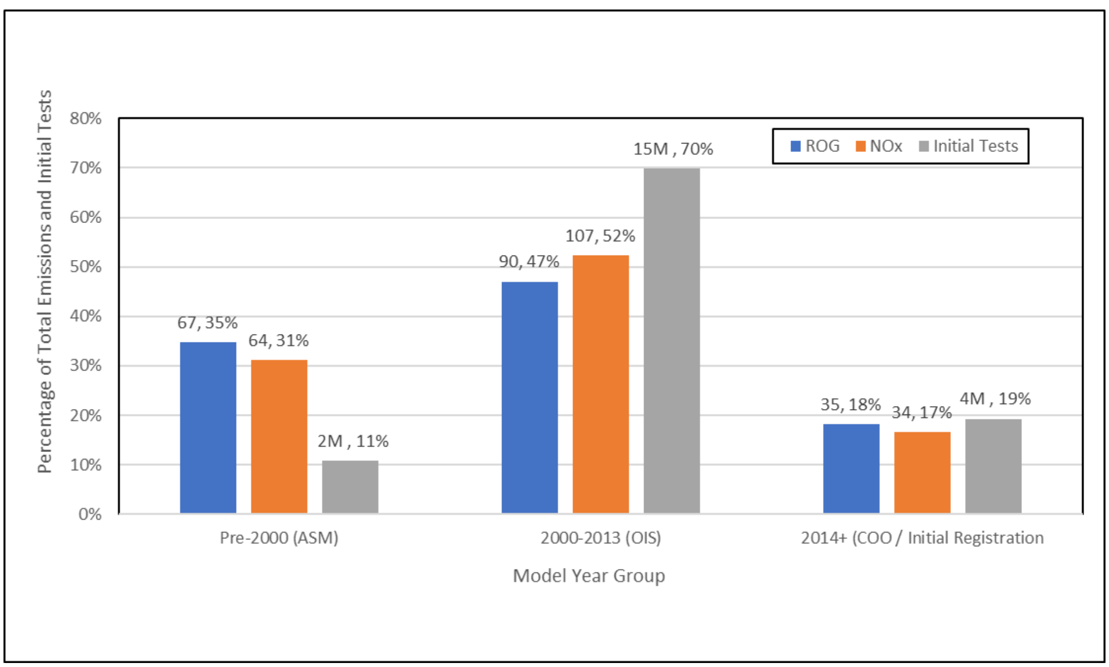
Current Estimate of Excess Emissions

The authors of the 2009 Report used roadside ASM emission test results to derive the estimate of an additional 70 tpd reduction of HC+NOx achievable through Program improvements. Because emissions are not measured for 2000 and newer MY vehicles within Smog Check (approximately 90% of the on-road fleet), differences in emission levels of vehicles certified by high and low performing stations could not be reliably estimated for this version of the report. Alternatively, CARB's official on-road motor vehicle emissions inventory model, EMFAC (Emission Factor), along with Smog Check and roadside inspection data were used to estimate achievable reductions.

CARB developed, maintains, and routinely updates their EMFAC computer model, which is designed to estimate the emissions of California's on-road fleet. The latest version of the model available at the time of this report, EMFAC2021 (v1.0.2), was used to estimate the excess emissions associated with the Program. In this instance, excess emissions are defined as those additional benefits that could be realized if all vehicles subject to the Program were inspected at "high performing" Smog Check stations.

According to EMFAC, gasoline-, and diesel-powered light-duty autos, light-, and medium-duty vehicles, and light-heavy-duty trucks with a gross vehicle weight rating (GVWR) of less than 14,001 pounds contributed a total of 289 tpd of ROG+NOx to the CY 2022 statewide emissions inventory. A breakdown of the inventory by MY group and pollutant is shown in Figure 7 below along with the number of initial Smog Check tests performed over the CY 2021-2022 biennial inspection cycle.

Figure 7
Exhaust ROG + NOx Emissions by Model Year Group
and Number of Smog Check Inspections Performed in CY 2021-2022*

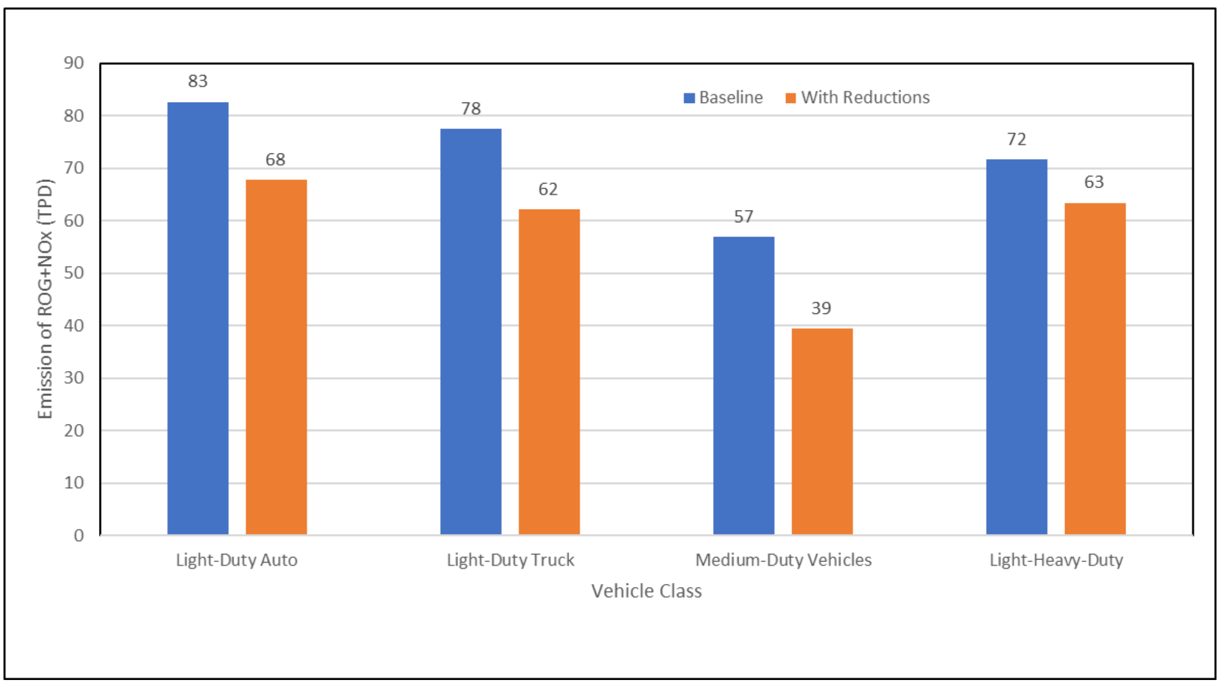


*The numbers above the bars represent the emissions in tons per day or number of initial tests in millions (M) followed by the percentage of the total inventory or total number of initial tests performed.

It is important to note that the current version of EMFAC does not explicitly model the impact of the Program on the emissions inventory. Like roadside inspections, the benefits of the Program are assumed to be implicitly reflected within the baseline. Further, it is assumed within CARB's model that increases in fleet emissions are directly attributable to the degradation in effectiveness, or the complete failure of emission control components and systems.

Under these assumptions, a one-to-one relationship can be established between the age specific failure rates as observed during roadside and initial Smog Check inspection, with the age specific emissions rates as estimated by EMFAC. For purposes of this report, the potential additional benefits of the Program were determined by lowering the RFRs to a level equal to that of the initial SCFRs and calculating the related change in emissions. Using this methodology, it is estimated that approximately 56 tpd of additional benefit (reduction in emissions of ROG+NOx) could be achieved if all Smog Check stations were to perform at the level of high performing stations (See Figure 8 below). That is, if RFRs were equivalent to the SCFRs, the resulting reduction in emissions would be equivalent to removing close to 2.5 million (fleet average) gasoline-powered passenger cars from daily operation. The methodology used in estimating the additional potential benefits of the Program are included in Attachment C of this report.

Figure 8
Potential Reductions of Exhaust ROG + NOx
By Vehicle Class for CY 2021-2022



Evaluation of Best Practices of Vehicle Inspection Programs prepared by University of California Riverside (CE-CERT)

The following is a summary of the current techniques, practices, and procedures utilized within I/M programs conducted in 30 U.S. states and the District of Columbia. Each of the programs evaluated here were found to utilize at least one, but more typically some combination of two or more of the test procedures described below.

OBD Tests

OBD tests are typically administered to 1996 and newer MY gasoline-powered vehicles and 1998 and newer MY diesel-powered vehicles equipped with OBD systems. The test is performed while the vehicle is stationary. After communication is established with the OBD system, the vehicle's on-board computer is queried to determine test readiness and collect any stored diagnostic trouble codes (DTCs) that are relevant in assessing that components and systems that are critical for emissions control are functioning properly. DTCs observed in the CY 2021-2022 roadside OIS tested fleet are presented in Table 5 (below).

Table 5
Observed DTCs by Category for Roadside OIS Inspected Vehicles*

DTC Category	Observations	Percentage	DTC Description
P01	928	22.7%	Air Fuel Metering System
P02	18	0.4%	Fuel or Air Metering Injection System
P03	774	18.9%	Ignition System
P04	1391	34.0%	Emissions System
P05	82	2.0%	Speed and Idle Control System
P06	31	0.8%	Computer Output Circuit
P07-P08	165	4.0%	Transmission-related

*Several vehicles were found to have multiple stored codes.

Loaded Mode Tests

Typically administered to 1995 and older MY (pre-OBD) vehicles weighing less than 14,001 pounds GVWR, loaded mode tests require vehicles to be operated under load on a treadmill-like device called a dynamometer. Emissions are measured while the vehicle is in operation with the drive wheels on the dynamometer. Several different driving cycles (vehicle speed/time/load traces) are used throughout the states including the I/M 97, I/M 147, I/M 240, the ASM 25/25, and the ASM 50/15. (The number following "I/M" in the name of the test denotes the length of the test cycle in seconds. The numbers in the numerator and denominator that follow "ASM" in the name of the test denote the load on the vehicle expressed in percent, and the vehicle speed in miles per hour (mph), respectively.)

Idle Tests

Although best practices dictate that a loaded mode test be performed, idle tests can be conducted without a dynamometer and are therefore less costly. Idle tests are typically administered to older vehicles (pre-catalyst equipped) or vehicles that cannot easily or safely be tested on a dynamometer (including most all-wheel drive vehicles (AWD), some vehicles with anti-lock braking systems (ABS), and vehicles weighing more than 14,000 pounds GVWR). During an idle test, tailpipe emissions of HC and carbon monoxide (CO) are collected from a stationary vehicle operating at one or more engine speeds (low and/or high idle). NOx is not measured during idle tests as NOx emissions are produced under load.

Gas Cap/Evaporative System Tests

A properly sealing gas cap is essential in limiting evaporative emissions from escaping the fuel tanks of gasoline-powered vehicles. During the gas cap test, a technician may perform a visual examination to see that the cap fits tightly to the fuel filler neck. Alternatively, a functional check may be performed to ensure that the cap can hold pressure without leaking. Some states including California perform a test of the vehicle's evaporative emission control system. Using an adaptor in place of the gas cap and after temporarily sealing a vapor line, a small amount of nitrogen is injected to test the system for leaks.

Opacity Tests

Typically administered to diesel-powered vehicles, opacity tests are performed to determine the amount of light absorbed by the vehicle's exhaust as a proxy for emission levels of particulate matter (PM). The exhaust plume is evaluated while the vehicle's engine is in operation. Various test procedures are used to determine levels of opacity including:

- The **Snap-Idle** or **Snap-Acceleration** test calls for the engine speed to be raised from idle to the maximum speed as rapidly as possible with the vehicle in park, followed by fully releasing the throttle allowing the engine to return to idle.
- The **Lug-Down** is a loaded test performed either on-road or on a dynamometer. At wide open throttle (WOT) the engine is slowly loaded using the service brakes. Loading is applied linearly throughout an engine rpm range from maximum to seventy percent in no less than seven seconds.
- The **Stall Test** Procedure is a full-load stationary test designed for vehicles equipped with automatic transmissions. With the vehicle brakes applied, engine speed is increased until the transmission's stall speed is attained.[9] Stall speed is maintained for approximately five seconds to allow for stabilization.
- The **High Idle** Test Procedure is performed with the vehicle's transmission in neutral. The engine speed is slowly increased to the maximum governed no-load rpm and the plume is evaluated when the rpm stabilizes.

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9 Stall speed is the maximum engine RPM achieved with the transmission in a forward operating gear without generating any driveshaft motion (i.e., the vehicle remains stationary).

Visual Inspections

Technicians may perform a visual inspection of the vehicle to determine the presence and condition of the following visually inspected components:

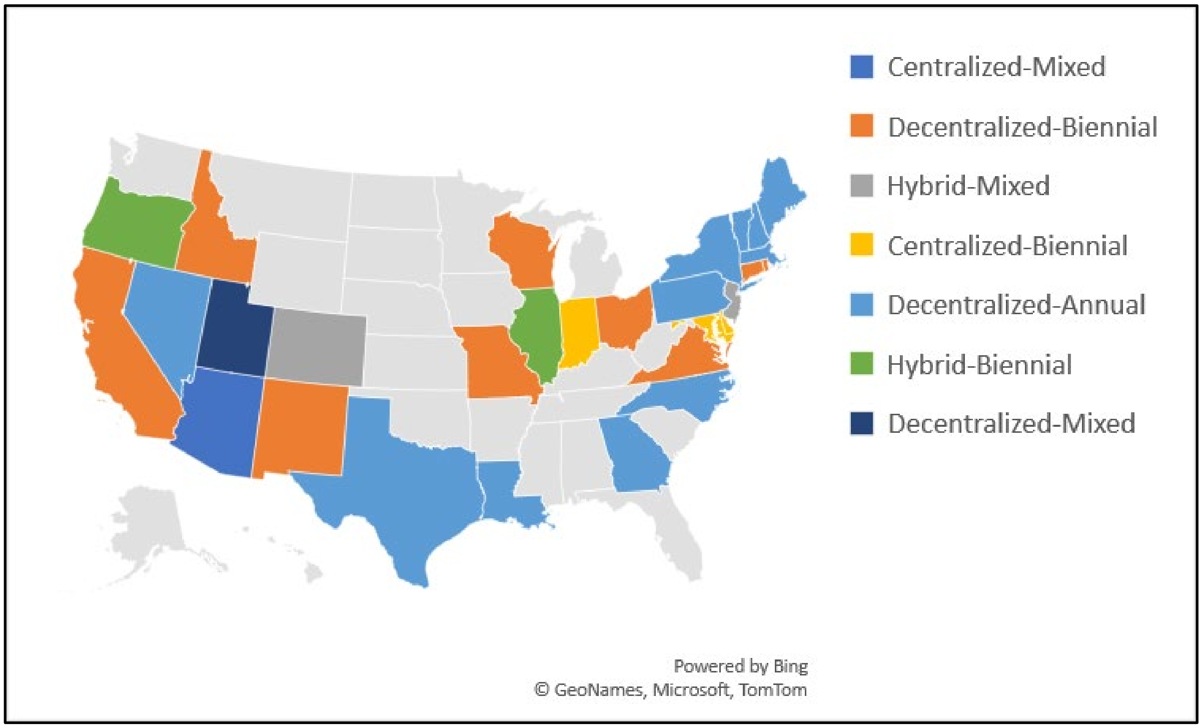
- Crankcase Emission Controls
- Fuel Evaporative System
- Exhaust Gas Recirculation (EGR)
- Fuel Metering System
- Computers, Sensors, and Switches
- Liquid Fuel Leaks
- Thermostatic Air Cleaner (TAC)
- Exhaust Gas After Treatment System
- Ignition Spark Controls
- Air Injection System (AIS)
- Other Emission Related Components
- Visible Smoke

I/M Program Summary

The programs evaluated in this summary can be divided into broad categories by:

- **Program Administration** (i.e., who holds primarily responsibility for vehicle testing)
  - Centralized (test performed by government or their contractor)
  - Decentralized (test performed by entities licensed by the state) or
  - Hybrid, which is a mixture of both centralized and decentralized testing.
- **Frequency of testing**
  - Annually – every year
  - Biennially – every other year

Figure 9
I/M Program Administration and Inspection Frequency by Area



The largest fraction of states conducting I/M was found to operate decentralized programs with an annual inspection requirement (11 states). The second most frequently occurring program structure is decentralized-biennial, which is utilized in California and nine other states including Connecticut, Idaho, New Mexico, Missouri, Ohio, Rhode Island, Utah, Virginia, and Wisconsin. Three states, Delaware, Indiana, and Maryland, employ centralized-biennial programs, and two, Arizona and the District of Columbia, administer centralized-mixed programs. Illinois and Oregon utilize a hybrid-biennial approach, while Colorado and New Jersey run a hybrid-mixed program.

- The Tennessee Department of Environment and Conservation (TDEC) announced August 17, 2021, that emissions testing in several counties would end. Beginning January 14, 2022, residents in Hamilton, Williamson, Rutherford, Sumner, and Wilson counties have been able to register or renew their vehicle registrations without obtaining an emissions test certificate.
- There are currently five contractors supporting state I/M programs. Opus/Gordon Darby now administers I/M programs in 17 states and the District of Columbia. Applus+ Technologies supports six 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).
- Thirteen 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.

- California, 10 other states, and the District of Columbia require vehicles to be tested upon change of ownership. Two 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 that is significantly and adversely impacted by on-road motor vehicles. Statewide testing in California is only required for change of ownership and initial registration.
- The overall number of emissions testing stations fell nationwide over the past year, presumably due to the pandemic and the steadily diminishing population of pre-OBD vehicles. The number of licensed stations dropped by nearly 1,000 in California in 2022 compared to the previous year.
- California had 6,628 licensed stations in 2022, which is the third largest in network size behind New York (10,000 stations) and Pennsylvania (8,000 stations). Other states range from as few as two stations in the District of Columbia, to as many as 5,700 in Texas. Delaware, Indiana, and Oregon each have less than 10 stations in their test networks.
- The average cost of inspection varies widely from state to state and by test type. The cost associated with annual inspection ranges from as little as $10.00 in Louisiana, to as much as $52.50 in Missouri. For those biennial programs that charge an inspection fee, costs range from a low of $14.00 in Maryland, to a high of over $70.00 in California. Delaware, Illinois, Indiana, Ohio, and Wisconsin do not charge inspection fees. Centralized tests in New Jersey are also performed at no charge to vehicle owners.
- Except for Idaho, all states and the District of Columbia require the periodic testing of hybrid-electric vehicles.
- Given the low failure rate among the newest vehicles in the fleet, most I/M programs, with the notable exception of Maine, New Hampshire, and Vermont, exempt new vehicles from testing from 1 to 8 years.

Supplemental Programmatic Elements

In addition to the features described above, several states have implemented supplemental test procedures designed to either better identify those vehicles most likely to benefit from inspection and/or provide greater convenience to vehicle owners.

- **Remote Sensing** - Remote Sensing Devices (RSD) are an integral part of the I/M programs in Colorado, Connecticut, Ohio, Rhode Island, and Texas. These devices measure emissions by shining a laser across a roadway. Pollutant concentrations are determined by measuring the attenuation of the laser signal through the exhaust plume of passing vehicles. The advantage of using RSD is that many vehicles can be tested quickly and relatively inexpensively. However, because only a "snapshot" of the

vehicle’s emissions is captured under either uncontrolled or loosely controlled conditions, RSD is typically used to make coarse determinations. A determination that vehicles are low emitting, a practice referred to as “clean screening,” is used to consider exemption from inspection. Monitoring the fleet for high emitting vehicles is referred to as “dirty screening.” It is important to note that vehicles are not usually failed based on RSD readings alone, rather suspect vehicles are required to undergo more comprehensive inspection within conventional programs. The state of Virginia is scheduled to end RSD testing in March of 2023. Arizona is nearing the completion of a three-year RSD pilot project; the results of which will be used to determine the viability of establishing a more comprehensive program in that state.

- **Remote OBD** - In California, Oregon, Nevada, and Utah’s Davis County, portions of the light-duty fleet subject to periodic testing are allowed to opt into a remote OBD monitoring program. Participating vehicles are fitted with devices that allow their on-board computers to be queried remotely and relevant data are retrieved through telematics. The advantage of this approach is the ability to continuously monitor vehicle emission control systems compared to testing once per year or once every other year. Although currently more expensive than conventional testing, this approach has been shown to be convenient for subscribers and has the potential of achieving surplus emission reductions by minimizing the time between failure and repair, and detection of failure in the otherwise exempted fleet. Participation in California’s remote OBD inspection, the Continuous Test Program (CTP), is currently limited to light-duty vehicles operated by government fleets.

- **OBD Kiosks** - Maryland, Ohio, Oregon, and the District of Columbia offer a self-testing option to owners of OBD-equipped vehicles. Motorists use an ATM-like touch-screen computer equipped with a cable designed to interface with their vehicles’ on-board computer. OBD kiosks are conveniently located and are available 24 hours per day, seven days per week. Although this approach appears promising, several states have expressed reluctance to adopt this unsupervised form of testing given the prevalence of the fraudulent use of surrogate vehicles or defeat devices.

- **Mobile/On-Site OBD Testing** - Rather than have dealerships or fleets bear the cost and inconvenience of bringing cars in one-by-one for testing at a licensed station, the state of Oregon offers on-site testing by appointment. The availability of Oregon’s Mobile on-site testing (MOST) units saves participating vehicle owners both time and travel costs. The same fraud-related concerns expressed with respect to OBD kiosks apply to mobile testing unless these inspections are conducted by the state or their designated contractor.

Summary of Best Practices of I/M Programs

The following are considered best practices for I/M programs in the U.S. A summary of the different testing practices by State is provided in Table 6.

Test Frequency

Those states and districts performing periodic emissions inspections are almost equally split between those requiring biennial and annual tests. It has been suggested that more frequent inspection (annual rather than biennial) might result in lessening fraud and increasing emission reductions. These potential positives must be weighed against increased costs and public inconvenience.

OBD-Equipped Vehicles

Best practices call for:

- a scan of the vehicle's on-board computer to verify that monitors have run and that DTCs are present.
- clearance of permanent DTCs by running the vehicle's self-check rather than clearing codes with a scan tool or disconnecting the vehicle's battery.
- the development and incorporation of a comprehensive system for the detection of fraud in decentralized programs.

Non OBD-Equipped Vehicles

Best practices include several methods for the inspection of pre-OBD vehicles including:

- Performance of loaded-mode dynamometer emissions testing using established cycles such as the I/M 240, I/M 147, or ASM tests.
- Performance of a two-speed idle emissions tests for vehicles that cannot safely or reliably be tested on a dynamometer.
- The use of RSD or similar method to make quick pass/fail determinations.

Evaporative System Checks

The main elements of evaporative system checks include the following, which are currently integrated into California's Program:

- Low-pressure evaporative system tests to check for leaks for pre-OBD vehicles.
- Separate leak check of the fuel cap.

Visual Inspection of the Emission Control System

Inspection of the emission control systems should include:

- Performance of an inspection for the presence and outward appearance of the catalyst, EGR system, air injection, positive crankcase ventilation, etc.

Specific Suggestions for Program Improvement

- As the population of pre-2000 MY vehicles continues to decline, maintaining the dynamometers and emissions test equipment needed to inspect these vehicles becomes increasingly cost prohibitive. BAR should consider establishing a centralized test network, perhaps through the expansion of the existing Referee network, for the inspection of pre-2000 MY vehicles. Centralized testing of pre-2000 MY vehicles should eliminate fraudulent certification and ineffective repairs, however, BAR might consider increasing test frequency should failure rates remain high. It should be noted that BAR raised the issue of centralized inspections for vehicles requiring BAR-97 inspections in their 2023 Sunset Review report.
- BAR should consider implementing approaches to limit refusals for testing at roadside. In CY 2021-2022, approximately 8,000 vehicle owners declined to participate in roadside inspection, which represents about a third of the total vehicles solicited. Although these refusals have not been shown to skew the overall roadside results, it is reasonable to assume that as the rate of refusal increases, confidence in the representativeness of the result decreases. At a minimum, a visual inspection of the malfunction indicator light (MIL) should be conducted for those OBD equipped vehicles whose owners refuse to undergo more comprehensive testing.
- In order to minimize inspection time and maximize convenience, tests of evaporative emission control systems are not currently performed at roadside. BAR might consider implementing, alone or in cooperation with CARB, a special test program specifically designed to gather information on the frequency and severity of evaporative system failures. The results of such a program would be used to assess the effectiveness of efforts to control evaporative emissions within Smog Check and to better estimate the incidence and impact of Clean Tanking.
- BAR should consider addressing the issue of fraudulent tests through the modification of EIS algorithms. As proposed, the technician would be warned when a test result appears to be fraudulent. A system lock-out would be imposed if multiple suspected fraudulent entries are made. Vehicles that are certified under suspicious conditions would be referred to the Referee for confirmatory testing.
- BAR should consider expansion of their remote OBD pilot program (CTP) to non-governmental fleets with compliance tied to “fix-it” tickets. The current practice of anchoring compliance to vehicle registration may limit the potential benefits of prompt compliance as motorist tend to delay repair until their required inspection, which could be up to two years under the current Program requirements and up to eight years for newer, exempted vehicles.
- Each year BAR directs a number of vehicles with a high likelihood of failing Smog Check to be tested by STAR stations. BAR might explore the feasibility of refocusing their selection criteria to include vehicles that may have been fraudulently certified during their last inspection cycle as well as newer vehicles currently exempted for age.
- The effectiveness of an OBD-based program could potentially be improved by adopting supplemental elements that either expand coverage, lower costs, and/or increase

consumer convenience including the use of OBD kiosks, and mobile testing. BAR may consider a pilot where kiosks are made available to governmental and/or municipal fleet vehicles and establishing mobile platforms utilized by the Referee.

- As emissions are not measured for the 90% of the on-road fleet that is MY 2000 or newer, BAR should consider working with CARB on designing future surveillance programs and developing a version of the EMFAC capable of estimating the current and potential benefits of the Smog Check program.

Table 6
I/M Test Requirements by State

State	Fuel	GVWR	Model Year(s)	Steady State	Loaded Mode	OBD	Gas Cap	Opacity	Visual
Arizona	Gas	-	1996+	-	-	X	-	-	X
Arizona	Gas	<8501	1967-1995	-	I/M 147	-	-	-	X
Arizona	Gas	<26001	-	-	-	-	-	Dyno	X
Arizona	Diesel	>26000	-	-	-	-	-	Snap Idle	X
California	Gas	<14001	2000+	-	-	X	-	-	X
California	Gas	-	<2000	-	ASM25/25	-	-	-	-
California	Gas	-	<2000	-	ASM50/15	-	X	-	X
California	Diesel	<14001	1998+	-	-	X	-	Snap Idle	X
Colorado	Gas	-	Age 8 to 11	-	-	X	-	-	-
Colorado	Gas	-	Age 12+	-	I/M 240	-	-	-	-
Colorado	Gas	-	<1982	TSI	-	-	-	-	-
Colorado	Diesel	-	-	-	-	-	-	X	-
Connecticut	Gas	<8500	1996+	-	-	X	X	-	-
Connecticut	Gas	8500-10000	All	PC TSI	-	-	X	-	-
Connecticut	Gas	-	1995	-	ASM25/25	-	X	-	Catalyst
Connecticut	Diesel	<8501	1997+	-	-	X	-	X	-
Connecticut	Diesel	8501-10000	-	-	-	-	-	X	-
Delaware	Gas	<8501	1996+	-	-	X	X	-	Catalyst
Delaware	Gas	-	1981-1995	TSI	-	-	X	-	Catalyst
Delaware	Diesel	-	1968-1990	Curbside	-	-	X	-	Catalyst
Delaware	Diesel	-	1997+	-	-	X	-	-	-
D.C.	Gas	<8501	1996+	-	-	X	-	-	-
D.C.	Gas	-	1984-1995	-	I/M 240	-	-	-	-
D.C.	Gas	-	1968-1983	TSI	-	-	-	-	-
D.C.	Gas	-	1975+	-	-	-	X	-	Catalyst

State	Fuel	GVWR	Model Year(s)	Steady State	Loaded Mode	OBD	Gas Cap	Opacity	Visual
Georgia	Gas	<8501	1996+			X	X	-	Catalyst
Idaho	Gas	<14001	1996+	-	-	X	X	-	X
Idaho	Gas	-	1981-1995	TSI	-		X	-	X
Idaho	Diesel	-	1997+	-	-	-	-	-	-
Idaho	Diesel	-	<1997	-	-	-	-	Snap Idle	-
Illinois	Gas	<8501	1996+	-	-	X	-	-	-
Illinois	Gas	8501-14000	2007+	-	-	X	-	-	-
Indiana	Gas	<9001	1996+	-	-	X	X	-	-
Indiana	Gas	-	1981-1995	-	I/M 93	-	X	-	-
Indiana	Gas	-	1976-1980	SSI	-	-	X	-	-
Louisiana	Gas	<10001	1996+	-	-	X	X	-	Catalyst
Maine	Gas	-	1996+	-	-	X	X	-	Catalyst
Maine	Gas	-	1983-1995	-	-	-	X	-	Catalyst
Maine	Gas	-	1974-1982	-	-	-	X	-	-
Maine	Diesel	>18000	-	-	-	-	-	X	-
Maryland	Gas	<8501	1996+	-	-	X	-	-	Catalyst
Maryland	Diesel	<14001	-	-	-	X	-	-	Catalyst
Maryland	Diesel	8501-26000	-	SSI	-	-	X	-	Catalyst
Massachusetts	Gas	-	2005+	-	-	X	-	-	-
Massachusetts	Diesel	>10000	-	-	-	-	-	X	-
Missouri	Gas	<8501	1996+	-	-	X	-	-	--
Missouri	Diesel	-	1997+	-	-	X	-	-	-
Nevada	Gas	<14001	1996+	-	-	X	-	-	-
Nevada	Diesel	-	1968-1995	TSI	-	-	-	-	-
New Hampshire	Gas	<8501	1996+	-	-	X	-	-	-
New Hampshire	Diesel	-	-	-	-	-	-	-	-

State	Fuel	GVWR	Model Year(s)	Steady State	Loaded Mode	OBD	Gas Cap	Opacity	Visual
New Jersey	Gas	-	1996+	-	-	X	-	-	-
New Mexico	Gas	<10001	1996+	-	-	X	X	Smoke	-
New York	Gas	<8501	1996+	-	-	X	X	Smoke	X
New York	Gas	<18000	<25 To 1995	-	-	-	-	-	Comp
New York	Diesel	<8501	1997+	-	-	X	-	-	-
New York	Diesel	<18000	<1997	-	-	-	-	X	Comp
North Carolina	Gas	<8501	1996+	-	-	X	-	-	-
Ohio	Gas	-	1996+	-	-	X	X	-	-
Ohio	Diesel	-	1997+	-	-	X	-	-	-
Oregon	Gas	-	1996+	-	-	X	-	-	-
Oregon	Gas	-	<1996	SSI	-	-	-	-	-
Pennsylvania	Gas	<8501	1996+	-	-	X	X	-	-
Pennsylvania	Gas	-	<1996	-	-	-	X	-	Comp
Rhode Island	Gas	<8501	1996+	-	-	X	-	-	-
Rhode Island	Diesel	-	1997+	-	-	X	-	-	-
Rhode Island	Diesel	-	<1997	-	-	-	-	-	X
Tennessee	Gas	-	1996+	-	-	X	Visual	-	-
Tennessee	Gas	-	<1996	TSI	-	-	Visual	-	-
Tennessee	Diesel	-	2002+	-	-	X	-	X	-
Tennessee	Diesel	-	<2002	Curbside	-	-	Visual	-	X
Texas	Gas	-	1996+	-	-	X	-	-	-
Texas	Gas	-	<1996	TSI	-	-	-	-	-
Utah	Gas	All Weights	1969-1995	TSI	-	-	-	-	-
Utah	Gas	<8501	1996-2007	-	-	X	-	-	-
Utah	Gas	8501+	1996-2007	TSI	-	-	-	-	-
Utah	Gas	<14001	2008-2018	-	-	X	-	-	-
Utah	Gas	>14000	2008-2018	TSI	-	-	-	-	-

State	Fuel	GVWR	Model Year(s)	Steady State	Loaded Mode	OBD	Gas Cap	Opacity	Visual
Utah	Diesel	<14001	1998-2006	-	-	-	-	-	X
Utah	Diesel	<14001	2007-2018	-	-	X	-	-	-
Vermont	Gas	-	2005+	-	-	X	Visual	-	Catalyst
Vermont	Diesel	-	2005+	-	-	X	-	-	-
Virginia	Gas	<10001	1996+	-	-	X	Visual	-	-
Virginia	Diesel	<8501	1997+	-	-	X	-	-	-
Wisconsin	Gas	<8501	1996-2018	-	-	X	-	-	-
Wisconsin	Gas	8501-14000	2007-2018	-	-	X	-	-	-
Wisconsin	Diesel	8501-14000	2007-2018	-	-	X	-	-	-

Attachments

Attachment A – Specific Comments from University of California, Riverside, Bourns College of Engineering – Center for Environmental Research and Technology (CE-CERT) “Review of the 2021 Smog Check Performance Report” and BAR Responses

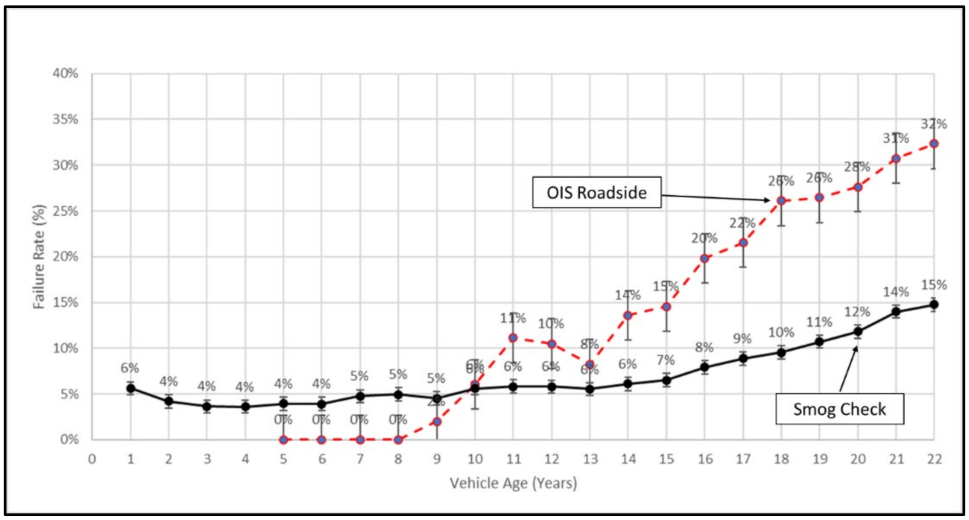
Attachment B – List of Acronyms

Attachment C – Methodology and sample calculation of additional potential benefits of Smog Check

Attachment A
Specific Comments from CE-CERT "Review of the 2022 Smog Check Performance Report" and BAR Responses

This attachment consists of specific comments from the *Review of the 2022 Smog Check Performance Report* conducted by the University of California at Riverside's, Bourns College of Engineering - Center for Environmental Research and Technology, (CE-CERT) in November of 2022, with annotations (*in italics*) by BAR. Comments by CE-CERT on specific statements, tables, and page numbers refer to BAR's 2022 SCPR.

Figure 1
OIS Fail Rates by Vehicle Age using Smog Check and Roadside Testing Data
(CY 2020-2021, MY 2021 and Older Gasoline-Powered Vehicles)



CE-CERT: Page 4 – in reference to Figure 1

It seems unusual that there is a roughly 5% failure rate for vehicles 9 years old or newer, and 6% or less for the first 14 years. This seems high. Although newer vehicles are not required to get a periodic Smog Check, it still looks like 11% of the vehicles that are Smog Check tested are 8 years old or newer. Looking at the response to a question related to Figure 1 in the previous SCPR in Attachment A, there appears to be a consistent 5% failure rate in the first 12 years in that set. Does BAR have an explanation for the consistent 5% failure rate? If there is a consistent 5% failure rate in the fleet, it might be worth investigating roadside tests to see if exempting vehicles less than 8 years old from inspection is still appropriate.

BAR Response: *Several questions are raised by CE-CERT in their first comment.*

1. Does the 5% failure rate for vehicles 9 years old or newer, and 6% or less for the first 14 years appear high?

   It is important to note that those vehicles tested during the first eight years of life are not representative of the rest of the fleet. These vehicles are either registering in California for the first time or undergoing a change of ownership. That being said, because the *failure rate does not change significantly beyond the period of exemption, the 5% rate of failure is not considered abnormally high.*

2. Does BAR have an explanation for the consistent 5% failure rate?

   Because the compliance with Smog Check requirements for OIS equipped vehicles is based primarily upon "self-report" by the vehicles' OBD systems rather than the direct measurement of emissions, the major cause of failure tends to be related to readiness.

3. If there is a consistent 5% failure rate, should BAR revisit exempting these vehicles from inspection?

   BAR has no plans to revisit the new vehicle exemption at this time. The decision to exempt newer vehicles from periodic inspection was based upon several factors including the fact that these vehicles tend to have a low failure rate; contribute significantly less to the total on-road emissions inventory than their numbers would imply; are covered under manufacturers' warranty against failure of emission control components or systems; are subject to recall; and are required to be inspected upon initial registration in the state and upon change of ownership.

CE-CERT: Page 4 – Footnote 3

[3]"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."

It would be useful for BAR to provide some information about how the FPR score is derived. For example, does an FPR > 0.9 represent the top 10% of stations?

BAR Response: *It would be more accurate to think of the FPR as a grade ranging from 0 to 1 as opposed to a ranking. FPRs reflect the probability that the vehicles previously certified by that station or inspector are passing at a rate that is above average. As such, an FPR score that is greater than .9 would be akin to an "A rating" rather than denoting performance in the top 10% among stations or technicians. More information about the definition and derivation of FPR scores can be found by following this link:* [STAR Program FAQ - Bureau of Automotive Repair (ca.gov)]

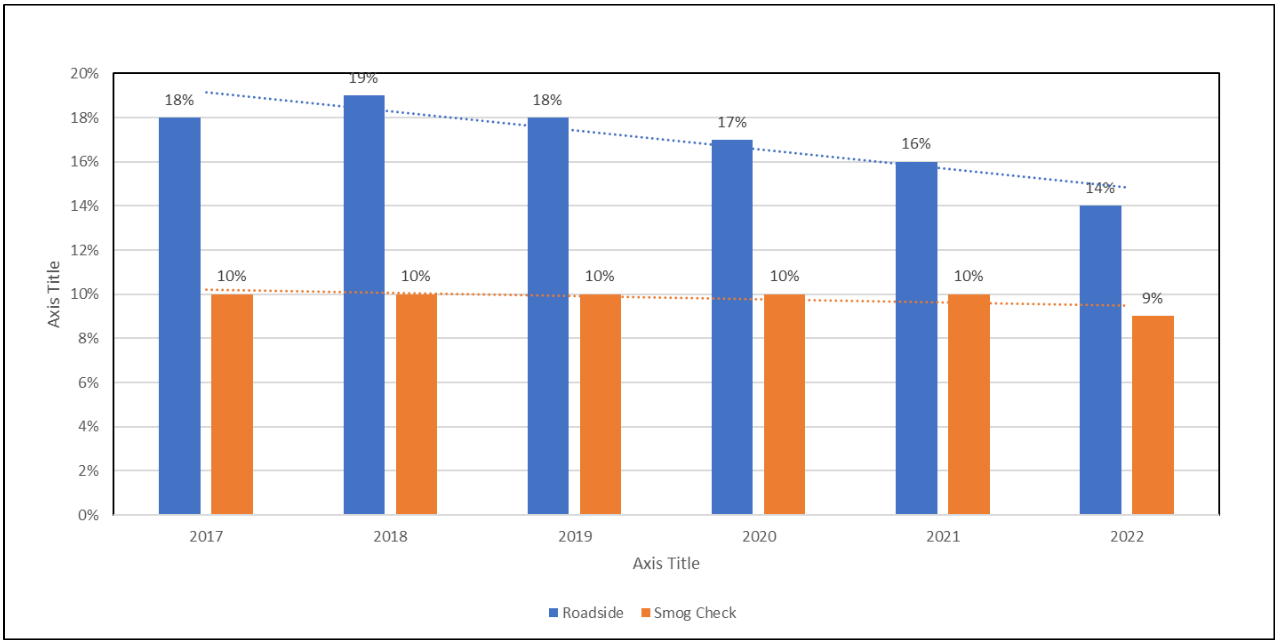
CE-CERT: Page 5 – Summary Findings #3

3. Incremental improvements to the Smog Check Program are evidenced through declining differences between roadside and Smog Check failure rates, and an increase in enforcement actions against stations and technicians engaging in fraudulent practices.

No information is provided on the differences between the roadside and Smog Check failure rates over time.

BAR Response: *Although not expressly spelled out in the 2022 SCPR, a review of BAR's Annual Executive Summary reports confirm that Smog Check failure rates have declined over time. The figure below presents historic Roadside and Smog Check failure rates and the* *following link is provided to access BAR's Executive Summary Reports: [Search Results - Bureau of Automotive Repair (ca.gov)]*

Historic Random Roadside and Smog Check Failure Rates



CE-CERT: Page 6 – Footnote 4

"[4] Austin, T., McClement, D., and Roeschen, J.D., 2009, "Evaluation of the California Smog Check Program Using Random Roadside Data, Report No. SR09-03-01, March 12, 2009, Sierra Research http: www.calautoteachers.com/PDF/Final_RoadsideReport_O31209.pdf"

The published link is no longer active. It seems that it would be worthwhile to post the Sierra Research report on BAR's website in association with the SCPR since it is a foundational document.

BAR Response: *The report can be accessed through the following link [Evaluation of the California Smog Check Program on JSTOR,] which will be included in subsequent versions of the SCPR.*

CE-CERT: Page 7- 1st paragraph – in reference to Table 2

Table 2
Roadside Inspection Datasets (Vehicles Tested)

Model Year Group	CY 2019	CY 2020	CY 2021
1976-1995	877	124	175
1996-1999	1,576	264	446
2000-2003	3,152	538	1,080
2004-2006	2,310	452	1,015
2007+	2,925	712	2,038
Total	**10,840**	**2,090**	**4,754**

The report refers to 6,800 vehicles being used to support the findings of the report, but the number of vehicles in table 2 is greater than 17,000, so some clarification about where the 6,800 number comes from is needed.

BAR Response: *The report points out that approximately 6,800 vehicles were tested at roadside for calendar years 2020 and 2021 (2,090 in 2020 and 4,754 in 2021), which is significantly less compared to the 10,840 vehicles tested pre-pandemic in 2019.*

CE-CERT: Page 7 – 1st paragraph

The report speaks to the scarcity of test data for pre-2000 MY vehicles to present separate results, however Table 2 shows that over 3,462 pre-2000 vehicles were tested. This seems like a number that is significant enough for analysis. If this number is insufficient, I think the reasoning for why it was determined to be insufficient should be given. Is there a specific number of samples from statistical methods that was used as a benchmark?

BAR Response: *It is important to note that of the 3,462 vehicles mentioned, close to half, 1,576 vehicles, were tested in 2019 (See Table 2 above). Only 388 pre-200 MY vehicles were tested in calendar year 2020 and 681 in 2021. Combined data were used to produce the results displayed in Table 1 of the report and the dataset was insufficient to perform the model year specific analysis shown in Figure 1 of the 2022 SCPR (See Table below).*

Pre-2000 MY Roadside Inspection Dataset for Calendar Years 2020 and 2021
(Vehicles Tested within One Year after Smog Check)

Model Yr.	Vehicles	Model Yr.	Vehicles	Model Yr.	Vehicles	Model Yr.	Vehicles
1999	149	1993	30	1987	14	1981	1
1998	153	1992	35	1986	18	1980	1
1997	102	1991	44	1985	12	1979	0
1996	94	1990	25	1984	6	1978	4
1995	62	1989	19	1983	7	1977	2
1994	61	1988	23	1982	1	1976	0

CE-CERT: Page 9 – referring to the most prevalent fraudulent techniques

Since these acts are specific to either pre-2000 or 2000+ MY vehicles, it might be useful to have this denoted in the bullet points, so that it is easy for the reader to see going into the discussions. i.e., “Clean Piping (pre-2000 vehicles).”

<u>BAR Response</u>: *Good suggestion. The following clarification will be included in subsequent reports.*

- Clean Piping (pre-2000 MY vehicles)
- Clean Gassing (pre-1996 MY vehicles)
- Clean Plugging (2000+ MY vehicles)
- Clean Tanking (pre-2000 MY vehicles), and
- Registration-based fraud (all vehicles)

CE-CERT: Page 10 – 2nd paragraph – referring to the most prevalent fraudulent techniques

“Finally, Registration-based fraud involves providing false information to Department of Motor Vehicles (DMV) in order to obtain registration without a required Smog Check.”

It would be useful to provide some examples.

<u>BAR Response</u>: *Smog Check requirements are specific to the region of the state where the vehicle is registered. A number of motorists have falsely claimed that their vehicles are registered in “attainment areas” of the state in order to avoid inspection. Others have reported to DMV that their vehicles have been converted and are no longer powered by gasoline or diesel fuel, again as a means of bypassing inspection.*

CE-CERT: Page 10 – in reference to Table 3

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)

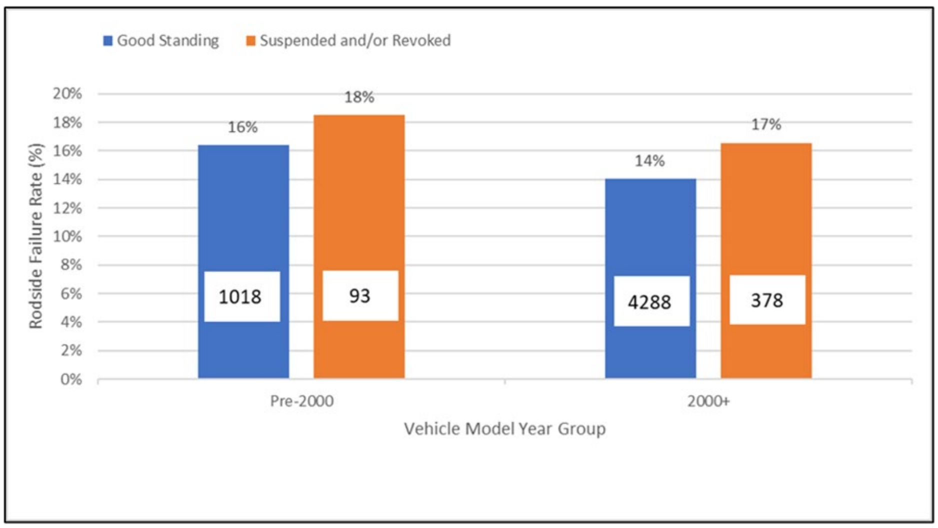
Year	Case Filings to OAG	Outcome: Revocation	Outcome: Suspension	Outcome: Probation
2016	117	2	0	0
2017	555	39	0	3
2018	252	280	9	9
2019	63	342	30	48
2020	96	249	24	69
2021	99	124	36	47
Total	**1182**	**1036**	**99**	**176**

The report lacks discussion of the meaning of Table 3 or some of the notable trends. For example, it appears that there were significantly more filings in 2017 and 2018. Is this because the program identified the more egregious violators first? Alternatively, do you believe bad actors who are now aware of the greater scrutiny are better able to hide fraud?

<u>BAR Response</u>: *While it is likely that some stations and/or technicians have become more adept at concealing fraudulent acts, it is just as likely that many have ceased illegal activities in the face of prosecution and potential suspension or loss of licenses. New devices used to commit OBD fraud have outpaced the current DAD's ability to detect fraud. With the introduction of DAD 2.0, BAR will have improved ability to detect and prevent fraud.*

CE-CERT: Page 11 – in reference to Figure 5

Figure 5
Roadside Failure Rate by MY Group and Station License Status Where Vehicle was Last Certified

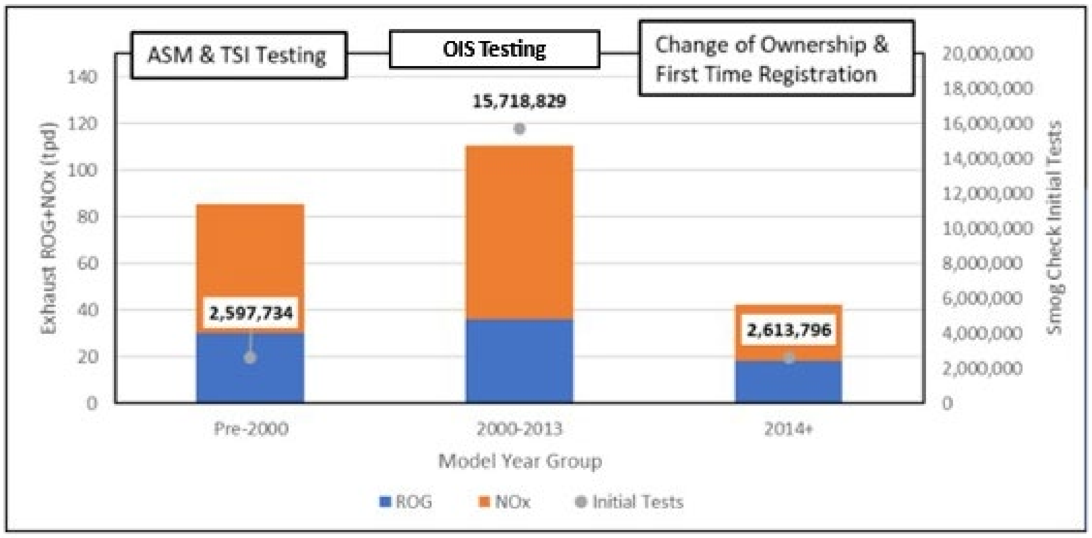


It would be interesting to see how the stations with high FPR ratings compare on this graph. It seems like it would be worth including that bar in the graph, with some corresponding discussion in the paragraph above this figure.

<u>BAR Response</u>: *BAR will consider inclusion of the suggested analysis in the 2023 version of the SCPR.*

CE-CERT: Page 12 – In reference to Figure 6

Figure 6
Exhaust ROG + NOx Emissions by Model Year Group and Number of Smog Check Inspections for CY 2020-2021



It might be clearer to the reader if the second "Y" axis were eliminated.

<u>BAR Response</u>: *BAR will explore alternative methods of presenting this information in the 2023 SCPR.*

CE-CERT: Page 12 – Last paragraph – 2nd sentence

"The potential benefit was determined by lowering the roadside failures to a level equal to Smog Check failures and recalculating emissions."

It might be worth mentioning that this factor was applied to both running exhaust and start emissions.

<u>BAR Response</u>: *Agreed. Both exhaust and starting emissions were included in both the 2021 and 2022 estimates of potential additional benefits.*

CE-CERT: Page 12 – Last paragraph – 3rd sentence

"Using this methodology, it is estimated that approximately 53 tpd of additional benefit (reduction in emission of ROG+NOx) could be achieved if all Smog Check stations were to perform at the level of high performing stations (See Figure 7 below)."

The amount of excess emissions calculated in the 2022 SCPR is significantly higher than that calculated in the 2021 SCPR, which was on the order of 20 to 40 tpd. Was this due to a change in the calculation methodology or other factors? From the final response to last year's comments, it appears that the 40 tpd was when cold start emissions were included. Presumably cold start emissions were also used in the current calculation.

<u>BAR Response</u>: *The estimate included in the 2022 SCPR represents a significant departure from the previous methodology. The estimate of potential additional emission reductions available through Smog Check presented in the 2021 SCPR was based on an assessment of the emissions measurements collected at roadside. These measurements were then applied to CARB's EMFAC model. The change was necessary given the scarcity of available roadside test data due to the pandemic and the diminishing population of pre-2000 MY vehicles. As stated in the 2022 SCPR, the estimate of potential emission reductions was based on the observed difference between roadside and Smog Check failure rates and these differences were used to modify the default assumptions in EMFAC. It is important to note that light-heavy-duty vehicles with a GVWR of up to 14,000 pounds were also included in the latest estimate, which were omitted in the previous methodology.*

CE-CERT: Page 12 – Last paragraph – Last sentence

"That is, if roadside failure rates were the same as Smog Check failure rates, the resulting reduction in emissions would be equivalent to removing close to eight million gasoline-powered passenger cars from daily operation."

In terms of removing the 8 million vehicles, it seems important to state what model year these vehicles are. Presumably it would be "with the same age distribution as the current in use fleet" or a specific model year equivalent emissions (for example MY 2013, etc.).

<u>BAR Response</u>: *The statement included in the 2022 SCPR refers to the removal of eight million "fleet average" gasoline-powered passenger cars from operation. This estimate was made using the emission rates and activity estimates from CARB's EMFAC model. In calendar year 2021, the average gasoline-powered passenger car would have been about ten years old or MY 2011.*

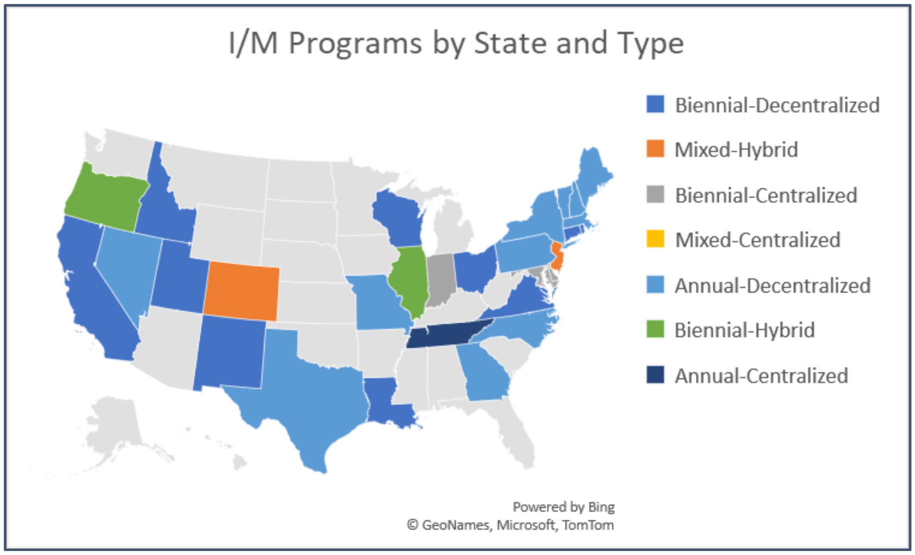
CE-CERT: Page 15 – I/M Program Summary

It might be useful to add California program specific information where possible, to allow the reader to more easily understand how California compares to other states.

<u>BAR Response</u>: *Agreed. BAR will explore methods of presenting this information in the 2023 SCPR.*

CE-CERT: Page 16 – In reference to Figure 8

Figure 8
I/M Program Administration and Inspection Frequency by Area



The Tennessee Department of Environment and Conservation (TDEC) announced August 17, 2021, that emissions testing in several Tennessee counties will end on January 14, 2022, now that the USEPA approved a revision to the state's air quality plan. As of January 14, 2022, residents in Hamilton, Williamson, Rutherford, Sumner, and Wilson counties may now register or renew their registration without an emissions testing certificate. Davidson County's requirement for vehicle emissions testing ended on February 4, 2022

<u>BAR Response</u>: *These changes will be reflected in the 2023 SCPR.*

CE-CERT: Page 16 – In reference to Figure 8

Arizona should be shaded as biennial-centralized.

<u>BAR Response</u>: *This change will be reflected in the 2023 SCPR.*

CE-CERT: Page 16 – Referring to the 2nd bullet.

- "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."

Perhaps this could be eliminated since it refers to 2020.

<u>BAR Response:</u> *This information will not be carried over to the next submission of the SCPR.*

CE-CERT: Page 17 – Referring to the last bullet

- "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."

The report talks about exempting the newest vehicles from inspection due to low failure rates, however the 5% failure rate seen in Figure 1 of the SCPR does not seem that small.

<u>BAR Response</u>: *This issue was addressed in a previous response.*

Attachment B
List of Acronyms

2009 Report, *Evaluation of the California Smog Check Program Using Random Roadside Data*

AB, Assembly Bill

ABS, Antilock Braking System

AIS, Air Injection System

API, Application Programming Interface

ASM, Acceleration Simulation Mode

ATM, Automated Teller Machine

AWD, All Wheel Drive

BAR, Bureau of Automotive Repair

BER, Basic Emission Rate

CARB, California Air Resources Board

CCR, California Code of Regulations

CE-CERT, College of Engineering-Center for Environmental Research and Technology (University of California, Riverside)

CHP, California Highway Patrol

CO, Carbon Monoxide

Comp, Comprehensive

COO, Change of Ownership

CTP, Continuous Test Program

CY, Calendar Year

DAD, Data Acquisition Device

Directed Vehicles, these vehicles can only receive Smog Check certification from STAR test only or STAR test and repair stations.

DTC, Diagnostic Trouble Code

DR, Deterioration Rate

DMV, California Department of Motor Vehicles

Dyno, Dynamometer

Eng, State Assemblyman Mike Eng

EGR, Exhaust Gas Recirculation

EIS, Emissions Inspection System

EMFAC, **Em**ission **Fac**tor – CARB's official on-road motor vehicle emissions inventory estimation model

ER, Emission Rate

FPR, Follow-up Pass Rate

gms, grams

gpm, grams per mile

Gross Polluter, a vehicle with tailpipe emissions exceeding the gross polluter exhaust emission standards prescribed in CCR Section 3340.42

GVWR, Gross Vehicle Weight Rating

HC, Hydrocarbon

Hp, horsepower

I/M, Inspection and Maintenance

LDA, Light-Duty Auto

LDT, Light-Duty Truck

LHD, Light-Heavy-Duty

M, Million

MDV, Medium-Duty Vehicle

MI, mile

MOST, Mobile On-Site Testing

Mph, Miles per Hour

MY, Model Year

NOx, Oxides of Nitrogen

OAG, Office of the Attorney General

OAH, Office of Administrative Hearings

OAL, Office of Administrative Law

OBD, On-Board Diagnostics, 2nd generation, generally required on 1996 and newer MY, gasoline-powered light-duty vehicles.

OBD3, On-Board Diagnostics, 3rd generation, referring to remote OBD or OBD II + telematics.

OIS, OBD Inspection System for testing OBD-equipped vehicles including MY 2000 and newer gasoline-powered vehicles and 1998 and newer MY diesel-powered vehicles.

PC, Passenger Car

Program, Smog Check

RFR, Roadside Failure Rate

RPM, Revolutions per Minute

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

SCFR, Smog Check Failure Rate

SCPR, Smog Check Performance Report

SSI, Single Speed Idle

STAR, Classification of Smog Check stations that can certify directed vehicles

TAC, Thermostatic Air Cleaner

TDEC, Tennessee Department of Environmental Conservation

tpd, Tons per day

TSI, Two-Speed Idle

U.S., United States

USEPA, United States Environmental Protection Agency

VMT, Vehicle Miles of Travel

WEP, Worldwide Environmental Products

WOT, Wide Open Throttle

YR(s), Year / Years

Attachment C
Methodology for Estimating Potential Additional Emission Reductions and Example Calculation

The following presents a detailed explanation of how the estimate of excess emissions was derived for the 2023 SCPR.

Ideally, emission reductions associated with Smog Check are estimated by comparing the measured emissions of vehicles passing or failing during roadside inspection. However, given that the pass/fail determination for 2000 and newer MY vehicles is based upon OBD status, emissions measurements are unavailable for most of the fleet.

CARB developed a sophisticated mathematical model used to characterize the emissions of pollutants attributable to the operation of the on-road fleet. The EMFAC model, which is periodically reviewed and approved by the U.S. EPA, is used to estimate the benefits of both proposed and adopted emission control strategies and legislation. In this version of the SCPR, the EMFAC model was used to estimate the potential additional benefits associated with Smog Check.

In support of the development and maintenance of EMFAC, CARB conducts “surveillance’ test programs. Under surveillance, vehicles are randomly selected from the fleet for extensive testing in CARB’s laboratory. Like BAR’s roadside inspection, it is assumed that the random sample procured by CARB faithfully reflects the impact of various adopted emission reduction strategies including Smog Check.

Figure C-1 (below) displays both the roadside inspection and initial Smog check failure rates as a function of vehicle age for OIS tested vehicles. As this data reflects the characteristics of the fleet in 2022, MY 2022 vehicles are represented in the graphic as age zero and MY 2000 vehicles as being 22 years of age. Note that 16% of MY 2000 vehicles would be expected to fail based on Smog Check initial tests, however 29% were found to fail at roadside. For purposes of this analysis, the differences between the roadside and the Smog Check failure rates were used to estimate excess emissions associated with the program.

Figure C-1
OIS Fail Rates by Vehicle Age using Smog Check and Roadside Test Data (CY 2021-2022, Gasoline-Powered Vehicles)

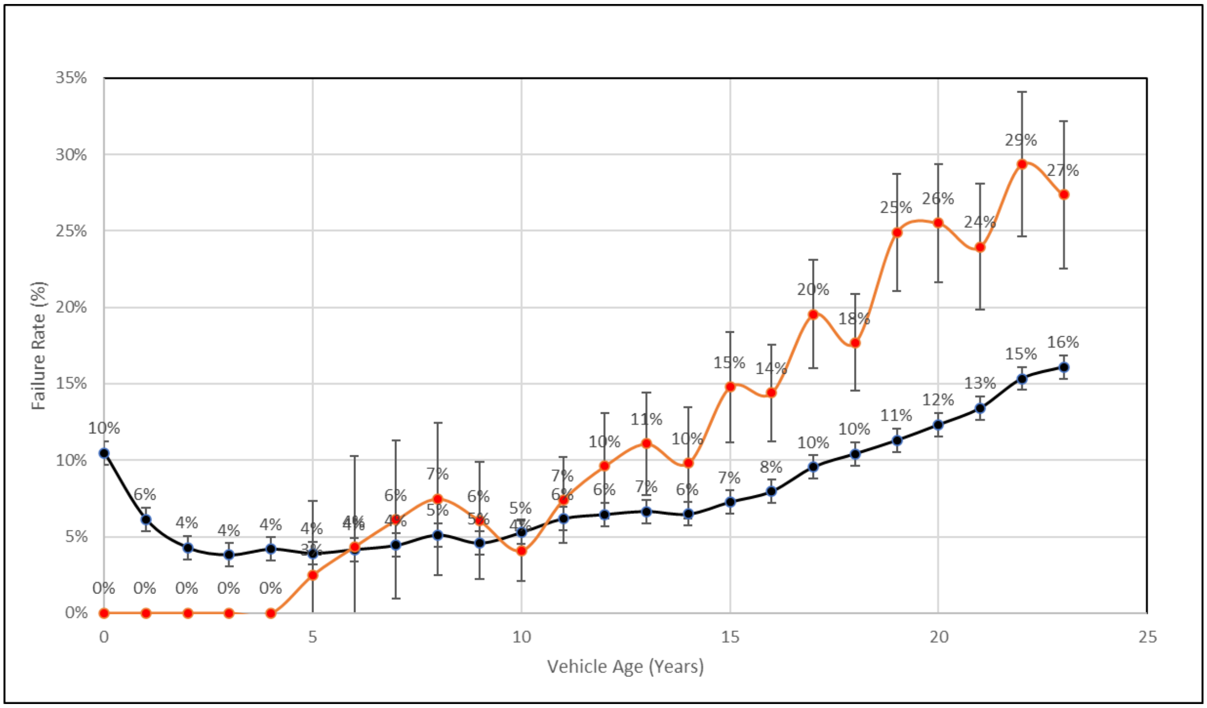


Figure C-2 (below) presents the age specific gram per mile (gpm) ROG+NOx exhaust emission rates for MY 2000 gasoline-powered LDAs as estimated by CARB's model EMFAC2021 (v1.0.2). The statewide, annual average, age specific emissions rates were derived by dividing the CY and MY tpd estimates from the model by the corresponding vehicle miles of travel (VMT). For example, the basic emission rate (BER), the emissions at zero miles is 0.2 gpm for MY 2000 vehicles, which increases to 0.85 gpm at age 22.

Equation 1:

Emissions (gpm) = (Emissions tpd)*(453.59 gms/lb. X 2000 lbs./ton) / VMT

BER MY 2000 (gpm) = (8.91 tpd X 907180 gms/ton) / 40955507 mi/day = 0.20 gpm

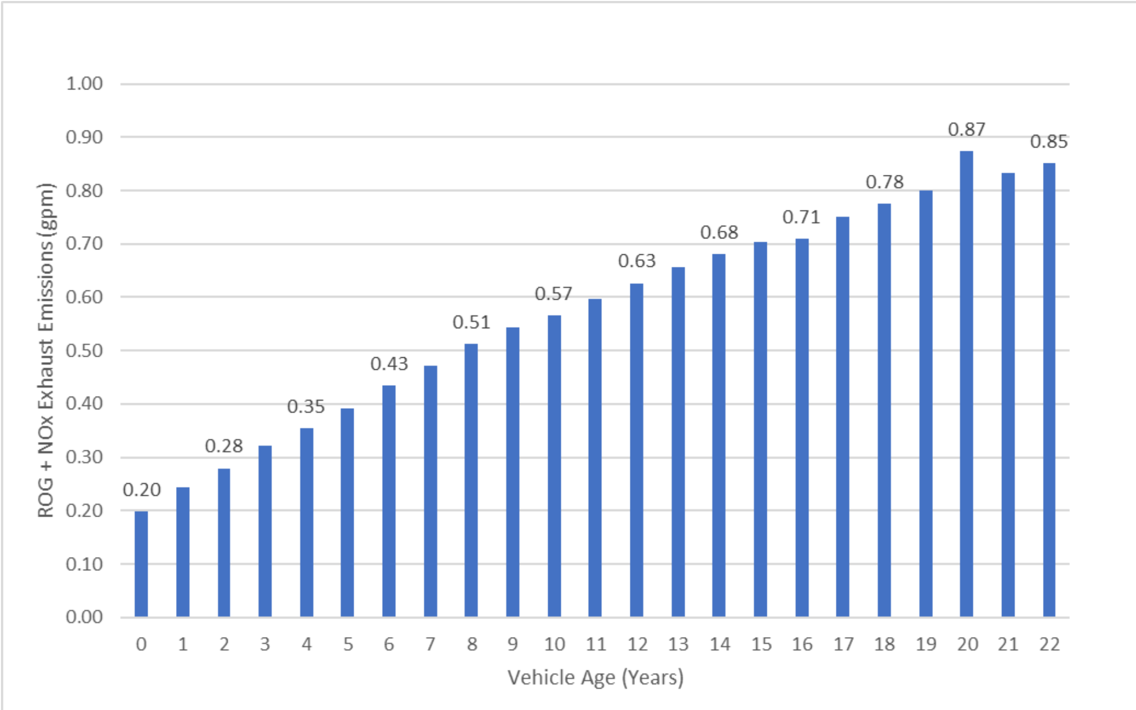
Equation 2:

Emissions (gpm) = (BER gpm X DR gpm/yr X Vehicle Age (yrs))

Emissions (gpm) = 0.2 gpm + .03 X 22 = 0.85 gpm

(Assuming linear deterioration)

Figure C-2
Grams/Mile Exhaust Emissions of ROG + NOx by Age MY 2000 Gasoline-Powered LDAs
(EMFAC2021 Statewide/Annual)



The gpm emission rates presented in Figure C-2 can be broken down into two components; 1) the BER, or intercept, and 2) the incremental increase in emissions as a function of age referred to as the deterioration rate (DR), or slope. Assuming that any increase in emissions over and above the BER can be attributed to the loss of efficiency or failure of emission control components or systems, the amount of deterioration can be directly correlated to Smog Check failures in the fleet (See Figure C-3 below).

As such, the 0.85 gpm emission rate for 22-year-old vehicles as estimated by EMFAC can be assumed to reflect the impact of the 27% failure rate observed at roadside. Therefore, additional emission reductions for 22-year-old vehicles can be calculated by comparing the emission rate at a 31% failure rate (roadside) to the emissions associated with the 16% failure rate observed during Smog Check (See Figure C-4 below).

Figure C-3
Basic Emission Rate and Deterioration Rate
MY 2000 Gasoline-Powered LDAs (Exhaust ROG + NOx)

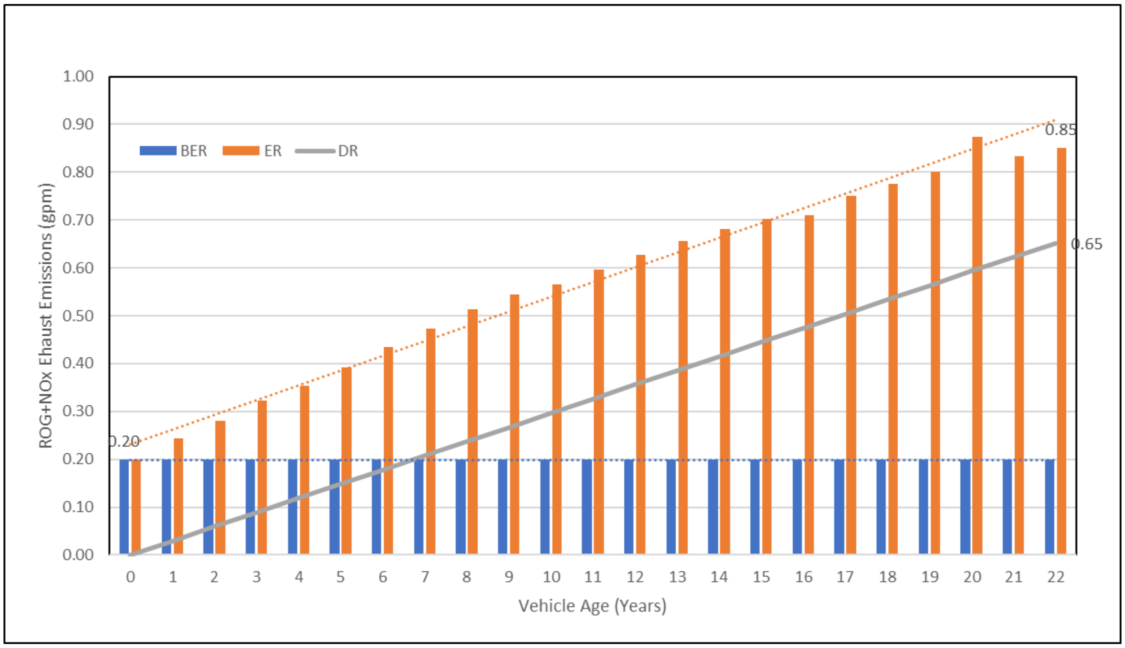
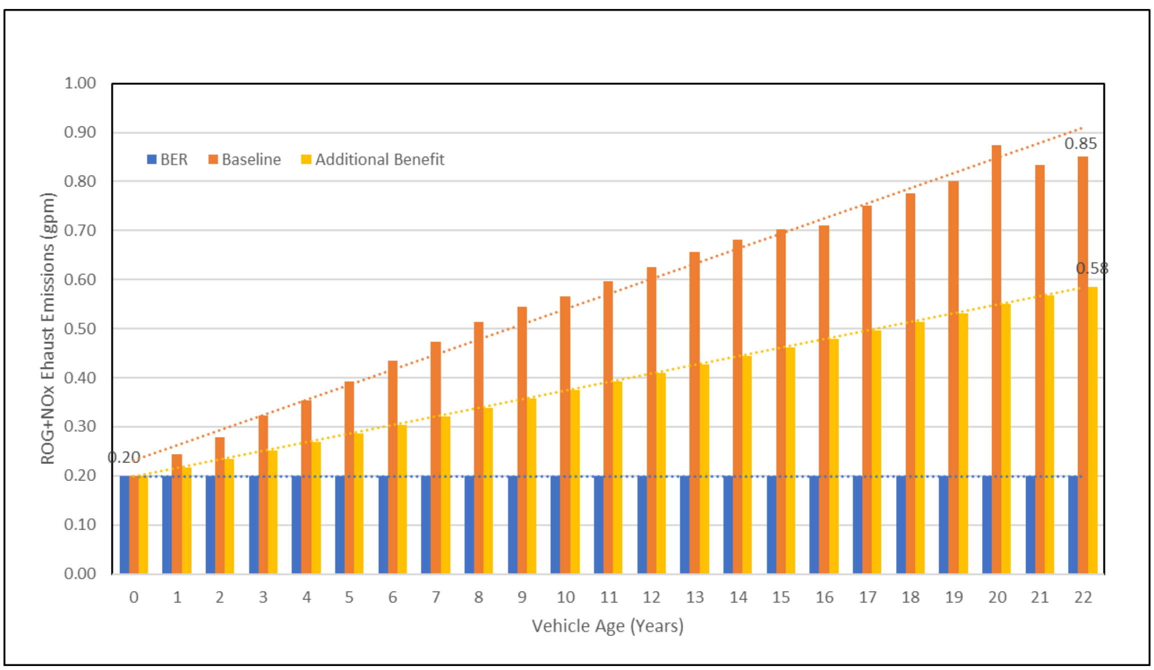


Figure C-4
Basic Emission Rate and Deterioration Rate
MY 2000 Gasoline-Powered LDAs (Exhaust ROG + NOx)



Equation 3:

Potential Benefit (tpd) =$\sum_{45}^{0}(\mathrm{ER} - \mathrm{BER})/\mathrm{RFR} * (\mathrm{RFR} - \mathrm{SCFR}) * \mathrm{VMT}/(\mathrm{gms./lb.} * \mathrm{lbs./ton})$

Example:

For MY 2000 LDA in CY 2022

=(0.85gpm-0.20gpm) / 27% X 100 X (27%-16%) X 4,518,738 mi/day /(453.59 gms/lb X 2000 lbs/ton)

= 0.65 gpm / 27 X 11 = (0.26 gpm X 4,518,738 mi/day) / 907,180 gms/ton = 1.295 tpd

Equation 4:

Vehicle Displacement = Total Benefit (tons/day) / LDA Fleet Emission Rate (tons/vehicle-day)
56 tpd / 0.000022 tons/vehicle-day = 2,543,349 fleet average, gasoline-powered LDAs