DEPARTMENT OF CONSUMER AFFAIRS

BAR

Bureau of Automotive Repair

Smog Check Performance Report

July 2026

Introduction and Summary

Assembly Bill (AB) 2289 (Eng, Chapter 258, Statutes of 2010), requires the Bureau of Automotive Repair (BAR) to periodically publish a report providing an update on the status of California's Smog Check Program and an assessment of the performance of those participating stations and technicians. AB 2289 further directs BAR to implement both inspection-based performance standards for stations inspecting directed vehicles[1] and On-Board Diagnostics (OBD) focused inspections for newer vehicles that are so equipped. AB 2289 also enhances BAR's ability to identify and take corrective action against those stations and technicians performing improper inspections. AB 1263 (Berman, Chapter 681, Statutes of 2023) requires BAR to publish the Smog Check Performance Report (SCPR) every other year rather than annually. As such, this submission of the SCPR satisfies the statutory reporting requirement for calendar year (CY) 2026.

BAR, in cooperation with the California Air Resources Board (CARB), performs specific analyses of Smog Check-related data and the results of these analyses are shared with the public through the publication of the SCPR. Specific information required to be presented in this report includes:

- 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 and districts. 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, in this report, the term is used to describe the additional emissions reductions that could be achieved through programmatic improvements.

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

Summary of findings

A summary of the roadside survey results for model year (MY) 2000 and newer vehicles inspected in CYs 2022-2023 and 2024-2025 are presented in Table 1 below. Separate results are shown for vehicles that initially failed Smog Check and subsequently received certification (FAIL), and those which initially passed Smog Check (PASS). Overall, vehicles tested in CY 2024-2025 failed roadside inspection at a statewide fleet-weighted average[2] of about 14%, which is comparable to the overall failure rate found in the CY 2022-2023 roadside sample. Sufficient data were not available to present separate results for pre-2000 MY tailpipe-tested vehicles for inclusion in all the analyses performed in this report. Although Smog Check certification is also required for diesel-powered vehicles with a gross vehicle weight rating (GVWR) of less than 14,001 lbs., the resulting roadside dataset was also too small to draw meaningful conclusions for this portion of the fleet.

Table 1
Roadside failure rates of tested gasoline-powered vehicles, MYs 2000+*

Initial Smog Check Results	Roadside Failure Rates Within One Year after Smog Check (CY 2022-2023)	Roadside Failure Rates Within One Year after Smog Check (CY 2024-2025)
FAIL	30% (345)	65% (125)
PASS	13% (6,167)	14% (25,148)
Overall	**14% (6,512)**	**14% (25,273)**

* Sample sizes are shown in parentheses. The variability in the failure rate of initially failing vehicles (“FAIL”) is attributed to the relatively small sample size for this sub-fleet.

Analyses of the CY 2024-2025 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. Incremental improvements to the Smog Check Program are evidenced by:
   - A decline in the roadside failure rates.
   - A narrowing of the differences between roadside and Smog Check failure rates.
   - Ongoing enforcement actions against stations and technicians performing fraudulent inspections.
2. Vehicles certified by “high performing” Smog Check stations with higher Follow-up Pass Rate (FPR)[3] scores failed at a lower rate during roadside inspections compared to vehicles certified by “low performing” Smog Check stations with lower scores.

[2] Roadside failure rate percentages were weighted by MY population to match the number of initial Smog Check tests performed in California in CYs 2024 and 2025.

[3] The 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).

3. Vehicles certified by Smog Check stations in “good standing” failed at a lower rate during roadside inspections compared to vehicles certified by stations that had their licenses suspended or revoked.

4. BAR and CARB staff estimate that in CY 2025, 44 additional tons per day (tpd) of exhaust and evaporative emission reductions of reactive organic gases (ROG) and oxides of nitrogen (NO_x) might have been reduced through programmatic improvements.

After a brief overview of BAR’s Roadside Emissions Survey Program data collection efforts conducted in support of the 2026 SCPR, this report discusses the following:

- Key factors that affect the Smog Check and roadside failure rates (and by inference, in-use emission rates) that include correlations with vehicle age or mileage, level of performance of the prior certifying Smog Check station, technician performance, and other factors.

- BAR’s efforts to improve station and technician performance in Smog Check.

- An assessment of excess emissions associated with poor station performance.

- An update on recently adopted measures geared toward improving the program.

- A summary of the efforts of other states and districts to reduce emissions through inspection and maintenance (I/M).

- Specific recommendations for program improvement.

Background

The state of California operates the third largest I/M network in the U.S., with over 8,000 active stations in operation in CYs 2024-2025, and an average annual volume of 1,500 vehicles per station. California’s Smog Check is a biennial program requiring the inspection of vehicles’ emissions and/or engines and emissions control components and systems every other year. It is important to note that gasoline-powered vehicles eight years old and newer are currently exempt from biennial inspection. However, these vehicles, like others, are tested upon initial registration in California and upon change of ownership (COO).

The analyses included in this report are based upon data collected during CYs 2024 and 2025, representing the latest complete test cycle for the entire fleet. For purposes of these analyses, the fleet was subdivided into three broad groups; pre-2000 MY vehicles that receive an Acceleration Simulation Mode (ASM) or Two Speed Idle (TSI) exhaust emissions test, 2000 and newer MY vehicles equipped with OBD II that receive an OBD-focused inspection using the BAR OBD Inspection System (OIS), and 2018 and newer MY vehicles that are subject to inspection upon COO.

In a comprehensive program evaluation report[4] prepared for CARB and BAR ("2009 Report") by Austin, *et al.,* differences between failure rates observed at roadside and the initial test results from Smog Check histories were examined. 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."*

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 after having been repaired. The authors estimated that Smog Check could have achieved an additional 70 tpd reduction of excess emissions of hydrocarbon (HC) and NO_x 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.

Figure 1 (below) presents the age specific initial failure rates for the CYs 2024-2025 OIS Smog Check tested fleet compared to the results of roadside inspection. As can be seen, the Smog Check failure rates increased by a factor of four from about 4% for 8-year-old vehicles, to 15% for 25-year-old vehicles. However, significantly higher failure rates were observed in the corresponding roadside fleet, increasing from about 5% for vehicles age 8, to 34% for 25-year-old vehicles. For purposes of this report, vehicle age was determined by subtracting the vehicle's MY from the CY of inspection (Vehicle Age=CY-MY). The error bars included in the figure depict the variability about the mean, or the level of error in the estimate.

While fraud and incompetence may contribute to the observed differences between the Smog Check and roadside failure rates, several other factors exist that may make a direct comparison of the two fleets problematic. These issues include differences in fleet age, differences in test procedures, where and when roadside tests are conducted, and the impact of pre-inspection repairs. These issues contribute to the level of uncertainty around the estimate and are discussed in more detail in Attachment C of this report.

Figure 2 presents the current and historic roadside and Smog Check failure rates for CYs 2017 to 2025. While the Smog Check failure rate has remained relatively constant, roadside failures have declined from a fleet-adjusted high of 19% in 2018, to 14% in 2025. Perhaps of greater significance is the narrowing of the difference between the Smog Check and roadside failure rates. The decline in roadside failures and the narrowing gap between the Smog Check and roadside failures are evidence of incremental program improvement.

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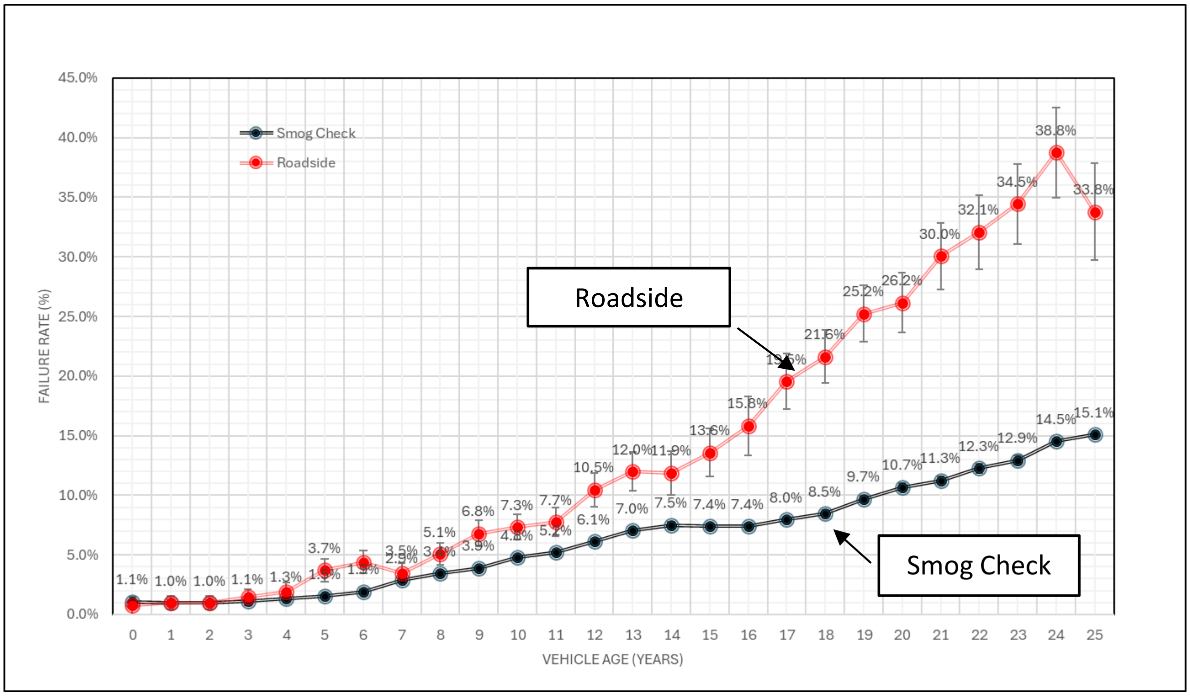
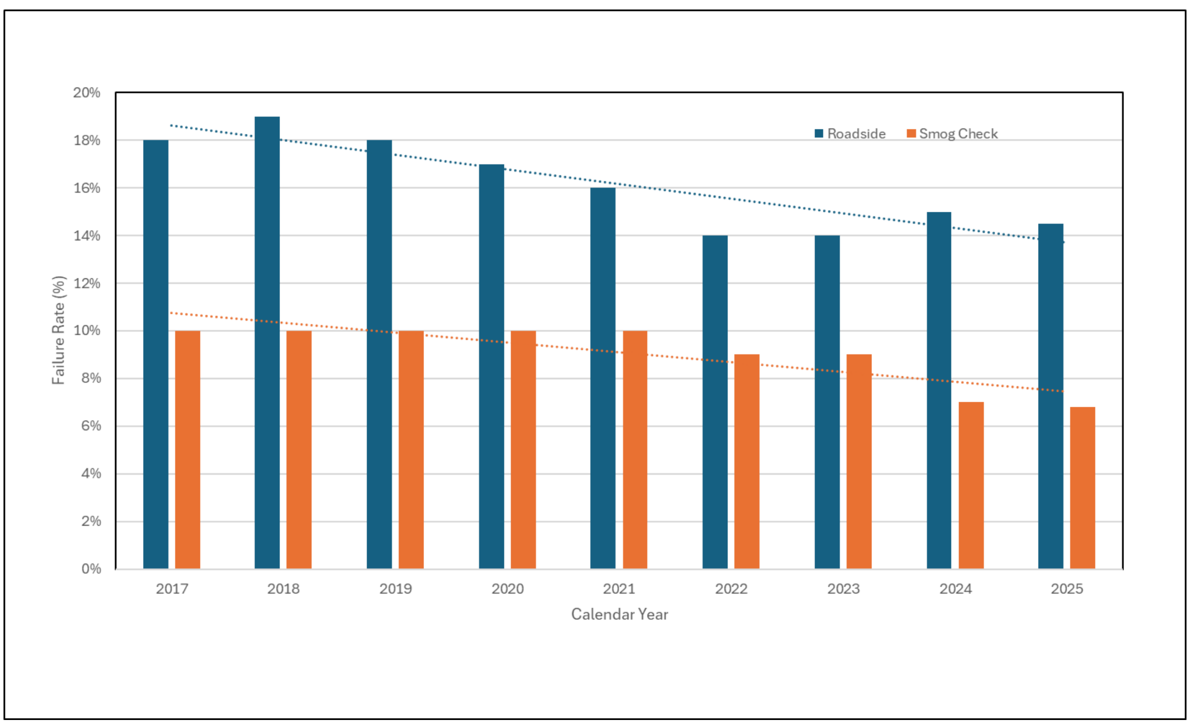
[4] Austin, T., McClement, D., and Roeschen, J.D., 2009, Report No. SR09-03-01, March 12, 2009, Sierra Research. (Copies of the 2009 Report are available upon request)

Figure 1
OIS fail rates by vehicle age using Smog Check and roadside testing data (CY 2024-2025, MY 2000 to 2025 gasoline-powered vehicles)*



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

Figure 2
Current and historic roadside and Smog Check failure rates by CY



Roadside Emissions Survey Program

Chapter 40 of the Code of Federal Regulations, (40 CFR Part 51 Subpart S), requires states with I/M programs to conduct on-road testing of at least 0.5% of the vehicle population subject to inspection or 20,000 vehicles (whichever is less) per cycle, to assess compliance with program requirements. BAR, with the assistance of the California Highway Patrol (CHP), continuously conducts statewide roadside emissions surveys with the objective of gathering sufficient data to perform an independent assessment of Smog Check.

Roadside inspection is completely voluntary, and the results do not affect the official pass/fail status of any vehicles tested. The inspections are performed after vehicles are randomly selected and directed by a CHP officer to an inspection area. These vehicles are then tested by BAR Automotive Program Representatives in a manner similar to Smog Check (tests performed at roadside are abbreviated to minimize inconvenience and increase public participation). Just over 35,000 vehicles, composed of roughly 97% 2000 and newer MY OIS tested vehicles, and 3% 1999 and older tailpipe tested vehicles, were used in support of the findings in this report (See Table 2 below). Because of the declining population of older vehicles, BAR discontinued roadside ASM testing in June of 2024 allowing more OBDII equipped vehicles to be inspected regardless of age.

Table 2
Roadside Inspection datasets - vehicles tested

MY Group	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025
1976-1995	124	175	276	196	88	-
1996-1999	264	446	571	575	636	275
2000-2003	538	1,080	1,289	1,329	1,836	968
2004-2006	452	1,015	1,306	1,303	2,196	1,312
2007+	712	2,038	3,408	3,600	14,267	13,493
Total	**2,090**	**4,754**	**6,850**	**7,003**	**19,023**	**16,048**

*Due to the COVID-19 pandemic, participation in roadside inspection was greatly reduced in CYs 2020 to 2023.

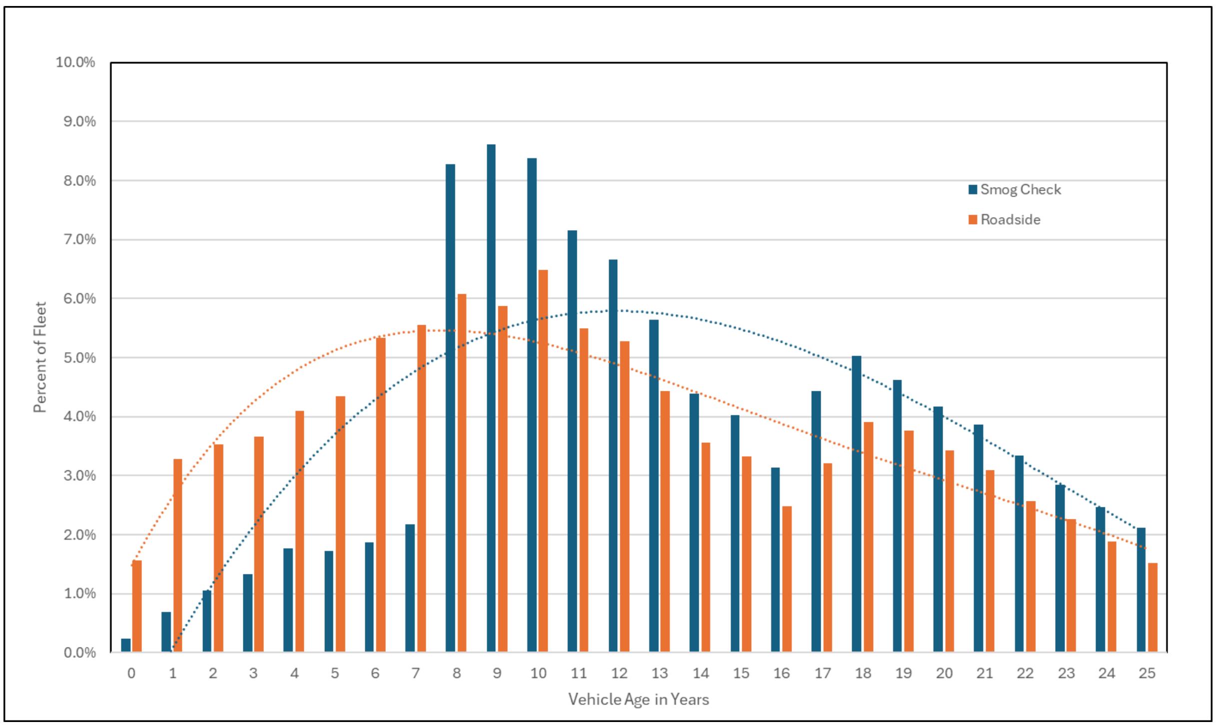
As can be seen in Figure 1, both the roadside and Smog Check datasets reflect the fact that as vehicles age, their emission control components wear, become less effective, or fail outright. It is the objective of Smog Check to accurately identify these vehicles and incentivize their prompt and effective repair. As age is arguably one of the strongest indicators of the performance of a vehicle’s emissions control system, it is important to assess the representativeness of the roadside dataset with respect to the distribution of vehicles by age.

As seen in Table 2 above, there was a dramatic increase in the number of roadside tests performed in CYs 2024-2025 compared to 2022-2023, most notably for 2007 and newer MY vehicles. Figure 3 (below) presents the distribution by MY of the CY 2024-2025 roadside fleet, as well as the distribution of initial tests performed within Smog Check for the same period. As a result of changes to roadside recruitment, the average age of the roadside fleet was found to be two MYs newer (11.4 yrs.) than the Smog Check fleet (13.5 yrs.) (See Figure 3 below).

To compensate for differences in the ages of the two fleets, BAR weights the roadside sample results by the number of initial Smog Check tests (i.e., the number of unique vehicles of each MY tested in California) prior to computing the statistics for the fleet.

During OIS inspections, the vehicles' OBD system may not have completed all necessary self-diagnostic tests needed to make a definitive pass/fail determination. That is, the relevant monitors may require more time or miles to be driven to accurately assess their status. For the purpose of these analyses, it was assumed that vehicles with an OBD status of "not ready" that were still under warranty at the time of inspection (less than 7 MYs old or less than 70,000 miles driven) would ultimately pass inspection and those vehicles outside of warranty would ultimately fail. This reclassification resulted in a decrease in the failure rates of both the Smog Check and roadside fleets from 8% to 7%, and from 13% to 12%, respectively. It is important to note that vehicles will not pass Smog Check if not ready, regardless of their warranty status.

Figure 3
Smog Check and roadside population distributions by MY



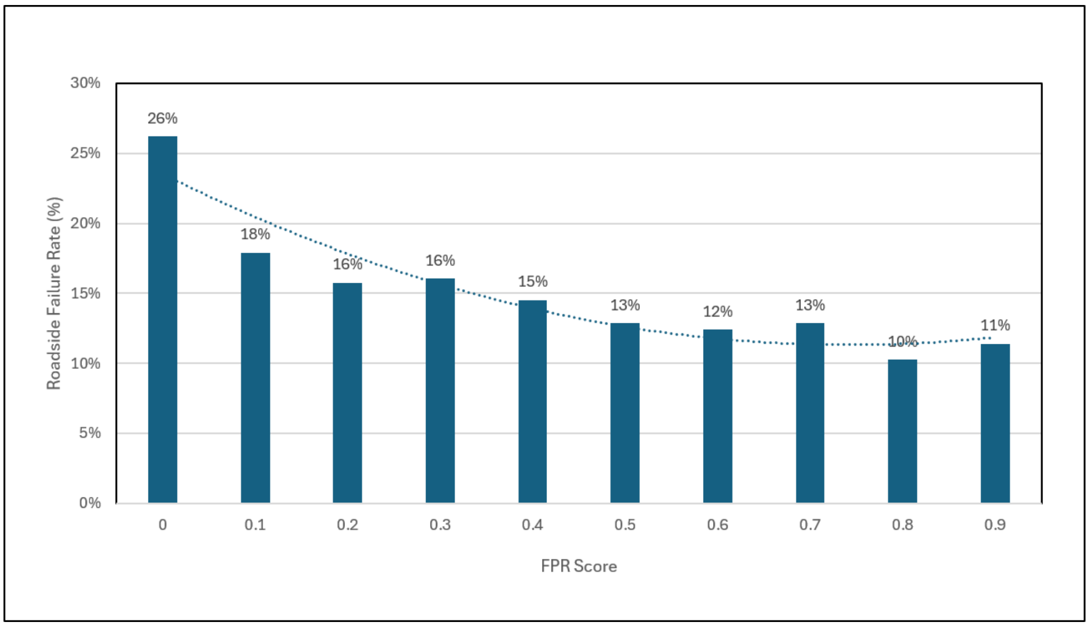
Efforts to improve station performance

BAR has taken exhaustive measures to improve Smog Check station and technician performance through education, incentives, and administrative discipline. Individuals and businesses licensed by BAR are also subject to a process of progressive discipline beginning with reminders and warnings but, in cases of fraudulent testing, may be subject to license suspension or revocation as required by state law.

Established in 2013, BAR's voluntary STAR program is well subscribed and effective. The performance of STAR program participants is assessed against other stations and technicians within the program. As an incentive for more stations to become high performing, BAR directs a portion of the enhanced area fleet,[5] including vehicles designated as "gross polluters,"[6] to those stations that meet all STAR requirements.

The popularity of the STAR program is evidenced by the fact that in CY-2025, 49% of all licensed stations were STAR certified and 83% of all Smog Check tests were performed by STAR certified stations. The effectiveness of the STAR program in reducing emissions is evidenced by the significantly lower roadside FRs of vehicles previously certified by high-performing stations (those with an FPR greater than or equal to 0.9) compared to those vehicles certified by stations with low FPRs (See Figure 4 below).

Figure 4
Performance of certifying Smog Check station vs. roadside failure rates
CY 2024-2025 roadside data*



* The labels above the bars reflect the percentage of stations whose scores fall into each range of FPRs.

Fewer follow-up failures directly benefit motorists by eliminating repeat testing and repairs, and environmental benefits are achieved through a reduction in the emissions of smog-forming pollutants. Figure 5 compares the average FPRs of STAR certified and non-STAR certified stations. As can be seen, STAR certified stations tend to have higher FPR scores which translate to fewer failures at roadside.

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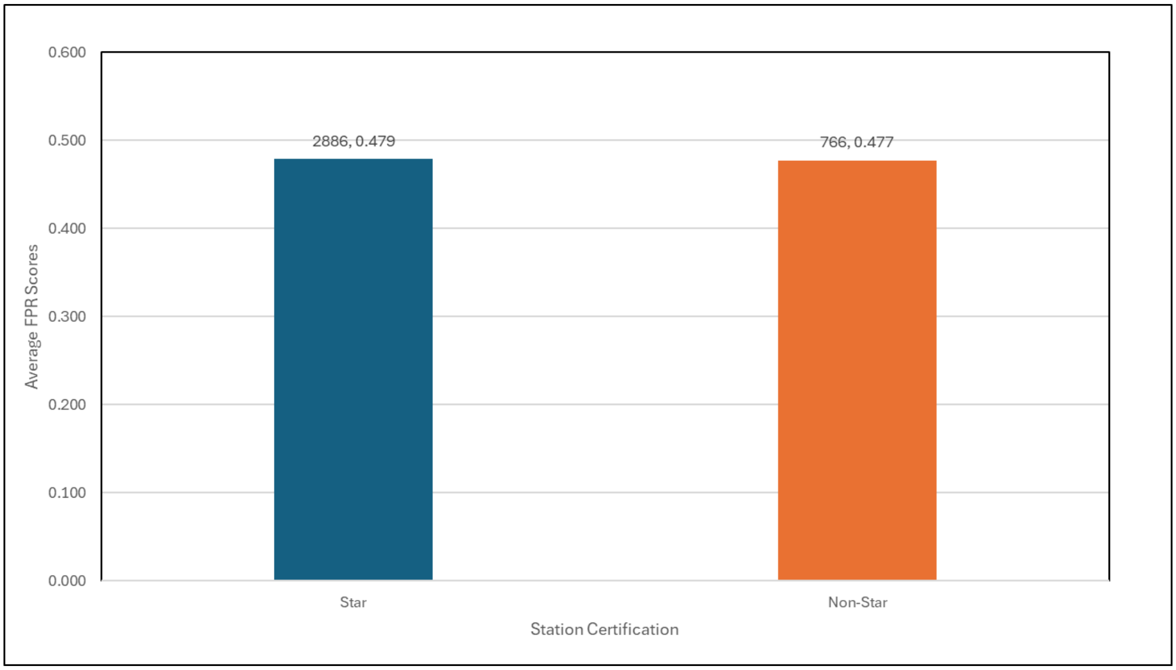
[5] Enhanced Smog Check areas are designated urbanized regions with serious, severe, or extreme air quality problems. Vehicles registered in these areas are subject to stricter inspection standards.

[6] "Gross Polluters" refers to vehicles that emit much more than typical vehicles that fail a Smog Check tailpipe test. Their emission levels vary according to vehicle type and MY, however they typically exceed at least one of the gross polluter standards (twice the minimum emissions limit). There is no Gross Polluter designation for vehicles that fail an OIS inspection.

While incentives like STAR are popular with most Smog Check stations, an effective program having thousands of decentralized (privately owned) stations, also requires a comprehensive enforcement mechanism employing a variety of tools including announced and unannounced station inspections, use of undercover documented vehicles (those with implanted defects) and other methods of identifying improper and/or illegal behaviors and pursue corrective actions.

Figure 5
Mean FPR score as a function of station type where vehicle was last certified*



*The numbers above the bars reflect the number of stations included in the analysis and the average FPR score

The most prevalent fraudulent practices in California impacting Smog Check include:

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

"Clean piping" involves fraudulently obtaining an emissions sample from a known passing vehicle and representing the results as having been obtained from the vehicle being tested.

"**Clean gassing**" is a method by which a surrogate gas is introduced into an Emission Inspection System (EIS),[7] such that the EIS measures the surrogate gas or a mixture of

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

surrogate gas and exhaust emissions and issues a passing test result based upon those readings rather than the actual emissions of the vehicle.

"**Clean plugging**" is the OBD equivalent of clean piping in that OBD data reportedly collected from the vehicle being inspected is actually obtained from a known passing vehicle or from a device called a simulator designed to generate passing readings.

"**Clean tanking**" involves reporting fraudulent evaporative control system test results that are derived from a calibration tank, or other 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. There are a number of ways this can occur, ranging from motorists falsely claiming that their vehicles are registered in "attainment areas"[8] of the state to avoid inspection, to others reporting to DMV that their vehicles are no longer powered by gasoline or diesel fuel.

It should be noted that BAR was granted the authority to establish a contracted inspection network for 1995 and older MY vehicles and is in the process of soliciting input from the public and industry on both the design and implementation of such a program. It is reasonable to assume that the incidence of at least three types of fraudulent acts, clean piping, gassing and tanking, could be mitigated should BAR implement such a network.

To deter fraudulent inspections, BAR has developed and continues to refine its ability to identify suspicious activities and gather related evidence to support administrative and legal actions. Table 3 (below) provides a summary of BAR's case filings with the California Office of the Attorney General (OAG), along with case outcomes for each year.[9] 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. The data presented in Table 3 reflect case filings that were based on the assessment of Smog Check data only and exclude other filings that were based on more traditional BAR investigations or those investigations and actions taken by the DMV[10] or the US Department of Justice.

The process of bringing regulatory action against stations and technicians involved in fraudulent activities can be both complex and time-consuming. For every case listed in Table 3, there may be dozens in development that have not reached the point of filing with the OAG. A year-to-year decline in case filings should not be misinterpreted as a decline in fraudulent practices within the program, rather it better reflects the year-to-year decline in the total number active stations, the complexity of compiling actionable cases for submission to the OAL or OAG, and the resources available to develop and prosecute these cases.

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[8] If the air quality in a geographic area meets or is cleaner than the national standard, it is designated as an attainment area.

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

[10] "Traditional" investigations include, but are not limited to, the use of undercover vehicles with implanted defects and station surveillance.

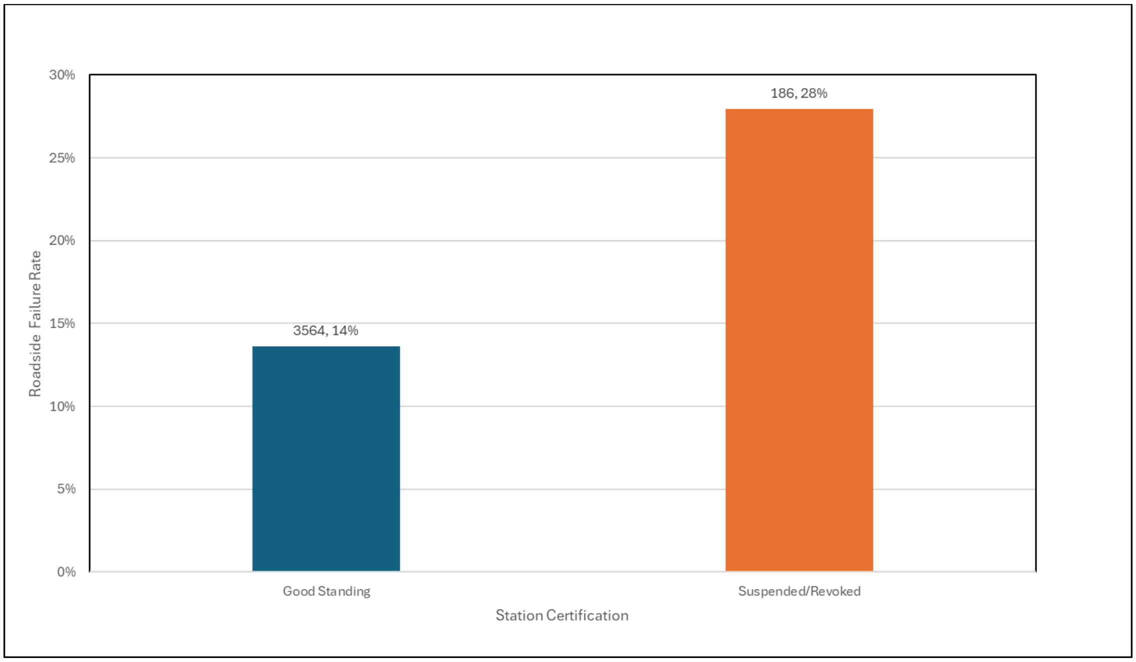
Table 3
Summary by year of BAR Smog Check data-only case filings and outcomes (outcomes still pending on some filings)

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
2023	91	62	12	17
2024	75	66	3	28
2025	115	92	3	11
Total	**1534**	**1356**	**139**	**258**

Figure 6 (below) illustrates the superior performance of stations in “good standing” compared to those that have had their licenses suspended or revoked. As shown, vehicles certified by stations in good standing failed at a lower rate at roadside compared to those that had their licenses suspended and/or revoked in CYs 2024-2025.

The DMV grants licensed business partners the ability to conduct certain transactions including registration renewals. In responding to questionable practices performed by some of these business partners, BAR and DMV developed an Application Programming Interface (API), a method of exchanging information between the two agencies that makes it more difficult for motorists to illegally bypass the requirement to show proof of compliance with Smog Check necessary for registration renewal. This joint action has resulted in a significant reduction in registration-based fraud.

Figure 6
Roadside failure rate and station license status where vehicle was last certified*



*Where the numbers above the bars show the sample size and the percentage of vehicles failing at roadside

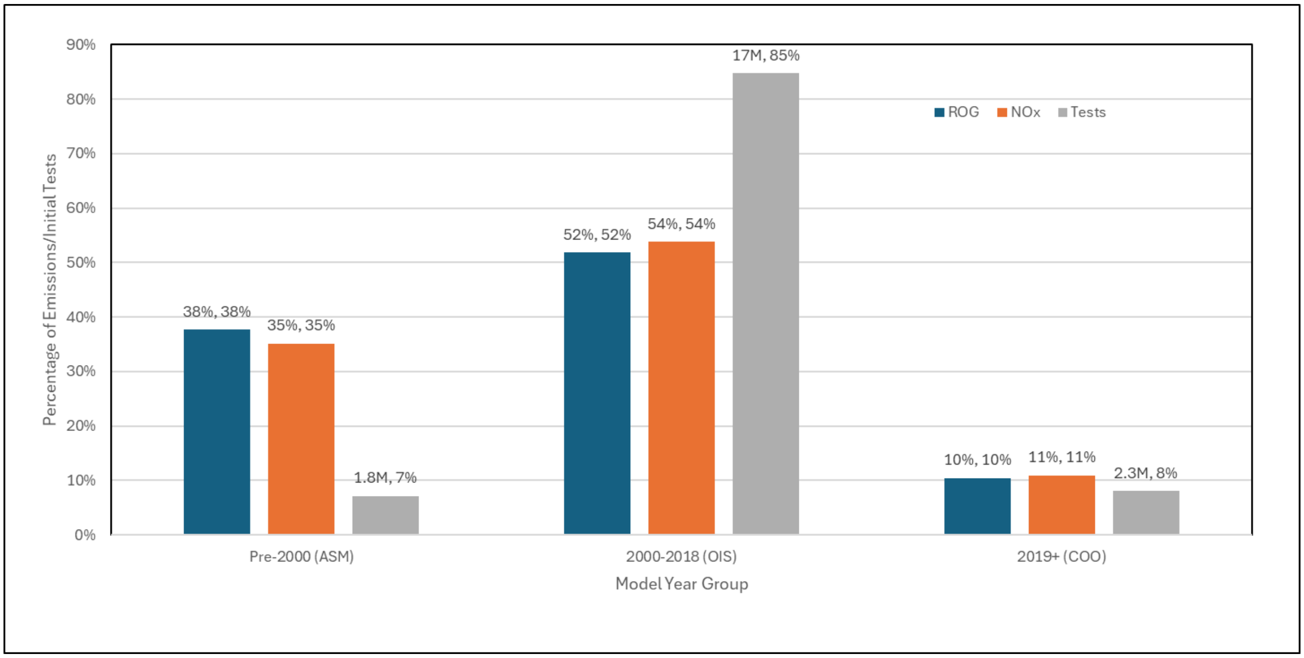
Estimate of excess emissions

The authors of the 2009 Report used ASM emission test results collected at roadside to derive an estimate of an additional 70 tpd reduction of HC+NO_x achievable through Smog Check program improvements. Given that emissions are not routinely measured for 2000 and newer MY vehicles within Smog Check (approximately 97% of the on-road fleet), an alternative methodology was needed to estimate excess emissions.

CARB developed, maintains, and routinely updates their EMFAC, (**Em**ission **Fac**tor), computer model, designed to estimate the emissions of California's on-road fleet. The latest official (US EPA approved) version of the model available at the time of this report, EMFAC2025 (v2.0.0), was used to estimate the excess emissions associated with the Smog Check program. In this instance, excess emissions are defined as those additional emission reductions that might be obtained if roadside failure rates were equal to those observed in Smog Check.

According to EMFAC, gasoline-powered, diesel-powered, and hybrid-electric light-duty autos, light, and medium-duty vehicles, motor homes, and light-heavy-duty trucks with a GVWR of 14,000 lbs. or less contributed a total of 362 tpd of ROG + NO_x to the CY 2025 statewide, on-road emissions inventory. An accounting of the inventory by MY group and pollutant is shown in Figure 7 (below) accompanied by the number of initial Smog Check tests performed over the CY 2024-2025 biennial inspection cycle.

Figure 7
ROG + NO_x emissions by MY group & Smog Check inspections performed in CY 24-25*



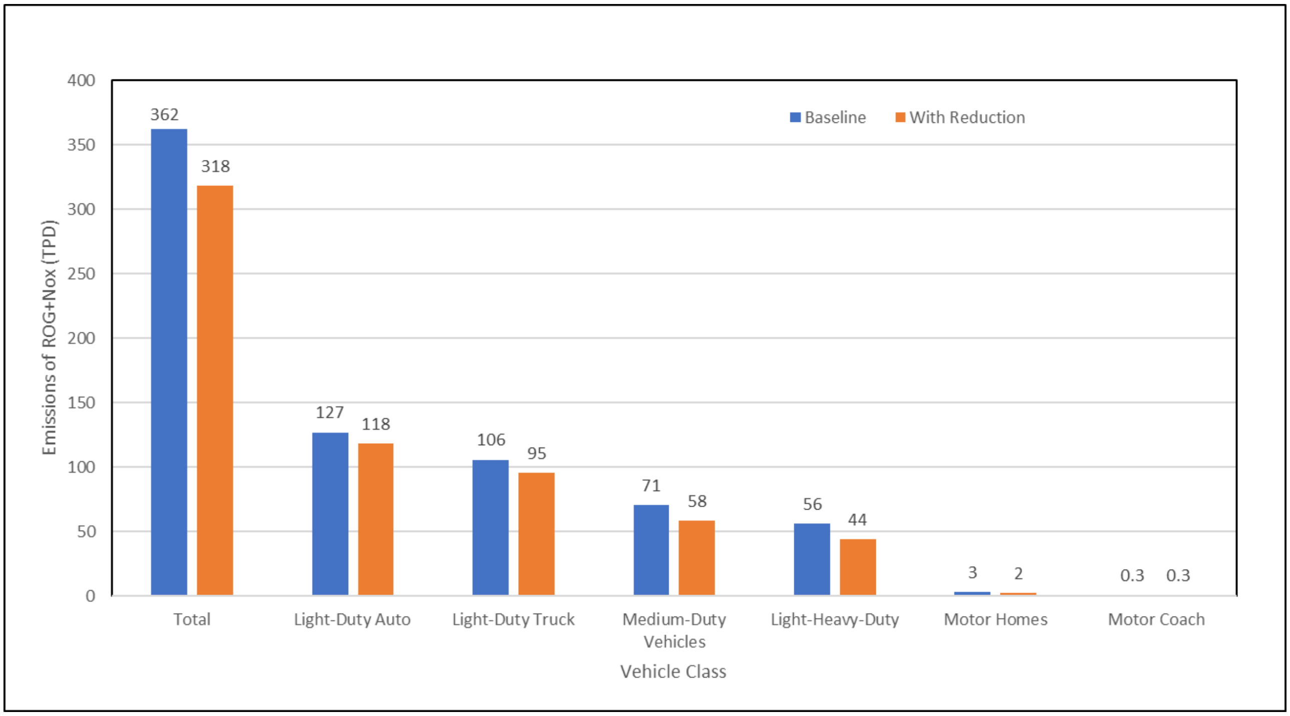
*Where the numbers above the bars present the percentage of the total on-road ROG emissions inventory or the number of initial Smog Check tests in millions (M), followed by the percentage of the total on-road NOx emissions inventory or the percentage of all initial Smog Check tests.

EMFAC2025 does not explicitly model the impact of Smog Check on the emissions inventory. Not unlike the Roadside Emissions Survey program, the benefits of Smog Check are assumed to be implicitly reflected within the baseline. Further, it is assumed within EMFAC that increases in fleet emissions are directly attributable to the degradation in the effectiveness, or complete failure of emission control components and systems.

Under these assumptions, a one-to-one relationship was established between the mileage/age specific failure rates observed during roadside and Smog Check, and the mileage/age specific emissions rates estimated by EMFAC. The potential additional benefits of the program were estimated by lowering the roadside failure rates to the levels observed in Smog Check and calculating the resulting change in emissions. Employing this methodology, it is estimated that approximately 44 tpd of additional benefit (reduction in emissions of ROG + NO_x) could have been achieved through program improvement, a reduction equivalent to removing over 7 million light-duty automobiles from daily operation (see Figure 8).

Previous estimates of additional benefits carried the assumption that all observed failures impact both the exhaust and evaporative emission rates of failing vehicles. Departing from this methodology, stored diagnostic trouble codes (DTCs) recorded during OIS inspections were used to identify vehicles failing for exhaust related issues only, evaporative related issues only, or both. This distinction is important in that while exhaust failures result in higher emissions of both ROG and NO_x, evaporative control system failures result in increases in ROG emissions only. A comprehensive explanation of the methodology used in estimating the potential additional benefits of the program is included in Attachment D of this report.

Figure 8
Potential reductions of ROG + NO_x by vehicle class for CY 2024-2025



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 29 states and the District of Columbia (D.C.). 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. The test is performed while the vehicle is stationary. After communication is established, the vehicle's on-board computer is queried to determine test readiness and collect any stored DTCs that are relevant to determining the functioning of components and systems that are critical for emissions control. For example, those DTCs observed in the CY 2024-2025 failing OBD-equipped fleet at roadside are presented in Table 4.

Table 4
Observed DTCs by category for vehicles failing roadside OIS inspection*

DTC Category	Observations	% of Vehicles	DTC Description
P00	62	8.5%	Camshaft / Crankshaft Position
P01	185	25.3%	Air Fuel Metering System
P02	15	2.1%	Fuel or Air Metering Injection System
P03	112	15.3%	Ignition System
P04	292	39.9%	Emission Control System
P05	25	3.4%	Speed and Idle Control System
P06	14	1.9%	Computer Output Circuit
PO7-PO8	26	3.6%	Transmission-Related

*The percents presented are of those vehicles with stored codes. Several vehicles had multiple stored codes.

Loaded mode tests

Typically administered to 1995 and older MY (pre-OBD II) vehicles weighing less than 14,001 lbs. 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 are typically conducted without a dynamometer and are therefore easier and less costly to perform. Idle tests are most often administered to older (pre-catalyst equipped) vehicles 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 lbs. 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). NO_x emissions are not measured during idle tests as NO_x is not produced at idle.

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 for leaks in the system.

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, which 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** test, which 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 (revolutions per minute) range from maximum to 70% in no less than seven seconds.
- The **stall test** procedure, which is a fully-load stationary test designed for vehicles equipped with automatic transmissions. With the vehicle's brakes applied, the engine speed is increased until the transmission's stall speed is attained.[11] The stall speed is maintained for approximately five seconds to allow for stabilization.
- The **high idle** test procedure, which 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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[11] 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 conduct a visual inspection of the vehicle to determine the presence and condition of the following components:

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 (Catalyst)
- 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 inspection)
    - Centralized (inspection performed by the government or their contractor);
    - Decentralized (inspection performed by private entities licensed by the state); or
    - Hybrid, a mixture of both centralized and decentralized inspection.
- **Frequency of testing**
    - Annually – every year
    - Biennially – every other year
    - Mixed - Varies by vehicle model year and type - can be either annual or biennial.

Most states (21) operate decentralized programs. These states are split between those that require annual inspection (10) and those requiring biennial inspection (11). Four states and D.C. operate centralized programs while the remaining four states, Colorado, Illinois, New Jersey and Oregon, operate hybrid programs (see Figure 9 and Table 5 below)

Figure 9
I/M program administration and inspection frequency by area

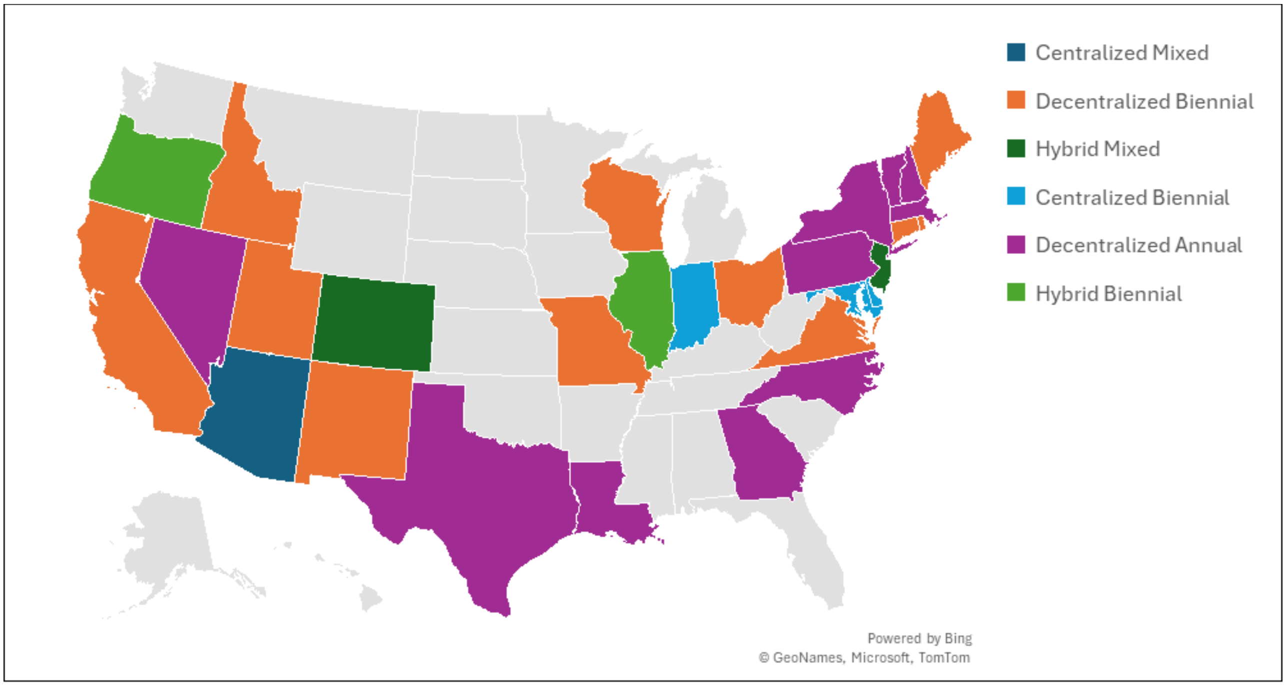

Table 5
I/M program administration and inspection frequency by area

Centralized Biennial	Centralized Mixed	Decentralized Annual	Decentralized Biennial	Hybrid Biennial	Hybrid Mixed
Delaware	Arizona	Georgia	California	Illinois	Colorado
D.C.	-	Louisiana	Connecticut	Oregon	New Jersey
Indiana	-	Massachusetts	Idaho	-	-
Maryland	-	Nevada	Maine	-	-
-	-	New Hampshire	Missouri	-	-
-	-	New York	New Mexico	-	-
-	-	North Carolina	Ohio	-	-
-	-	Pennsylvania	Rhode Island	-	-
-	-	Texas	Utah	-	-
-	-	Vermont	Virginia	-	-
-	-	-	Wisconsin	-	-

- Several states have suspended emissions testing of their light-duty fleets, including Tennessee (as of January 14, 2022), in all counties; Idaho: (as of July 1, 2023); and Washington: (as of January 1, 2020). New Hampshire's emission & safety contract was extended through the end of 2026, despite the state's desire to end the program.
- As stated, BAR was granted the authority to establish a centralized/hybrid test network for pre-OBD vehicles. If implemented, the existing OIS test requirement would be expanded to include 1996 to 1999 MY vehicles.
- Five contractors currently support state I/M programs; California by Voyatek (formerly OnCore Consulting), Opus/Gordon Darby administers I/M programs in 22 states and D.C., Applus+ Technologies in four states, Parsons Engineering Science in three, and Worldwide Environmental Products (WEP) holds contracts in the two remaining states.
- Thirteen states and D.C. conduct periodic safety inspections in addition to emissions testing. BAR's Vehicle Safety Systems Inspection Program (VSSI) went into effect on July 8, 2024, through the enactment of AB 471, Low, Chapter 372, Statutes of 2021.
- Eight states require stickers to be displayed as proof of compliance with emissions and safety inspection requirements. All other areas tie compliance directly to vehicle registration in the form of either denial, suspension, or revocation.
- California, nine other states and D.C., require vehicles to be tested upon change of ownership. Three other states, North Carolina, Rhode Island and Utah require testing upon COO only when the vehicle is sold by a dealer.
- California's program is conducted statewide, as are the programs in eight other states and D.C. (district-wide). The remaining states require testing only in those areas where air quality is most severely impacted by on-road motor vehicles. Statewide testing in California is only required for COO and initial registration.
- The number of licensed Smog Check Stations in operation in California has declined by 13% since CY 2020 while annual inspections grew by 10%. The average test load in California in CY 2025 was 1,500 inspections per station, up from 1,100 inspections per station in 2020. Network sizes in other states range from as few as three stations in D.C., to as many as 10,000 in New York. Delaware, Indiana, and Oregon each have less than ten stations in their test networks.
- Except for Idaho, all states and D.C. require periodic testing of hybrid-electric vehicles.
- Given that new vehicles are least likely to fail, most I/M programs exempt vehicles up to two MYs old from inspection. California exempts light-duty gasoline-powered autos that are eight MYs old or newer, which is the longest period of exemption except for Utah's Cache County where the age of first test is 11. California does require otherwise exempted vehicles to be tested upon initial registration and upon COO.
- CARB has informed DMV and BAR that implementation of the Smog Check Contingency Measure for San Joaquin Valley[12] is needed to fulfill a State Implementation Plan (SIP) requirement. This measure would roll back the new vehicle exemption in certain areas of the San Joaquin Valley from eight to seven MYs.

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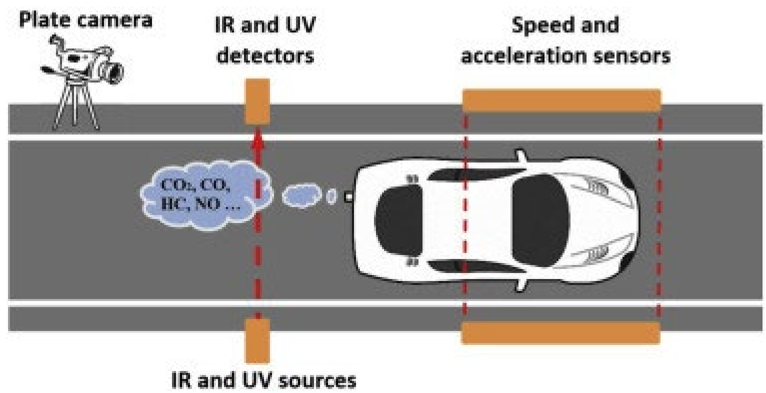
[12] https://ww2.arb.ca.gov/resources/documents/california-smog-check-contingency-measure

Supplemental programmatic elements

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

- **Remote Sensing**



Remote Sensing Devices (RSD) are an integral part of the I/M programs in Arizona, Colorado, Connecticut, Maryland, Ohio, Rhode Island, Texas, and Virginia. These devices estimate emissions by shining an infrared light source or laser across a roadway and measuring the attenuation of the signal through the exhaust plumes of passing vehicles. The advantage of RSD is that information on a large population of vehicles can be obtained both quickly and inexpensively. However, because only a "snapshot" of the vehicle's emissions is captured under either uncontrolled or loosely controlled conditions, the use of RSD is typically limited to making coarse determinations. In some areas RSD is used to identify low emitting vehicles for exclusion from periodic inspection, a practice referred to as "clean screening". Alternatively, RSD may be used to identify vehicles that have a high probability of failing an inspection, a practice referred to as "dirty screening." Vehicles are not typically failed based on RSD readings alone, rather suspect vehicles are required to undergo more comprehensive inspections within conventional programs.

- **Remote OBD**

In California, Nevada, and Oregon, portions of the light-duty fleet are allowed to opt into a remote OBD monitoring program. Participating vehicles are fitted with devices that allow their on-board computers to be remotely queried and relevant data are retrieved through telematics. The advantage of this approach is the ability to continuously monitor vehicle emission control systems compared to once per year or once every other year. Although some concern exists regarding fraud, this approach has been shown to be both convenient and cost effective and has the potential of achieving surplus emission reductions by minimizing the time between failure and repair and detecting failures within the otherwise exempted fleet. Participation in California's Continuous Testing Program (CTP) is completely voluntary and is currently limited to government fleets.

- **OBD kiosks**

Maryland, Ohio, Oregon, and D.C. offer a self-testing option to owners of OBD-equipped vehicles. Motorists use an ATM-like touch-screen computer equipped with hardware designed to interface with and retrieve relevant information from the vehicles' on-board computer. OBD kiosks are conveniently located and are available 24 hours per day, seven days per week. Although cameras are used to record tests performed at kiosks, concerns have been raised regarding the potential for fraudulent use of surrogate vehicles or simulators to circumvent compliance requirements.

- **Mobile/on-site OBD testing**

The states of Oregon, Georgia, Missouri and Utah offer on-site testing by appointment, saving participating vehicle owners time, and reducing travel related emissions. The same fraud-related concerns expressed with respect to OBD kiosks could be applied 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 test procedures used in each state is provided in Table 5 below.

Test frequency

Those states and districts performing periodic emissions inspections are evenly split between those requiring biennial and annual tests. It has been suggested that more frequent inspection (annual rather than biennial) might result in lessening the impact of fraud and increasing emission reductions. These potential benefits 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 are ready and whether 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 two-speed Idle emissions tests for vehicles that cannot safely or reliably be tested on a dynamometer.
- The use of RSD or a similar method to make quick pass/fail determinations or as a screening tool for including or exempting vehicles from further inspection.

Evaporative system checks

The main elements of evaporative system checks include the following, which are currently integrated into California's Smog Check 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 Smog Check improvement

- Tighten criteria for STAR certification / Publicize station scores / Reward high Scorers
- Streamline the process of bringing enforcement actions to the OAG
- Incorporate "reasonable test duration" timing into DAD 2.0
- Supplement roadside emissions survey with paper audits of Smog Check repair orders
- Centralize testing of the pre-OBD fleet
- Coordinate with CHP on expanded use of vehicle code 27156 citations
- Utilize Smog Check histories to reassess directed vehicle criteria
- Invite original equipment manufacturers (OEM) to participate in CTP
- Place OIS kiosks in specific areas of the state for motorist convenience
- Further assess the Impact of pre-inspection and the efficacy of repairs on failure rates
- Make the printing of passing vehicle inspection reports (VIR) optional
- Coordinate with CARB on surveillance testing and modeling of baseline and excess on-road emission rates.

Table 5
I/M testing requirements by state

State/Area	Fuel	GVWR	Model Year(s)	Steady State	Loaded Mode	OBD	Gas Cap	Opacity	Visual
Arizona	Gas	<8501	1996 to age 5	-	-	X	X	-	X
Arizona	Gas	<8501	1967 to 1995	-	I/M 147	-	X	-	X
Arizona	Diesel	<26001	-	-	-	-	-	Dyno	X
Arizona	Diesel	>26000	-	-	-	-	-	Snap Idle	X
California	Gas	<14001	2000 to age 9	-	-	X	-	-	X
California	Gas	<14001	<2000	TSI	ASM25/25 ASM50/15	-	X	-	X
California	Diesel	<14001	1998 and newer	-	-	X	-	Snap Idle	X
Colorado	Gas	<8501	2007 to age 8	-	-	X	X	-	-
Colorado	Gas	<8501	1982 to 2006	-	I/M 240	-	X	-	-
Colorado	Gas	<8501	1967 to 1981	TSI	-	-	X	-	-
Colorado	Gas	8501-14000	1982 to 2010	TSI	-	-	X	-	-
Colorado	Diesel	-	-	-	-	-	-	X	-
Connecticut	Gas	<8501	1996 to age 5	-	-	X	-	-	-
Connecticut	Gas	8501-10000	2008 to age 5	-	-	X	-	-	-
Connecticut	Gas	8501-10000	1998 to 2007	TSI	-	-	X	-	-
Connecticut	Gas	8501-10000	1995 to 1997	-	ASM25/25	-	X	-	Catalyst
Connecticut	Diesel	<8501	1998 to age 5	-	-	X	-	X	-
Connecticut	Diesel	8501-10000	2007 to age 5	-	-	X	-	-	-
Connecticut	Diesel	8501-10000	1996 to 2006	-	-	-	-	X	-
Delaware	Gas	<8501	1996 to age 8	-	-	X	-	-	Catalyst
Delaware	Gas	<8501	1981 to 1995	TSI	-	-	X	-	Catalyst
Delaware	Gas	<8501	1968 to 1990	Curbside	-	-	X	-	Catalyst

State/Area	Fuel	GVWR	Model Year(s)	Steady State	Loaded Mode	OBD	Gas Cap	Opacity	Visual
Delaware	Diesel	<8501	1997 to age 8	-	-	X	-	-	-
District of Columbia	Gas	<8501	1996+	-	-	X	-	-	-
District of Columbia	Gas	<8501	1984 to 1995	-	I/M 240	-	-	-	-
District of Columbia	Gas	<8501	1968 to 1983	TSI	-	-	-	-	-
District of Columbia	Gas	<8501	1975+	-	-	-	X	-	Catalyst
Georgia	Gas	<8501	Ages 4 to 24	-	-	X	X	-	Catalyst
Illinois	Gas	<8501	1996 to age 4	-	-	X	X	-	-
Illinois	Gas	8501-14000	2007 to age 4	-	-	X	-	-	-
Indiana	Gas	<9001	1996 to age 4	-	-	X	X	-	-
Indiana	Gas	<9001	1981-1995	-	I/M 93	-	X	-	-
Indiana	Gas	<9001	1976-1980	SSI	-	-	X	-	-
Louisiana	Gas	<10001	1996 to age 3	-	-	X	-	-	Catalyst
Louisiana	Gas	<10001	1980 to 1995	-	-	-	X	-	X
Maine	Gas	-	1996+	-	-	X	X	-	Catalyst
Maine	Gas	-	1987 to 1995	-	-	-	X	-	Catalyst
Maine	Gas	-	1974 to 1986	-	-	-	X	-	-
Maine	Diesel	>18000	-	-	-	-	-	X	-
Maryland	Gas	<8501	1996 to age 4	-	-	X	-	-	Catalyst
Maryland	Diesel	8501-14000	2008 to age 4	-	-	X	-	-	Catalyst
Maryland	Diesel	>10000	2008 to age 4	SSI	-	-	X	-	-
Maryland	Diesel	8501-26000	1977 to 1995	SSI	-	-	X	-	Catalyst
Massachusetts	Gas	-	Ages 0 to 14	-	-	X	-	-	-
Massachusetts	Diesel	>10000	-	-	-	-	-	X	-
Missouri	Gas	<8501	1996 to age 2	-	-	X	-	-	--

State/Area	Fuel	GVWR	Model Year(s)	Steady State	Loaded Mode	OBD	Gas Cap	Opacity	Visual
Missouri	Diesel	-	1997 to age 2	-	-	X	-	-	-
Nevada	Gas	<14001	1996+	-	-	X	-	-	-
Nevada	Diesel	<14001	1968 to1995	TSI	-	-	-	X	-
New Hampshire	Gas	<8501	Ages 0 to 20	-	-	X	-	-	-
New Hampshire	Diesel	<8501	Ages 0 to 20	-	-	X	-	-	-
New Jersey	Gas	<8501	1996 to age 5	-	-	X	-	-	-
New Jersey	Gas	8501-14000	2008 to age 5	-	-	X	-	-	-
New Jersey	Gas	>14000	2014 to age 5	-	-	X	-	-	-
New Jersey	Diesel	<8501	1997 to age 5	-	-	X	-	-	-
New Mexico	Gas	<10001	1996+	-	-	X	X	Smoke	Catalyst
New Mexico	Gas	<10001	Age 35 to 1995	TSI	-	-	X	Smoke	Catalyst
New York	Gas	<8501	Ages 0 to 25	-	-	X	X	Smoke	X
New York	Gas	8501-18000	Ages 0 to 25	-	-	-	X	-	X
New York	Diesel	<8501	Ages 0 to 25	-	-	X	-	-	-
New York	Diesel	8501-18000	Ages 0 to 25	-	-	-	-	X	X
North Carolina	Gas	<8501	Ages 3 to 20	-	-	X	-	-	-
Ohio	Gas	<10001	Ages 3 to 25	-	-	X	-	-	-
Ohio	Diesel	<10001	Ages 3 to 25	-	-	X	-	-	-
Oregon	Gas	<8501	1996 to age 5	-	-	X	-	-	-
Oregon	Gas	<8501	1975 to 1995	SSI	-	-	-	-	-
Oregon	Diesel	<8501	1997 to age 5	-	-	X	-	-	-
Oregon	Diesel	<8501	1975 to 1996	SSI	-	-	X	-	-
Pennsylvania	Gas	<9001	1996 to age 2	-	-	X	X	-	-
Pennsylvania	Gas	<9001	1975 to 1995	SSI	X	-	X	-	Comp
Rhode Island	Gas	<8501	1996 to age 2	-	-	X	X	-	-

State/Area	Fuel	GVWR	Model Year(s)	Steady State	Loaded Mode	OBD	Gas Cap	Opacity	Visual
Rhode Island	Gas	<8501	<1996	-	-	-	X	-	X
Rhode Island	Diesel	<8501	1997 to age 2	-	-	X	X	-	-
Rhode Island	Diesel	<8501	<1997	-	-	-	-	-	X
Texas	Gas	-	Ages 2 to 24	-	-	X	X	-	-
Utah	Gas	All Weights	1968 to 1995	TSI	-	-	-	-	-
Utah	Gas	<8501	1996 to 2016	-	-	X	-	-	-
Utah	Gas	>8500	1996 to 2016	TSI	-	-	-	-	-
Utah	Gas	<14001	2008 to 2018	-	-	X	-	-	-
Utah	Gas	>14000	2008 to 2018	TSI	-	-	-	-	-
Utah	Diesel	<14001	1998 to 2006	-	-	-	-	-	X
Utah	Diesel	<14001	2007 to 2018	-	-	X	-	-	-
Vermont	Gas	<8501	Ages 0 to 16	-	-	X	Visual	-	Catalyst
Vermont	Diesel	<8501	Ages 0 to 16	-	-	X	-	-	-
Virginia	Gas	<10001	Ages 0 to 25	-	-	X	Visual	-	Catalyst
Virginia	Diesel	<8501	1997+	-	-	X	-	-	X
Wisconsin	Gas	<8501	1996 to 2006	-	-	X	-	-	-
Wisconsin	Gas	8501-14000	2007 to 2018	-	-	X	-	-	-
Wisconsin	Diesel	8501-14000	2007 to 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 2026 Smog Check Performance Report” and BAR responses

Attachment B - List of acronyms

Attachment C – Issues related to the Roadside Emissions Survey Program representativeness

Attachment D – Methodology and sample calculation of potential benefits of Smog Check

Attachment A
Specific comments on the 2026 SCPR and BAR responses

This attachment contains specific comments from the review of 2026 SCPR conducted by the University of California at Riverside's Bourns College of Engineering - Center for Environmental Research and Technology (CE-CERT). BAR's responses are shown in italics.

- On Page 3 – It is worth noting that the number of vehicles in the roadside fleet that fail their initial Smog Check is very small. It is likely that the result of any in-depth analysis using this data would be inconclusive.

Figure 1 on Page 3 of the report includes a footnote alerting the reader to the fact that "The variability in the failure rate of initially failing vehicles ("FAIL") is attributed to the relatively small sample size for this sub-fleet (125 vehicles out of a total of 25,273 or about 0.5% of the roadside fleet). The number of initially failing vehicles is expected to continue to decline as more owners enact repairs prior to their official test.

- Referring to Page 6, Figure 1 – There is an interesting high point of 38.8% at 24 years. A similar high point is shown in previous versions of the report. Is there an explanation for this consistently high point, or is this due in part to an overlap in data sets?

There is no overlap in the data used in the 2024 and 2026 SCPR. However, it is important to note that the data set is relatively small for the oldest vehicles shown in Figure 1 as indicated by the larger error bars. More data is needed to determine whether this peak is statistically significant.

- Referring to page 8, the discussions on the analysis of readiness and warranty status should be clarified. The text speaks about this being a "changed" definition or methodology, but it doesn't say what it was changed from. Perhaps term "changed" could be removed from the discussion.

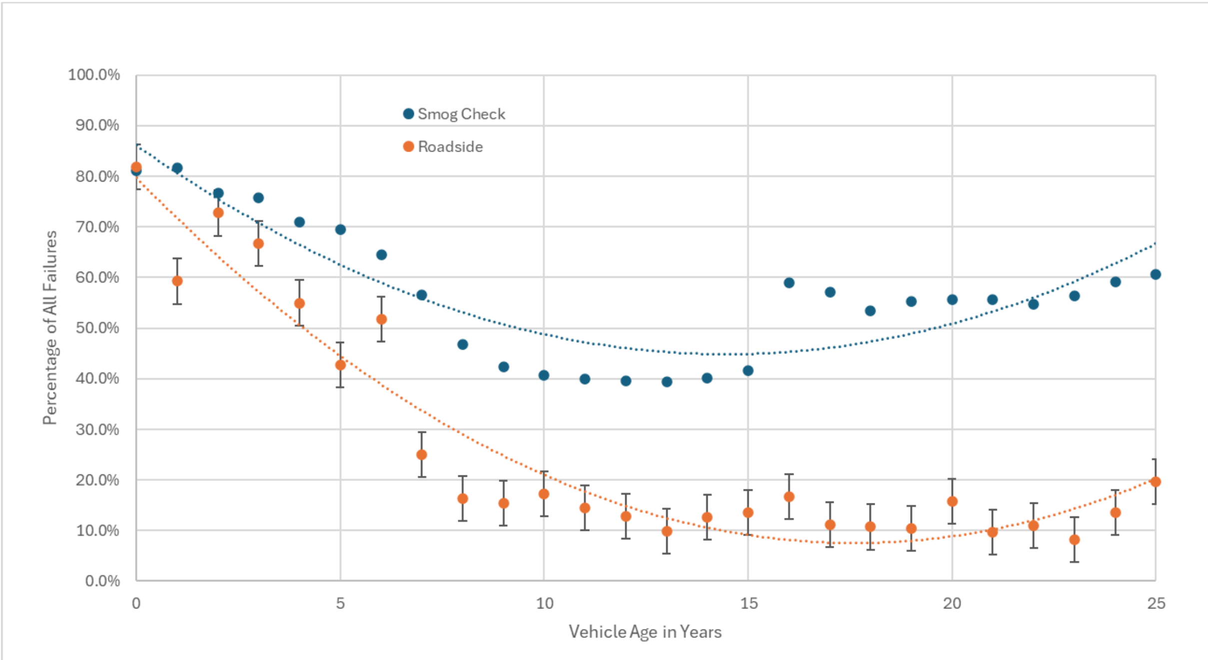
This sentence was removed. However, in previous versions of the report all "not ready" vehicles were classified as failing.

- Again, referring to page 8, the text refers to the reclassification of "not ready" vehicles as either passing or failing inspection impacting 2% of the fleet of newer vehicles. Does this mean that readiness issues are less common for older vehicles?

The 2% mentioned in this sentence (since removed) referred to newer vehicles assumed to be under warranty, those less than seven years of age or driven less than 70,000 miles. Readiness issues as a percentage of overall failures were found to initially decline, then increase with age. While this trend is observed in both the roadside and Smog Check fleets (See Figure A-1 below), readiness failures in Smog Check were found to be consistently and significantly higher than observed at roadside.

Figure A-1

Contribution of readiness issues to overall failure rates



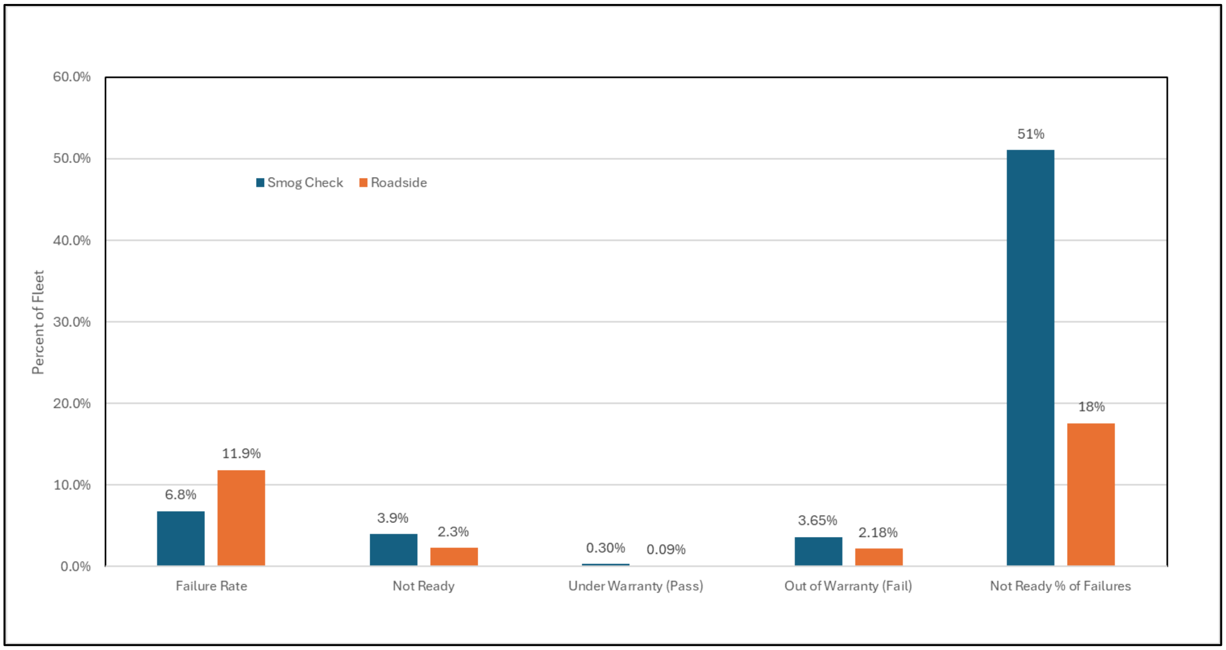
- Later in the same paragraph on page 8 it states that only 25% of the "not ready" roadside inspections were considered passes.

This sentence was removed.

- What is the overall prevalence of readiness issues within the Smog Check and roadside fleets for comparison?

Figure A-2 below presents the contribution of "not ready" vehicles to the overall failure rates within the Smog Check and roadside fleets as well as impact on the fleet of assuming vehicles with readiness issues that are under warranty would ultimately pass inspection and those outside of warranty would ultimately fail.

Figure A-2
Assessment of readiness issues in the Smog Check and roadside fleets*



*The percentages shown above the bars are unweighted

- On page 8 - Figure 3: The population distribution of the roadside inspections is considerably higher for newer years, whereas in the past, it was preferentially weighted to older vehicles. Is this related to new recruitment goals, and if so, can those be discussed briefly in the text (a couple sentences)?

The "newer" roadside fleet results from a significant increase in vehicles tested in CYs 2024-2025 compared to CYs 2022-2023 and the suspension of the testing of pre-2000 MY vehicles in April of 2024 (Please refer to Table 2 on Page 7).

- Referring to Page 9 Figure 4 - The failure rates seem to be considerably lower than those reported for CYs 2023-2024, where the failure rates range from 13% to 41%, depending on the FPR score. Is there a reason for this large drop?

The difference in failure rates reflect a change in methodology rather than being data driven. In previous versions of the SCPR, the FPR scores used were those applicable at the time the report was written. In this version of the report, the reported FPR scores are those that were applicable at the time each vehicle was tested.

- Referring to Page 10. While the discussion talks about the FPR for the STAR certified stations tending to have higher FPR scores than the non-STAR certified stations, Figure 5 shows a very small difference (0.479 to 0.477 in FPR score), which doesn't seem to support this narrative. Is there another aspect that is not discussed to further support this statement?

STAR stations, on average, have higher FRP scores than non-STAR stations. The "small" difference referenced is attributable to the relatively small number of non-STAR stations included in the analysis (2,866 STAR stations vs. 766 non-STAR stations).

- In reference to Page 12, previous versions of the SCPR have shown case filings going back to 2016. Would it be possible to include these earlier years in this report as well. In the first paragraph on the page, it talks about some of the year-to-year variations being related to resources availability. Does this mean that BAR is allocating less resources to these efforts?

Table 3 (Page 12) was expanded as suggested. The decline in filings has more to do with the increased complexity of compiling actionable cases for submission to OAL or OAG.

- On Page 13 – Figure 6. The gap in the roadside failure rates between good standing and suspended/revoked stations has widened from 2% in the 2024 SCPR to 14% for the 2026 SCPR. Any thoughts as to why this may be happening?

Given that the specific stations that have their licenses suspended or revoked change from one year to next, direct comparison may not be appropriate.

- In reference to Page 14 – Figure 7 – The notes to the figure don't seem to be consistent with the values in the figure. It talks about the numbers above the bars being either emissions in tons per day or number of tests, whereas the number for the pollutants are fractional percentages of the inventory. Then it says the second number is the percentage of the inventory, or total number of initial tests, when it seems to be that it's the fraction of initial tests in each category.

The notation below the graphic was corrected to state that "The numbers above the bars present the percentage of the total ROG emissions inventory or the number of initial Smog Check tests in millions (M), followed by the percentage of total NOx emissions inventory or the percentage of all initial Smog Check tests."

- On Page 15 – Figure 8. It would be interesting to add a "Totals" bar for all categories, so that the reader can easily see 45 ton per day difference in the totals.

Figure 8 on Page 15 was updated to include bars showing the totals for the "baseline" and "with reduction" estimates.

- On Page 21 – The abbreviation CTP is used in the remote OBD paragraph, but there is no definition or discussion of what CTP is.

BAR's Continuous Testing Program (CTP) is now spelled out on page 21 and included in the list of acronyms.

- On Page 34 – The average age of the participating fleet (11.4 years) is significantly lower than in previous years. Again, is this due to differences in recruitment strategies?

The newer roadside fleet is due to the cessation of pre-OBD vehicle testing and the increased recruitment of newer vehicles.

- On Page 38 – at the end of the first paragraph, the text states that… "Roadside inspection should only miss those vehicles that fail for no other reason". It's unclear what this statement is trying to convey, so perhaps it could be clarified.

As visual and functional tests are not routinely performed at roadside, vehicles that fail Smog Check for these issues may not be reflected in the roadside failure rates.

- On Page 39 – The number of OIS tests in CY 2024/2025 is stated to be 26,000, which is much higher than the value given in previous SCPRs.

The higher number of tests reflects the changes in roadside recruitment discussed earlier along with increased participation related to the end of the pandemic.

- On Page 41 – the text presents an estimate for acts of fraud of 5%. Can some additional details be added here, or somewhere. For example, the difference between the roadside and Smog Check failure rates is 10%, with 3% potentially being due to pre-inspection and repair. To what do your attribute the other 2%?

The remaining 2% is attributable to adjustments made for readiness, age/usage, and regional over or under sampling at roadside. The existing text will be modified to make this clearer to the reader.

- On Page 41 – referring to the second paragraph. The statement should be modified to read… "the EMFAC model was again used to estimate the potential additional benefits associated with the Program <u>if all stations performed at the level of high performing stations</u>." This addition would provide context for the whole section.

Per your suggestion, the second paragraph on Page 41 was rewritten.

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

BAR97, The EIS required to inspect most 1999 and older MY vehicles. The system requires an analyzer, dynamometer, BAR-certified low-pressure fuel evap tester, fuel cap tester, and other approved equipment and parts.

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)

CFR, Code of Federal Regulations

CHP, California Highway Patrol

CO, Carbon Monoxide

Comp, Comprehensive

COO, Change of Ownership

CTP, Continuous Testing Program

CY, Calendar Year

DAD 2.0, Data Acquisition Device – Second Generation

D.C., District of Columbia

Directed Vehicles; vehicles that can only receive Smog Check certification from STAR Test Only or STAR Test and Repair stations.

DTC, Diagnostic Trouble Code

DMV, California Department of Motor Vehicles

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

ETW, Equivalent Test Weight - a standardized value used to set the correct load on a dynamometer for consistent and comparable emissions tests for regulatory purposes.

FPR, Follow-up Pass Rate: The 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."

FR, Failure 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

Mi, mile

Mph, Miles per Hour

LDA, Light-Duty Auto

LDT, Light-Duty Truck

LDT1, Light-duty Trucks with a GVWR less than 6,000 lbs. and an ETW <=3,750 lbs.

LDT2, Light-duty Trucks with a GVWR less than 6,000 lbs. and an ETW >3,750 & <5,751 lbs.

LHD, Light-Heavy-Duty

LHD1, Light-Heavy-Duty Trucks with a GVWR between 8,501 to10,000 lbs.

LHD2, Light-Heavy-Duty Trucks with a GVWR between 10,001 to 14,000 lbs.

M, Million

MC, Motor Coach: a high-end, large, luxury RV (essentially a bus or truck chassis converted into a premium mobile home with extensive amenities)

MDV, Medium-Duty Vehicle (GVWR 5,751 to 8,500 lbs.)

MH, Motor Home: a single vehicle unit for non-commercial recreational/emergency use, built on a self-propelled chassis with permanently installed living facilities

MY, Model Year

NO_x, Oxides of Nitrogen

OAG, Office of the Attorney General

OAH, Office of Administrative Hearings

OAL, Office of Administrative Law

OBD II, On-Board Diagnostics - 2nd generation, generally required in 1996 and newer MY, gasoline-powered light-duty vehicles. All 1997 and newer model year diesel fueled passenger cars and trucks are also required to meet the OBD II requirements.

OEM, Original Equipment Manufacturer

OIS, OBD II 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

PM, Particulate Matter

PPM, Parts per Million

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

RV, Recreational Vehicle

SCPR, Smog Check Performance Report

SIP, State Implementation Plan - comprehensive plan that describe how an area will attain compliance with national ambient air quality standards

SSI, Single Speed Idle

STAR, Classification of Smog Check stations allowed to certify directed vehicles

TAC, Thermostatic Air Cleaner

tpd, Tons per day

tpvd, Tons per vehicle-day

TSI, Two-Speed Idle

U.S., United States

USEPA, United States Environmental Protection Agency

v, Version

VC, Vehicle Code

VMT, Vehicle Miles of Travel

VOC, Volatile Organic Compounds

VSSI, Vehicle Safety Systems Inspection Program

WEP, Worldwide Environmental Products

WOT, Wide Open Throttle

YR(s), Year / Years

Attachment C
Issues related to Roadside Emissions Survey Program representativeness

Of the 19 million 2000+ MY vehicles tested In CY 2024-2025, about 1.3 million (7%) failed Smog Check. Tests performed at roadside, however, suggest that the true failure rate is closer to 15%. Assuming that the vehicles tested at roadside faithfully represent the larger fleet, an additional 1.5 million vehicles should have failed Smog Check in the last full cycle of the program but did not.

The authors of the 2009 Report suggested that the observed difference between the Smog Check and roadside failure rates is attributable to either outright fraud, intentionally gaming the system, or incompetence, performing repairs that had no lasting impact on emissions. This section of the SCPR presents several factors beyond fraud and incompetence that make direct comparison between the Smog Check and roadside fleets problematic. These factors include:

- Voluntary participation in roadside inspection
- Differences in age/usage in the two fleets
- Differences in test procedures
- Initial registration
- Pre-inspection and repair

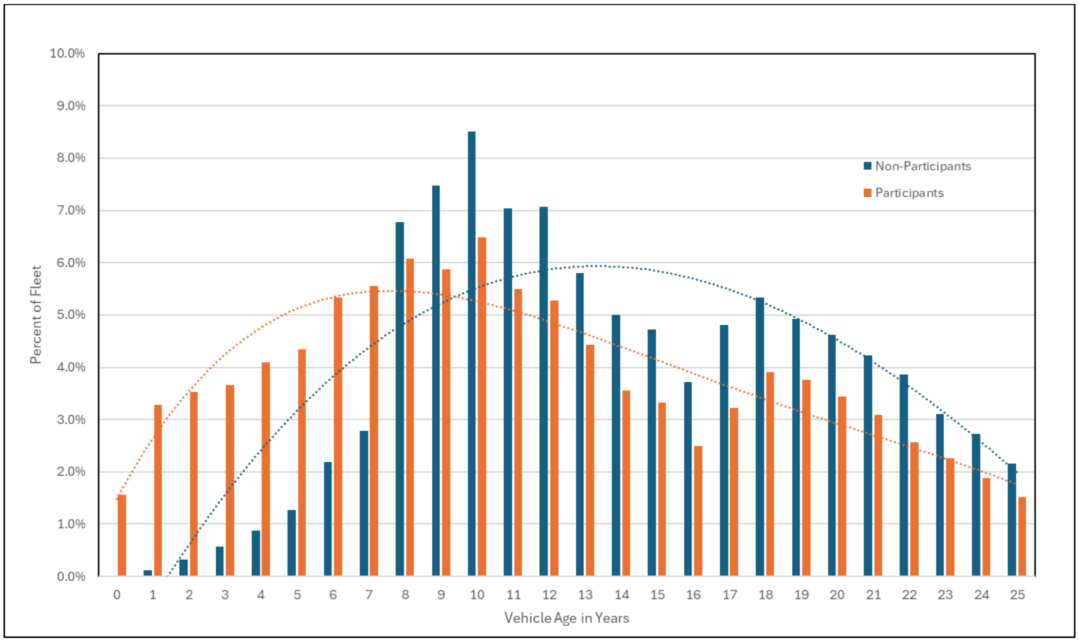
Voluntary participation

In CYs 2024 and 2025, some 12,000 vehicle owners, close to 40% of those directed by the CHP, declined to allow BAR staff to inspect their vehicles at roadside. Although several reasons for refusal might exist, if these reasons include prior knowledge or suspicion of failure, the sample of participating vehicles could be skewed, and the roadside failure rates underestimated.

In assessing whether the voluntary nature of roadside inspection threatens its validity, several comparisons were made between vehicles participating in roadside inspection and the non-participating fleet. In observing the MY distribution of the two fleets, the average age of the non-participating fleet was found to be 14.2 years which is close to three MYs older than the average age of the participating fleet (11.4 years) (see Figure C-1 below), due to a greater emphasis on recruiting new vehicles for roadside testing as of April or 2024.

Other relevant characteristics of the non-participating fleet were assessed through an examination of their Smog Check histories. It is important to note that no histories were found for 2,500 of the un-inspected vehicles, almost all of which were either registered outside of California, exempt from inspection due to age, or registered in COO only areas. Table C-1 (below) provides a comparison of the characteristics of the remaining non-participant vehicles to the resulting roadside sample.

Figure C-1
MY distributions of the participating and non-participating fleets



The results of this comparison suggest that the participating and non-participating fleets were more similar than different; however, it is notable that a larger percentage of the non-participating vehicles received their last Smog Check at non-STAR stations and failed at a slightly higher rate. This is consistent with findings discussed earlier in this report, that vehicles certified by non-STAR stations fail at higher rates at roadside.

The result of these comparisons suggests that, at least at the current rate of participation and refusal, those vehicles that go un-inspected at roadside do not significantly skew the representativeness of the roadside sample.

Differences in age/usage

As discussed earlier, vehicle age has proven to be a strong predictor of failure in both the Smog Check and roadside fleets. Traditionally, roadside failure rates are normalized using the Smog Check MY/Age distribution prior to comparison. However, usage is known to vary widely even within vehicles of the same age or MY. Perhaps a more precise surrogate for usage, and by extension wear on vehicle's emission controls, would be the use of a combination of vehicle age and average odometer reading, carrying the assumption that vehicles that are driven more frequently would have a higher likelihood of failure compared to vehicles of the same age or MY that are driven less.

The average odometer reading for the CY 2024-2025 Smog Check fleet was found to be 136,000 miles. In comparison, the unweighted average odometer reading for the roadside fleet was determined to be 101,000 miles. Figure C-2 (below) presents the average odometer readings of the roadside and Smog Check fleets as a function of age and C-3 presents the Smog Check and roadside failure rates as a function of mileage.

Table C-1
Comparison of non-participant and roadside inspected fleets

Factor	Status	Non-Participants	Participants	Smog Check
Prior Smog Check Result	Fail	0.9%	0.5%	6.8%
Prior Smog Check Result	Pass	99.1%	99.5%	93.2%
Station License Status	Good Standing	94.2%	96.5%	87.1%
Station License Status	Suspended/Revoked	5.8%	3.5%	12.9%
***Station FPR Rank**	A	11.0%	11.9%	3.9%
***Station FPR Rank**	B	24.2%	22.8%	13.5%
***Station FPR Rank**	C	40.1%	39.2%	32.3%
***Station FPR Rank**	D	19.6%	20.9%	21.1%
***Station FPR Rank**	F	5.1%	5.1%	20.4%
Smog Check Area Type	Enhanced	97.5%	96.9%	83.2%
Smog Check Area Type	Partial	1.7%	2.1%	5.2%
Smog Check Area Type	Basic	0.7%	0.9%	9.9%
Smog Check Area Type	Change of Ownership	0.1%	0.1%	1.3%
Station Type	STAR	85.8%	83.9%	82.9%
Smog Check Area Type	Non-STAR	14.2%	16.1%	17.1%

*Where "A" includes stations with an FPR score between 0.9 and 1.0, "B" from 0.7 to 0.9, "C" from 0.4 to 0.7, "D" from 0.1 to 0.4 and "F" being less than 0.1.

To account for this difference, when estimating the potential additional benefits of the program, the mileage accrual rates (MAR), i.e., the miles per year driven as a function of age, for the roadside fleet were weighted by the Smog Check accrual rates and the correlation between odometer reading and failure was determined. It is important to note that improvements in roadside recruitment should eliminate the need to correct for these differences in the future.

Figure C-2
Average age-specific odometer readings of the CY roadside and Smog Check fleets

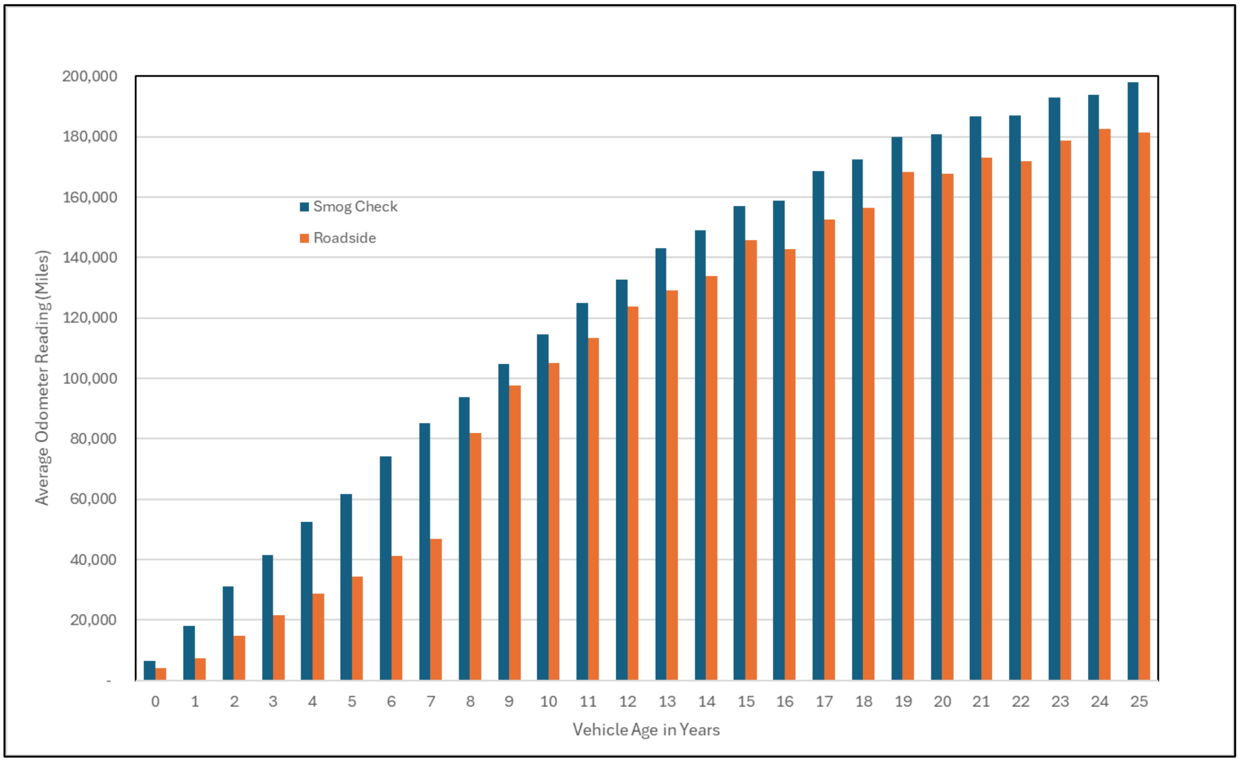
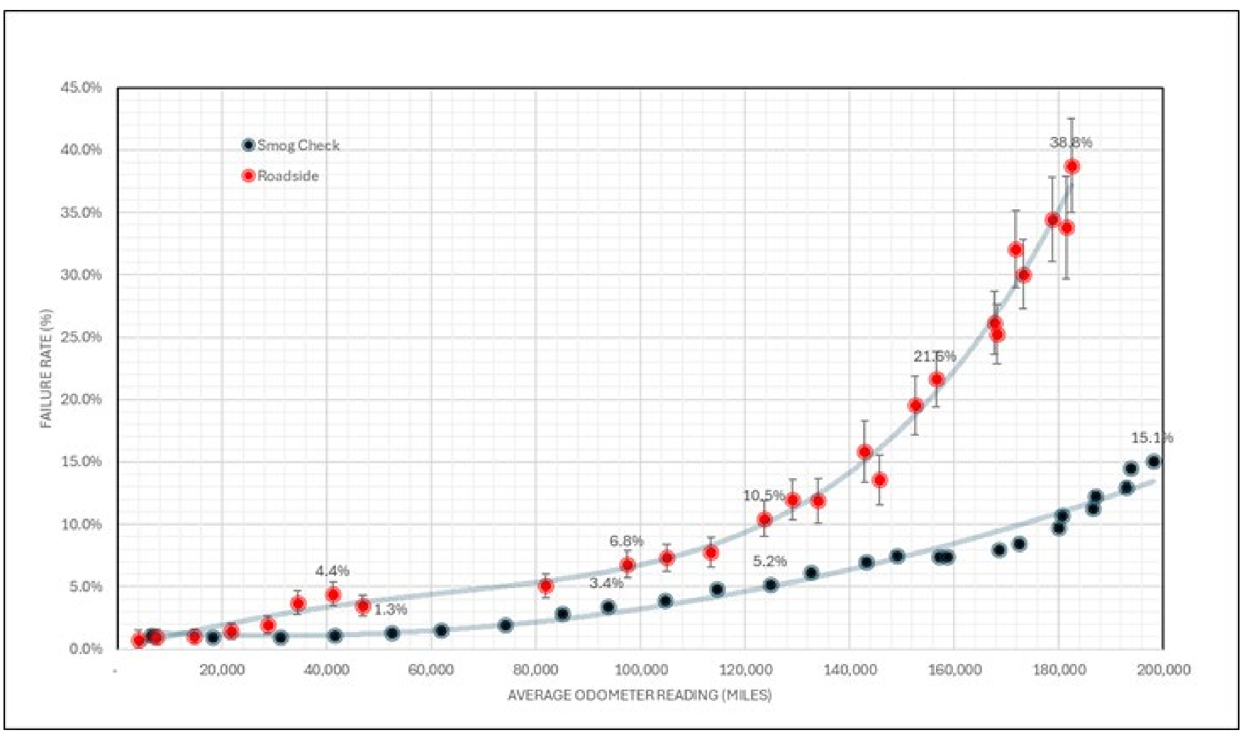


Figure C-3
Failure rate as a function of mileage



Procedural differences

Some visual and functional checks of emission control components that are integral to Smog Check are not routinely performed at roadside. As a result, some Smog Check failures might go undetected during roadside inspection, artificially lowering the roadside failure rate. Table C-2 (below) contrasts the Smog Check and roadside failures by category. As shown, 1.27% and 0.14% of the Smog Check fleet failed for “Visual” and “Smoke/Liquid Leak”, respectively, with no comparative statistic for roadside inspection. It should be noted that the “Fail Smoke/Liquid Leak” statistic in Table C-2 is a subcategory of visual failures and is not mutually exclusive.

Table C-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	10.67%	14.20%	-	-
Fail Gross Polluter	0.46%	5.90%	-	-
Fail Functional	9.50%	-	6.89%	10.99%
Fail Visual	3.20%	-	1.27%	-
Fail OBD	-	-	6.80%	11.09%
Fail Readiness	-	-	4.12%	5.42%
Fail Smoke/Liquid Leak	-	-	0.14%	-

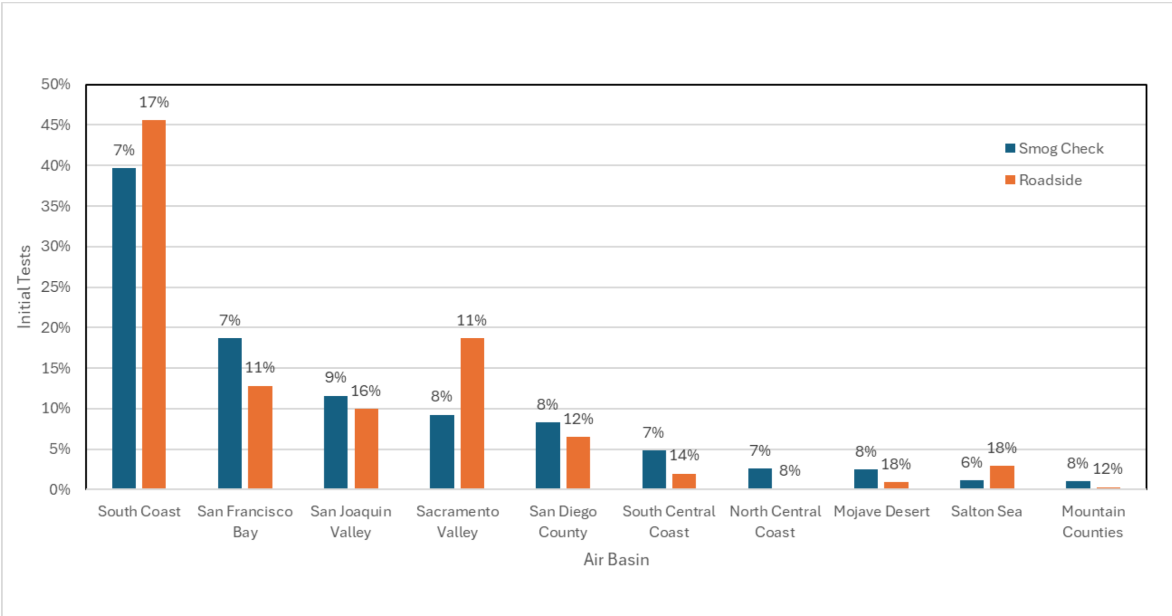
*Emissions are not measured for 2000+ MY vehicles. Not all visual and functional checks are performed at roadside.

Regional Differences

California is divided into 15 air basins to better manage pollution control efforts. Air basin boundaries were determined by grouping together areas with similar geographical and meteorological features. BAR’s roadside teams operate year-round throughout the state to obtain a representative sample of the fleet in support of the SCPR. Given the fact that regional differences exist with respect to Smog Check requirements and failure rates, adjustments may be necessary to compensate for any over- or under-sampling by area. Figure C-3 (below) compares the percentage of initial Smog Check tests performed in each of California’s Air Basins to the percentage of roadside inspections performed in the same areas in CYs 2024-2025 along with the air basin specific failure rates.

As illustrated in Figure C-4, a higher percentage of the roadside fleet was inspected in the South Coast, Sacramento Valley, and the Salton Sea Air Basins compared to the percentage of initial Smog Check tests. It is also notable that the roadside failure rates in these areas tended to be higher overall compared to under-sampled areas. Reweighing the roadside results may be necessary to address any differences due to regional sampling bias.

Figure C-4
Percentage of Smog Check and roadside tests and relative failure rates by air basin*



*Where the height of the bars represents the percentage of Smog Check initial tests or roadside inspections and numbers above the bars represent the relative failure rates.

Initial registration and Smog Check

Every year over 1.5 million vehicles are added to the fleet subject to biennial inspection. These include those newer vehicles that were previously age-exempted, and those belonging to motorists relocating to California. In CYs 2024-2025, some 9,700 vehicles inspected at roadside had no prior Smog Check history of which seven percent failed. Given that these vehicles might not yet have been tested within the Program, roadside failure rates may be artificially higher compared to Smog Check.

Pre-inspection repair

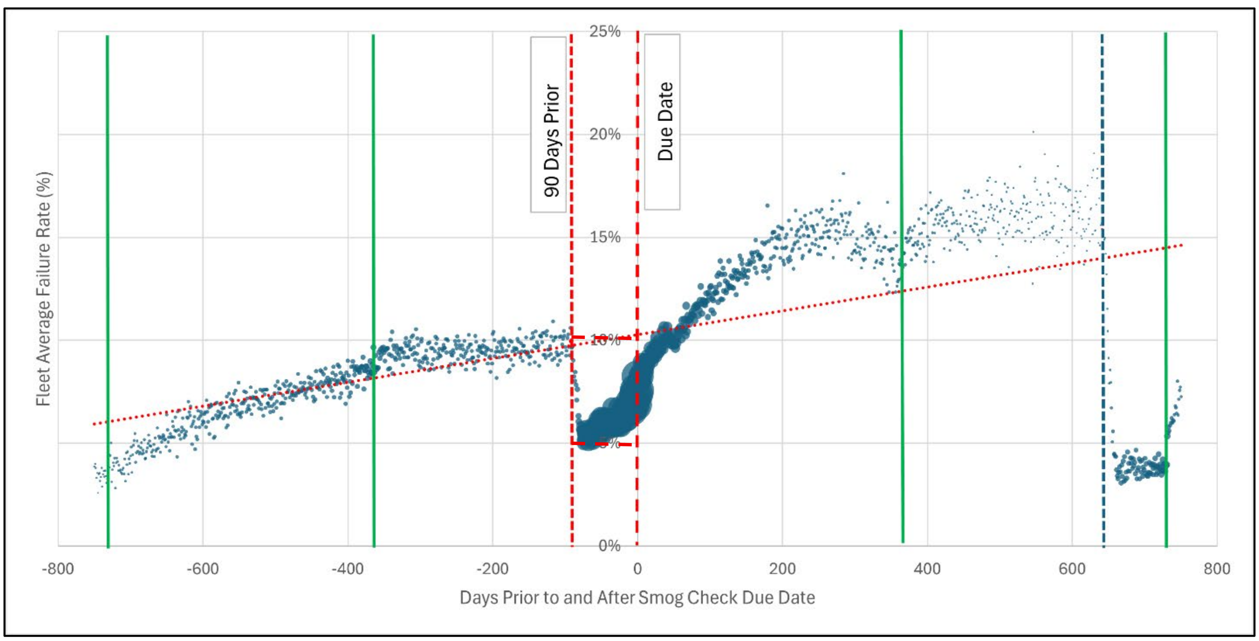
On average, about 26,000 vehicles per day received an OIS test in CYs 2024 and 2025. As a courtesy to their customers, many Smog Check stations, as well as vehicle maintenance and repair related businesses, offer low or no cost "pre-inspections". As the term implies, pre-inspections inform vehicle owners of their likelihood of failing, affording them the opportunity to seek repairs prior to Smog Check. That is, an unknown population of vehicles that were likely to fail Smog Check did not because problems were corrected prior to official inspection. While minimizing the time between system failure and repair is beneficial to the program overall, the widespread practice of pre-inspection and repair results in lower Smog Check failure rates compared to those observed at roadside.

As compliance with Smog Check is tied to registration renewal, California's DMV informs vehicle owners by mail that an inspection is due around 90 days prior to the date of registration expiration. In attempting to assess the magnitude of the impact of pre-inspection and repair, an analysis was performed to determine the daily average failure rate of the CY 2024-2025 OIS tested fleet leading up to and beyond the Smog Check "due date".

About half of all Smog Check inspections occur during the three-month period prior to the due date. As can be seen in Figure C-4 below, during this period the fleet average failure rate is cut in half, falling from ten to five percent. Assuming that the failure rates would not decline in the absence of the threat of Smog Check failure, the impact of pre-inspection and repair, for the purposes of this analysis, was estimated by counting the number of vehicles that fell below the fleet average failure rate in the three-month period prior to the registration renewal due date. Applying this methodology, it is estimated that an additional 580,000 vehicles, about three percent of the Smog Check fleet, would have failed but were repaired prior to inspection. Properly accounting for pre-inspection repair would explain more than a third of the observed difference between the roadside FRs and Smog Check FRs, raising the Smog Check FR from seven to about ten percent.

This estimation of the impact of pre-inspection repair should be considered conservative as many motorists are likely to respond to an illuminated MIL without regard to registration renewal. It is likely that the daily failure rates displayed in Figure C-4 would be even higher if vehicle owners were not motivated to take corrective action outside of the program.

Figure C-4
Daily failure rate of the 2024-2025 CY fleet with respect to the Smog Check due date



Summary and suggestions

Although the authors of the 1990 Report attribute the observed differences between the Smog Check and roadside failure rates directly to acts of incompetence and/or fraud within the program, the analyses performed in this section of the SCPR highlight several other factors that might impact the Smog Check FRs, roadside FRs, or both, in ways that make direct comparison problematic.

An accurate estimation of acts of fraud within Smog Check is essential in estimating the additional potential benefits obtainable through programmatic improvement. As such, it is suggested that all of the “known” differences in the Smog Check and roadside failure rates be quantified and that the estimates of fraud be relegated to, and bounded by, the remaining “unknown” differences. Given that 3% of the difference is potentially due to pre-inspection and repair and another 2% due to readiness, age/usage and regional over or under sampling, it is estimated that acts of fraud within the program are limited to about five percent.

CARB’s EMFAC model was again used to estimate the potential additional benefits associated with the program if all stations performed at the level of high performing stations, resulting in the roadside failure rates being equal to the Smog Check failure rates. Using the adjusted baseline described above as a starting point (adjusting for differences in vehicle age/mileage, regional differences and pre-inspection repair), Attachment D of this report presents a detailed discussion of the methodology used to estimate the additional emissions reductions that might be achieved through further programmatic improvement.

Suggestions by CE-CERT on improving roadside inspection

BAR continually evaluates issues related to sample representativeness and improvements are made to the roadside test procedures when deemed appropriate. The following are specific suggestions made by CE-CERT for modifying the protocol and procedures used during roadside inspection that are geared toward improving representativeness of the collected data. BAR’s responses to these suggestions are shown in italics.

Eliminate the testing of diesel-powered vehicles

- It is unlikely that diesel-powered vehicles can be inspected in sufficient numbers at roadside to make any useful determination about their status. It is therefore suggested that BAR consider eliminating testing these vehicles at roadside.

Although BAR inspects fewer diesels than pre-OBD vehicles, concerns exist regarding a total lack of data on this important segment of the fleet. Alternative methods to gather data on diesel-powered vehicles, including collaboration with CARB on their Surveillance test programs, are being considered.

Implement approaches to increase participation

- Allowing motorists to opt-out of roadside inspection raises serious concerns regarding the representativeness of the resulting dataset. BAR should consider approaches to incentivize voluntary inspection or take a more aggressive stance to compel participation. At the very least, roadside staff should conduct a visual check of the MIL of non-participating vehicles.

An extensive assessment of the non-participating fleet is presented earlier in this report which concludes that “at least at the current rate of recruitment and refusal, those vehicles that go un-inspected at roadside do not significantly skew the representativeness of the roadside sample.”

Augment roadside inspection with remote sensing data sources

- It is our understanding that BAR has access to CARB's multi-location RSD study data. Would it be possible to obtain data from CARB related to high emitters, or a snapshot of the emissions of both participating and non-participating vehicles. As envisioned, the high emitter data could be cross correlated with either low or higher performing stations to see if any trends exist related to station performance. It should be noted that given the potential variability of RSD measurement, care should be taken to make sure any data analyzed would require multiple measurements or otherwise be screened to ensure that the data are not outliers.

Although BAR actively participates in CARB's multi-location RSD studies, RSD as an integral element of roadside inspection is considered to be of limited value. Alternatively, CARB has been working with BAR's roadside inspection teams to recruit vehicles for testing at their laboratory. Although fewer vehicles will be assessed in this way, it is believed that the resulting data will be more useful compared to "snapshots" of emissions obtained by RSD.

Analyze the impact of time dependency of roadside inspection data on failure rates

- Another factor impacting the comparability of roadside and Smog Check test failure rates is the amount of time between inspections. As can be seen in Figure C-4 on page 34, the fleet average failure rates leading up to and following the Smog Check due date are significantly different. Perhaps aware of these differences, the authors of the 2009 report suggested that BAR "Perform inspections of vehicles ***immediately*** following certification at Smog Check stations …" (See page 5). The longer the time between Smog Check and roadside inspection, the greater the probability that the vehicle will have changed state (pass to fail or fail to pass). BAR should perform an analysis of this time dependency with the objective of either modifying the roadside recruitment strategy, establishing an optimal time interval between tests for evaluation, or both, with respect to comparing the two fleets.

BAR is currently performing the analysis you propose through a longitudinal study of vehicles enrolled in CTP. The objective of this study is to determine, on average, how long vehicles operate with the MIL illuminated, and once extinguished, how long vehicles operate before the MIL is again illuminated. The results of this analysis will be used to establish a window of time when the average vehicles are most likely in the same state of repair as that observed in their last Smog Check. A time dependency analysis will be included in the 2028 publication of the SCPR.

Conduct a special project to assess evaporative emissions control issues

- BAR should conduct, perhaps in partnership with CARB, a special test project to assess the frequency and severity of evaporative control system failures, including fraudulent practices, within the regulated fleet.

BAR assesses the frequency and severity of evaporative emission control problems through analysis of stored DTCs observed in Smog Check and the roadside fleet. As laboratory testing is necessary to determine the magnitude of emissions associated with issues detected through OIS, BAR is in discussion with CARB regarding this issue.

Attachment D
Methodology for estimating potential emission reductions

Ideally, the reduction in pollutants associated with Smog Check is estimated by comparing the measured emissions of vehicles passing roadside inspection to those that fail. However, the pass/fail determination for 2000 and newer MY vehicles is based upon OBD status checks rather than the direct measurement of emissions.

CARB has developed a sophisticated statistical model used to characterize the emissions of pollutants attributable to the on-road fleet. The EMFAC model, which is periodically reviewed and approved by the USEPA, is used to estimate the benefits of both proposed and adopted emission control strategies and the impact of related legislation and regulations. In this version of the SCPR, the EMFAC model was again used to estimate the potential additional benefits achievable by the program if all stations performed at a high level.

In support of EMFAC, CARB conducts routine "surveillance" test programs during which vehicles are randomly selected from California's on-road fleet for extensive testing at CARB's southern California laboratory. Like BAR's Roadside Emissions Survey Program, participation in surveillance is voluntary and it is assumed that the random sample of vehicles procured by CARB is representative of the fleet at large and faithfully reflects the impact of various adopted emission reduction strategies including Smog Check.

Figure D-1 displays the Smog Check and roadside failure rates as a function of odometer reading for MY 2000 and newer vehicles. Adjustments to the baseline were performed to correct for age specific average odometer readings, for regional differences and for the impacts of pre-inspection repair. These adjustments are discussed at length in Attachment C.

The EMFAC model carries the assumption that 45 MYs or more of light-duty autos are active in a given calendar year. Figure D-2 presents the age specific gram per mile (gpm) ROG+NO_x exhaust emission rates (ERs) for gasoline-powered LDAs for MYs 2000 to 2025 in CY 2025 as estimated by EMFAC2025 v2.0.0, the official version of the model available at the time of this report. The statewide, annual average, ERs were derived by dividing the MY specific tpd contribution to the inventory by the corresponding estimates of activity (expressed as vehicle miles of travel or VMT). For example, the ROG+NO_x ER as estimated by EMFAC for MYs 2025 and 2000 in CY 2025 are 0.03 gpm and 1.15 gpm, respectively.

Equation 1:
ER (gpm) = (Emissions tpd)*(453.59 gms/lb. X 2000 lbs./ton) / VMT
ER MY 2025 (gpm) = (0.525 tpd X 90,7180 gms/ton) / 14,521,141 mi/day = 0.03
ER MY 2000 (gpm) = (2.840 tpd X 90,7180 gms/ton) / 1,863,459 mi/day = 1.15

As previously stated, vehicles equipped with OBD systems are not routinely tested for emissions. However, since CY 2003, BAR, at the request of CARB, has performed over 27,000 ASM tests of 1996 and newer MY vehicles during roadside inspections. While insufficient to estimate the MY specific emission rates of passing and failing vehicles, these data were used in this analysis to establish age specific multipliers (M) (See Equation 2 and Figures D-3 and D-4, below).

D-1
OIS failure rates by odometer reading for Smog Check and roadside test data

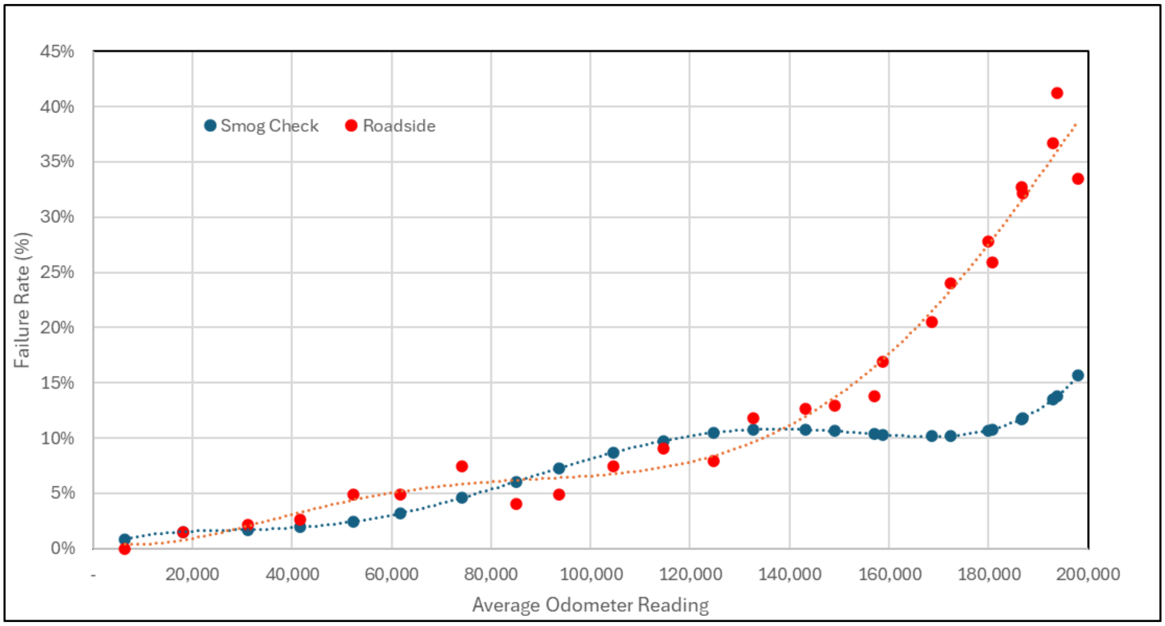
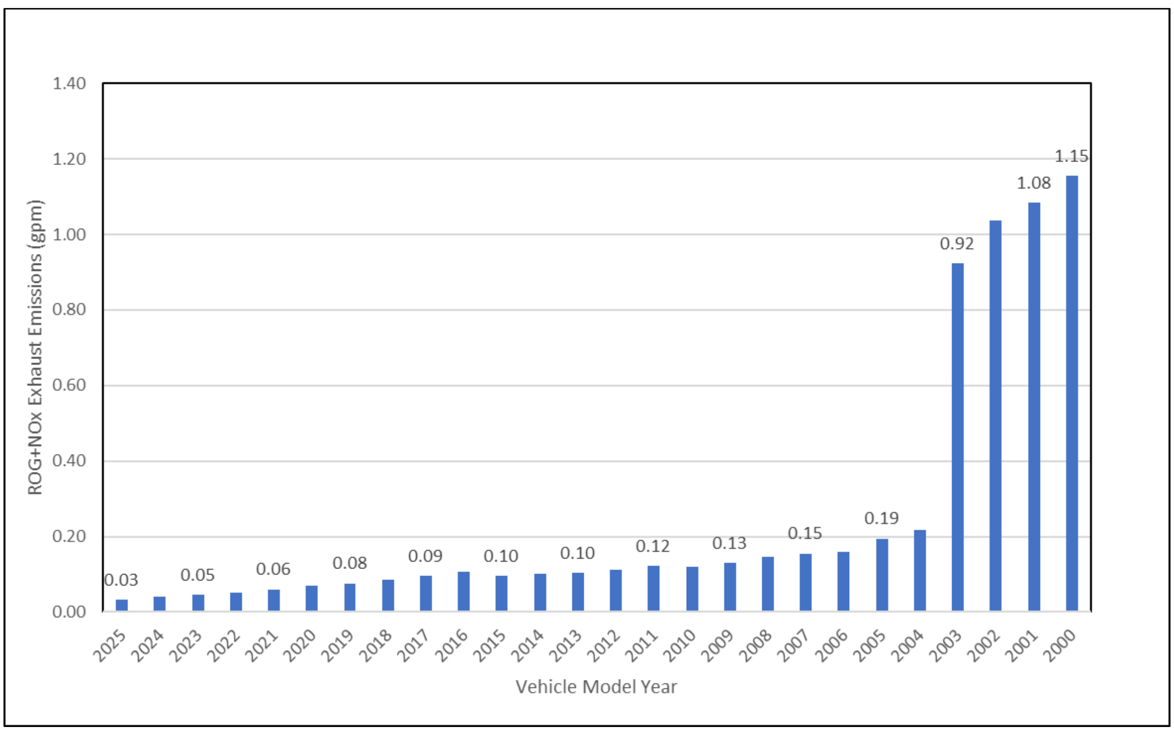


Figure D-2
Grams/mile exhaust emissions of ROG+NO$_x$ by model year



Equation 2:

$$ER\ (gpm) = ER_{Passing} * (\%\ Passing) + ER_{Failing} * (\%\ Failing)$$

$$ER\ (gpm) = ER_{Passing} * (1-FR) + ER_{Passing} * Multiplier * FR$$

$$ER_{Passing} = ER / (1-FR) + M * FR \quad \& \quad ER_{Failing} = ER_{Passing} * M$$

Figure D-3
Average passing and failing exhaust emission rates by vehicle age (ROG)

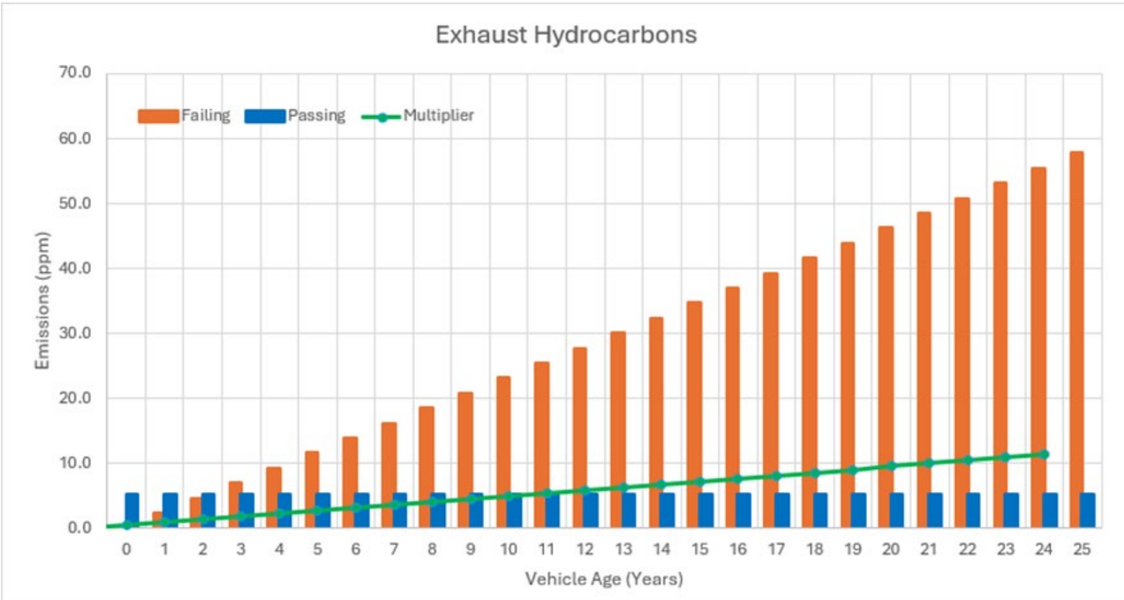
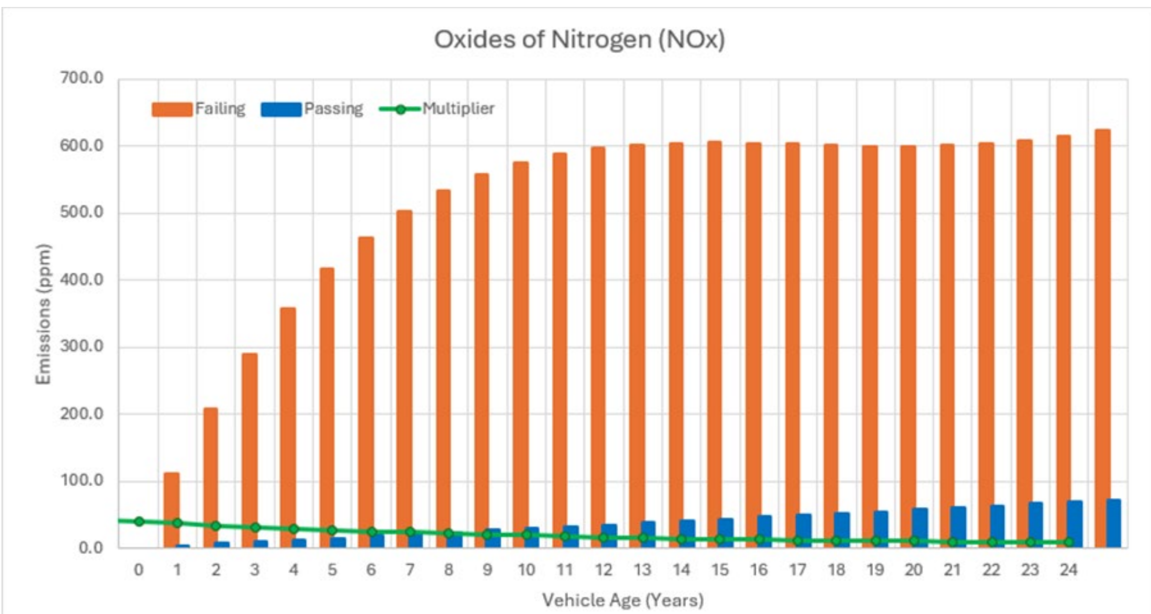
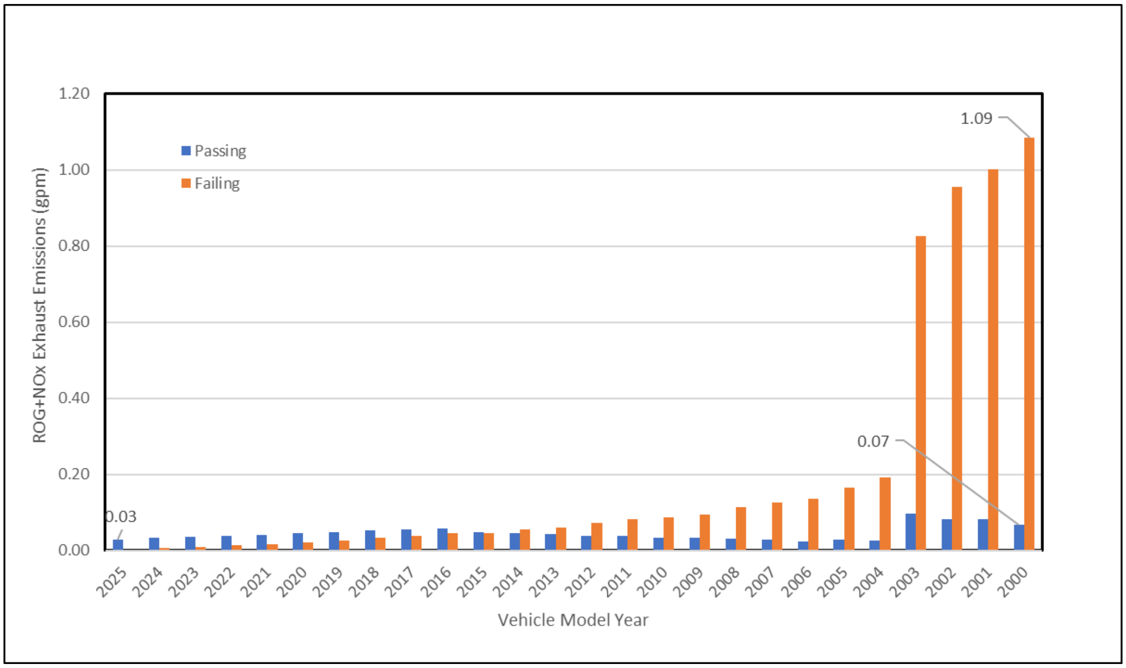


Figure D-4
Average passing and failing exhaust emissions rates by vehicle age (NOx)



As evidenced in Figures D-3 and D-4 above, vehicles that fail Smog Check tend to have significantly higher emission rates compared to passing vehicles. The methodology used in this version of the SCPR calls for the establishment of a one-to-one relationship between EMFAC's estimated ERs and the MY specific failure rates observed in either Smog Check or at roadside. Through the application of Equation 2 (above), EMFAC's MY specific emission rates can be subdivided into the relative emission rates of passing and failing vehicles (See Figure D-5 below).

Figure D-5
Baseline gram/mile emissions rates of passing and failing vehicles
MY 2000+ LDAs (exhaust ROG + NO_x)



Further assuming that the roadside failure rates faithfully reflect the baseline condition of the fleet, the overall potential reduction in exhaust emissions were calculated by substituting the Smog Check failure rates for the roadside failure rates and noting the corresponding change in the inventory estimate (See Equation 3 below).

Equation 3:
Potential Benefit (tpd) = Age $\sum_{0}^{25}(\text{ER Roadside } - \text{ER Smog Check}) * \text{VMT}/(\text{gms./lb.} * \text{lbs./ton})$

Reduction of evaporative emissions

In this version of the SCPR, stored DTCs were used to separately identify those vehicles that failed inspection for exhaust related issues and those vehicles failing due to problems with evaporative emission control. Although evaporative control-only failures are relatively rare, this distinction is considered important in that exhaust emissions failures contribute to excess emissions of both ROG and NO_x, while vehicles with evaporative control issues contribute only to excess emissions of ROG (See Figure D-7). Table D-1 lists those evaporative control system-related DTCs used in this analysis.

Figure D-7
Sources of vehicular emissions

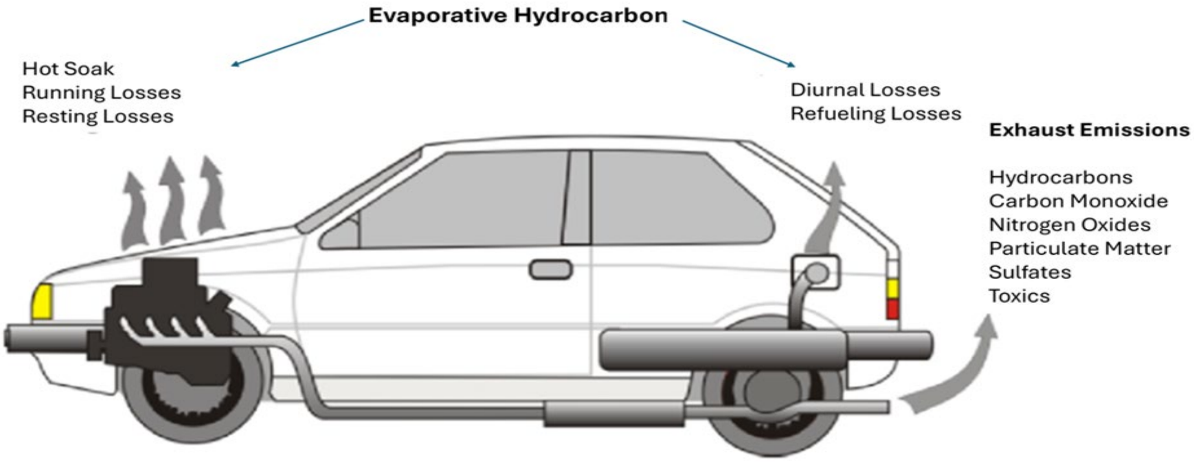
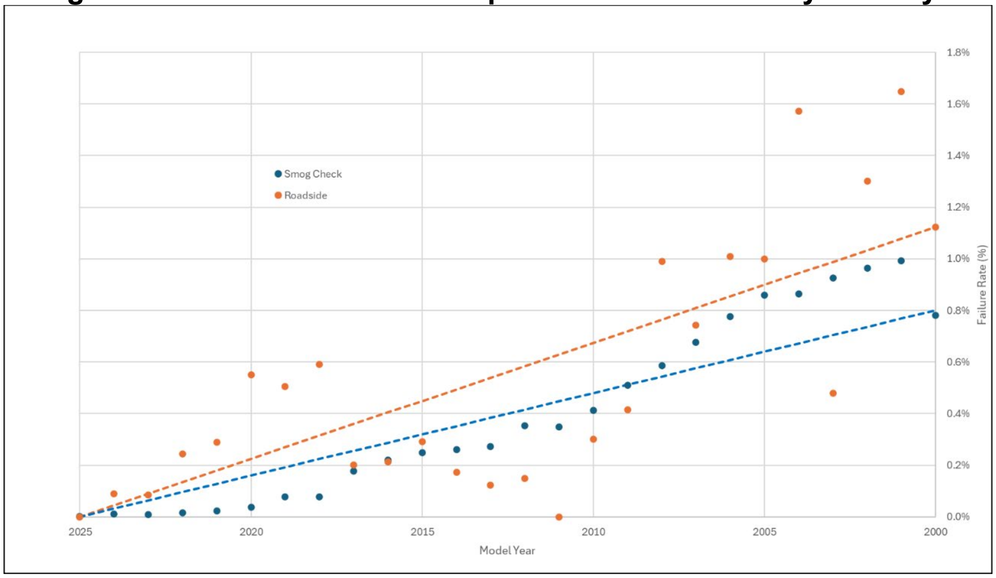


Table D-1
Evaporative emission control system-related DTCs

DTC	Description	DTC	Description
P0440	System Malfunction	P0456	Small Leak Detected
P0441	Incorrect Purge flow	P0457	System Leak Detected
P0442	Leak Detected (small leak)	P0460	Pressure Sensor Malfunction / Fuel Level
P0443	Purge Control Valve Circuit Malfunction	P0461	Pressure Sensor Range
P0444	Purge Control Valve Circuit Open	P0463	Pressure Sensor High Input / Fuel Level
P0445	Purge Control Valve Circuit Shorted	P0464	Pressure Sensor Intermittent / Fuel Level
P0447	Vent Control Circuit Open	P0465	System Tank (gross leak) / Purge Flow
P0448	Vent Control Circuit Shorted	P0466	Leak Detected (very small) / Purge Flow
P0449	Vent Valve/Solenoid Circuit Malfunction	P0467	Leak Detected (fuel cap loose/off)
P0450	Pressure Sensor Malfunction	P0468	Purge Control Valve Circuit Low
P0451	Readings outside of acceptable range	P0469	Purge Control Valve Circuit High
P0452	Pressure Sensor Low Input	P0496	High Purge Flow
P0454	Pressure Sensor or Switch	P0497	Low Purge Flow
P0455	System Gross Leak	P0498	Vent Control Circuit Low

Figure D-8 below presents the roadside FRs and Smog Check FRs for evaporative emissions control-only failures. For purposes of this analysis, vehicles with stored DTCs indicating both exhaust and evaporative emission control systems issues were included in both the exhaust and evaporative emission failure rates.

Figure D-8
Smog Check and roadside OIS evaporative failure rates by model year*



*Because of the relatively low sample size, a simple linear regression was used to model evaporative failure rates

Figure D-9 presents MY specific evaporative emission rates for the 2025 CY fleet and D-10 presents the data used to establish multipliers specific to the repair of evaporative emission control systems.

Figure D-9
Grams/vehicle-day evaporative emission rates by model year

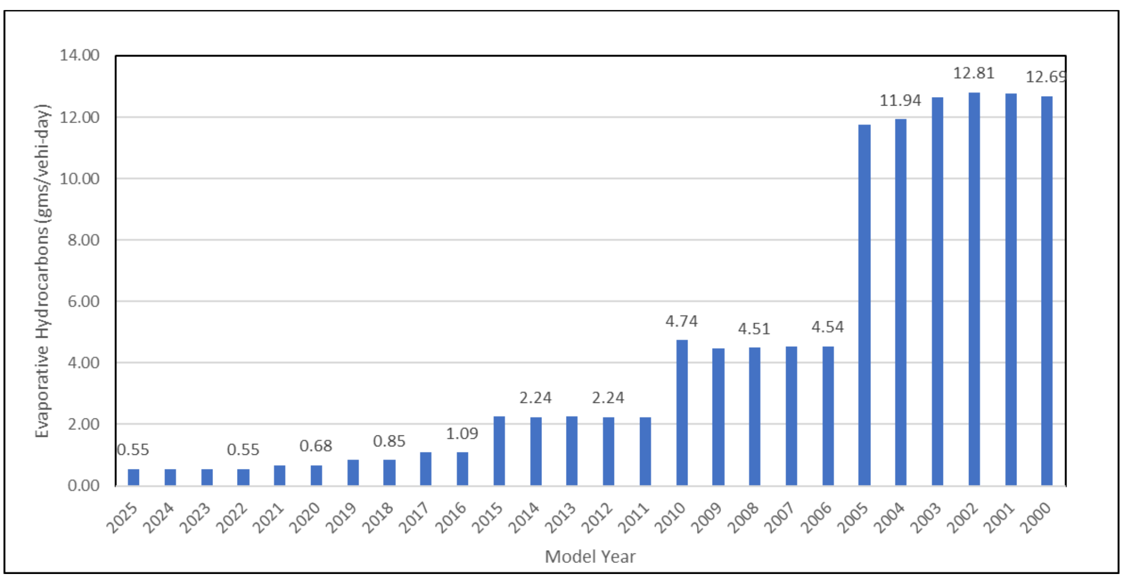
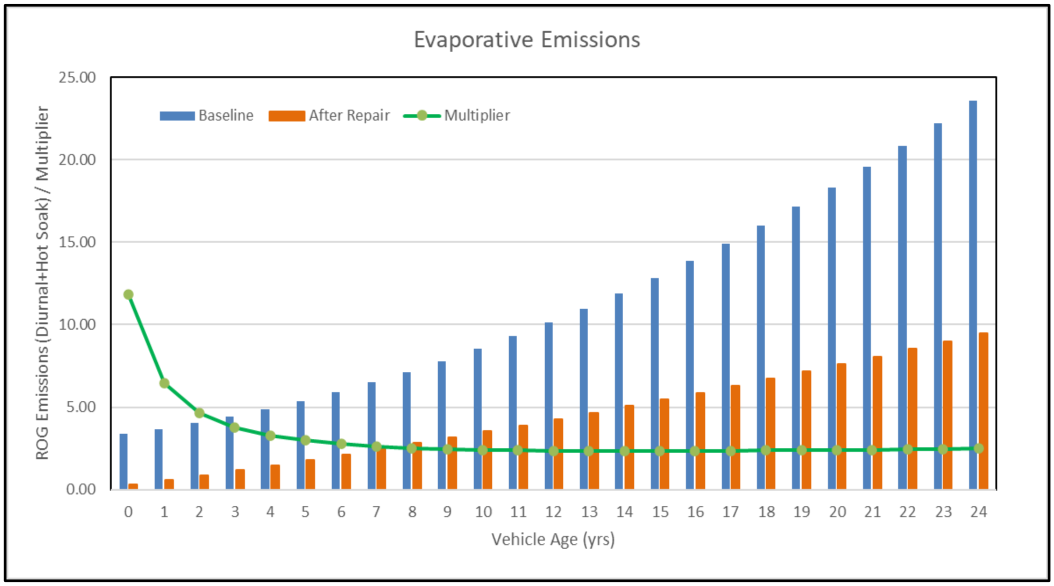


Figure D-10
Baseline and after repair evaporative emissions rates by age and resulting multipliers

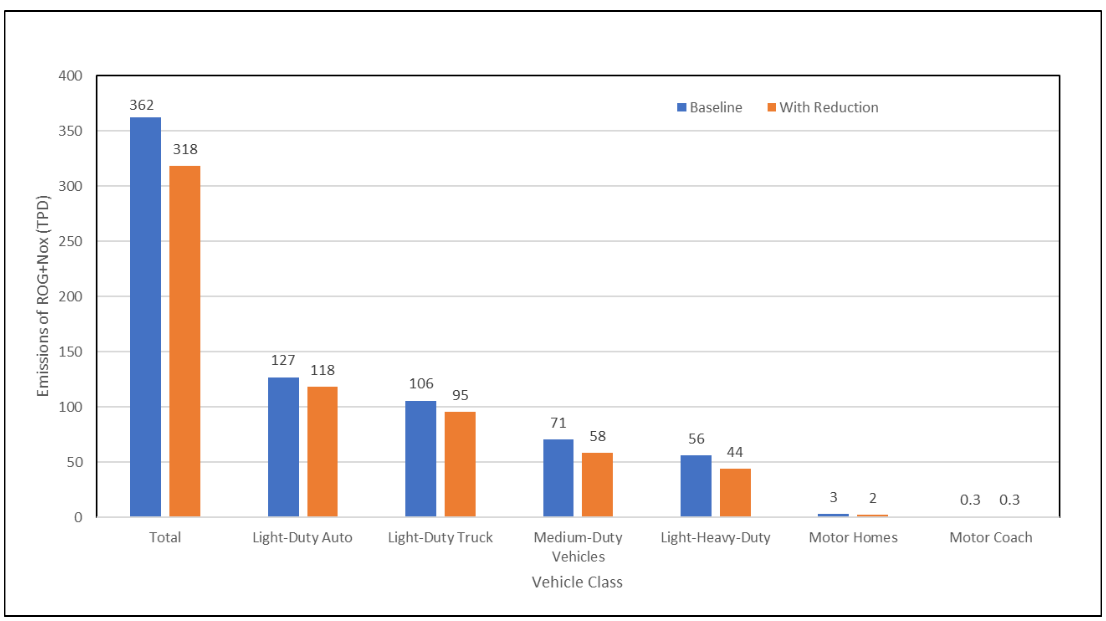


Applying the methodology described above for both exhaust and evaporative emissions, it is estimated that an additional 44.3 tpd of ROG + NO_x might have been realized though programmatic improvements to Smog Check. A reduction of this magnitude would be equivalent to removing over six million LDA's from daily operation (See Figure D-11 and Equation 4).

Equation 4:

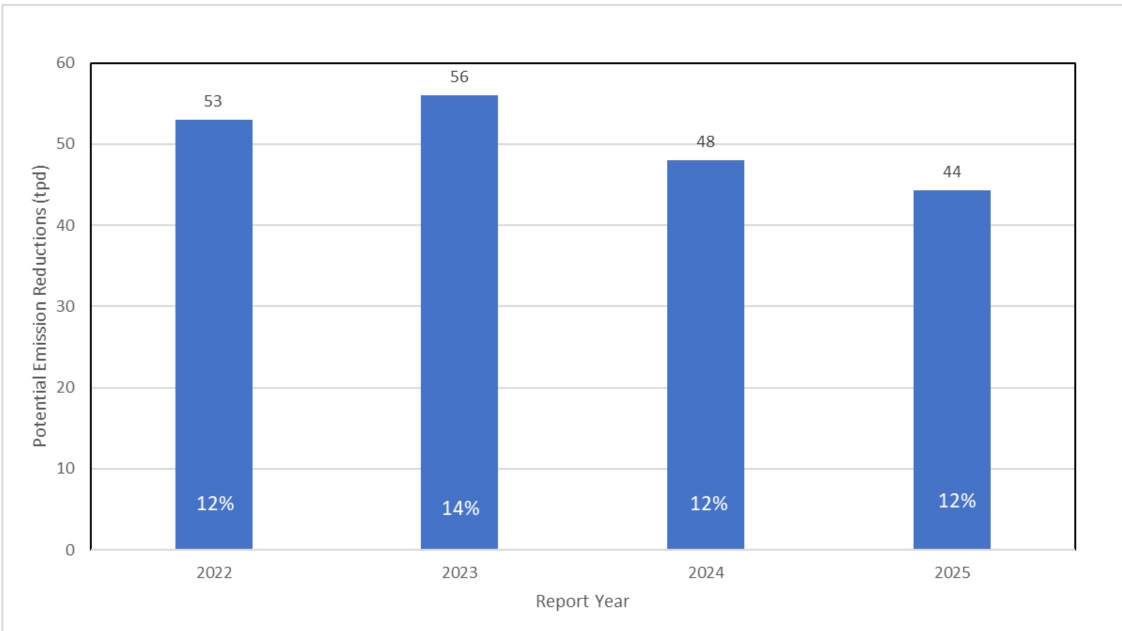
Vehicles Removed = Estimated Benefit (tpd) / LDA Fleet Average Emission Rate (tons/veh-day) = 44.3 tpd / 6.366265E-06 tpvd = 6,952,329.78 vehicles.

Figure D-11
Estimated additional emission reduction achievable through improvement to Smog Check



The ton per day estimates of potential additional emission reductions related to program improvements vary considerably across editions of the SCPR reflecting both changes to fleet makeup and methodology. Despite these differences, the estimated additional achievable benefits expressed as a percent reduction from the baseline has been reasonably consistent ranging from 12% to 14%. Figure D-12 presents the current and historical estimates expressed in both tons per day and as a percentage of the overall emissions inventory of vehicles subject to the program.

Figure D-12
SCPR estimates of potential emission reductions by report year



The reader should note that BAR is working in cooperation with CARB to better model the overall benefits of Smog Check and to refine the estimate of the impact on the emissions related to specific changes to programmatic elements.