Appendix H – Original SRIA Submitted to DOF

State of California
Air Resources Board

Proposed Heavy-Duty Inspection and Maintenance Regulation
Standardized Regulatory Impact Assessment (SRIA)

Date of Release: July 28, 2021

California Air Resources Board
1001 I Street
Sacramento, California 95814

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List of Acronyms and Abbreviations

AGPA - Associate Governmental Program Analyst
ALPR - Automated License Plate Recognition
APS - Air Pollution Specialist
ARE - Air Resources Engineer
ARS - Air Resources Supervisor
ART - Air Resources Technician
ATA - American Trucking Association
BAR - Bureau of Automotive Repair
CalEPA - California Environmental Protection Agency
Caltrans - California Department of Transportation
CARB or Board - California Air Resources Board
CCPI - California Consumer Price Index
CDFA - California Department of Food and Agriculture
CHP - California Highway Patrol
CI – Confidence interval
CO - Carbon monoxide
CO_2 - Carbon dioxide
CSTDM - California Statewide Travel Demand Model
CTA - California Trucking Association
CVEF - Commercial Vehicle Enforcement Facilities
DEF - Diesel exhaust fluid
DMV - Department of Motor Vehicle
DOC - Diesel oxidation catalysts
DOF - Department of Finance
DPF - Diesel particulate filter
DR - Deterioration rate
ECL - Engine Certification Label
EGR - Exhaust gas recovery
ELD - Electronic logging device
EMA - Engine Manufacturers Association
EMD - Engine Manufacturer Diagnostic
EMFAC - EMission FACtors
ER - Emergency room
ERG - Eastern Research Group
FY - Fiscal year
g/bhp-hr - Grams per brake horsepower-hour
GDP – Gross domestic product
GSP - Gross state product
GVWR - Gross vehicle weight rating
HC - Hydrocarbon
HD I/M - Heavy-Duty Inspection and Maintenance
HDVIP - Heavy-Duty Vehicle Inspection Program
HSC - Health and Safety Code
IPT – incidence per ton

IRP - International Registration Plan
ITS - Information Technology Specialist
M&O - Maintenance & operation
MIL - Malfunction indicator light
MY - Model year
NAICS – North American Industry Classification System
NH3 - Ammonia
NMHC - Non-methane hydrocarbon
NOx - Oxides of nitrogen
OAL - Office of Administrative Law
OBD - On-Board Diagnostic
OEM - Original equipment manufacturer
OOS - Out-of-state
PEAQS - Portable Emissions AcQuisition System
PM - Particulate matter
PSIP - Periodic Smoke Inspection Program
REMI – Regional Economic Models, Inc.
RSD - Remote sensing devices
RSQE – Research Seminar in Quantitative Economics
SAE - Society of Automotive Engineers
SAM - State Administrative Manual
SB - Senate Bill
SCR - Selective catalytic reduction
SIP - State Implementation Plan
SRIA - Standardized Regulatory Impact Assessment
TAC - Toxic air contaminant
tpd - tons per day
tpy - tons per year
TWC - Three-way catalyst
U.S. - United States
U.S. EPA - United States Environmental Protection Agency
VDECS - Verified Diesel Emissions Control Strategy
VIN - Vehicle identification number
WSTA - Western States Trucking Association

A. INTRODUCTION

Heavy-duty vehicles[1] continue to be major contributors to statewide and local communities' mobile air pollution even though this sector makes up only a small portion of California's total on-road vehicle fleet, i.e., about three percent of total on-road vehicles. In 2020, these vehicles emitted approximately 52 percent of the statewide on-road mobile source oxides of nitrogen (NOx) emissions and about 54 percent of the statewide on-road mobile source particulate matter (PM) 2.5 emissions.[2,3] Heavy-duty vehicles' PM and NOx emissions impose a damaging effect on human health and the environment. In 1998, California Air Resources Board (CARB or Board) listed PM as one of the identified carcinogenic toxic air contaminants (TAC) due to its contribution to increased mortality, cancer risk, and serious illness.[4] NOx is a precursor of ozone formation and several other air toxics including PM. Exposure to PM and ozone can lead to serious adverse health effects such as asthma, cardiopulmonary and respiratory diseases, and premature deaths. The majority of densely populated areas in California, such as the South Coast and the San Joaquin Valley air basins, are not in attainment with the federal ozone and PM 2.5 standards.[5] To achieve federal air quality standards and improve public health in these regions as well as across the State, it is critical to substantially reduce NOx and PM emissions from on-road heavy-duty vehicles.

CARB's existing heavy-duty vehicle inspection programs rely on random field inspections by CARB staff (the Heavy-Duty Vehicle Inspection Program, or HDVIP) and annual self-inspections for California fleets of two or more heavy-duty diesel vehicles by vehicle owners to test for smoke opacity levels (the Periodic Smoke Inspection Program, or PSIP). While these programs have improved air quality, a more comprehensive program is needed to better ensure that vehicle owners are regularly inspecting and repairing their vehicles' broken emission controls. In September 2019, Governor Gavin Newsom signed Senate Bill (SB), 210 (Leyva, Chapter 5.5, Statutes of 2019) into law, directing CARB to develop a new, comprehensive heavy-duty inspection and maintenance (HD I/M) program to more effectively control emissions from on-road heavy-duty vehicles in California.[6] The Proposed Regulation would implement a more robust and enforceable, yet streamlined inspection and maintenance test procedure for non-gasoline combustion heavy-duty vehicles with gross vehicle weight rating (GVWR) greater than 14,000 pounds operating in California, as directed under SB 210. The Proposed Regulation for heavy-duty vehicles would be analogous to the Smog Check program for light-duty vehicles that has been in place for several decades.

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[1] Heavy-duty vehicles discussed in this SRIA are defined as vehicles with gross vehicle weight rating (GVWR) greater than 14,000 pounds

[2] (CARB, 2021a) CARB's on-road motor vehicle emissions inventory model, California Air Resources Board, accessed January 2021. EMFAC (ca.gov)

[3] PM 2.5 is particulate matter with a diameter of less than 2.5 micrometers.

[4] (CARB, 2021b) Diesel Risk Reduction Plan, California Air Resources Board, accessed January 2021. Diesel Risk Reduction Plan | California Air Resources Board

[5] (US EPA, 2021) Nonattainment Areas for Criteria Pollutants (Green Book), United States Environmental Protection Agency, last updated March 31, 2021. Nonattainment Areas for Criteria Pollutants (Green Book) | US EPA

[6] (SB210, 2019) Heavy-Duty Vehicle Inspection and Maintenance Program, Senate Bill 210, Leyva, September 23, 2019. Bill Text - SB-210 Heavy-Duty Vehicle Inspection and Maintenance Program. (ca.gov)

The Proposed Regulation would help curb on-road heavy-duty NOx and PM emissions by ensuring heavy-duty vehicles' emission control systems are well maintained and functioning as designed throughout their vehicle life. Vehicles with broken emission control systems would be required to be repaired in a timely manner. The Proposed Regulation is critical for helping California to meet the State Implementation Plan's (SIP) commitment of achieving federal ambient air quality attainment in the San Joaquin Valley and South Coast air basins by 2024 and 2031, respectively.[7]

1. Regulatory History

a. Heavy-Duty Engine Emission Standards

Beginning in 2007, new heavy-duty diesel engines are subject to PM, NOx, and non-methane hydrocarbon (NMHC) standards of 0.01 grams per brake horsepower hour (g/bhp-hr), 0.20 g/bhp-hr, and 0.14 g/bhp-hr, respectively. The PM standard took full effect in 2007. The NOx and NMHC standards were phased in on a percent of sales basis from 2007 through 2010.[8] These more stringent emissions standards resulted in the introduction of more advanced engine and aftertreatment control technologies for heavy-duty vehicles. For example, the PM standard resulted in the installation of a diesel particulate filter (DPF) exhaust aftertreatment to meet the emissions standards. The NOx and NMHC standards resulted in the use of urea-based selective catalytic reduction (SCR) systems and diesel oxidation catalysts (DOC).

b. On-Board Diagnostic (OBD) Requirements

OBD systems are self-diagnostic systems incorporated into a vehicle's on-board computer. They are comprised mainly of software designed to detect emission-control system malfunctions as they occur. The OBD system continuously works in the background during vehicle operation to monitor emission-related components and alerts the vehicle operator of detected malfunctions by illuminating the malfunction indicator light (MIL) on the vehicle's instrument panel. Additionally, the OBD system stores important information, including identification of the faulty component or system and the nature of the fault, which allows for quick diagnosis and proper repair of the problem by technicians. This helps vehicle owners experience less expensive repairs, and promotes repairs being done correctly the first time.

CARB implemented the first generation of OBD requirements for passenger cars, light- and medium-duty vehicles with three-way catalysts (TWC) and feedback control (referred to as OBD I) in 1988. These first-generation requirements necessitated monitoring of only a few of the emission-related components on the vehicle. In 1989, CARB adopted regulations requiring a second generation of OBD systems (referred to as OBD II) that standardized the system and addressed shortcomings of the OBD I requirements. OBD II required

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[7] (CARB, 2021c) 2016 State Strategy for the State Implementation Plan for federal Ozone and PM 2.5 Standards (State SIP Strategy), California Air Resources Board, accessed January 2021. 2016 State Strategy for the State Implementation Plan for Federal Ozone and PM2.5 Standards (State SIP Strategy) | California Air Resources Board

[8] (CARB, 2019a) California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles, California Air Resources Board, last amended April 18, 2019. HDD TPs (ca.gov)

manufacturers to equip all 1996 and newer passenger cars, light-duty trucks, and medium-duty vehicles and engines with OBD II systems.[9]

Starting in 2004, CARB adopted regulations requiring diagnostic systems for heavy-duty vehicles and engines. CARB first adopted the Engine Manufacturer Diagnostic (EMD) regulation, which required manufacturers of heavy-duty engines and vehicles to implement diagnostic systems on all 2007 and subsequent model year (MY) on-road heavy-duty engines. The EMD regulations were intended for heavy-duty manufacturers to achieve a minimum level of diagnostic capability by requiring the monitoring of a few major emission control technologies with no standardization requirements. In 2005, CARB adopted more comprehensive and standardized OBD requirements for heavy-duty vehicles and engines, phasing in starting with 2010 MY engines. Specifically, manufacturers were required to implement an OBD system on a single engine family for 2010-2012 MY engines before implementing it on all 2013 and subsequent MY engines. The majority of 2013-2015 MY engines had less stringent requirements with higher MIL illumination thresholds relative to 2016 and subsequent MY engines. By the 2016 MY engines, more stringent OBD requirements fully phased in for all new heavy-duty diesel engines. OBD requirements for alternative fuel and hybrid vehicles fully phased in starting with the 2018 MY engines.[10]

c. Emissions Warranty Requirements on Heavy-Duty Engines and Vehicles

In late 1970s, the Board adopted emission warranty regulations that required heavy-duty diesel vehicles and the engines used in such vehicles to be covered by a five-year, 100,000-mile, or 3,000-hour emissions warranty period, whichever first occurs. Emissions warranties are intended to ensure manufactured emission control systems are free of defects in materials and workmanship that would cause them to not be identical to the parts originally certified when the vehicles/engines were new. If there are such defects on the warranted emission control systems during the warranty period, the manufacturers are liable for fixing them free of charge to the end user. In 2018, the Board adopted amendments to the emissions warranty regulations (or Step 1 Warranty Amendments). These amendments lengthened the warranty periods on heavy-duty emission control systems for 2022 and subsequent MY heavy-duty vehicles and engines to better reflect actual longer service mileages of modern heavy-duty vehicles and engines. Table A-1 summarizes the amended warranty periods for 2022 and subsequent MY heavy-duty vehicles and engines.

Table A- 1: Heavy-Duty Diesel Warranty Periods for 2022 and Subsequent MYs

Engine/Vehicle Categories	Warranty Periods
Heavy heavy-duty diesel (Class 8, >33,000 pounds GVWR)	350,000 miles or 5 years, whichever first occurs
Medium heavy-duty diesel (Class 6-7, 19,501-33,000 pounds GVWR)	150,000 miles or 5 years, whichever first occurs

[9] (CARB, 2021d) Past OBD II Regulatory Document, California Air Resources Board, accessed January 2021. Past OBD II Regulatory Documents | California Air Resources Board

[10] (CARB, 2021e) Past Heavy-Duty On-Board Diagnostic Regulatory Document, California Air Resources Board, accessed January 2021. Past HD OBD Regulatory Documents | California Air Resources Board

Engine/Vehicle Categories	Warranty Periods
Light heavy-duty diesel (Class 4-5, 14,001-19,500 pounds GVWR)	110,000 miles or 5 years, whichever first occurs

The Step 1 Warranty Amendments also clarified the link between heavy-duty warranty coverage and heavy-duty OBD MIL illumination. That is, the amendments specifically indicated any defects in materials or workmanship that cause the vehicle's OBD MIL to illuminate are considered a warrantable condition.

d. CARB's Existing Heavy-Duty Inspection Programs

In the early 1990s, CARB adopted the HDVIP that allows CARB staff to inspect heavy-duty trucks and buses operating in California for excessive smoke, tampering, and engine certification label (ECL) compliance.[11] CARB inspections are typically performed at border crossings, California Highway Patrol's (CHP) Commercial Vehicle Enforcement Facilities (CVEF, or commonly known as "weigh stations"), fleet facilities, and randomly selected roadside locations. Vehicle owners found in violation are subject to monetary penalty and required to provide proof of correction to clear violations.

In addition to HDVIP, CARB adopted the PSIP to control heavy-duty vehicle smoke emissions.[12] Under the PSIP regulation, fleet owners of two or more heavy-duty diesel vehicles are required to perform annual smoke opacity tests following the Society of Automotive Engineers (SAE) J1667 testing procedure,[13] keep the smoke test records for potential auditing purposes, and repair vehicles that exceed the allowed smoke opacity limits. CARB staff randomly audits fleets, reviews maintenance and inspection records, and tests a representative sample of vehicles to enforce the PSIP regulation.

In 2018, the Board adopted amendments to the HDVIP and PSIP, establishing a more stringent set of smoke opacity limits.[14] The recent smoke opacity limit updates reflect the improvement in engine design, diesel fuel composition, and improvements in vehicular emissions control technologies since the HDVIP and PSIP were first adopted in the 1990s. The more stringent smoke opacity limits help ensure inspections can more readily identify vehicles with broken or compromised PM emission control systems in need of repair and further reduce on-road diesel smoke emissions.

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[11] (CARB, 2021f) Heavy-Duty Diesel Inspection & Periodic Smoke Inspection Programs, California Air Resources Board, accessed January 2021. Heavy-Duty Diesel Inspection & Periodic Smoke Inspection Programs | California Air Resources Board

[12] (CARB 2021f) Heavy-Duty Diesel Inspection & Periodic Smoke Inspection Programs, California Air Resources Board, accessed January 2021. Heavy-Duty Diesel Inspection & Periodic Smoke Inspection Programs | California Air Resources Board

[13] (SAE, 1996) Snap Acceleration Smoke Test Procedure for Heavy-Duty Powered Vehicles, Society of Automotive Engineers (SAE) J1667 Recommended Practice, February 1996. Test Methods: 1998-12-22 1996 Snap Accelerated Smoke Test Procedure for Heavy Duty Powered Vehicles (ca.gov)

[14] (CARB, 2019c) Smoke Testing Compliance Advisory—California's Periodic Smoke Inspection Program (PSIP) for Heavy-Duty Diesel Vehicles, California Air Resources Board, Rev. November 2019. adv 298 (ca.gov)

2. Statement of the Need of the Proposed Regulation

Despite the significant improvement in California's air quality over the past decades, major populated regions in California are still not in attainment with the federal PM2.5 and ozone standards, specifically, South Coast and San Joaquin Valley air basins. In order to meet the federal air quality standards and improve public health, further PM and NOx emissions reductions are needed from the heavy-duty sector.

Emission rates from on-road heavy-duty engines and vehicles have declined over the past several decades, as a result of increasingly stringent emission standards and corresponding advancements in emissions control technologies. With modern vehicles' advanced aftertreatment systems including an SCR system and DPF on each vehicle, a rigorous inspection and maintenance program is needed to ensure emissions control systems are properly maintained and the originally certified emission standards are met throughout vehicles' operating lives. Although the recent amendments to the smoke opacity level stringencies were implemented in 2019, there is no testing currently in place for controlling in-use vehicle NOx emissions. The required smoke opacity testing under HDVIP/PSIP are only readily able to identify if vehicles have broken DPFs; hence it is limited to controlling vehicle PM emissions only. Now that modern heavy-duty vehicles are also equipped with SCR for NOx control, additional testing procedures that can readily detect issues with NOx emissions control technologies are needed. Additionally, California fleets of single heavy-duty diesel vehicle (i.e., owner operator vehicles) and out-of-state (OOS) vehicles are not subject to the annual smoke opacity testing requirement under the PSIP regulation.

California's current light-duty vehicle inspection and maintenance program, otherwise known as the Smog Check program, is administered by the California Department of Consumer Affairs' Bureau of Automotive Repair (BAR). The Smog Check program for light-duty vehicles requires a more robust emissions testing and verification process compared to CARB's current heavy-duty inspection procedures in the HDVIP and PSIP.[15] Under the current Smog Check program, light-duty vehicles are subject to a biennial Smog Check inspection that includes the following testing elements:

- Visual inspection of the vehicle emission control systems
- OBD systems data check
- Vehicle tailpipe emissions inspection using BAR-certified Emissions Inspection System (BAR-97) (for non-OBD vehicles)

As noted previously, OBD systems are designed for monitoring the complete emissions control system of in-use engines. When malfunctions of the monitored emissions systems are detected, OBD will illuminate the MIL and store fault codes identifying the detected malfunctions. The Smog Check program uses testing methods that more readily ensure a vehicle's full emissions control system is checked while also allowing an easy way to identify if a problem is present. Using similar testing methods for heavy-duty vehicles now that they are

[15] (BAR, 2021) California Smog Check Program, Bureau of Automotive Repair, accessed January 2021. Smog Check FAQ - Bureau of Automotive Repair (ca.gov)

equipped with OBD systems can lead to a more robust inspection process relative to the current HDVIP and PSIP testing procedures and more effectively reduce in-use emissions.

Furthermore, the enforceability of CARB's current HDVIP/PSIP regulations needs to be improved to ensure vehicles meet the requirements of the programs. The HDVIP program relies on roadside inspections of vehicles operating in California with nearly 20,000 inspections performed annually. In 2019, about ten percent of inspected vehicles were non-compliant with the CARB's heavy-duty inspection program.[16] However, there are approximately 1,000,000 heavy-duty vehicles above 14,000 pounds GVWR operating in California, which makes finding all vehicles with mal-maintained emissions control systems challenging. The PSIP program relies on CARB enforcement audits to determine a fleet's annual compliance requirements. CARB faces challenges in effectively ensuring all fleets are meeting the PSIP requirements. As a result, non-compliant vehicles still operate on California roadways with excessive smoke emissions, and it can be challenging to find and ensure these vehicles are compliant with our regulations. To resolve these issues, under SB 210, the Legislature directed CARB to develop a new HD I/M program with technology-based enforcement tools to ensure CARB can readily ensure vehicles operating in California are compliant.

Overall, the Proposed Regulation would build on the current inspection programs, modernizing California's HD I/M program to be more effective for modern vehicles and aftertreatment. It would help identify emissions control issues today's program misses and require more timely repairs, thereby helping ensure heavy-duty vehicles are properly functioning and low-emitting throughout their entire operating lives. The Proposed Regulation would also incorporate robust enforcement tools into the design of the program to enhance vehicle compliance and ensure an equal playing field for all affected heavy-duty vehicles operating in California. Additionally, as many major populated regions and economically disadvantaged communities are near heavy trucking traffic areas, by reducing heavy-duty truck emissions, the Proposed Regulation would help achieve equitable clean air quality for all Californians.

a. Regulatory Authority

The Legislature has granted CARB broad authority under the California Health and Safety Code (HSC) to adopt the Proposed Regulation. The California Legislature has designated CARB as the State agency that is "charged with coordinating efforts to attain and maintain ambient air quality standards, to conduct research into the causes of and solution to air pollution, and to systematically attack the serious problem caused by motor vehicles, which is the major source of air pollution in many areas of the State" (HSC 39003). The Legislature has authorized CARB to adopt standards, rules, and regulations needed to properly execute the powers and duties granted to and imposed on CARB by law (HSC 39601).

[16] (CARB, 2020c) 2019 Annual Enforcement Report, California Air Resources Board, June 2020. 2019 Annual Enforcement Report (ca.gov)

In 2019, California Legislature adopted, and California's Governor Newsom signed SB 210,[17] which requires CARB to develop and implement a HD I/M Program for non-gasoline combustion heavy-duty on-road motor vehicles. California HSC 44152. SB 210 specifically granted CARB authority to develop and adopt the Proposed Regulation.

3. Proposed Regulatory Action

Under the Proposed Regulation, CARB would establish a comprehensive HD I/M program to ensure that emissions control systems on heavy-duty vehicles driven in the State of California are operating as designed and are repaired when they malfunction. The HD I/M program would require all non-gasoline combustion heavy-duty vehicles with GVWR greater than 14,000 pounds operating within the State boundary to demonstrate program compliance. Similar to the BAR's Smog Check program for light-duty vehicles, affected heavy-duty vehicles would be required to submit to periodic emissions testing to show compliance at specified intervals. OBD-equipped vehicles would be subject to OBD testing, while non-OBD vehicles would be subject to smoke opacity testing and visual inspection.

Enforcement would be multi-faceted. CARB would deploy roadside vehicle emission monitoring and an automated license plate recognition (ALPR) camera network throughout the State to identify potentially non-complaint vehicles. HD I/M program compliance would be tied to DMV vehicle registration for in-state vehicles, while all vehicles operating in California would be required to have a valid HD I/M compliance certificate to operate legally in the State. Freight contractors who conduct businesses in California would be required to verify their dispatched vehicles comply with the HD I/M program. To further enhance enforcement efforts, CHP officers may inspect a vehicle's HD I/M compliance certificate, check for MIL issues, and look for visible smoke. These inspections may be incorporated into CHP's standard vehicle safety inspections, which would increase the program's roadside enforcement presence. Finally, CARB (with contractor assistance as necessary) would develop and maintain a HD I/M program database system, institute a referee testing network for the HD I/M program, support the required heavy-duty emissions testing, and run all the necessary day-to-day operations once the HD I/M program is implemented.

As discussed further in subsections a. through h. below, the Proposed Regulation would include the following elements:

- Vehicle owner reporting requirement (subsection a),
- Periodic inspection requirement (subsection b),
- HD I/M-approved tester requirement (subsection c),
- HD I/M compliance certification requirement (subsection d),
- HD I/M roadside monitoring (subsection e),
- HD I/M field inspections (subsection f),
- Freight contractor requirement (subsection g), and

[17] (SB210, 2019) Heavy-Duty Vehicle Inspection and Maintenance Program, Senate Bill 210, Leyva, September 23, 2019. Bill Text - SB-210 Heavy-Duty Vehicle Inspection and Maintenance Program. (ca.gov)

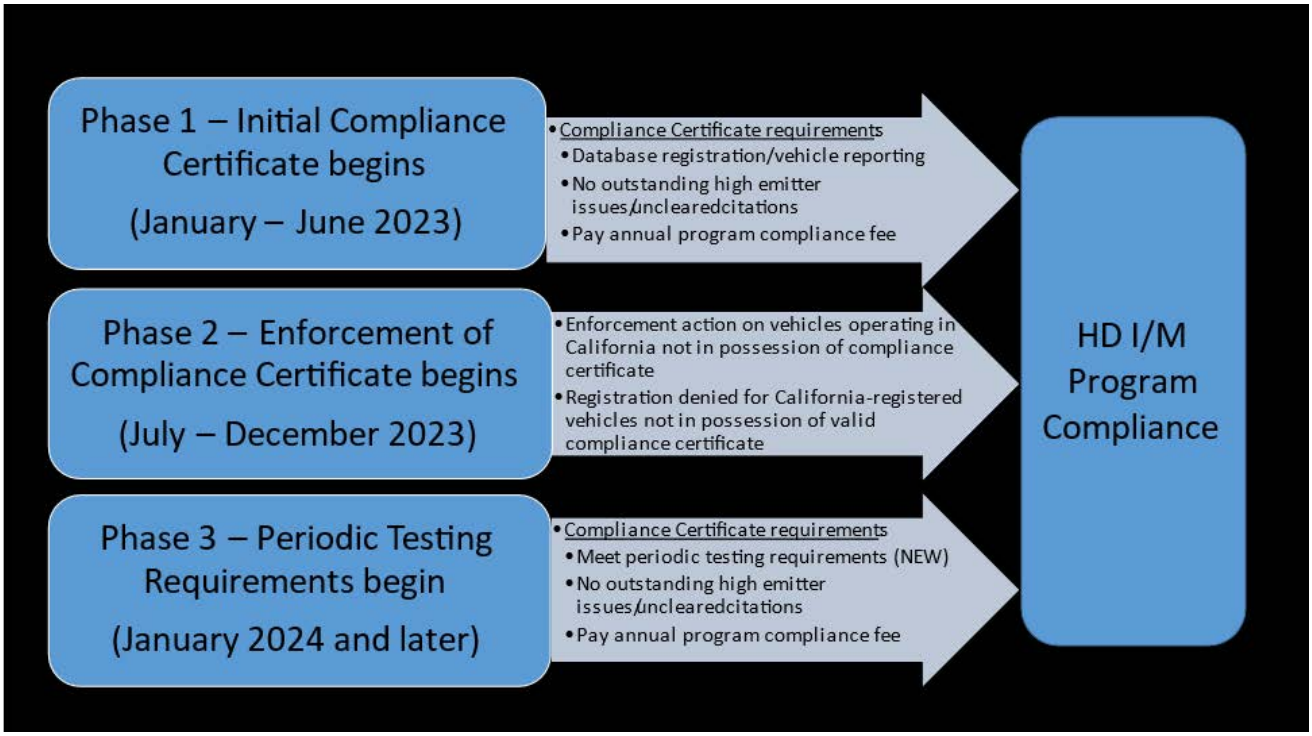
- A certification process for OBD testing devices (subsection h).

The Proposed Regulation implementation would begin in 2023 and roll out in three phases as follows:

- Phase 1 starting on January 1, 2023: During this first phase, roadside emissions monitoring systems monitor emissions of heavy-duty vehicles operating in California. Owners of vehicles that are flagged by CARB as high-emitting vehicles with a potential emissions control issue would be required to submit a vehicle compliance test (either an OBD test or opacity test/visual inspection) to ensure any issue has been resolved. By the end of Phase 1, vehicle owners subject to the HD I/M program would also be required to register in CARB's HD I/M database system and report their vehicle information, pay the annual program compliance fee, and obtain a compliance certificate. Any outstanding high emitter issues would need to be resolved before an owner could obtain a vehicle's compliance certificate.
- Phase 2 starting in July 2023: During this phase, enforcement of the compliance certificate requirement would begin. All heavy-duty non-gasoline combustion vehicles, including OOS vehicles, operating in California would need to have a valid HD I/M compliance certificate to legally operate in the State. Vehicles identified as operating in California without a valid compliance certificate would face enforcement actions. Furthermore, HD I/M program compliance would be tied to DMV vehicle registration for California-registered vehicles. Thus, any in-state vehicle not in the possession of a valid compliance certificate would be denied vehicle registration with DMV until they meet the requirements of the program.
- Phase 3 starting in January 2024: During this phase, periodic testing requirements would begin. Beginning with Phase 3, all vehicles operating in the State would need to perform the applicable periodic testing, resolve any outstanding CARB-issued program citations, and pay the required annual compliance fee in order to obtain the compliance certificate. The Proposed Regulation would now be fully implemented.

Figure A-1 summarizes the three implementation phases of the Proposed Regulation.

Figure A- 1: Proposed Regulation's Phased-in Implementation for Affected Heavy-Duty Vehicle Owners



a. Vehicle Owner Reporting Requirement

Under the Proposed Regulation, owners of heavy-duty vehicles operating in California (including OOS vehicles) would be required to report their vehicle information to CARB, pay the annual program compliance fee, and obtain a compliance certificate by July 2023. Owners would first need to establish an account in the CARB's HD I/M database system and then report the required vehicle information for vehicles within their fleet. Through coordination with California DMV, the HD I/M database would contain the vehicle information needed for vehicles that are registered in the California DMV and/or International Registration Plan (IRP) databases. Only owners whose vehicles are not registered within one of these two databases or contain critical data elements that are missing (e.g., vehicle identification number (VIN), license plate, etc.) would need to add additional vehicle information for their fleet. A vehicle owner's HD I/M account would then be used to pay the program compliance fee and obtain a compliance certificate, submit any supporting compliance documentation, and access vehicle compliance status information.

b. Periodic Inspection Requirement

The Proposed Regulation would require heavy-duty vehicle owners to periodically submit vehicle inspection data to CARB to show compliance with the HD I/M program in order to obtain the compliance certificate starting in January 2024. OBD-equipped vehicles would be subject to quarterly OBD data submissions, while non-OBD vehicles would be subject to biannual (twice a year) smoke opacity tests and visual inspection submissions. Vehicles submitting non-compliant periodic test data would be required to make any necessary

repairs and resubmit a passing valid test result within a specified time interval. Such testing requirements would identify vehicles that have developed emission-related malfunctions with age and use and result in timely vehicle repairs that would reduce excessive vehicle emissions.

For OBD-equipped vehicles, owners would have three options for submitting the required OBD data to CARB:

- Option 1: Telematics – The Proposed Regulation would allow the use of certified telematics systems[18] to collect and submit the required OBD data. Telematics systems connect to a vehicle's internal engine control unit and can transmit vehicle operation data remotely to the user. Telematics technology has gained wide popularity in the heavy-duty transportation industry to help support fleet logistics needs, vehicle maintenance management programs, and federal electronic logging requirements.[19] A telematics testing option allows for a cost effective and streamlined testing approach for fleets to take advantage of technology already equipped in their vehicles to demonstrate compliance without needing to take the vehicle out of service for testing.
- Option 2: Testing by a HD I/M-approved tester – The Proposed Regulation would give fleets the option to hire a HD I/M-approved tester to perform compliance testing. As discussed in the next subsection c. below, HD I/M-approved testers would use certified testing devices to perform vehicle compliance testing and remotely submit the data to the HD I/M database. Similar to the current smoke opacity testing structure under the PSIP regulation, such testing could be performed anywhere based on the convenience of the fleet and the tester.
- Option 3: The Proposed Regulation would allow specific locations throughout the State to host certified testing devices. Locations would likely include dense trucking locations like truck stops or other businesses in large trucking hubs. Operators choosing this option would be able to check out the testing devices for use, perform the needed testing, and return the devices once they have completed. Once completed, the test results would be remotely transmitted to the HD I/M database.

For non-OBD vehicles, owners would be required to complete a SAE J1667 opacity test and complete a visual inspection of the vehicle's emissions control components to verify the components are in the manufacturer-approved configuration. Vehicles would be subject to the same smoke opacity test limits as specified in the current HDVIP/PSIP regulations. Compliance testing for non-OBD vehicles would be required to be performed by a HD I/M-approved tester and following the completion of the compliance tests, the test results would be uploaded to the HD I/M database by the tester.

c. HD I/M-Approved Tester Requirement

Under the Proposed Regulation, individuals registered with CARB as HD I/M-approved testers would be able to perform vehicle compliance tests as described above on vehicles

[18] Telematics systems would be required to be certified and approved by CARB prior to using for the proposed OBD testing; see Section A.3.h. for further details on OBD testing device certification.
[19] (FMCSA, 2018) General Information about the ELD Rule, Federal Motor Carrier Safety Administration, last updated April 9, 2018. General Information about the ELD Rule | FMCSA (dot.gov)

subject to the regulation. Individuals that wish to become HD I/M-approved testers would need to complete the required training and obtain a HD I/M tester credential. Training would involve ensuring testers have an adequate knowledge of the regulatory requirements of the program for all parties involved and have a demonstrated knowledge of how to properly perform the vehicle compliance tests. Such training would help ensure the required testing is performed properly and accurately to better identify vehicles with mal-maintained emissions control systems for repairs. To obtain a valid tester credential, an individual would need to take a training course projected to take one-hour via an online training mechanism and would need to pass an associated exam every two years to remain eligible as an HD I/M-approved tester.

d. HD I/M Compliance Certificate Requirement

The Proposed Regulation would require heavy-duty vehicle owners to have a valid HD I/M compliance certificate with the vehicle while operating in California and present it to a CARB inspector and/or CHP officer upon request, as specified in SB 210. A vehicle owner would receive a HD I/M compliance certificate once the vehicle has demonstrated compliance with the Proposed Regulation and paid the program's annual compliance fee of $30 per vehicle.[20] This compliance fee would be used to fund the State costs of implementing the HD I/M program (see section D. Fiscal Impacts for further details).

Furthermore, California-registered heavy-duty vehicle owners would not be allowed to renew their vehicle registration with DMV unless they demonstrate the vehicles are compliant with the HD I/M program by the time they are due for DMV registration renewal. Requiring a compliance certificate and linking to DMV registration would enhance the overall program compliance rate as evidenced by the recent success of incorporating a similar DMV registration linkage to compliance with CARB's Truck and Bus regulation.

e. HD I/M Roadside Monitoring

To assist with enforcement and improve program compliance, roadside emission monitoring equipment, such as remote sensing devices (RSD) and/or CARB's Portable Emissions AcQuisition System (PEAQS), and ALPR cameras are being deployed throughout the State to detect potentially non-compliant vehicles. These systems operate autonomously and can be controlled remotely, which would significantly increase the program compliance inspection coverage compared to the current HDVIP's roadside inspections, which rely on the physical field presence of CARB staff.

RSDs are designed to remotely measure emissions, using absorption spectroscopy, from vehicles as they are driven through or under the emission-measurement devices with minimal to zero vehicle traffic flow interference. Measured pollutants could include, but are not limited to, hydrocarbon (HC), carbon monoxide (CO), CO_2, NOx, and PM. CARB has developed a similar device to RSD known as PEAQS; PEAQS measures a vehicle's emissions utilizing plume capture, where a sample of vehicle exhaust is physically collected and

[20] The compliance fee would be annually adjusted to reflect changes in the California Consumer Price Index (CCPI) as published by the Department of Industrial Relations. Each annual fee adjustment would be made based on the change in the CCPI ending in June of a given year. *See* Health & Safety Code § 4156.5(e)(2).

measured, while the vehicle passes through the unit. CARB's PEAQS units in combination with other RSDs would be installed throughout the State to detect potential high-emitting vehicles. Vehicles screened and flagged as having high emission measurements as they pass through the PEAQS/RSD systems suggest an emissions control system issue. Under the Proposed Regulation, these vehicles would be required to verify their vehicles are still in compliance with the program requirements. Such verification would be done by vehicle owners submitting an emissions test following the periodic testing methods discussed above or through CARB's referee testers. Such an effort would help ensure these vehicles are operating with properly functioning emissions control systems and/or get repaired if needed.

ALPR cameras would be installed throughout the State to monitor vehicles operating on California roads. Identified vehicles on the ALPR cameras would be checked through CARB's HD I/M database system to determine if vehicles have valid HD I/M compliance certificates. Vehicles without a valid HD I/M compliance certificate, but found operating in California, would be issued a HD I/M non-compliance citation.

f. HD I/M Field Inspections

Similar to the current HDVIP, CARB staff would perform field inspections on heavy-duty vehicles operating in California to ensure vehicle compliance as part of the enforcement effort for the HD I/M program. During a field inspection, a heavy-duty vehicle driver would be required to allow CARB field inspectors to check the vehicle emissions control systems and perform emissions testing such as smoke opacity or OBD testing. Vehicles not in compliance with the program requirements would be issued a citation to fix the non-compliance issue.

New to enforcement efforts, as a result of new authority from SB 210, would be the ability for CHP officers to inspect vehicles for valid HD I/M certificates of compliance and MIL issues and issue citations if the vehicles are not in compliance. Such inspections could be done quickly by CHP officers during their normal day-to-day safety inspections at weigh stations and other roadside locations throughout the State. The CHP inspection in combination with CARB inspection, as compared to CARB inspection alone under the current HDVIP's roadside inspection, would significantly increase program compliance inspections in the field. This would further enhance program compliance and help level the playing field among all vehicles operating within the State.

g. Freight Contractor Requirement

Freight contractors are defined as all parties involved in a transaction requiring the operation of a heavy-duty truck in California. These parties can include, but are not limited to, shippers, receivers, drivers, and applicable facilities.

Under the Proposed Regulation, freight contractors would be required to verify that vehicles and fleets they hire to do business with are compliant with the HD I/M program and keep records of transactions involving these vehicles. Verification of HD I/M compliance would involve a freight contractor obtaining a fleet compliance certificate from the entities they do business with to confirm that the fleet is indeed compliant with the proposed HD I/M

regulation. A freight contractor would be required to have confirmed a fleet's compliance status within the last 12 months and provide these records to CARB staff upon request.

Port and intermodal railyard freight facilities would be required to verify and attest that only compliant vehicles would enter and operate on their property; or maintain records about all vehicles that enter their property for which compliance cannot be verified. Facilities could verify compliance by checking a fleet's compliance certificate or digitally checking compliance using CARB's electronic reporting system. Thirty six freight facilities within California would be subject to these requirements.[21]

Finally, drivers and/or vehicle owners of heavy-duty vehicles operating in California would be required to retain documentation about their hiring entity and their current contract, and have the documentation available within the vehicle and provided to CARB staff immediately upon request.

h. OBD Device Certification Requirement

The Proposed Regulation would require OBD compliance testing be performed using CARB-certified testing devices. Vendors of OBD testing devices would need to perform validation testing on their device and receive CARB approval prior to their device being used for vehicle compliance testing. Vendors would follow a CARB-specified testing protocol that would include downloading the required OBD data from various vehicle types and submitting it to CARB to ensure that their device meets the OBD data collection and submission requirements of the HD I/M program. The proposed device certification requirement would ensure that testing devices used in the program can accurately test vehicles to determine compliance and provide users assurance that the devices have been tested and verified.

4. Major Regulation Determination

SB 617 (Calderon, Chapter 496, Statutes of 2011) defines major regulation as "proposed adoption, amendment, or repeal of a regulation subject to review by the Office of Administrative Law … that will have an economic impact on California business enterprises and individuals in an amount exceeding fifty million dollars ($50,000,000)." The Proposed Regulation would be fully implemented in 2024 and would result in an economic impact exceeding $50 million starting in 2023. CARB staff has estimated that the Proposed Regulation could result in direct costs to regulated entities of up to $332M in a given year.

5. Baseline Information

The economic and emission impacts of the Proposed Regulation are evaluated against the current baseline scenario for each year from 2023 through 2037. [22] The Proposed Regulation's baseline reflects the implementation of the currently existing Federal and State

[21] (CARB, 2021h) Seaport and Railyard Facilities, California Air Resources Board, accessed April 2021. Seaport and Railyard Facilities | California Air Resources Board

[22] The Proposed Regulation is fully implemented in 2024. The cost and benefit impacts of the Proposed Regulation are evaluated through 2037 as they contribute to 2037 ozone goals in the San Joaquin Valley and South Coast air basins.

laws and regulations on the vehicles the Proposed Regulation would affect, i.e., non-gasoline combustion heavy-duty vehicles with GVWR greater than 14,000 pounds.

The Proposed Regulation's emission impacts are estimated using CARB's EMission FACtors (EMFAC) model.[23] The EMFAC's emission baseline assumptions for the Proposed Regulation reflect the currently existing adopted regulatory requirements such as the engine certification standards, the HDVIP, and the PSIP. The Proposed Regulation would result in more repairs on heavy-duty vehicles' emissions control systems, which would reduce heavy-duty vehicles' mal-maintenance rates, and consequently, reduce emissions. The Proposed Regulation's emissions impacts are modeled based on staff's estimated incremental increase in vehicle repairs relative to the current baseline. Details on the Proposed Regulation's emission impact analysis are discussed in Section B. Benefits.

Under the existing HDVIP and PSIP regulations, heavy-duty diesel vehicles are subject to smoke opacity testing. The Proposed Regulation would impose more stringent in-use testing requirements on heavy-duty fleets and increase scope relative to the current HDVIP/PSIP regulations. This would result in increased cost impacts on heavy-duty vehicle owners as they would be required to perform vehicle compliance testing and undergo vehicle repairs to comply with the Proposed Regulation. In this SRIA, the economic analysis of the Proposed Regulation accounts for incremental cost impacts on the affected entities from the current baseline. Details on the Proposed Regulation's incremental cost impacts are discussed in Section C. Direct Costs.

CARB staff is currently finalizing the proposed Heavy-Duty Engine and Vehicle Omnibus Regulation and Associated Amendments (or Heavy-Duty Omnibus Regulation), which was approved for adoption by the Board in August 2020. The Heavy-Duty Omnibus Regulation is expected to be in place by the time the Proposed Regulation is implemented.[24] The proposed Heavy-Duty Omnibus Regulation would require more stringent NOx emission standards on new heavy-duty engines sold in California starting with 2024 MY engines. Heavy-duty vehicles subject to the Proposed Regulation include vehicles also impacted by the proposed Heavy-Duty Omnibus Regulation. Hence, the proposed Heavy-Duty Omnibus Regulation would affect the Proposed Regulation's baseline by reducing NOx emissions levels within the baseline estimates. However, as the proposed Heavy-Duty Omnibus Regulation is not yet fully adopted, this HD I/M SRIA baseline analysis does not take into account the proposed Heavy-Duty Omnibus Regulation; the baseline without the Heavy-Duty Omnibus Regulation included is referred to as "legal baseline" in this SRIA analysis. Nevertheless, CARB staff also performed an additional scenario including the Heavy-Duty Omnibus Regulation in the baseline (referred to as "modified baseline" in this SRIA analysis) to more realistically portray the Proposed Regulation's impacts. Details on the Proposed Regulation's impact analysis based on the modified baseline are discussed in Section G. Modified Baseline Analysis.

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[23] (CARB, 2021a) CARB's on-road motor vehicle emissions inventory model, California Air Resources Board, accessed January 2021. EMFAC (ca.gov)

[24] (CARB, 2020a) Heavy-Duty Omnibus Regulation, California Air Resources Board, page last reviewed September 29, 2020. Heavy-Duty Omnibus Regulation | California Air Resources Board

6. Public Outreach and Input

Consistent with Government Code sections 11346, subdivision (b),[25] and 11346.45, subdivision (a),[26] and with the Board's long-standing practice, CARB staff held public workgroup, workshops, and other meetings with the trucking industry and other interested stakeholders during the development of the Proposed Regulation. These public meetings provided staff with important information and feedback that was integrated in the developed Proposed Regulation.

a. Workgroup Meetings

Since May 2019, CARB staff held nine workgroup meetings engaging heavy-duty fleets, trucking associations, engine/vehicle/device manufacturers, non-governmental organizations, and vehicle inspection and maintenance administrators in other states and countries outside of the United States (U.S.) as the Proposed Regulation was being developed. The workgroup meetings were created to exchange ideas with interested stakeholders related to the potential design of the HD I/M program. At workgroup meetings, staff and stakeholders dug into the details of specific program elements and development activities such as OBD testing specifications, HD I/M pilot activities, the regulatory language concepts, and enforcement strategies. The first four workgroup meetings were conducted in person and via conference call at CARB's Depot Park Facility in Sacramento, California. Due to the COVID pandemic and the resulting Governor's regional stay-at-home order, the last five workgroup meetings were conducted remotely via online webinars. These meetings frequently consisted of more than 300 participants.

In accordance with State Administrative Manual (SAM) 6600 Standardized Regulatory Assessment Requirements,[27] CARB staff requested public input on alternatives to the draft regulatory proposals during the workgroup meetings.[28] Staff received responses from public stakeholders, which were used to develop the two alternatives discussed in Section F. Alternatives.

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[25] (Government Code, 2001) Government Code, Title 2, Division 3, Part 1, Chapter 3.5, Article 5 - Public Participation: Procedure for Adoption of Regulations, Section 11346, January 1, 2001. Law section (ca.gov)
[26] (Government Code, 2001a) Government Code, Title 2, Division 3, Part 1, Chapter 3.5, Article 5 - Public Participation: Procedure for Adoption of Regulations, Section 11346.45, January 1, 2001. Law section (ca.gov)
[27] (SAM, 2014) "SAM 6600(2)(d): The agency shall also seek public input regarding alternatives from those who would be subject to or affected by the regulations (including other state agencies and local agencies, where appropriate) prior to filing a notice of proposed action with OAL unless the agency is required to implement federal law and regulations which the agency has little or no discretion to vary. An agency shall document and include in the SRIA the methods by which it sought public input."
State Administrative Manual 6600 Standardized Regulatory Assessment Requirements
https://www.dgsapps.dgs.ca.gov/documents/sam/SamPrint/new/sam_master/sam_master_file/chap6000/6600.pdf
[28] During CARB's HD IM workgroup on February 22, 2021, staff officially solicited alternatives to the draft regulatory proposals from participating stakeholders.

b. Workshop Meetings

In addition to workgroup meetings, staff held four workshops on February 11, 2019, January 29, 2020, August 12, 2020, and May 27, 2021. At these workshops, staff discussed ideas and strategies to reduce in-use emissions from heavy-duty vehicles in California, draft concepts for California's future HD I/M program, and the program pilot activities. The first two workshops were conducted in person at California Environmental Protection Agency (CalEPA) Headquarters Building in Sacramento. These workshops were also webcasted to reach a wider audience. Due to the COVID pandemic, the last two workshops were conducted remotely via online webinar.

c. Other Meetings

In addition to workgroup meetings and workshops, CARB staff also had individual meetings with interested stakeholders including the California Trucking Association (CTA), American Trucking Association (ATA), Western States Trucking Association (WSTA), California Farm Bureau, Engine Manufacturers Association (EMA), Society of Automotive Engineers (SAE International), environmental organizations, telematics providers, OBD test device vendors, Department of Defense, and vehicle inspection and maintenance program representatives from Oregon, Massachusetts, and Canada. Staff also presented and discussed HD I/M program concepts at community meetings, conferences, and workshops throughout the development process.

B. BENEFITS

The Proposed Regulation is expected to significantly reduce PM and NOx emissions from in-use heavy-duty vehicles operating in California, thus helping attain federal air quality standards as CARB has committed to do in the California SIP. The Proposed Regulation is designed to ensure that heavy-duty vehicles operating in California are properly maintained and that those with broken emissions control systems get repaired in a timely manner. As mentioned earlier, PM and NOx emissions contribute to increased asthma, cardiopulmonary and respiratory diseases, and mortality. The anticipated emission reductions due to the Proposed Regulation would reduce Californian's exposure to harmful pollutants and consequently the number of emergency room (ER) and doctor's office visits for asthma, hospitalizations for heart disease, as well as premature deaths.

Subsection 1 below discusses in detail the emission benefits of the Proposed Regulation. Subsection 2 discusses benefits to typical businesses. Subsection 3 discusses benefits to small businesses. Finally, subsection 4 discusses benefits to individuals.

1. Emission Benefits

a. Inventory Methodology

Staff used the EMFAC2021 model[29] to assess the emission reductions associated with the Proposed Regulation. EMFAC is California's official on-road (e.g., cars, trucks, and buses) mobile source inventory model that is used by CARB for various clean air planning and policy development efforts. EMFAC2021 incorporates CARB's latest understanding of statewide and regional vehicle activity and emissions, and reflects recently adopted heavy-duty vehicle regulations. Two baselines, and two corresponding scenarios with the Proposed Regulation are considered in the emission benefit analysis. One baseline has incorporated the Heavy-Duty Omnibus Regulation, or modified baseline, and it is taken directly from the public available version of EMFAC2021 (v1.0.0). The other baseline is developed without accounting for Heavy-Duty Omnibus Regulation, which is pending Office of Administrative Law (OAL) approval at the time of this SRIA development, or legal baseline.

In EMFAC, heavy-duty vehicle base emission rates are comprised of two major components: zero-mile rate and deterioration rate (DR). DR reflects emission increases due to engine and aftertreatment malfunction, as vehicles age and accrue mileage. More details can be found in the EMFAC2021 Technical Support Document.[30] The Proposed Regulation would require vehicle owners to demonstrate that their vehicles' emissions control systems are properly functioning, thereby reducing excess NOx and PM emissions resulting from mal-maintenance and tampering. To estimate emissions benefits from the Proposed Regulation, staff calculated scaling factors that are applied to the DR in EMFAC to reflect lower rate of deterioration due to induced repairs and better maintenance resulted from the Proposed Regulation.

In the Proposed Regulation, three major factors would affect heavy-duty vehicle emission rates, particularly DRs:

- **Effective repair rates**: This is a combination of the efficacy of the proposed HD I/M program in a) identifying the non-compliant vehicles, and b) inducing effective repairs that result in real-world emission reductions. The effective repair rates would vary as the Proposed Regulation phases in and becomes fully implemented.
- **Repair durability**: The light-duty Smog Check program has proven that not all repairs are durable; and while the proposed HD I/M program can ensure a non-compliant vehicle is repaired, there is still a chance for the vehicle to re-fail after some time passes. MacKay's national survey data on heavy-duty vehicle and engine component replacement intervals were used to estimate the annual re-fail rates for repaired vehicles.[31]

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[29] (CARB, 2021a) CARB's on-road motor vehicle emissions inventory model, California Air Resources Board, accessed January 2021. EMFAC (ca.gov)
[30] (CARB, 2021i) EMFAC2021 Volume III Technical Document, California Air Resources Board, March 31, 2021. https://ww2.arb.ca.gov/sites/default/files/2021-03/emfac2021_volume_3_technical_document.pdf.
[31] (MacKay, 2019) MacKay & Company Data on Heavy-Duty Engine Rebuilds and Replacements, MacKay & Company, 2019.

- **Inspection frequency**: The Proposed Regulation would require vehicle owners to periodically submit inspection data to CARB's HD I/M database system. The non-compliant vehicles would be more likely to be identified and repaired with more frequent inspections.

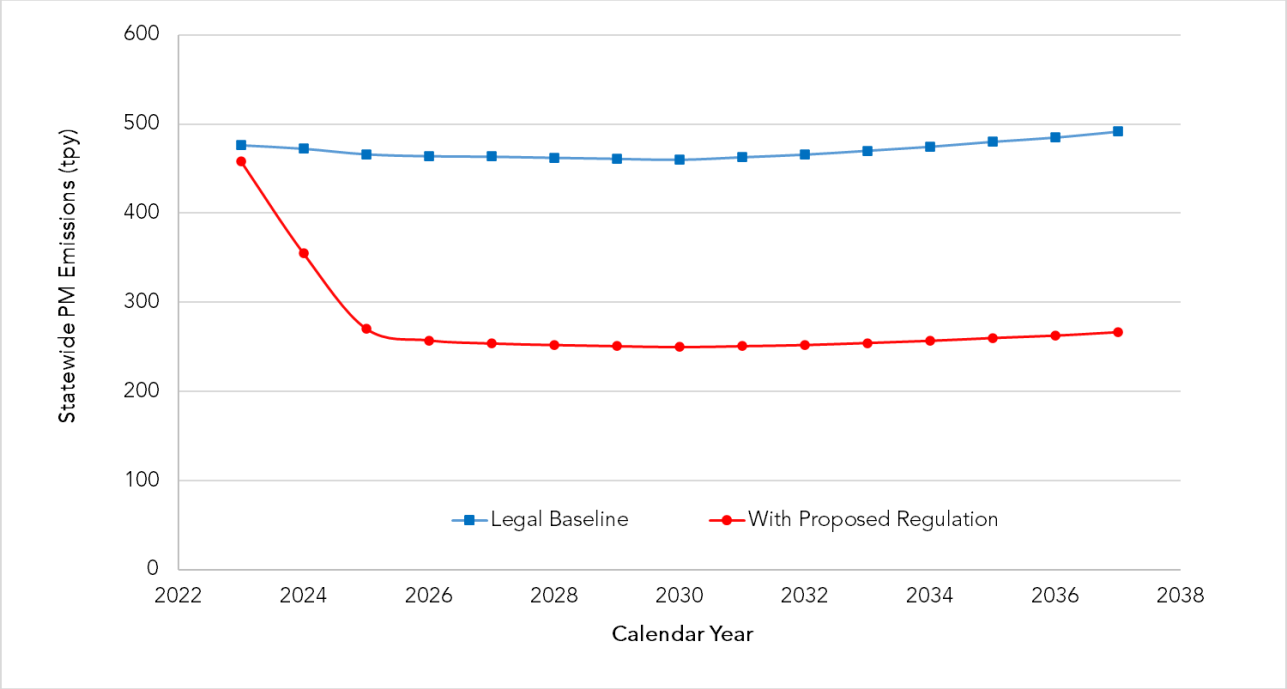
Staff have developed a mathematical model that takes into account the effects of these three factors[32] in reducing the number of heavy-duty vehicles with mal-functioning aftertreatment system and engine components as the proposed HD I/M program is implemented. Utilizing this information, emission DRs in EMFAC2021 were adjusted to estimate emission reductions resulting from the proposed HD I/M program.

b. Anticipated Emission Benefits

i. PM Benefits

Figure B-1 shows the projected statewide PM emissions for the legal baseline and the Proposed Regulation scenarios from 2023 through 2037. Table B-1 shows the projected statewide PM emission benefits (in tons per year (tpy) and tons per day (tpd)) due to the Proposed Regulation from 2023 through 2037. The Proposed Regulation is projected to reduce statewide PM emissions by approximately 2,904 tons for the 2023-2037 period.

Figure B- 1: Projected Statewide PM Emissions for the Legal Baseline and the Proposed Regulation Scenarios from 2023 through 2037 (from Total Heavy-Duty Vehicles Operating in California)



[32] See Section C.1.e, for further details.

Table B- 1: Projected Statewide PM Emission Benefits under the Proposed Regulation from 2023 through 2037 (versus the Legal Baseline)

Calendar Year	PM Benefits (tpy)	PM Benefits (tpd)
2023	18	0.058
2024	117	0.377
2025	196	0.627
2026	207	0.663
2027	210	0.672
2028	210	0.674
2029	210	0.674
2030	210	0.674
2031	212	0.680
2032	214	0.685
2033	216	0.692
2034	218	0.698
2035	220	0.706
2036	222	0.713
2037	225	0.722
Total (2023-2037)	**2,904 tons**	

ii. NOx Benefits

Figure B-2 shows projected statewide NOx emissions for the legal baseline and the Proposed Regulation scenarios from 2023 through 2037. Table B-2 shows the projected statewide NOx emission benefits (in tpy and tpd) due to the Proposed Regulation from 2023 through 2037. The Proposed Regulation is projected to reduce statewide NOx emissions by approximately 312,716 tons for the 2023-2037 period.

Figure B- 2: Projected Statewide NOx Emissions for the Legal Baseline and the Proposed Regulation Scenarios from 2023 through 2037 (from Total Heavy-Duty Vehicles Operating in California)

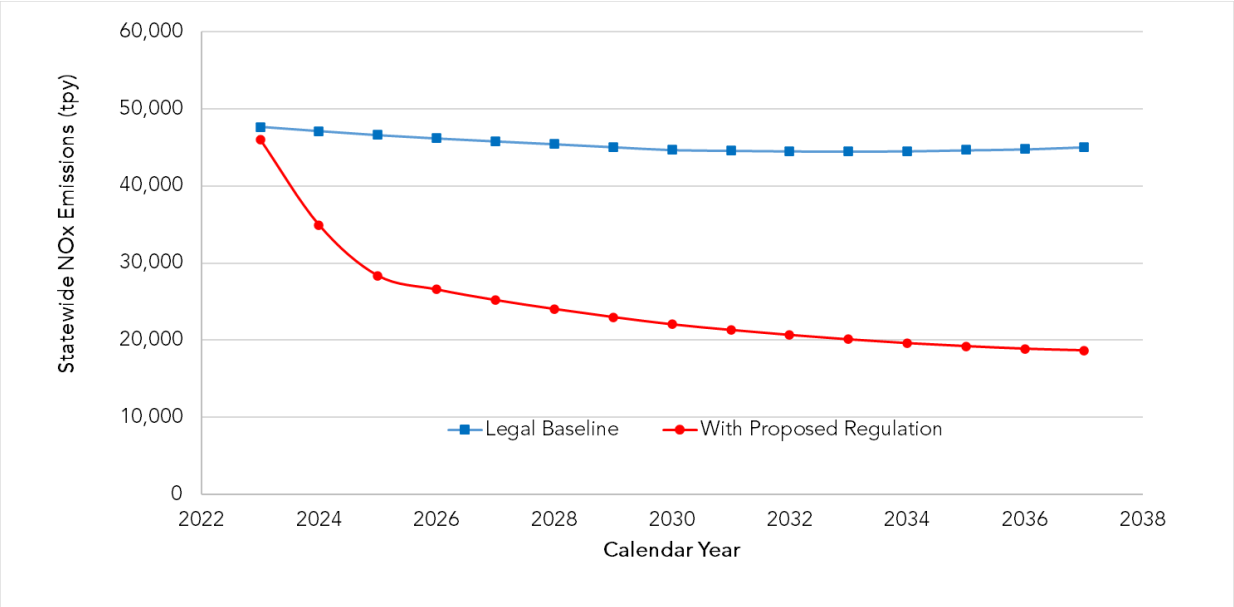


Table B- 2: Projected Statewide NOx Emission Benefits under the Proposed Regulation from 2023 through 2037 (versus the Legal Baseline)

Calendar Year	NOx Benefits (tpy)	NOx Benefits (tpd)
2023	1,627	5.22
2024	12,178	39.0
2025	18,246	58.5
2026	19,623	62.9
2027	20,617	66.1
2028	21,413	68.7
2029	22,088	70.8
2030	22,660	72.7
2031	23,294	74.7
2032	23,866	76.5
2033	24,403	78.2
2034	24,935	79.9
2035	25,462	81.6
2036	25,914	83.1
2037	26,390	84.6
Total (2023-2037)	**312,716 tons**	

2. Benefits to Typical Businesses

Typical businesses such as heavy-duty vehicle emissions testing equipment manufacturers, vehicle emissions testers, telematics providers, heavy-duty part manufacturers and suppliers,

and heavy-duty repair shops would be expected to benefit from the Proposed Regulation. In-state heavy-duty vehicle fleets would also benefit from reduced smoke opacity testing costs due to the changes to PSIP proposed as part of the Proposed Regulation. Finally, to the extent that the emission benefits from the Proposed Regulation benefit the health of truck drivers, such fleets would benefit from their drivers taking slightly fewer sick days.

The Proposed Regulation would impose more stringent vehicle inspection requirements on California operating heavy-duty vehicles to ensure their emissions control components are operating as designed. This in turn would increase demand on vehicle testing device supply and testing services and, subsequently, bring in more business opportunities for heavy-duty vehicle emission testing equipment manufacturers, vehicle emissions testers, as well as telematics providers.

As a result of the Proposed Regulation, staff expects more heavy-duty vehicle repairs as more vehicles with malfunctioning emissions control systems would be identified and required to be repaired in order to comply. As a result, heavy-duty repair shops may benefit from the increased demand in vehicle repairs under the Proposed Regulation. Additionally, these vehicle repairs could include replacement of emission control systems such as DPF and SCR as well as other upstream engine components. The increase in repairs would also increase heavy-duty vehicle part demand, hence increasing volume for heavy-duty part manufacturers and suppliers.

Heavy-Duty Fleet Owners

The reduction in PM and NOx emissions due to the Proposed Regulation would likely reduce occupational exposure to the harmful pollutants for truck drivers, as well as other workers near high trucking areas, including but not limited to, port and warehouse employees. This reduced exposure may result in fewer sick days off from work due to health issues, which in turn would increase economic productivity. Details on the Proposed Regulation's resulted health benefits are discussed in subsection 4. below.

The Proposed Regulation would promote fleets' vehicle preventive maintenance practices, as fleets improve maintenance to ensure their vehicle emission control systems are functioning properly in order to comply with the Proposed Regulation. This induced proactive maintenance approach could decrease the likelihood of having catastrophic vehicle failures. This in turn could result in cost savings to fleet owners through reduced vehicle operating costs due to minimizing expensive repairs and less vehicle downtime due to less vehicle failures in the long run. However, for the purposes of this SRIA analysis, staff conservatively did not quantify such savings. Additionally, given the proposed more stringent vehicle inspection and maintenance requirements, the Proposed Regulation would provide a more level playing field for heavy-duty fleets already investing in vehicle maintenance by helping ensure all fleets operating in California would practice proper emission-related maintenance.

Even though the Proposed Regulation would result in incremental costs on heavy-duty vehicle owners as further discussed in Section C. Direct Costs, there would also be cost savings for vehicle owners. Under the current PSIP requirements, California fleets of two or more heavy-duty diesel vehicles are subject to annual smoke opacity testing. Under the

Proposed Regulation, starting in 2024, heavy-duty OBD-equipped vehicles would no longer be required to perform the annual smoke opacity testing as currently required under the PSIP. These OBD-equipped vehicles would instead be subject to periodic OBD testing.[33] As a result, owners of heavy-duty OBD-equipped vehicles would see cost savings due to the avoided annual periodic smoke opacity test for each vehicle.

Not all OBD-equipped vehicle owners would have the same cost savings per avoided smoke opacity test. As further discussed in Section C.1.b.i., some fleets are currently choosing to hire contracted testers to perform the required smoke opacity tests on their vehicles. Other fleets are performing the required smoke opacity tests on their vehicles in-house using their previously purchased smoke meters. Fleets that perform the smoke opacity tests in-house most likely would see a cost savings under the Proposed Regulation through the avoided labor costs of their employees' time to perform the test, which were estimated about $8.62 per avoided test.[34] Fleets that have their annual smoke opacity tests performed by contracted testers pay an average estimated cost of $125 per test;[35] hence, they would have a cost savings from the avoided annual smoke opacity test of $125 per avoided test under the Proposed Regulation.

For the purpose of this analysis, staff assumed heavy-duty California fleets of two to 20 vehicles are hiring contracted testers for their current smoke opacity testing need. Staff also assumed larger California fleets of more than 20 vehicles are performing the current smoke opacity testing in-house using their previously purchased smoke opacity meters.[36] California owner operators of OBD-equipped vehicles would not incur cost savings due to the Proposed Regulation because they are currently not subject to the PSIP annual smoke opacity testing requirement. Table B-3 summarizes staff's estimated smoke opacity testing cost savings on California vehicle owners under the Proposed Regulation from 2023 through 2037. The total cost savings on vehicle owners are approximately $424M for the 2023-2037 period.

Table B- 3: Smoke Opacity Testing Cost Savings on Heavy-Duty OBD-Equipped Vehicle Owners under the Proposed Regulation from 2023 through 2037

Calendar Year	Smoke Opacity Testing Cost Savings[37]
2023	$0
2024	$24,706,000
2025	$26,150,000
2026	$27,454,000
2027	$28,634,000
2028	$29,645,000
2029	$30,439,000

[33] See Section C.1.b.ii. for cost assessment of the proposed periodic OBD testing on OBD-equipped vehicles.
[34] See section C.1.b.i. for further details on staff's assumptions.
[35] See section C.1.b.i. for further details on staff's assumptions.
[37] Cost savings were rounded to the nearest thousand.
[37] Cost savings were rounded to the nearest thousand.

Calendar Year	Smoke Opacity Testing Cost Savings[37]
2030	$31,013,000
2031	$31,543,000
2032	$31,939,000
2033	$32,249,000
2034	$32,474,000
2035	$32,604,000
2036	$32,686,000
2037	$32,761,000
Total	**$424,299,000**

3. Benefits to Small Businesses

Similar to typical businesses, small businesses in heavy-duty vehicle emission testing and vehicle repair sectors are expected to benefit from the Proposed Regulation due to the anticipated increase in vehicle testing and repair demands. Small heavy-duty fleets are defined as fleets of three or fewer vehicles. The small heavy-duty fleet owners of two to three vehicles would also experience cost savings from the avoided smoke opacity testing need on their OBD-equipped vehicles under the Proposed Regulation, a saving of about $125 per OBD-equipped vehicle per year, as discussed above. The cost savings would partially offset the increase in vehicle operating costs that small fleet owners would incur due to the Proposed Regulation. Costs on small business are further discussed in Section C.3.

4. Benefits to Individuals

The Proposed Regulation would reduce toxic PM2.5 diesel exhaust and NOx – a precursor of ozone and secondary PM2.5 formation, which would benefit California residents by reducing harmful emissions exposure, which in turn results in reduced adverse health impacts.

a. Health Benefits

CARB staff evaluated the reduction in adverse health impacts including cardiopulmonary mortality, hospitalizations for cardiovascular illness and respiratory illness, and ER visits for asthma. Staff estimates that the total number of cases statewide that would be reduced (from 2023 to 2037) from implementation of the Proposed Regulation are as follows:

- 3,303 premature cardiopulmonary deaths reduced (2,584 to 4,034, 95 percent confidence interval (CI)),
- 476 hospital admissions for cardiovascular illness reduced (0 to 933, 95 percent CI),
- 568 hospital admissions for respiratory illness reduced (133 to 1,002, 95 percent CI), and
- 1,563 ER visits reduced (989 to 2,137, 95 percent CI).

Table B-4 shows the estimated reductions in health outcomes resulting from the Proposed Regulation from 2023 to 2037 relative to the current baseline. Significant health benefits are expected to be obtained throughout the State, with the majority of benefits coming in the

South Coast, San Joaquin Valley, and Bay Area regions. Note that because CARB staff are evaluating a limited number of health impacts, the full health benefits of the Proposed Regulation are expected to be underestimated. An expansion of the assessment of outcomes, including additional cardiovascular and respiratory illnesses, nervous system diseases, nonfatal/fatal cancers, and work loss days would provide a more complete picture of the benefits from reduced exposure to air pollution. Additionally, while CARB's mortality and illness assessment is just for PM2.5, there are other pollutants that can cause health issues. For instance, while NOx can lead to the formation of secondary PM2.5 particles, NOx can also react with other compounds to form ozone, which can cause respiratory problems. And the TACs emitted from diesel engines have been determined to cause cancer. Altogether, CARB's current PM2.5 mortality and illness evaluation represents only a portion of the benefits of the Proposed Regulation.

The health modeling methodology is discussed in detail in Section H. Health Modeling Methodology Appendix of this SRIA.

Table B- 4: Cumulative Regional and Statewide Avoided Health Incidents from 2022 through 2037 Under the Proposed Regulation* (versus the Legal Baseline)

Air Basin	Cardiopulmonary Mortality	Hospitalizations for Cardiovascular Illness	Hospitalizations for Respiratory Illness	Emergency Room Visits for Asthma
Great Basin Valleys	1 (1 - 2)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)
Lake County	1 (1 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Lake Tahoe	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Mojave Desert	54 (42 - 67)	8 (0 - 15)	9 (2 - 16)	21 (14 - 29)
Mountain Counties	22 (17 - 27)	2 (0 - 4)	2 (1 - 4)	7 (5 - 10)
North Central Coast	13 (10 - 16)	2 (0 - 4)	3 (1 - 5)	8 (5 - 11)
North Coast	4 (3 - 5)	0 (0 - 1)	0 (0 - 1)	2 (1 - 2)
Northeast Plateau	1 (1 - 2)	0 (0 - 0)	0 (0 - 0)	1 (0 - 1)
Sacramento Valley	147 (115 - 180)	17 (0 - 33)	20 (5 - 35)	57 (36 - 78)
Salton Sea	39 (31 - 48)	5 (0 - 10)	6 (1 - 11)	19 (12 - 26)
San Diego County	121 (95 - 149)	16 (0 - 31)	19 (4 - 33)	50 (32 - 69)
San Francisco Bay	233 (182 - 286)	35 (0 - 69)	42 (10 - 74)	130 (82 - 178)
San Joaquin Valley	750 (588 - 915)	83 (0 - 163)	99 (23 - 175)	278 (176 - 380)
South Central Coast	35 (27 - 43)	5 (0 - 10)	6 (1 - 11)	16 (10 - 21)
South Coast	1,879 (1,471 – 2,294)	302 (0 - 593)	361 (85 - 637)	973 (616 – 1,330)
Statewide	**3,303 (2,584 – 4,034)**	**476 (0 - 933)**	**568 (133 – 1,002)**	**1,563 (989 – 2,137)**

*Values in parentheses represent the 95 percent CI. Totals may not add due to rounding but are within the 95 percent CI.

The results presented in Table B-4 are estimated at a regional scale, at the air basin level. However, it is important to consider that individuals who live in high risk areas near major trucking and freight corridors, such as ports and rail yards, are exposed to higher PM concentrations from heavy-duty vehicles than the average person. These individuals are at higher risks of developing respiratory impairments as a result of heavy-duty vehicle PM emissions, especially those in sensitive groups. For example, people with low socioeconomic standing as may be more susceptible to health problems from exposure to air pollution. Although it is difficult to quantitatively determine the emission benefits in these high-risk areas, the Proposed Regulation is expected to provide the largest PM emission reductions, and consequently, health benefits in regions with the most heavy-duty truck traffic.

In accordance with U.S. EPA practice, health outcomes are monetized by multiplying incidence by a standard value derived from economic studies. The valuation per incident is presented in Table B-5.

The valuation for avoided premature cardiopulmonary mortality is based on willingness to pay, which is a statistical construct based on the aggregated dollar amount that a large group of people would be willing to pay for a reduction in their individual risks of dying in a year. This is not an estimate of how much any single individual would be willing to pay to prevent a certain death of any particular person, nor does it consider any specific costs associated with mortality such as hospital expenditures. While the valuation associated with reductions in premature cardiopulmonary mortality is an important benefit of the Proposed Regulation, that valuation does not correspond to changes in expenditures and is not included in the macroeconomic modeling (Section E).

Unlike premature cardiopulmonary mortality valuation, the valuations for avoided hospitalizations and ER visits are based on a combination of typical costs associated with hospitalization and the willingness of surveyed individuals to pay to avoid adverse outcomes that occur when hospitalized. These include hospital charges, post-hospitalization medical care, out-of-pocket expenses, and lost earnings for both individuals and family members, lost recreation value, and lost household production (e.g., valuation of time-losses from inability to maintain the household or provide childcare). Because these are most closely associated with specific cost-savings to individuals (and costs to the healthcare system), monetized benefits from avoided hospitalizations and ER visits are included in macroeconomic modeling (Section E).

Table B- 5: Valuation per Incident for Avoided Health Outcomes

Outcome	Value per Incident (2020$)
Avoided Premature Cardiopulmonary Mortality	$10,030,076
Avoided Cardiovascular Hospitalizations	$59,247
Avoided Acute Respiratory Hospitalizations	$51,678
Avoided ER Visits	$848

The annual statewide valuation of health benefits of the Proposed Regulation was calculated by multiplying the annual avoided health outcomes by the valuation per incident presented in Table B-5, as summarized in Table B-6 below. The estimated total statewide monetized

health benefits due to emission reductions from 2023 through 2037 are estimated to be $33.2B. The spatial distribution of these benefits follows the distribution of emission reductions and avoided health outcomes; therefore, most cost savings to individuals would occur in the South Coast, San Joaquin Valley, and Bay Area regions.

Table B- 6: Statewide Valuation from Avoided Health Outcomes Under the Proposed Regulation (versus the Legal Baseline)

Calendar Year	Avoided Premature Cardiopulmonary Mortality	Avoided Cardiovascular Hospitalizations	Avoided Acute Respiratory Hospitalizations	Avoided ER Visits	Valuation (2020$)[38]
2023	20	2	3	10	$196,116,000
2024	120	15	18	59	$1,209,228,000
2025	182	23	28	88	$1,824,954,000
2026	198	26	31	95	$1,986,986,000
2027	210	28	34	101	$2,109,076,000
2028	220	30	36	105	$2,209,553,000
2029	229	32	38	109	$2,298,810,000
2030	237	34	40	112	$2,379,315,000
2031	246	36	43	116	$2,469,157,000
2032	254	37	45	120	$2,553,272,000
2033	262	39	47	123	$2,635,470,000
2034	270	41	49	127	$2,715,872,000
2035	278	42	51	130	$2,796,480,000
2036	285	44	52	133	$2,864,811,000
2037	292	45	54	135	$2,934,689,000
Total	**3,303**	**476**	**568**	**1,563**	**$33,183,790,000**

C. DIRECT COSTS

The Proposed Regulation would result in direct cost impacts on owners of heavy-duty vehicles operating in California. The Proposed Regulation would require additional reporting, testing, and training, as well as a compliance fee on heavy-duty vehicles operating in California, which would impose additional costs on the vehicle owners. In addition, the Proposed Regulation would also lead to additional vehicle repairs and costs on the vehicle owners relative to the current baseline. The Proposed Regulation would be implemented starting in 2023 and with full implementation occurring in 2024. In this SRIA, staff performed economic impacts of the Proposed Regulation relative to the projected legal baseline from calendar year 2023 through 2037. All estimated costs are in calendar year 2020 dollar (2020$), unless otherwise specified.

1. Direct Cost Inputs

The Proposed Regulation's cost impacts on heavy-duty vehicle owners include the following direct cost inputs, which are then described in detail in subsections a through f:

[38] Values were rounded to the nearest thousand.

- Reporting (subsection a),
- Heavy-duty vehicle testing (subsection b),[39]
- HD I/M-approved tester training (subsection c),
- Compliance certificate fee (subsection d),
- Heavy-duty vehicle repairs (subsection e), and
- Freight contractors' verification of vehicle compliance (subsection f).

Subsection g. summarizes the total direct costs of the Proposed Regulation on the affected heavy-duty vehicle owners.

Staff estimated the number of affected heavy-duty vehicles using CARB's EMFAC model. EMFAC projects annual heavy-duty vehicle population operating in California based on DMV vehicle registration and IRP datasets. For the purpose of this analysis, the heavy-duty vehicle population is categorized into in-state and OOS vehicles,[40] and then further broken down into OBD-equipped and non-OBD vehicles for the given vehicle category. In general, OBD-equipped vehicles refer to heavy-duty vehicles installed with 2013 and newer MY diesel engines or 2018 and newer MY alternative-fuel and hybrid engines; whereas non-OBD vehicles refer to those installed with older MY engines.

The summary of EMFAC's projected heavy-duty vehicle population is shown in Table C-1 below. Figure C-1 shows a visual presentation of the projected vehicle population breakdown of heavy-duty non-OBD and OBD-equipped vehicles affected by the Proposed Regulation.

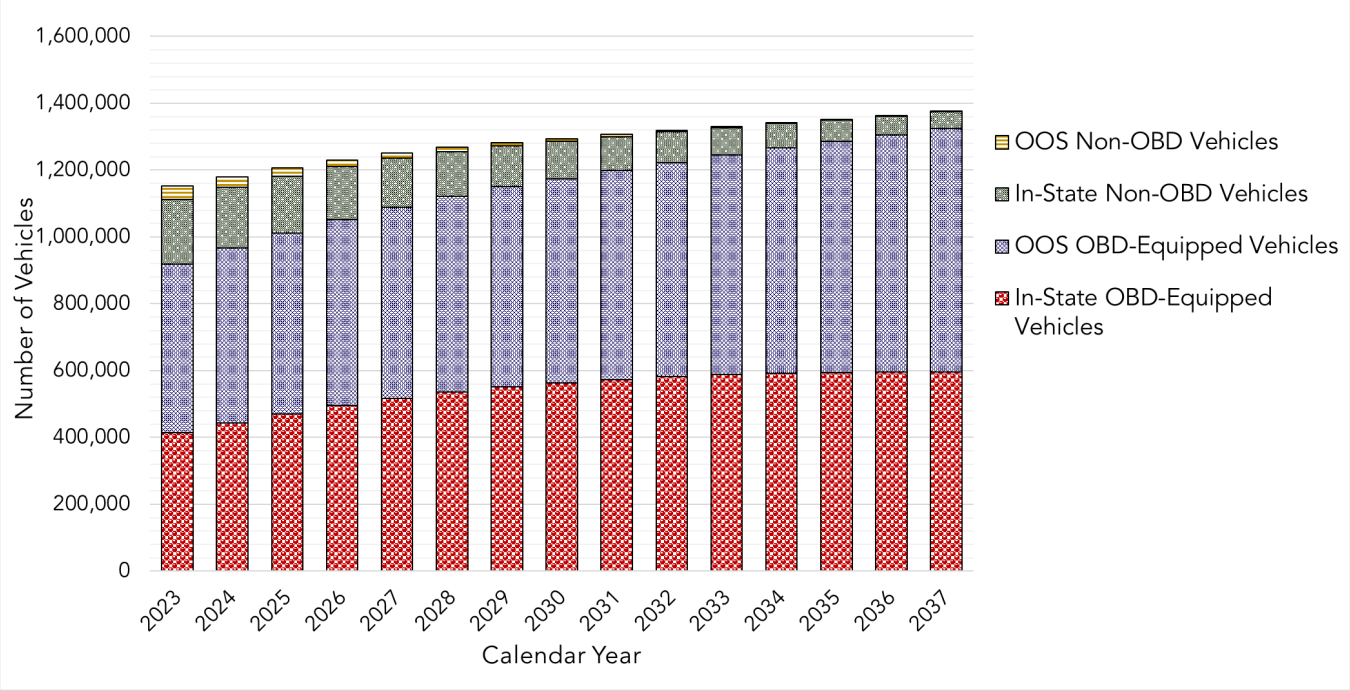
Table C- 1: Projected Annual Heavy-Duty Vehicle Population in California from 2023 through 2037

Calendar Year	In-State Heavy-Duty OBD-Equipped Vehicles	In-State Heavy-Duty Non-OBD Vehicles	OOS Heavy-Duty OBD-Equipped Vehicles	OOS Heavy-Duty Non-OBD Vehicles	Total Affected Heavy-Duty Vehicles[41]
2023	415,157	193,508	502,953	40,087	1,151,704
2024	443,008	181,014	523,800	31,948	1,179,770
2025	470,176	168,952	541,623	25,476	1,206,227
2026	494,842	157,363	557,470	20,301	1,229,976
2027	517,284	145,602	571,953	16,136	1,250,975
2028	536,780	133,628	585,389	12,788	1,268,586
2029	552,448	122,014	598,106	10,060	1,282,628
2030	563,559	111,190	610,446	7,923	1,293,119

[39] The OBD test device certification requirement under the Proposed Regulation would impose costs on OBD test device providers. Staff assumed these costs would be eventually passed on to vehicle owners who use the certified devices to submit the required OBD data to CARB. Staff accounted for these costs when estimating incremental costs on vehicle owners due to the proposed OBD testing requirement.
[40] In-state vehicles are California-registered vehicles. OOS vehicles are those registered outside of California.
[41] Note that for some rows, the columns do not add to the total shown in the rightmost column due to rounding.

Calendar Year	In-State Heavy-Duty OBD-Equipped Vehicles	In-State Heavy-Duty Non-OBD Vehicles	OOS Heavy-Duty OBD-Equipped Vehicles	OOS Heavy-Duty Non-OBD Vehicles	Total Affected Heavy-Duty Vehicles[41]
2031	573,758	100,793	625,734	6,281	1,306,565
2032	581,607	91,246	641,403	4,960	1,319,217
2033	587,822	81,733	657,458	3,923	1,330,936
2034	592,353	72,937	674,037	3,104	1,342,430
2035	593,953	64,789	691,071	2,456	1,352,269
2036	595,506	57,534	708,842	1,945	1,363,827
2037	596,701	51,043	727,619	1,541	1,376,904

Figure C- 1: Projected Affected Heavy-Duty Non-OBD and OBD-Equipped Vehicles under the Proposed Regulation



a. Reporting Costs

Reporting costs would result from the two processes below:

- Vehicle/fleets reporting requirements for vehicle owners; and
- Vehicle inspection result reporting requirements for HD I/M-approved testers.

i. Vehicle Owner Reporting

The Proposed Regulation would require owners of heavy-duty vehicles operating in California to register with CARB by July 2023. Owners would be required to report relevant fleet information into the CARB's HD I/M database system, including fleet owner and company

contact information, along with vehicle registration information. Through interagency coordination with the California DMV, the CARB's HD I/M database system would already contain relevant vehicle information extracted from its California DMV registration (for in-state vehicles) and IRP registration (for OOS vehicles) data sources. For example, the DMV database already contains vehicle owner name, address, vehicle license plate, etc. for California-registered vehicles; hence, owners would not need to re-enter this information when registering their vehicles in the CARB's HD I/M database system. Only a small segment of the owner population whose vehicles are not registered in California DMV or IRP databases would need to report their vehicle information from scratch. All other entities would simply have to report relevant fleet owner and company information and their relevant VIN. However, for a conservative (i.e., high) reporting cost estimate, staff assumed a five-minute reporting time needed for each reported vehicle and applied this to all affected vehicles operating in California as shown in Table C-1, in 2023. In the subsequent years, staff only accounted reporting time for newly added vehicles to the operating population. Staff assumed a total employee compensation cost of $34.47 per hour[42] for vehicle owners or a designee to report their vehicle and company information in the CARB's HD I/M database. Table C-2 summarizes staff's estimated costs on affected owners due to the proposed vehicle owner reporting requirements from 2023 through 2037.

Table C- 2: Statewide Incremental Vehicle Owner Reporting Costs under the Proposed Regulation from 2023 through 2037

Calendar Year	Vehicle Reporting Time (hour)	Vehicle Reporting Costs[43]
2023	95,975	$3,308,000
2024	2,339	$81,000
2025	2,205	$76,000
2026	1,979	$68,000
2027	1,750	$60,000
2028	1,468	$51,000
2029	1,170	$40,000
2030	874	$30,000
2031	1,121	$39,000
2032	1,054	$36,000
2033	977	$34,000
2034	958	$33,000
2035	820	$28,000
2036	963	$33,000

[42] (US BLS, 2021) Occupational Outlook Handbook, U.S. Bureau of Labor Statistics, page last modified April 9, 2021. Diesel Service Technicians and Mechanics : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

(US BLS, 2021a) Employer Costs for Employee Compensation – December 2020, U.S Bureau of Labor Statistics, March 18, 2021. Employer Costs for Employee Compensation - December 2020 (bls.gov)

Staff assumed a median pay rate of $24.13 per hour and adjusted for the total compensation rate of $24.13/0.7 = $34.47 per hour.

[43] Costs were rounded to the nearest thousand.

Calendar Year	Vehicle Reporting Time (hour)	Vehicle Reporting Costs[43]
2037	1,090	$38,000
Total	**114,742**	**$3,955,000**

ii. Vehicle Inspection Result Reporting

In addition to vehicle owner reporting, vehicle compliance testing results for non-OBD vehicles performed by a HD I/M-approved tester due to either the proposed periodic testing requirements or PEAQS/RSD follow-up testing[44] would need to be manually reported to the CARB's HD I/M database system. Compliance testing performed on OBD-equipped vehicles would be remotely submitted to CARB through the OBD testing device at the time the OBD test is performed, thus would not result in any manual reporting by an individual. Any potential costs associated with OBD testing devices submitting the test results to the CARB database are assumed to be passed through to the customer and embedded in the purchase costs of the devices themselves, which are further discussed in section C.1.b.ii. below. Staff conservatively assumed that it would take approximately ten minutes to report non-OBD vehicle compliance test results each time a vehicle is tested. Staff then assumed a total employee compensation cost of $34.47 per hour[45] for a HD I/M-approved tester to report non-OBD vehicle inspection results in the CARB's HD I/M database and estimated the statewide incremental costs due to the proposed vehicle inspection result reporting as shown in Table C-3. The inspection result reporting costs for heavy-duty non-OBD vehicles are projected to be lowest in 2023 ($16,000) because the proposed periodic testing requirements would not take effect until 2024. Thus, costs in 2023 would only be associated with follow-up tests from PEAQS/RSD high emitter identification. As the proposed periodic testing starts in 2024, the inspection result reporting costs would increase to the highest amount of $2.34M in 2024. After 2024, the annual reporting costs would decline over time due to the retirement of older non-OBD vehicles and associated reduced need for reporting of vehicle inspection results for non-OBD vehicles.

Table C- 3: Statewide Incremental Heavy-Duty Non-OBD Vehicle Inspection Result Reporting Costs under the Proposed Regulation from 2023 through 2037

Calendar Year	Inspection Result Reporting Time (hour)	Inspection Result Reporting Costs[46]
2023	461	$16,000
2024	67,825	$2,338,000

[44] See Section C.1.b. for detailed discussion on periodic testing and PEAQS/RSD's follow-up testing.
[45] (US BLS, 2021) Occupational Outlook Handbook, U.S. Bureau of Labor Statistics, page last modified April 9, 2021. Diesel Service Technicians and Mechanics : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)
(US BLS, 2021a) Employer Costs for Employee Compensation – December 2020, U.S Bureau of Labor Statistics, March 18, 2021. Employer Costs for Employee Compensation - December 2020 (bls.gov)
Staff assumed a median pay rate of $24.13 per hour and adjusted for the total compensation rate of $24.13/0.7 = $34.47 per hour.
[46] Costs were rounded to the nearest thousand.

Calendar Year	Inspection Result Reporting Time (hour)	Inspection Result Reporting Costs[46]
2025	61,588	$2,123,000
2026	56,060	$1,932,000
2027	50,889	$1,754,000
2028	45,973	$1,585,000
2029	41,425	$1,428,000
2030	37,298	$1,286,000
2031	33,508	$1,155,000
2032	30,029	$1,035,000
2033	26,668	$919,000
2034	23,576	$813,000
2035	20,755	$715,000
2036	18,278	$630,000
2037	16,088	$555,000
Total	**530,422**	**$18,284,000**

iii. Total Reporting Costs

Table C-4 summarizes staff's estimated total incremental reporting costs on affected heavy-duty vehicle owners due to the Proposed Regulation from calendar year 2023 through 2037, which is the sum of the reporting costs shown in Table C-2 and C-3 above. The estimated reporting costs are highest in 2023 ($3.32M) when heavy-duty vehicle owners would be first required to report information on all of their heavy-duty vehicles operating in California. The reporting costs decrease in subsequent years as owner reporting costs decrease substantially after the initial year and vehicle compliance testing reporting costs decrease due to the natural turnover of non-OBD vehicles to OBD-equipped vehicles.

Table C- 4: Statewide Incremental Reporting Costs under the Proposed Regulation from 2023 to 2037

Calendar Year	Total Reporting Costs[47]
2023	$3,324,000
2024	$2,419,000
2025	$2,199,000
2026	$2,001,000
2027	$1,815,000
2028	$1,635,000
2029	$1,468,000
2030	$1,316,000
2031	$1,194,000
2032	$1,072,000

[47] Costs were rounded to the nearest thousand.

Calendar Year	Total Reporting Costs[47]
2033	$953,000
2034	$846,000
2035	$744,000
2036	$663,000
2037	$592,000
Total	**$22,240,000**

b. Heavy-Duty Vehicle Testing

The Proposed Regulation would impose more stringent vehicle testing requirements on heavy-duty vehicles operating in California relative to the current vehicle testing requirement under the HDVIP/PSIP. Such increases include newly added periodic testing requirements for California-registered owner operators (i.e., California fleets of single vehicle) and OOS vehicles operating in California, as well as increasing the overall frequency of the periodic testing requirements from once a year to twice a year for non-OBD vehicles and four times a year for OBD-equipped vehicles. In addition, heavy-duty vehicles that pass through CARB's RSD/PEAQS systems and are flagged as high-emitting vehicles would be required to submit follow-up vehicle inspection test results to verify the vehicles' compliance with the Proposed Regulation. As a result, heavy-duty vehicle owners would incur incremental vehicle testing costs relative to current baseline costs. Details on the incremental vehicle testing cost estimates for non-OBD and OBD-equipped vehicles are discussed in subsections i. and ii., respectively. Subsection iii. summarizes the total incremental vehicle testing costs.

i. Heavy-Duty Non-OBD Vehicles Vehicle Compliance Testing Costs

Periodic Testing Costs

The current PSIP only requires annual smoke opacity testing for California-registered fleets of two or more heavy-duty vehicles. The Proposed Regulation would require biannual (twice per year) smoke opacity testing on heavy-duty non-OBD vehicles operating in California regardless of fleet size and fleet's registered state. In other words, California-registered owner operators as well as OOS fleets whose heavy-duty non-OBD vehicles operating in California are not currently subject to the PSIP would now also be subject to the periodic smoke opacity testing.

Under the proposed periodic testing requirement, California-registered owner operators and OOS fleets would incur costs for the incremental two smoke opacity tests on their non-OBD vehicles per year. Meanwhile, California-registered fleets of two or more vehicles would incur costs for the incremental one smoke opacity test on their non-OBD vehicles per year. In addition, heavy-duty vehicle owners would also incur costs due to the newly added visual inspection requirement on their non-OBD vehicles twice a year. Table C-5 summarizes the proposed periodic testing requirements for non-OBD equipped vehicles and compares them to the current PSIP requirements.

Table C- 5: Proposed Periodic Testing Requirements for Heavy-Duty Non-OBD Vehicles Relative to Current PSIP Requirements

Fleet Types	California-Registered Owner Operators	California-Registered Fleets of two or more Vehicles	OOS Fleets Operating in California
Current PSIP	None	One smoke opacity test per year	None
Proposed Regulation	Two smoke opacity tests and visual inspections per year	Two smoke opacity tests and visual inspections per year	Two smoke opacity tests and visual inspections per year

For California fleets of more than 20 vehicles, staff assumed their own employees are already performing PSIP opacity testing in-house. Thus, these fleets are projected to already have their own opacity testing equipment and would send their internal employees to training to become HD I/M-approved testers[48] so they could continue to perform the vehicle compliance testing for the proposed HD I/M program. These fleets would incur incremental periodic testing costs due to the time it would take for in-house HD I/M-approved testers to perform one additional smoke opacity test and two visual inspections[49] for each non-OBD vehicle per year. Based on the average roadside inspection duration for CARB enforcement staff to perform vehicle inspections on heavy-duty vehicles under the current HDVIP, it takes about 15 minutes for each smoke opacity test performed and another 15 minutes for each visual inspection performed. Hence, staff assumed it would take in-house HD I/M-approved testers about 30 minutes to complete a non-OBD vehicle compliance inspection. This would result in an additional 45 minutes[50] per vehicle per year above the current baseline for these California fleets of more than 20 vehicles to complete their non-OBD vehicle inspections. Staff estimated a total employee compensation cost of $34.47per hour[51] for a HD I/M-approved tester to perform the proposed tests.

Staff projects that California fleets of two to 20 heavy-duty vehicles are currently hiring a contracted tester to meet their current smoke testing requirements for the PSIP regulation. With the cost of a smoke meter running approximately $5,000 (2016$),[52] staff anticipates that it is more cost effective for fleets of these sizes to hire a contractor to perform PSIP testing

[48] See Section C.1.c. for more details on HD I/M-approved testers

[49] Visual inspection would only require testers to do visual inspection of vehicle emissions control systems without the need of additional test equipment.

[50] [1 smoke opacity test] x [15 minutes per test] + [2 visual inspections] x [15 minutes per inspection] = 45 minutes

[51] (US BLS, 2021) Occupational Outlook Handbook, U.S. Bureau of Labor Statistics, page last modified April 9, 2021. Diesel Service Technicians and Mechanics : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

(US BLS, 2021a) Employer Costs for Employee Compensation – December 2020, U.S Bureau of Labor Statistics, March 18, 2021. Employer Costs for Employee Compensation - December 2020 (bls.gov)

Staff assumed a median pay rate of $24.13 per hour and adjusted for the total compensation rate of $24.13/0.7 = $34.47 per hour.

[52] (CARB, 2017) Proposed Regulatory Amendments to the Heavy-Duty Vehicle Inspection Program and Periodic Smoke Inspection Program, Standardized Regulatory Impact Assessment (SRIA), California Air Resources Board, August 10, 2017. 08 ISOR App F SRIAHDVIP-PSIP (ca.gov)

versus purchasing the testing equipment themselves to perform the testing in-house. Some of the larger fleets may determine that it is more cost effective for them in the long run to purchase testing equipment and perform HD I/M testing in-house now that the testing frequency would be increased to twice per year. However, for this cost analysis, staff conservatively estimated that all fleets currently contracting out PSIP testing would continue to do so in the proposed HD I/M program by hiring a HD I/M tester outside of their employment to perform their vehicle compliance testing. Staff also projects California-registered owner operators who are currently not subject to the PSIP's smoke opacity testing requirement would hire outside HD I/M-approved testers to perform the proposed periodic smoke opacity testing requirement. Per staff's discussion with several OOS fleets, OOS fleets are expected to hire outside HD I/M approved testers to perform the required vehicle compliance testing on their vehicles as well. Based on discussion with stakeholders and survey results from heavy-duty fleets, the cost of performing smoke opacity testing by an outside tester ranges from $50 to $200 per test per vehicle.[53] Hence, staff estimated an average smoke opacity testing cost of $125 per test per vehicle for the purposes of this SRIA cost analysis (this assumed cost has not yet taken into account costs for HD I/M-approved testers to perform visual inspection testing). Similar to California-registered fleets of more than 20 vehicles, in addition to smoke opacity testing costs, these California-registered fleets of 20 or fewer vehicles and OOS fleets would also incur costs due to the proposed newly added visual inspection. Staff similarly assumed it would take 30 minutes per year (15 minutes for each visual inspection per vehicle) for an HD I/M-approved tester to perform the proposed visual inspection on each heavy-duty non-OBD vehicle. Staff assumed visual inspections would occur twice a year with a total employee compensation cost of $34.47 per hour[54] for the HD I/M-approved tester to perform the inspection.

Table C-6 summarizes staff's estimated incremental per vehicle periodic testing costs for non-OBD vehicles from different fleet types under the Proposed Regulation. Table C-7 summarizes staff's estimated total incremental periodic testing costs on the affected heavy-duty non-OBD vehicle owners due to the Proposed Regulation from calendar year 2023 through 2037. California heavy-duty fleet size distribution data based on 2018 DMV registration were used to weigh the costs among different California fleet size groups for the reported statewide costs in Table C-7. As shown, the periodic testing costs in 2023 is zero because the proposed periodic smoke opacity testing and visual inspection under the Proposed Regulation would not start until 2024. The estimated periodic testing costs are shown to be declining substantially from calendar year 2024 through 2037 (from $31.7M to $6.6M) due to the retirement of the old non-OBD vehicles over time.

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[53] (ERG, 2021) Heavy-Duty On-board Diagnostic Data Collection Demonstration and Repair Data Collection Study, Agreement Number – 18MSC001, Eastern Research Group, June 2021.

[54] (US BLS, 2021) Occupational Outlook Handbook, U.S. Bureau of Labor Statistics, page last modified April 9, 2021. Diesel Service Technicians and Mechanics : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

(US BLS, 2021a) Employer Costs for Employee Compensation – December 2020, U.S Bureau of Labor Statistics, March 18, 2021. Employer Costs for Employee Compensation - December 2020 (bls.gov)

Staff assumed a median pay rate of $24.13 per hour and adjusted for the total compensation rate of $24.13/0.7 = $34.47 per hour.

Table C- 6: Incremental Per Vehicle Periodic Testing Costs for Heavy-Duty Non-OBD Vehicles from Different Fleet Types under the Proposed Regulation

Fleet Types	California-Registered Owner Operators	California-Registered Fleets of 2-20 Vehicles	California-Register Fleets of more than 20 Vehicles[55]	OOS Fleets Operating in California
Incremental Annual Smoke Opacity Testing Costs per Vehicle	$250	$125	$8.62	$250
Incremental Annual Visual Inspection Costs per Vehicle	$17.2	$17.2	$17.2	$17.2
Total Incremental Annual Testing Costs per Vehicle	**$267**	**$142**	**$25.8**	**$267**

Table C- 7: Statewide Incremental Periodic Testing Costs on Heavy-Duty Non-OBD Vehicles under the Proposed Regulation from 2023 to 2037[56]

Calendar Year	Incremental Periodic Smoke Opacity Testing Costs	Incremental Periodic Visual Inspection Costs	Total Costs
2023	$0	$0	$0
2024	$28,013,000	$3,671,000	$31,684,000
2025	$24,981,000	$3,351,000	$28,332,000
2026	$22,327,000	$3,062,000	$25,390,000
2027	$19,941,000	$2,788,000	$22,728,000
2028	$17,757,000	$2,524,000	$20,281,000
2029	$15,801,000	$2,276,000	$18,077,000
2030	$14,060,000	$2,053,000	$16,113,000
2031	$12,519,000	$1,845,000	$14,365,000
2032	$11,105,000	$1,658,000	$12,763,000
2033	$9,774,000	$1,476,000	$11,250,000
2034	$8,556,000	$1,311,000	$9,867,000

[55] As staff assumed California-registered fleets of more than 20 vehicles most likely already have their own opacity testing equipment (i.e., smoke meters), the incremental costs due to the proposed periodic smoke opacity testing requirement would only be the compensation costs for their own employees to perform additional smoke opacity tests.

[56] Costs were rounded to the nearest thousand.

Calendar Year	Incremental Periodic Smoke Opacity Testing Costs	Incremental Periodic Visual Inspection Costs	Total Costs
2035	$7,460,000	$1,159,000	$8,619,000
2036	$6,510,000	$1,025,000	$7,535,000
2037	$5,680,000	$906,000	$6,586,000
Total	**$204,485,000**	**$29,106,000**	**$233,591,000**

Follow-Up Testing Costs

As the Proposed Regulation starts implementation in 2023, heavy-duty vehicles that are flagged as high-emitting vehicles as they pass through CARB's deployed PEAQS/RSD network would be required to submit follow-up vehicle testing to verify their compliance status. Hence, such flagged vehicles would incur additional vehicle testing costs above the current baseline. Specifically, flagged high-emitting non-OBD vehicles would be required to submit follow-up smoke opacity tests and visual inspections. To estimate the number of additional smoke opacity and visual inspection tests due to PEAQS/RSD follow-up testing submission requirement, staff used the estimated number of heavy-duty non-OBD vehicles repairs under the Proposed Regulation that are discussed in detail in Section C.1.e below. Staff assumed that the estimated number of non-OBD vehicle repairs shown in Table C-24 would be equivalent to the number of follow-up tests done by vehicles in 2023. Although some of these repairs could likely be attributed to fleets preparing for the upcoming periodic inspection requirements and other program enforcement strategies,[57] staff conservatively assumed all repairs in 2023 would be a result of the required compliance verification follow-up test requirement.

Once the periodic testing requirements take effect in 2024, some of these follow-up tests would be absorbed through the proposed periodic testing requirement. For example, the follow-up test due date happens to be overlapped with the periodic test due date, thus allowing a vehicle to satisfy both of the requirements with only the periodic inspection submission. However, to ensure a conservative (i.e., high) cost estimate, staff assumed the percentage of non-OBD vehicles subject to follow-up tests due to PEAQS/RSD screening would remain the same even after the periodic testing requirement is implemented. Estimated costs for this additional testing followed the same cost assumptions and methodology as discussed in the periodic testing costs section above. Table C-8 summarizes per vehicle follow-up testing costs for non-OBD vehicles from different fleet types. Table C-9 summarizes staff's estimated number of follow-up tests and associated costs for heavy-duty non-OBD vehicles due to PEAQS/RSD screening. As seen in Table C-9, the number of non-OBD follow-up tests would decrease over time. This would be due to the natural turnover of non-OBD vehicles to OBD-equipped vehicles as these older vehicles are retired and due to the reduction in non-compliant vehicles over time as the Proposed Regulation takes effect.

[57] See Section C.1.e. for staff's detailed number of heavy-duty repair estimate methodology.

Table C- 8: Per Vehicle Follow-Up Testing Costs for Heavy-Duty Non-OBD Vehicles from Different Fleet Types under the Proposed Regulation

Fleet Types	California-Registered Fleets of 1-20 Vehicles	California-Registered Fleets of more than 20 Vehicles[58]	OOS Fleets Operating in California
Per Vehicle Follow-Up Testing Costs	$134	$17.2	$134

Table C- 9: Statewide Incremental Follow-Up Testing Costs on Heavy-Duty Non-OBD Vehicles through PEAQS/RSD Screening under the Proposed Regulation from 2023 to 2037

Calendar Year	Number of Follow-Up Tests	Follow-Up Testing Costs[59]
2023	2,764	$286,000
2024	2,222	$229,000
2025	1,086	$112,000
2026	711	$73,000
2027	515	$53,000
2028	437	$45,000
2029	388	$40,000
2030	348	$35,000
2031	314	$32,000
2032	281	$28,000
2033	249	$25,000
2034	220	$22,000
2035	193	$19,000
2036	169	$17,000
2037	148	$15,000
Total	**10,045**	**$1,033,000**

Total Heavy-Duty Non-OBD Vehicle Testing Costs

Table C-10 summarizes staff's estimated total incremental vehicle testing costs on heavy-duty non-OBD vehicle owners due to the Proposed Regulation from 2023 through 2037. The costs include the sum of periodic testing costs and PEAQS/RSD follow-up testing costs presented in Table C-7 and C-9 above, respectively. The vehicle testing costs are lowest in 2023 ($0.286M) as there would be only PEAQS/RSD follow-up testing on a small number of heavy-

[58] As staff assumed California-registered fleets of more than 20 vehicles most likely already have their own opacity testing equipment (i.e., smoke meters), the incremental costs due to the proposed smoke opacity testing requirement would only be the compensation costs for their own employees to perform additional smoke opacity tests. Hence, per vehicle costs for California-registered fleets of more than 20 vehicles due to PEAQS/RSD follow-up tests would include the compensation costs for their own employees to perform the smoke opacity test ($8.62 per test) and the labor costs to perform the visual inspection ($8.62 per test).
[59] Costs were rounded to the nearest thousand.

duty vehicles that are flagged as potential high emitters. The testing costs are highest in 2024 ($31.9M) as the proposed periodic testing starts to take effect, which would require testing on all affected heavy-duty vehicles operating in California. The testing costs then decline in the subsequent years, to $6.6M in 2037, reflecting the retirement of older heavy-duty non-OBD vehicles over time.

Table C- 10: Statewide Incremental Vehicle Testing Costs on Heavy-Duty Non-OBD Vehicles under the Proposed Regulation from 2023 to 2037

Calendar Year	Vehicle Testing Costs[60]
2023	$286,000
2024	$31,913,000
2025	$28,444,000
2026	$25,463,000
2027	$22,781,000
2028	$20,325,000
2029	$18,117,000
2030	$16,149,000
2031	$14,397,000
2032	$12,792,000
2033	$11,276,000
2034	$9,889,000
2035	$8,638,000
2036	$7,552,000
2037	$6,601,000
Total	**$234,624,000**

ii. Heavy-Duty OBD-Equipped Vehicle Compliance Testing Costs

Periodic Testing Costs

The Proposed Regulation would require quarterly OBD data submissions from heavy-duty OBD-equipped vehicles. There is currently no periodic OBD testing requirement in place; hence, the proposed periodic OBD testing requirement would impose incremental OBD testing costs on owners of heavy-duty OBD-equipped vehicles operating in California. As described earlier, there would be three OBD data submission options that OBD-equipped vehicle owners could choose from: telematics, testing through a HD I/M-approved tester, or using CARB-provided OBD testing device at a designated location throughout the State. OBD testing costs on vehicle owners would vary based on the data submission method chosen.

Telematics technology has been widely used in the heavy-duty trucking industry, especially by large heavy-duty fleets, for fleet logistics management, vehicle diagnostics and preventive maintenance, and/or to meet the federal electronic logging device (ELD) requirement. ELDs

[60] Costs were rounded to the nearest thousand.

are currently required on most of commercial buses and trucks with limited exceptions for short-haul operations.[61] Per staff's discussion with stakeholders and survey results on heavy-duty fleets, most large fleets of more than 50 vehicles currently utilize telematics services.[62] In addition, discussions with OOS fleets indicate OOS fleets overwhelmingly use telematics services as well.[63] Telematics devices are continuously connected to the vehicle and remotely transmit vehicle operation data to the provider to support fleet management and regulatory needs.

Per staff's discussions with telematics providers and heavy-duty vehicle/engine original equipment manufacturers (OEM), the collection and submission of OBD data to meet CARB's requirements can be integrated into current telematics technology. For devices already in operation on vehicles, such capabilities can be incorporated through a software update and/or device reflash without having to replace the existing hardware. Once the telematics device is installed on the vehicle, the required OBD data would be automatically collected and submitted to CARB without interfering vehicle's normal business.

Fleet owners are typically paying a one-time average hardware cost of approximately $77 per device, and a monthly subscription fee of approximately $25-46 per vehicle, for their current telematics services.[64] The costs of adding a CARB-required OBD testing capability to current telematics service packages already in use were anticipated to be on the order of about $2 per vehicle per month based on staff's discussion with telematics providers. Staff expects most heavy-duty fleets that are currently subscribing to a telematics service would choose the telematics submission option to meet the proposed periodic OBD testing requirement given its convenience. In this SRIA analysis, staff assumed large California fleets of more than 50 vehicles and all OOS fleets already subscribe to a telematics service; thus, these fleets would pay an additional $2 per vehicle per month (or annual $24 per vehicle) to meet the proposed OBD testing requirement.

Staff conservatively estimates that smaller California fleets of 50 vehicles or less potentially do not currently subscribe to telematics services. For these fleets without telematics services, staff expects that they would choose one of the other two testing options, i.e., testing through a HD I/M-approved tester or using a CARB-provided OBD testing device at a designated location, instead of contracting with a telematics provider. Although the telematics submission method would likely be the most convenient way for fleets to meet the periodic OBD testing requirements, for fleets that have not yet subscribed to a telematics service, the added hardware and monthly service subscription costs could be seen as too expensive of an upfront cost. Thus, these fleets, especially the smallest fleets, are more likely to select one of the other two testing options to submit the required testing data.

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[61] (FMCSA, 2018) General Information about the ELD Rule, Federal Motor Carrier Safety Administration, last updated April 9, 2018. General Information about the ELD Rule | FMCSA (dot.gov)
[62] (ERG, 2021) Heavy-Duty On-board Diagnostic Data Collection Demonstration and Repair Data Collection Study, Agreement Number – 18MSC001, Eastern Research Group, June 2021.
[63] Personal communication with ATA and national fleets in April and May 2020.
[64] (ERG, 2021) Heavy-Duty On-board Diagnostic Data Collection Demonstration and Repair Data Collection Study, Agreement Number – 18MSC001, Eastern Research Group, June 2021.

Although the testing option at designated locations throughout the State would be available at the lowest cost to vehicle owners, they would need to drive their vehicles to these designated locations to perform the test. Such an option would suit the needs of vehicles that pass by near these testing locations during their normal business operations, however, may not meet the needs of vehicles that would have to go out of their way to access these testing locations. Owners of vehicles whose operating routes that do not match these designated testing locations are more likely to have a HD I/M-approved tester perform vehicle testing outside of their normal business operations. For a conservative cost estimate, staff assumed all vehicle owners not opting for the telematics submission approach would choose to hire a HD I/M-approved tester instead of opting for the designated test location for this SRIA cost analysis. Nonetheless, since these testing locations option would offer a cheaper alternative relative to hiring a HD I/M-approved tester and could be hosted at convenient locations such as truck stops along major trucking arteries, some vehicle owners would opt to use this testing option. Because it is difficult to predict the uptake of such a testing option at this time, CARB staff believed the best approach is to assume the higher costs to ensure the most conservative assessment.

As another option, fleets could perform the proposed OBD testing through a HD I/M-approved tester. Such a tester could either be a third-party HD I/M-approved tester hired by an owner to perform the OBD testing or an internal employee of an owner who has taken the adequate CARB training to become a HD I/M-approved tester themselves. All HD I/M-approved testers would be required to use a CARB-certified OBD testing device. Per staff's discussion with OBD testing device vendors and CARB's OBD testing study contract,[65] the costs of such OBD testing devices could range between $100 to $700 per device. Given this low-cost, staff expects most fleets that choose not to submit data via telematics would purchase a CARB-certified testing device and have internal employees become HD I/M-approved testers themselves instead of hiring third-party HD I/M-approved testers. This is in contrast to the expected testing pathway chosen for non-OBD vehicles where it is expected that fleets would tend to hire a third-party HD I/M-approved tester to perform the required vehicle testing. Such a contrast is expected due to the large cost difference in the cost of the two testing instrumentation (i.e., between $100 and $700 for an OBD testing device versus about $5,000 (2016$) for a smoke opacity testing device[66]).

Staff assumed an average cost of $400 per certified OBD testing device in this SRIA analysis.[67] California fleets of 20 vehicles or less would likely purchase one device per fleet to perform the required testing on all of their vehicles. California fleets of 21 to 50 vehicles would likely purchase two devices per fleet to perform the required testing on all of their vehicles as staff expects these fleets might have multiple fleet base locations and their vehicles are dispersed among the fleet locations. Hence, it would be more practical for fleets to purchase multiple devices for different fleet base locations. Staff also conservatively

[65] (ERG, 2021) Heavy-Duty On-board Diagnostic Data Collection Demonstration and Repair Data Collection Study, Agreement Number – 18MSC001, Eastern Research Group, June 2021.
[66] (CARB, 2017) Proposed Regulatory Amendments to the Heavy-Duty Vehicle Inspection Program and Periodic Smoke Inspection Program, Standardized Regulatory Impact Assessment (SRIA), California Air Resources Board, August 10, 2017. 08 ISOR App F SRIAHDVIP-PSIP (ca.gov)
[67] Average of $100 and $700 of the discussed OBD testing device price range for the average price of $400 per OBD testing device.

assumed OBD testing device' longevity to be five years due to potential wear and tear over time.[68] For the SRIA cost analysis purposes, staff assumes 20 percent of OBD testing devices are replaced per year. Such replacement costs are added to the total OBD testing costs starting in the second year of the periodic OBD testing requirement to reflect the gradual device replacement for fleets over time. Staff also accounted for the labor costs fleets may incur when performing their own testing through this non-telematics approach. Unlike the telematics option where the OBD testing process would take place automatically without involving human interaction with the tested vehicle or the testing device, the OBD data submission through the HD I/M-approved tester option would require human intervention. The tester would have to manually plug the OBD testing device into the vehicle's OBD port to initiate the remote OBD data submission process and unplug the testing device when the OBD data submission is completed. Staff assumed an average OBD testing duration of 2.5 minutes per vehicle[69] for each OBD data submission (or ten minutes per vehicle per year[70]) through a HD I/M-approved tester option with a total employee compensation costs of $34.47 per hour[71] for the HD I/M-approved tester to perform the proposed OBD testing.

Table C-11 summarizes staff's estimated incremental per vehicle periodic testing costs for OBD-equipped vehicles from different fleet types under the Proposed Regulation. Table C-12 summarizes staff's estimated incremental periodic OBD testing costs on the affected heavy-duty vehicle owners due to the Proposed Regulation from calendar year 2023 through 2037.

In general, the periodic OBD testing costs include the costs of purchasing OBD testing devices and the testers' compensation costs for fleets who choose to do testing through an internal HD I/M-approved tester and the annual telematics subscription costs for fleets who use their existing telematics services for the required OBD testing. Similar to the non-OBD vehicle testing costs methodology, California heavy-duty fleet size distribution data based on 2018 DMV registration were used to weigh the costs among different California fleet size groups for the reported statewide costs in Table C-12. The periodic OBD testing costs in 2023 is zero because the proposed periodic OBD testing would not start until 2024. The estimated periodic OBD testing costs are highest in 2024 ($84.9M) as fleets would start buying the OBD testing devices, then decrease in the subsequent years due to the reduced OBD testing device purchase costs over time. The costs related to the increase in telematics subscription costs over current baseline costs remains consistent throughout the analysis.

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[68] (Shop24pro, 2020) Shop24pro, September 1, 2020. KitBest Bluetooth OBD OBD2 Scanner Adapter for Android, Car Diagnostic Check Engine Light Scan Tool Code Reader. 5 Year Warranty – Shop24pro

[69] (ERG, 2021) Heavy-Duty On-board Diagnostic Data Collection Demonstration and Repair Data Collection Study, Agreement Number – 18MSC001, Eastern Research Group, June 2021.

[70] [2.5 minutes per test] x [4 tests per vehicle per year] = 10 minutes per vehicle per year

[71] (US BLS, 2021) Occupational Outlook Handbook, U.S. Bureau of Labor Statistics, page last modified April 9, 2021. Diesel Service Technicians and Mechanics : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

(US BLS, 2021a) Employer Costs for Employee Compensation – December 2020, U.S Bureau of Labor Statistics, March 18, 2021. Employer Costs for Employee Compensation - December 2020 (bls.gov)

Staff assumed a median pay rate of $24.13 per hour and adjusted for the total compensation rate of $24.13/0.7 = $34.47 per hour.

Table C- 11: Incremental Per Vehicle Periodic Testing Costs for Heavy-Duty OBD-Equipped Vehicles from Different Fleet Types under the Proposed Regulation

Fleet Types	California-Registered Fleets of 1-20 Vehicles	California-Registered Flees of 21-50 Vehicles	California-Registered Fleets of more than 50 Vehicles[72]	OOS Fleets Operating in California[73]
One-Time OBD Testing Device Purchase Costs[74] per Fleet	$400	$800	$0	$0
On-Going Annual OBD Testing Costs per Vehicle	$5.75	$5.75	$24	$24

Table C- 12: Statewide Incremental Periodic OBD Testing Costs under the Proposed Regulation from 2023 to 2037[75]

Calendar Year	Periodic OBD Testing Costs through HD I/M-Approved Testers	Periodic OBD Testing Costs through Telematics	Total Periodic OBD Testing Costs
2023	$0	$0	$0
2024	$70,232,000	$14,647,000	$84,878,000
2025	$18,761,000	$15,202,000	$33,963,000
2026	$19,194,000	$15,698,000	$34,891,000
2027	$19,591,000	$16,150,000	$35,742,000
2028	$19,849,000	$16,564,000	$36,413,000
2029	$19,929,000	$16,943,000	$36,872,000
2030	$19,826,000	$17,291,000	$37,117,000
2031	$20,016,000	$17,706,000	$37,721,000
2032	$20,018,000	$18,118,000	$38,137,000
2033	$20,040,000	$18,533,000	$38,573,000
2034	$20,013,000	$18,952,000	$38,965,000
2035	$19,801,000	$19,368,000	$39,169,000

[72] These fleets are assumed to already have existing telematics services. They would need to update their telematics services to include periodic OBD data submission capability to CARB for an incremental cost of $2/month/vehicle.
[73] These fleets are assumed to already have existing telematics services. They would need to update their telematics services to include periodic OBD data submission capability to CARB for an incremental cost of $2/month/vehicle.
[74] Note that staff assumed the OBD's testing device would eventually be replaced due to potential wear and tear over time.
[75] Costs were rounded to the nearest thousand.

Calendar Year	Periodic OBD Testing Costs through HD I/M-Approved Testers	Periodic OBD Testing Costs through Telematics	Total Periodic OBD Testing Costs
2036	$19,837,000	$19,802,000	$39,639,000
2037	$19,838,000	$20,258,000	$40,096,000
Total	**$326,945,000**	**$245,231,000**	**$572,176,000**

Follow-up Testing Costs

Similar to non-OBD vehicles, OBD-equipped vehicle owners may also incur costs due to the proposed PEAQS/RSD follow-up testing submission requirement because flagged high-emitting OBD-equipped vehicles would need to submit an OBD test to verify their compliance status. To estimate the number of follow-up OBD tests, staff followed the similar methodology as discussed above for non-OBD vehicles. Since the proposed periodic OBD testing requirement would not take effect until 2024, staff conservatively assumed that in 2023 fleets would hire a third-party HD I/M-approved tester to perform the follow-up test if they are required to submit a follow-up OBD test to CARB. Additionally, staff conservatively assumed HD I/M-approved testers would charge the same OBD testing fee as smoke opacity testing of $125 per test. Even though staff expects the testing fee would be lower than the non-OBD vehicle testing fee given the less costly OBD testing device and simpler OBD testing procedure relative to the non-OBD vehicle inspection requirements. Staff assumes that the costs of a HD I/M-approved tester purchasing an OBD device would be passed through to the end user, and thus, is absorbed in the $125 per vehicle test cost.

In subsequent years, fleets would either have already purchased CARB-approved OBD testing devices or updated their telematics subscription service to include the ability to submit OBD tests to CARB to meet the proposed periodic testing requirement. This could also be used for the proposed PEAQS/RSD follow-up testing submission requirement without the need of hiring third-party HD I/M-approved tester to perform the test as assumed in 2023. The costs for purchasing the CARB-approved testing devices or updating telematics subscription services have already been accounted for as described in the periodic testing costs discussion above. The only additional testing costs fleets would be subject to in 2024 and beyond for PEAQS/RSD follow-up testing would be the labor costs associated with performing the non-telematics testing option.

As discussed previously, staff assumed an average OBD testing duration of 2.5 minutes per vehicle[76] for each follow-up test through the purchased testing device with a total employee compensation cost of $34.47 per hour.[77] Additional OBD test submissions through telematics

[76] (ERG, 2021) Heavy-Duty On-board Diagnostic Data Collection Demonstration and Repair Data Collection Study, Agreement Number – 18MSC001, Eastern Research Group, June 2021.

[77] (US BLS, 2021) Occupational Outlook Handbook, U.S. Bureau of Labor Statistics, page last modified April 9, 2021. Diesel Service Technicians and Mechanics : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

(US BLS, 2021a) Employer Costs for Employee Compensation – December 2020, U.S Bureau of Labor Statistics, March 18, 2021. Employer Costs for Employee Compensation - December 2020 (bls.gov)

would not impose additional costs on fleet owners (i.e., California-registered fleets of more than 50 vehicles and OOS fleets). Table C-13 summarizes per vehicle follow-up testing costs for OBD-equipped vehicles from different fleet types. As discussed above in the non-OBD vehicle follow-up testing section, staff used the estimated number of vehicle repairs assumed under the Proposed Regulation to estimate the number of additional OBD tests associated with the PEAQS/RSD follow-up testing requirements. Table C-14 summarizes staff's estimated number of follow-up tests and associated costs for heavy-duty OBD-equipped vehicles due to PEAQS/RSD screening.

Table C- 13: Per Vehicle Follow-Up Testing Costs for Heavy-Duty OBD-Equipped Vehicles from Different Fleet Types under the Proposed Regulation

Fleet Types	California-Registered Fleets of 1-50 Vehicles	California-Registered Fleets of more than 50 Vehicles[78]	OOS Fleets Operating in California[79]
2023	$125	$125	$125
2024 and later	$1.44	$0	$0

Table C- 14: Statewide Incremental Follow-Up Testing Costs on Heavy-Duty OBD-Equipped Vehicles through PEAQS/RSD Screening under the Proposed Regulation from 2023 to 2037

Calendar Year	Number of Follow-Up Tests	Follow-Up Testing Costs
2023	18,037	$2,254,585
2024	16,726	$11,701
2025	7,367	$4,453
2026	4,532	$2,669
2027	3,304	$2,031
2028	3,012	$1,962
2029	2,951	$1,977
2030	2,947	$1,994
2031	2,947	$1,994
2032	2,991	$2,020
2033	3,033	$2,038

Staff assumed a median pay rate of $24.13 per hour and adjusted for the total compensation rate of $24.13/0.7 = $34.47 per hour.

[78] These fleets are assumed to already have existing telematics services. They would just need to update their telematics services to include periodic OBD data submission capability to CARB for an incremental cost of $2/month/vehicle starting in 2024. Additional OBD test submissions through telematics in 2024 and later would not impose additional costs on the fleet owners given the included periodic OBD data submission capability.

[79] These fleets are assumed to already have existing telematics services. They would just need to update their telematics services to include periodic OBD data submission capability to CARB for an incremental cost of $2/month/vehicle starting in 2024. Additional OBD test submissions through telematics in 2024 and later would not impose additional costs on the fleet owners given the included periodic OBD data submission capability.

Calendar Year	Number of Follow-Up Tests	Follow-Up Testing Costs
2034	3,072	$2,049
2035	3,112	$2,058
2036	3,150	$2,062
2037	3,189	$2,066
Total	**80,370**	**$2,295,658**

Total Heavy-Duty OBD-Equipped Vehicle Testing Costs

Table C-15 summarizes staff's estimated total incremental vehicle testing costs on heavy-duty OBD-equipped vehicle owners due to the Proposed Regulation from 2023 through 2037, which are the sum of periodic testing costs and PEAQS/RSD follow-up testing costs discussed above.

Table C- 15: Statewide Incremental Vehicle Testing Costs on Heavy-Duty OBD-Equipped Vehicles under the Proposed Regulation from 2023 to 2037[80]

Calendar Year	Vehicle Testing Costs
2023	$2,255,000
2024	$84,890,000
2025	$33,967,000
2026	$34,894,000
2027	$35,744,000
2028	$36,415,000
2029	$36,874,000
2030	$37,119,000
2031	$37,723,000
2032	$38,139,000
2033	$38,575,000
2034	$38,967,000
2035	$39,171,000
2036	$39,641,000
2037	$40,098,000
Total	**$574,472,000**

iii. Total Incremental Vehicle Testing Costs on All Affected Heavy-Duty Vehicles

Table C-16 summarizes the total incremental costs on affected heavy-duty vehicle owners due to the proposed vehicle testing requirements under the Proposed Regulation from 2023 through 2037. The total vehicle testing costs are the sum of incremental smoke opacity testing and visual inspection costs and OBD testing costs shown in Table C-10 and C-15, respectively.

[80] Costs were rounded to the nearest thousand.

Table C- 16: Statewide Incremental Vehicle Testing Costs under the Proposed Regulation from 2023 to 2037[81]

Calendar Year	Vehicle Testing Costs
2023	$2,541,000
2024	$116,803,000
2025	$62,412,000
2026	$60,357,000
2027	$58,525,000
2028	$56,741,000
2029	$54,991,000
2030	$53,268,000
2031	$52,120,000
2032	$50,930,000
2033	$49,850,000
2034	$48,856,000
2035	$47,809,000
2036	$47,194,000
2037	$46,700,000
Total	**$809,095,000**

c. HD I/M-Approved Tester Training

Under the Proposed Regulation, vehicle inspection tests (i.e., smoke opacity testing and visual inspection, or OBD testing) would be required to be performed by a HD I/M-approved tester. Individuals who want to become HD I/M-approved testers would be required to successfully complete one-hour online testing training course approved by CARB once every two years. This course would be offered through CARB's website and would be free to enroll. Staff assumed a total employee compensation cost of $34.47 per hour[82] for a heavy-duty technician or mechanic to take the CARB's training course. Staff estimated the number of HD I/M-approved testers that would apply to be part of this program based on ratioing the number of testers to the number of vehicles and fleets subject to the program requirements. To account for fleets that may want to complete compliance testing internally, staff assumed one HD I/M-approved tester for every California fleet between the size of one and 20 vehicles. For California fleets of 21 to 50 vehicles, staff assumed two HD I/M-approved testers per fleet of 21 to 50 vehicles. For California fleets of more than 50 vehicles, staff assumed a ratio of one HD I/M-approved tester for every 20 vehicles. Finally, staff assumed a

[81] Costs were rounded to the nearest thousand.

[82] (US BLS, 2021) Occupational Outlook Handbook, U.S. Bureau of Labor Statistics, page last modified April 9, 2021. Diesel Service Technicians and Mechanics : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

(US BLS, 2021a) Employer Costs for Employee Compensation – December 2020, U.S Bureau of Labor Statistics, March 18, 2021. Employer Costs for Employee Compensation - December 2020 (bls.gov)

Staff assumed a median pay rate of $24.13 per hour and adjusted for the total compensation rate of $24.13/0.7 = $34.47 per hour.

ratio of one third-party HD I/M-approved smoke opacity tester for every 2,080 non-OBD vehicles[83] not already accounted for.

Table C-17 summarizes staff's estimated incremental training costs due to the Proposed Regulation from calendar year 2023 through 2037. Similar to the vehicle testing costs methodology, California heavy-duty fleet size distribution data based on 2018 DMV registration were used to weigh the California fleet distributions used for this cost estimate in Table C-17. The annual training costs range from $3.20M to $5.89M during the 2023-2037 period.

Table C- 17: Statewide Incremental Training Costs under the Proposed Regulation from 2023 to 2037[84]

Calendar Year	Training Costs
2023	$5,889,000
2024	$3,203,000
2025	$3,321,000
2026	$3,419,000
2027	$3,508,000
2028	$3,579,000
2029	$3,626,000
2030	$3,649,000
2031	$3,685,000
2032	$3,702,000
2033	$3,718,000
2034	$3,725,000
2035	$3,714,000
2036	$3,717,000
2037	$3,716,000
Total	**$56,171,000**

d. Compliance Certificate Fee

Starting in July 2023, under the Proposed Regulation, heavy-duty vehicle owners would be required to pay a compliance fee in order to obtain a vehicle's HD I/M compliance certificate to legally operate in California. These fees will be used to support the State costs to implement and enforce the Proposed Regulation.[85] Staff is still working to finalize these State program implementation costs. To ensure a conservative estimate, staff assumed the compliance fee would be $30 per vehicle.

[83] For a back-to-back vehicle testing, a third-party tester could perform testing for up to 4,160 vehicles in a year (4 tests in an hour, work 40 hours a week for 52 weeks a year); however, to account for potential travel time of the testers to fleets for testing, staff conservatively reduced the third-party tester' testing capacity to 2,080 vehicles for each tester (reduced by 50 percent).

[84] Costs were rounded to the nearest thousand.

[85] See Section D.2. for further details on needed State resources to implement the Proposed Regulation

To estimate the percentage of in-state heavy-duty vehicles that would comply with the program requirements and pay the compliance fee to obtain a HD I/M compliance certificate, staff used BAR's Light-Duty Smog Check program's issued compliance certification statistics as a proxy. This is reasonable since the two programs would have similar ties to California DMV vehicle registration. Light-Duty Smog Check program data suggested an issued certificate percentage of approximately 90 percent,[86] thus staff assumed 90 percent of in-state heavy-duty vehicles would pay the compliance fee in this program to obtain a HD I/M compliance certificate. Because OOS vehicles are not subject to a DMV registration hold, staff assumed the percentage of OOS vehicles obtaining a HD I/M compliance certificate would be lower. In 2023, staff estimates the percentage of OOS vehicles would be about half of the in-state vehicle percentage, 45 percent. In later years once periodic testing is implemented and a more robust enforcement network is established (i.e., enhanced roadside inspection coordination between CARB and CHP, enhanced fraud detection, etc.), staff expects the percentage of OOS vehicle compliance would increase. Thus, staff projected an increase to 68 percent of the affected OOS vehicles would pay for the proposed compliance fee.[87] Table C-18 summarizes staff's estimated incremental HD I/M compliance fee costs on affected heavy-duty vehicle owners from calendar year 2023 through 2037.

Table C- 18: Statewide Incremental Compliance Certificate Fee Costs under the Proposed Regulation from 2023 to 2037[88]

Calendar Year	Costs on In-State Heavy-Duty Vehicles	Costs on OOS Heavy-Duty Vehicles	Total Costs
2023	$16,434,000	$7,331,000	$23,765,000
2024	$16,849,000	$11,254,000	$28,102,000
2025	$17,256,000	$11,484,000	$28,740,000
2026	$17,610,000	$11,700,000	$29,309,000
2027	$17,898,000	$11,909,000	$29,807,000
2028	$18,101,000	$12,113,000	$30,214,000
2029	$18,210,000	$12,315,000	$30,526,000
2030	$18,218,000	$12,522,000	$30,740,000
2031	$18,213,000	$12,798,000	$31,011,000
2032	$18,167,000	$13,089,000	$31,256,000
2033	$18,078,000	$13,393,000	$31,471,000
2034	$17,963,000	$13,712,000	$31,675,000
2035	$17,786,000	$14,044,000	$31,830,000
2036	$17,632,000	$14,393,000	$32,026,000
2037	$17,489,000	$14,765,000	$32,255,000
Total	**$265,904,000**	**$186,823,000**	**$452,727,000**

[86] (BAR, 2020a) Smog Check Executive Summary Reports, Bureau of Automotive Repair, 2020. Smog Check Executive Summary Reports - Bureau of Automotive Repair (ca.gov)

[87] Average of 45 percent OOS vehicle pay rate in 2023 and annual 90 percent in-state vehicle pay rate; 68 percent OOS vehicle pay rate in 2024 and later.

[88] Costs were rounded to the nearest thousand.

e. Heavy-Duty Vehicle Repairs

As mentioned, under the current PSIP, California-registered fleets subject to the regulation are required to repair vehicles that fail the annual smoke opacity tests to get within the required opacity limits. Under the current HDVIP, all heavy-duty vehicles operating in California are subject to CARB's roadside inspection. Owners of heavy-duty vehicles that have broken emissions control systems, as indicated through failing CARB-performed roadside vehicle component check, smoke opacity testing and/or OBD testing, are required to have those vehicles repaired. The Proposed Regulation would provide CARB additional tools to identify non-compliant vehicles, and once identified, ensure that these vehicles do indeed get repaired and back into compliance. As mentioned previously, these additional tools include more stringent periodic vehicle inspections on a broader category of vehicles, a new roadside emissions monitoring network, and enhanced State agency coordination between CARB and CHP, and a program compliance tie to DMV vehicle registration. As these improvements over the current HDVIP/PSIP regulations would significantly increase CARB's capability to ensure vehicle compliance, they would result in improved compliance rates and more vehicle repairs. Therefore, heavy-duty vehicle owners would incur incremental vehicle repair costs as compared to the current baseline.

i. Repair Costs Assumptions

Since heavy-duty non-OBD and OBD-equipped vehicles would be subject to different testing requirements (i.e., smoke opacity testing and visual inspection for non-OBD vehicles vs. OBD testing for OBD-equipped vehicles), they would experience different types of resulting repairs.

Since heavy-duty non-OBD vehicles are subject to similar testing requirements as in the current PSIP regulation, staff projected similar type of repairs and costs that were considered for vehicles that fail the vehicle inspection test in the HDVIP/PSIP Amendments' cost analysis. Table C-19 summarizes the assumed repairs and associated repair costs for non-OBD vehicles that fail the required vehicle inspection. The needed repairs would include a DPF replacement, and 62 percent of the time, there would also be an upstream engine component replacement such as DOC, EGR valve, EGR cooler, turbocharger, and fuel injector for a total average cost of $5,162 per vehicle repair.

Table C- 19: Repair Costs for Heavy-Duty Non-OBD Vehicles[89]

Upstream Engine Part	Upstream Engine Part Repair Probability	Repair Costs
DOC	45%	$4,247
EGR Valve	21%	$1,341

[89] (CARB, 2018) Proposed Regulatory Amendments to the Heavy-Duty Vehicle Inspection Program and Periodic Smoke Inspection Program, Staff Report: Initial Statement of Reasons (ISOR), California Air Resources Board, released on April 3, 2018. 02 ISOR HDVIP-PSIP (ca.gov)
2016$ value was converted to 2020$ value using (DOF, 2021) State of California, Department of Finance's Consumer Price Index Forecast, prepared by the Economic Research Unit in April 2021. Economic Forecasts, U.S. and California

EGR Cooler	9%	$3,465
Turbocharger	16%	$5,700
Fuel Injector	9%	$2,468
Average Weighted Upstream Repair		$3,639
DPF Replacement		$2,906
Repair Costs per Vehicle Repair[90]		**$5,162**

For heavy-duty OBD-equipped vehicle repairs, CARB staff contracted with Eastern Research Group (ERG) to conduct a cost analysis to estimate OBD-related repair costs on OBD-equipped vehicles that have an illuminated MIL.[91] Based on the OBD fault code data collected on heavy-duty OBD-equipped vehicles, the OBD fault codes were categorized into eight OBD fault code groups, and then commonly needed repairs along with the associated repair costs were identified for each group. The distribution of OBD fault code occurrences was then weighted to estimate an average OBD equipped vehicle repair cost of $1,977 per vehicle repair as shown in Table C-20.

Table C- 20: OBD-Related Repair Costs for Heavy-Duty OBD-Equipped Vehicles

OBD Fault Code Group	OBD Fault Code Group Distribution	Repair Costs
Boost Control	10.85%	$2,278
EGR	11.68%	$1,546
Fuel System Monitoring	15.95%	$1,848
NOx Sensor	14.86%	$1,877
PM Filter	11.75%	$2,305
PM Filter Frequent Regeneration	1.58%	$1,960
Reductant Delivery	19.45%	$2,169
SCR Catalyst	13.88%	$1,817
Weighted Average Costs per Vehicle Repair		**$1,977**

Because the OBD system is integrated in a vehicle's on-board computer for monitoring emissions control systems, it has the capability to detect emissions control issues earlier relative to the non-OBD vehicle test methods. Hence, this detection can allow for early action to be taken on the issue before an emissions component is completely damaged, while waiting could result in more time-consuming and expensive repairs. On the other hand, by the time vehicles fail the non-OBD vehicle opacity inspection, for example, such a failure typically results in the need to fully replace emissions control components, such as the DPF, thus likely resulting in more costly repairs. These factors result in a higher observed average non-OBD vehicle repair costs compared to OBD-equipped vehicle repair costs ($5,162 vs. $1,977).

[90] Repair costs per vehicle repair = DPF replacement costs + 0.62 x [average weighted upstream repair costs].

[91] (ERG, 2021) Heavy-Duty On-board Diagnostic Data Collection Demonstration and Repair Data Collection Study, Agreement Number – 18MSC001, Eastern Research Group, June 2021.

ii. Repair Rate Estimates

To estimate the number of incremental vehicle repairs to calculate incremental vehicle repair costs, staff first estimated the percentage of the total regulated vehicle population that would get repaired under the Proposed Regulation (referred to as the HD I/M vehicle repair rate). In general, the HD I/M vehicle repair rate in a given year can be described by the following equation:

$$\text{HD I/M vehicle repair rate} = A \times B \times C$$

Where:

A = percentage of the regulated vehicle population that does not meet the proposed compliance requirements (referred to as "non-compliant vehicles")

B = percentage of non-compliant vehicles that could be identified under the Proposed Regulation

C = percentage of identified non-compliant vehicles that would actually get repaired under the Proposed Regulation

Each listed parameter above is further described as followed:

Parameter A – Percentage of Non-Compliant Vehicles

Non-OBD Vehicles:

For heavy-duty non-OBD vehicles, staff estimated the percentage of non-compliant vehicles based on the projected percentage of statewide vehicles that fail the smoke opacity test in the current baseline. In November 2020, CARB staff undertook an effort to gauge current smoke opacity testing failure rates since the HDVIP/PSIP amendments took effect in July 2019. CARB staff performed smoke opacity testing on randomly selected participating heavy-duty vehicles at the California Department of Food and Agriculture (CDFA), Mountain Pass station. The testing results indicated that 6.78 percent of tested vehicles at Mountain Pass exceeded the current smoke opacity limits. Staff assumed the statewide smoke opacity failure rate in 2020 to be similar to the failure rate shown at Mountain Pass. Staff expects this statewide smoke opacity failure rate would increase over time in the absence of the Proposed Regulation due to vehicle degradation (i.e., more vehicles would fail over time as they get older). Based on CARB's roadside smoke opacity testing campaigns in the past (2011 through 2016), staff estimated an annual increase in the smoke opacity failure rate due to natural vehicle degradation to be about 0.24 percent per year. Staff applied this rate increase to the 2020 Mountain Pass data and projected a statewide smoke opacity failure rate in 2023 of 7.50 percent.

OBD-Equipped Vehicles:

For heavy-duty OBD-equipped vehicles, staff estimated non-compliant vehicle rates based on the projected percentage of statewide vehicles that would fail an OBD test (i.e., have an illuminated MIL) in the current baseline. Based on the collected heavy-duty OBD data from

recent CARB data collection efforts, staff established an OBD test failure rate as a function of a vehicle's odometer mileage:[92]

$$\text{Illuminated MIL Frequency} = 0.0016 \times (\text{Odometer mileage})^{0.37}$$

Based on the above illuminated MIL frequency equation and EMFAC's projected annual odometer mileage schedule for different heavy-duty vehicle categories, staff estimated an average statewide illuminated MIL frequency of 14.06 percent in 2023. Using the same approach, staff estimated an annual increase in the illuminated MIL frequency due to natural vehicle degradation of up to 0.27 percent per year moving forward if the Proposed Regulation was not implemented.

Parameter B – Percentage of Identified Non-Compliant Vehicles

As mentioned previously, the Proposed Regulation would improve the identification rate of non-compliant vehicles over the current baseline. Starting in 2023, the Proposed Regulation would allow for improved detection of high emitters flagged through CARB's roadside emission monitoring network (PEAQS/RSD), which would increase CARB's ability to identify non-compliant vehicles. The upcoming periodic testing requirements, fleet and owner reporting requirements, and enhanced roadside testing presence with CHP are also expected to incentivize owners to repair their vehicles beyond the current baseline rates in 2023. Based on California Statewide Travel Demand Model (CSTDM) data, staff estimated that for a network of 11 PEAQS systems rolled out at major State highway routes in San Joaquin Valley and South Coast regions, about 37.7 percent of heavy-duty vehicles travelling through these regions would travel through one of these installed systems. Based on CARB's past PEAQS pilot deployment, PEAQS' efficacy in identifying high emitters that travel through the systems is estimated to be about 81 percent. Furthermore, based on EMFAC estimates, staff estimated that about 70 percent of the total heavy-duty vehicle population would travel through either the San Joaquin Valley or South Coast regions. Thus, when taking into account these various factors, staff estimated a statewide improvement in identifying non-compliant vehicles of about 21 percent[93] in 2023 due to the implementation of the Proposed Regulation.

Starting in 2024, the proposed periodic testing requirement would take effect. Staff expects an increase in CARB's capability of identifying non-compliant vehicles as compared to the identification rate in 2023. Staff estimated the non-compliant vehicle identification rates in 2024 and later based on BAR's Light-Duty Smog Check program effectiveness.[94] For non-OBD vehicles, staff assumed an increase in the non-compliant vehicle identification rate to 70 percent against the current baseline, when accounting for the periodic testing requirements and identification tools already in use described above. For OBD-equipped vehicles, staff assumed a higher non-compliant vehicle identification rate than for non-OBD vehicles. This is

[92] (CARB, 2020b) EMFAC 202x Updates, California Air Resources Board, July 30, 2020. EMFAC202x Updates (ca.gov)
[93] [70% statewide vehicle coverage] x [81% PEAQS high-emitter identification efficacy] x [37.7% PEAQS vehicle capture rate] = 21% statewide high-emitter (or non-compliant vehicles) identification
[94] (BAR, 2020) 2020 Smog Check Performance Report, Bureau of Automotive Repair, July 1, 2020. 2020 Smog Check Performance Report (ca.gov)

because these OBD-equipped vehicles would be subject to a more frequent inspection testing interval (quarterly for OBD-equipped vehicles vs. biannual for non-OBD vehicles) and require a more robust inspection procedure. Staff assumed a non-compliant vehicle identification rate of 82 percent for heavy-duty OBD-equipped vehicles.

Starting in 2026, staff assumed an increase in non-compliant vehicle identification rate of 10 percent from the estimated rates in 2024 and 2025 due to the improvement in CARB's fraud detection of the submitted test data, and expansion of PEAQS/RSD network throughout the State. Therefore, estimated non-compliant vehicle identification rates of 80 and 92 percent are used for non-OBD vehicles and OBD-equipped vehicles, respectively.

Table C-21 summarizes staff's estimated incremental percentage of non-compliant vehicles that could be identified by CARB under the Proposed Regulation (parameter B) over different years.

Table C- 21: Estimated Percentage of Non-Compliant Vehicles Identified under the Proposed Regulation

Calendar Year	Non-Compliance Identification Rate for Heavy-Duty Non-OBD Vehicles	Non-Compliance Identification Rate for Heavy-Duty OBD-Equipped Vehicles
2023	21%	21%
2024-2025	70%	82%
2026 and later	80%	92%

Parameter C – Percentage of Repaired Identified Non-Compliant Vehicles

Staff does not expect all identified non-compliant vehicles would result in repairs as evidenced in the 2019 CARB's enforcement citation data which shows that only a percentage of issued HDVIP citations are resolved by vehicle owners.[95] The HDVIP citation data indicates that currently 74 percent of in-state vehicles and 36 percent of OOS vehicles that received a non-compliance citation actually resolve the issue at hand.[96] Unresolved citations are an indication that either a vehicle owner ignored a citation and did not repair their vehicle, whereby CARB can retroactively block vehicle registration, or that the vehicle is no longer operated in California due to being sold out of State or retired. Vehicles retired from use or sold out of state can effectively be considered the same as a vehicle repair as they would no longer be operating in California in a non-compliant state. When accounting for these additional variables, staff projected that the percentage of identified non-compliant vehicles that would effectively get repaired would be 90 percent for in-state vehicles. Staff projected this rate would remain consistent throughout the implementation of the Proposed Regulation as the tie to vehicle registration is the strongest hook to ensure vehicles get repaired.

[95] (CARB, 2020c) 2019 Annual Enforcement Report, California Air Resources Board, June 2020. 2019 Annual Enforcement Report (ca.gov)

[96] Note that OOS vehicles' resolved citation rate is just about half of in-state vehicles'

For OOS vehicles, staff projected 45 percent of identified non-compliant vehicles would get repaired in 2023, consistent with current HDVIP citation data that suggests enforcement efforts are about half as effective for OOS vehicles as for in-state vehicles. As enhanced enforcement efforts take effect in the subsequent phases of the Proposed Regulation implementation, it is expected that enforcement effectiveness for the OOS vehicle population would improve. Thus, starting in 2024, staff projected an increase in OOS vehicle repair percentage to 68 percent.[97]

Table C-22 summarizes staff's estimated percentage of identified non-compliant vehicles that would get repaired under the Proposed Regulation (parameter C) over different years.

Table C- 22: Estimated Percentage of Identified Non-Compliant Vehicles that would Get Repaired under the Proposed Regulation

Calendar Year	In-state Vehicles	OOS Vehicles
2023	90%	45%
2024 and later	90%	68%

Additional HD I/M Vehicle Repair Assumptions

In 2023, the statewide HD I/M vehicle repair rate is the product of the discussed parameters A, B, and C. Similarly, in 2024 and later, the statewide HD I/M vehicle repair rate is the product of the corresponding parameter A, B, and C values for the considered year. Parameters B and C maintain the constant values discussed above. Parameter A values (i.e., the percentage of statewide non-compliant vehicles) for 2024 and subsequent years are contingent on the number of vehicles repaired in the preceding year and incorporate the following assumptions:

- Vehicles that fail inspection tests (non-compliant vehicles) but were not repaired in the previous years would continue to fail the inspection tests in the subsequent years.
- A certain percentage of vehicles that do not fail inspection tests in the previous years would fail in the subsequent year due to natural vehicle degradation.
- A certain percentage of vehicles that get repaired in previous years would fail in the following years due to non-durable vehicle repairs. Staff estimated the annual rate of re-fails using MacKay & Company's (or MacKay) national survey data on heavy-duty vehicle and engine component replacement intervals.[98] Staff assumed that MacKay's projected replacement mileage for emissions related components was equivalent to the longevity of a repair, thus analogous to the component's average durability lifetime. For each of the repair parts or groups identified in Tables C-19 and C-20, staff determined the corresponding per part average replacement mileage based on the survey results provided by MacKay. Staff then converted the average replacement mileage to the equivalent number of replacement years based on EMFAC-modeled

[97] Average of 45 percent OOS repair in 2023 and annual 90 percent in-state vehicle repair for 68 percent OOS repair in 2024 and later.
[98] (MacKay, 2019) MacKay & Company Data on Heavy-Duty Engine Rebuilds and Replacements, MacKay & Company, 2019.

average annual mileage accumulation. Finally, staff weighted the per part replacement intervals to determine an average annual re-fail rate of repaired vehicles of 14.4 and 9.07 percent for non-OBD and OBD-equipped vehicle repairs, respectively (see Table C-23).

Table C- 23: Estimated Annual Re-Fail Rates of Repaired Heavy-Duty Vehicles

Repair Parts	Average Replacement Mileage (mile)	Average Replacement Year (year)	Repair Distribution	Average Annual Re-fail Rate
Heavy-Duty Non-OBD Vehicles[99]				**14.4%**
Upstream Engine Part	181,743	5.61	62%	
DPF	153,848	4.75	100%	
Heavy-Duty OBD-Equipped Vehicles				**9.07%**
Boost Control	175,911	5.43	10.85%	
EGR	301,387	9.31	11.68%	
Fuel System Monitoring	184,119	5.69	15.95%	
NOx Sensor	236,028	7.29	14.86%	
PM Filter	106,638	3.29	11.75%	
PM Filter Frequent Regeneration	166,898	5.15	1.58%	
Reductant Delivery	167,047	5.16	19.45%	
SCR Catalyst	87,387	2.70	13.88%	

Based on the calculated annual HD I/M repair rates and statewide heavy-duty vehicle population, staff estimated the incremental number of repairs due to the Proposed Regulation as shown in Table C-24. Subsequently, staff subtracted out vehicle repairs that would occur while the vehicle was projected to still be under warranty. This is because these repairs would be covered by the manufacturer and come at no cost to the vehicle owner and are already accounted for as part of the baseline for the Proposed Regulation's cost analysis. Specifically, warranty amendments recently adopted by the Board in 2018 lengthened warranty periods for 2022 and subsequent MY heavy-duty vehicles and engines and linked heavy-duty warranty coverage with heavy-duty OBD MIL illumination for these MY vehicles and engines.[100] Hence, staff estimated the percentage of 2022 and subsequent MY heavy-duty vehicle repairs that would still be under the warranty period in each year from 2023 through 2037 using EMFAC's projected in-state heavy-duty vehicle population. Staff then subtracted these repairs from the estimated total number of vehicle repairs estimated as part of this program (Table C-24) to determine the final number of vehicle repairs resulting in incremental repair costs attributed to this Proposed Regulation (Table C-25).

[99] Heavy-duty non-OBD repair would include a DPF replacement and 62 percent of the time, there would also be an upstream engine part repair. Staff conservatively used the higher re-fail rate of upstream engine part repair for the overall heavy-duty non-OBD repair's re-fail rate.

[100] See Section A.1.c. for further description of heavy-duty vehicle and engine warranty standards.

As shown in Table C-24 and Table C-25, the number of vehicle repairs are highest in 2024 during the initial implementation of the periodic testing requirement. The Proposed Regulation would reduce the number of non-compliant vehicles on the road over time, hence resulting in a reduced number of annual vehicle repairs observed starting in 2025. In addition, the older non-OBD vehicles would eventually be retired and replaced due to natural turnover to newer OBD-equipped vehicles over time, thus the observed decline in non-OBD vehicle repairs from 2025 through 2037. The observed gradual increase in the number of repairs for OBD-equipped vehicles starting in 2031 reflects the natural growth in number of newer OBD-equipped vehicles on the road over time.

Table C- 24: Estimated Statewide Incremental Number of Heavy-Duty Vehicle Repair under the Proposed Regulation from 2023 through 2037

Calendar Year	Heavy-Duty Non-OBD Vehicle Repairs	Heavy-Duty OBD-Equipped Vehicle Repairs	Total Vehicle Repairs
2023	2,764	18,037	20,801
2024	7,633	76,821	84,454
2025	3,739	35,001	38,739
2026	2,784	24,288	27,072
2027	2,006	17,550	19,556
2028	1,690	15,792	17,481
2029	1,494	15,367	16,861
2030	1,336	15,311	16,647
2031	1,199	15,314	16,513
2032	1,071	15,548	16,619
2033	949	15,786	16,734
2034	835	16,015	16,850
2035	731	16,261	16,992
2036	641	16,496	17,136
2037	561	16,738	17,300

Table C- 25: Estimated Statewide Incremental Number of Heavy-Duty Vehicle Repair Resulting in Incremental Repair Costs Attributed to the Proposed Regulation from 2023 through 2037

Calendar Year	Heavy-Duty Non-OBD Vehicle Repairs	Heavy-Duty OBD-Equipped Vehicle Repairs	Total Vehicle Repairs
2023	2,764	17,208	19,973
2024	7,633	71,832	79,465
2025	3,739	32,235	35,973
2026	2,784	21,875	24,659
2027	2,006	15,804	17,810
2028	1,690	14,132	15,821
2029	1,494	13,815	15,308

Calendar Year	Heavy-Duty Non-OBD Vehicle Repairs	Heavy-Duty OBD-Equipped Vehicle Repairs	Total Vehicle Repairs
2030	1,336	13,862	15,199
2031	1,199	13,966	15,165
2032	1,071	14,268	15,339
2033	949	14,557	15,505
2034	835	14,817	15,652
2035	731	15,098	15,829
2036	641	15,348	15,989
2037	561	15,592	16,153

iii. Statewide Repair Costs

The statewide repair costs were calculated by multiplying the estimated incremental statewide heavy-duty vehicle repairs presented in Table C-25 with the estimated costs per vehicle repair presented in Table C-19 and C-20 above. Table C-26 summarizes the incremental statewide repair costs for affected heavy-duty vehicles from 2023 through 2037. The repair costs are highest in 2024 ($181M) during the initial implementation of periodic testing. The costs decline substantially over time as the equilibrium rate of non-compliant vehicles would be reduced due to the Proposed Regulation.

Table C- 26: Statewide Incremental Heavy-Duty Vehicle Repair Costs under the Proposed Regulation from 2023 to 2037[101]

Calendar Year	Heavy-Duty Non-OBD Vehicle Repair Costs	Heavy-Duty OBD-Equipped Vehicle Repair Costs	Statewide Repair Costs
2023	$14,269,000	$34,028,000	48,297,000
2024	$39,399,000	$142,042,000	181,441,000
2025	$19,298,000	$63,742,000	83,040,000
2026	$14,371,000	$43,256,000	57,627,000
2027	$10,355,000	$31,250,000	41,605,000
2028	$8,722,000	$27,944,000	36,666,000
2029	$7,710,000	$27,317,000	35,027,000
2030	$6,898,000	$27,411,000	34,309,000
2031	$6,187,000	$27,617,000	33,804,000
2032	$5,529,000	$28,214,000	33,743,000
2033	$4,897,000	$28,784,000	33,681,000
2034	$4,310,000	$29,299,000	33,609,000
2035	$3,775,000	$29,854,000	33,629,000
2036	$3,308,000	$30,349,000	33,657,000
2037	$2,897,000	$30,832,000	33,729,000
Total	**$151,926,000**	**$601,939,000**	**$753,865,000**

[101] Costs were rounded to the nearest thousand.

f. Freight Contractors' Verification of Vehicle Compliance

The proposed Freight Contractor requirements under the Proposed Regulation would be the same as those required under current in-use diesel fleet regulations. Under CARB's existing Truck and Bus Regulation,[102] freight contractors are already required to verify that each hired company is in compliance with the regulation by obtaining a copy of a CARB-issued annual fleet compliance certificate. The Proposed Regulation would impose the same requirement; hence, fleets would simply have to attach an additional certificate showing HD I/M compliance to the documentation they already provide to freight contractors to meet the current Truck and Bus Rule regulation. Therefore, costs associated with such a requirement under the Proposed Regulation are considered negligible.

Furthermore, the proposed compliance verification requirements for port and intermodal railyard freight facilities are identical to the requirements under the current In-Use On-Road Diesel-Fueled Heavy-Duty Drayage Trucks regulation.[103] As such, these facilities already have existing methods to verify compliance and would not have to change processes to meet the requirements for the Proposed Regulation. For example, facilities would also check for vehicle HD I/M compliance while checking the vehicle compliance with the existing Drayage Truck regulation, which would be one additional certificate showing HD I/M compliance relative to currently required checked documentation. Hence, any potential costs associated with this proposed requirement are also negligible.

Finally, under the existing in-use diesel regulations for heavy-duty vehicles,[104] vehicle owners are currently required to maintain documentation regarding compliance, vehicle information, and documentation about parties who hire or dispatch the vehicle. The Proposed Regulation would require the same type of documentation from vehicle owners, hence would not impose additional costs on vehicle owners. Therefore, the proposed freight contractor requirements are not expected to pose any significant additional costs on the regulated community.

g. Total Costs

The total incremental costs of the Proposed Regulation, including reporting costs, vehicle testing costs, tester training costs, compliance certification fee, and heavy-duty vehicle repair costs, are summarized in Table C-27. The Proposed Regulation is projected to cost $2.09B

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[102] (CARB, 2019) Truck and Bus Regulation- How to Verify if Hired Fleets Comply, California Air Resource Board, last updated June 27, 2019. Truck and Bus Regulation - How to verify if hired fleets comply (ca.gov)

[103] (CARB, 2007) Regulation to Control Emissions from In-Use On-Road Diesel-Fueled Heavy-Duty Drayage Trucks, California Air Resources Board, 2007. finregoal (ca.gov)

[104] (CARB, 2012) Airborne Toxic Control Measure for In-Use Diesel-Fueled Transport Refrigeration Units (TRU) and TRU Generator Sets, and Facilities Where TRUs Operate, California Air Resources Board, October 2012. Final Regulation Order ATCM for In-Use Diesel-Fueled TRUs and TRU Gen Sets and Facilities where TRUS Operate (ca.gov)

(CARB, 2007) Regulation to Control Emissions from In-Use On-Road Diesel-Fueled Heavy-Duty Drayage Trucks, California Air Resources Board, 2007. finregoal (ca.gov)

(CARB, 2014) Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use Heavy-Duty Diesel-Fueled Vehicles, California Air Resources Board, December 2014. Truck & Bus Regulation Language (ca.gov)

over 2023-2037 period, with a maximum annual cost of $332M in 2024. As shown in Figure C-2, the majority of the costs stem from heavy-duty vehicle testing, repairs and compliance fee costs.[105] The cost effectiveness of the Proposed Regulation is about $83.62/pound PM and $1.89/pound NOx, which is well within the range of previous CARB regulations.[106]

[105] The compliance certificate fee will be used to support the State costs to implement and enforce the Proposed Regulation as further discussed in section D.2.

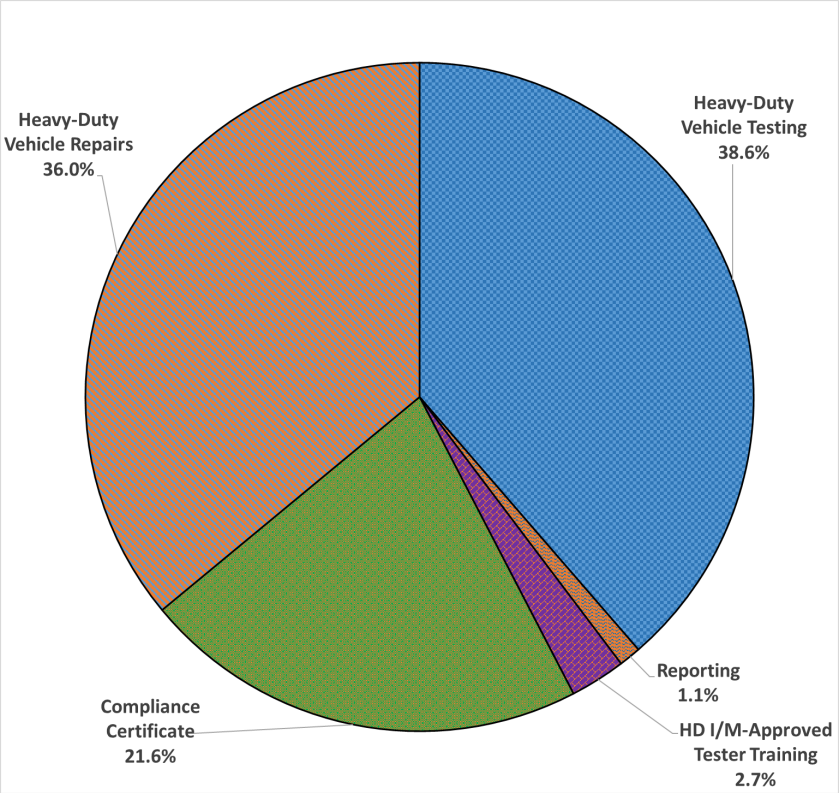
[106] Cost effectiveness = [Net Costs]/[Pound Emission Reduction]. Net Costs = [Total Costs] – [Cost Savings]. Staff attributed net costs to PM and NOx emission reduction based on the resulted PM and NOx repair cost ratios.

Table C- 27: Total Estimated Direct Incremental Costs Relative to the Baseline of the Proposed Regulation from 2023 through 2037[107]

Calendar Year	Reporting	Vehicle Testing	HD I/M-Approved Tester Training	Compliance Certificate	Heavy-Duty Vehicle Repairs	**Total Costs**
2023	$3,324,000	$2,541,000	$5,889,000	$23,765,000	$48,297,000	**$83,816,000**
2024	$2,419,000	$116,803,000	$3,203,000	$28,102,000	$181,441,000	**$331,969,000**
2025	$2,199,000	$62,412,000	$3,321,000	$28,740,000	$83,040,000	**$179,712,000**
2026	$2,001,000	$60,357,000	$3,419,000	$29,309,000	$57,627,000	**$152,713,000**
2027	$1,815,000	$58,525,000	$3,508,000	$29,807,000	$41,605,000	**$135,260,000**
2028	$1,635,000	$56,741,000	$3,579,000	$30,214,000	$36,666,000	**$128,835,000**
2029	$1,468,000	$54,991,000	$3,626,000	$30,526,000	$35,027,000	**$125,638,000**
2030	$1,316,000	$53,268,000	$3,649,000	$30,740,000	$34,309,000	**$123,282,000**
2031	$1,194,000	$52,120,000	$3,685,000	$31,011,000	$33,804,000	**$121,813,000**
2032	$1,072,000	$50,930,000	$3,702,000	$31,256,000	$33,743,000	**$120,703,000**
2033	$953,000	$49,850,000	$3,718,000	$31,471,000	$33,681,000	**$119,674,000**
2034	$846,000	$48,856,000	$3,725,000	$31,675,000	$33,609,000	**$118,710,000**
2035	$744,000	$47,809,000	$3,714,000	$31,830,000	$33,629,000	**$117,726,000**
2036	$663,000	$47,194,000	$3,717,000	$32,026,000	$33,657,000	**$117,256,000**
2037	$592,000	$46,700,000	$3,716,000	$32,255,000	$33,729,000	**$116,992,000**
Total	**$22,240,000**	**$809,095,000**	**$56,171,000**	**$452,727,000**	**$753,865,000**	**$2,094,099,000**

[107] Costs were rounded to the nearest thousand.

Figure C- 2: Relative Share of Costs for the Proposed Regulation



2. Direct Costs on Typical Businesses

Direct costs on a business would depend on the affected business' fleet size and vehicle makeup. Staff defines fleets of three or fewer vehicles as small businesses whose direct cost impact will be discussed subsequently in subsection 3. Based on 2018 DMV vehicle registration data, for heavy-duty fleets of more than three vehicles, most of impacted fleets under the Proposed Regulation have between four to ten vehicles (about 75 percent of fleets that have more than three vehicles). Hence, staff estimated the direct costs on a typical business to be the costs on a California fleet of seven vehicles.[108]

Based on EMFAC's projected vehicle population in 2024, about 82 percent of the vehicle population consists of OBD equipped vehicles, while 18 percent of the projected vehicle population consists of non-OBD vehicles. Thus, for the analysis of typical fleet costs, staff estimates six out of the fleet's seven vehicles are OBD equipped; whereas one of their vehicles are non-OBD vehicles. The typical fleet owner would incur the following costs in 2024, the year that fleets would incur highest costs:

- Reporting costs for reporting vehicle information of seven vehicles and vehicle smoke opacity testing and visual inspection results of one non-OBD vehicle,
- Vehicle testing costs for hiring a third-party HD I/M-approved tester to perform additional periodic smoke opacity and visual inspections on one non-OBD vehicles, as

[108] Average of 4 vehicles and 10 vehicles for a typical fleet of 7 vehicles

well as the one-time purchase of a CARB-certified OBD testing device and testing labor for periodic OBD testing on six OBD-equipped vehicles,
- Training costs for having one employee become a HD I/M-approved tester training to perform OBD testing,
- Compliance certificate fee for seven vehicles, and
- Vehicle repair costs. Note that the fleet owner would only incur vehicle repair costs if their vehicles do not pass the proposed inspection test due to broken vehicle emission control systems. Staff estimated the vehicle repair costs based on the estimated HD I/M vehicle repair rates in 2024 (the year that has highest number of vehicle repairs).

The costs calculation followed the same cost methodology and assumptions as discussed in subsection 1. above. As shown in Table C-28, direct costs on a typical fleet of seven heavy-duty vehicles are $2,104, which is expected to be minimal compared to normal revenues during the course of the Proposed Regulation. The majority of costs on typical fleets would stem from the needed vehicle repair (60 percent of the total costs), which fleet owners only incur if their vehicles do not pass the proposed inspection and required repair.

Table C- 28: Estimated Direct Costs on a Typical Fleet of Seven Heavy-Duty Vehicles

Reporting Costs	Vehicle Testing Costs	HD I/M Approved Tester Training Costs	Compliance Certificate Fee	Heavy-Duty Vehicle Repair Costs[109]	**Total Costs**
$32	$577	$34	$210	$1,252	**$2,104**

3. Direct Costs on Small Businesses

As mentioned above, small businesses are defined as heavy-duty fleets of three or fewer vehicles. Based on 2018 DMV vehicle registration data, these small businesses represent about 89 percent of fleets in California, however, only 44 percent of the vehicle population. Among the California small businesses, single-vehicle fleets are the largest groups, 79 percent of the small businesses; hence, staff estimated the direct costs on a small business to be the costs on a single-vehicle fleet.

For a single heavy-duty non-OBD vehicle fleet, the owner would incur the following costs in 2024, the year that fleets would incur highest costs:

- Reporting costs for reporting vehicle information and vehicle smoke opacity testing and visual inspection results of one vehicle,
- Vehicle testing costs for two smoke opacity tests and visual inspections performed by a third-party HD I/M-approved tester,

[109] Based on repair rate discussion in Section C.1.e., staff estimated there is a 4.1% chance a non-OBD vehicle requires repair, an 8.76% chance an OBD-equipped vehicle requires repair, that each non-OBD repair costs on average $5,162 as shown above in Table C-19, and that each OBD equipped vehicle repair costs on average $1,977 as shown in Table C-20. Hence, Heavy-duty vehicle repair cost = [6 OBD-equipped vehicles] x [8.76% OBD-repair probability] x [$1,977/OBD-vehicle repair] + [1 non-OBD vehicle] x [4.10% non-OBD repair probability] x [$5,162/non-OBD repair] = $1,252

- Compliance certificate fee for one vehicle, and
- Vehicle repair costs for the given vehicle. Note that the majority of vehicles subject to the proposed HD I/M program would not need to repair their vehicle to comply with the Proposed Regulation. Staff estimated the vehicle repair costs based on the estimated HD I/M vehicle repair rates in 2024 (the year that has highest number of vehicle repairs).

The costs calculation followed the same cost methodology and assumptions as discussed in subsection 1. above. As shown in Table C-29, direct costs on a single heavy-duty non-OBD vehicle fleet are $523, which is expected to be minimal compared to normal revenues during the course of the Proposed Regulation.

Table C- 29: Estimated Direct Costs on a Small Fleet of One Heavy-Duty Non-OBD Vehicle

Reporting Costs	Vehicle Testing Costs	Compliance Certificate Fee	Heavy-Duty Vehicle Repair Costs[110]	**Total Costs**
$14	$267	$30	$212	**$523**

For a single heavy-duty OBD-equipped vehicle fleet, the owner would incur the following costs in 2024, the year that fleets would incur highest costs:

- Reporting costs for reporting vehicle information of one vehicle,
- Vehicle testing costs for one-time purchasing a CARB-certified OBD testing device and testing labor for periodic OBD data submission,
- Training costs for completing the proposed HD I/M-approved tester training to perform OBD testing,
- Compliance certificate fee for one vehicle, and
- Vehicle repair costs. Again, note that the majority of vehicles subject to the proposed HD I/M program would not need to repair their vehicle to get into compliance with the Proposed Regulation; staff estimated the vehicle repair costs based on the estimated HD I/M vehicle repair rates in 2024 (the year that has highest number of vehicle repairs).

The cost calculation followed the same cost methodology and assumptions as discussed in subsection 1. above. As shown in Table C-30, direct costs on a single heavy-duty OBD-equipped vehicle fleet are $646, which is expected to be minimal compared to normal revenues during the course of the Proposed Regulation.

[110] Based on repair rate discussion in Section C.1.e., staff estimated there is a 4.1% chance a non-OBD vehicle requires repair and that each non-OBD repair costs on average $5,162 as shown above in Table C-19. Hence, Heavy-duty vehicle repair cost/non-OBD vehicle = [4.10% non-OBD repair probability] x [$5,162/non-OBD repair] = $212

Table C- 30: Estimated Direct Costs on a Small Fleet of One Heavy-Duty OBD-Equipped Vehicle

Reporting Costs	Periodic Inspection Costs	Tester Training Costs	Compliance Certificate Fee	Heavy-Duty Vehicle Repair Costs[111]	**Total Costs**
$3	$406	$34	$30	$173	**$646**

4. Direct Costs on Individuals

There are no direct costs to individuals as a result of this Proposed Regulation. Individuals may see health benefits as described in Section B.4.a above due to emissions reduction resulted from the decrease in non-compliant vehicles driven on the road under the Proposed Regulation. Staff estimates that fleets would see increased costs as a result of the Proposed Regulation and would likely pass the costs to individuals in the State (for example, customers of trucking firms). Individuals may see indirect and induced benefits and costs; these costs are discussed further in Section E. Macroeconomic Impacts.

D. FISCAL IMPACTS

1. Local Government

The Proposed Regulation would have cost impacts on local government fleets that own non-gasoline combustion heavy-duty vehicles because they would be subject to the same proposed requirements as other private entities operating in California. Based on EMFAC-modeled vehicle population, the local government fleets are estimated to make up about 6.69 percent of the total affected heavy-duty vehicles operating in California. The same proportion of total costs presented in Table C-27 are assumed to be incurred by local government fleets. The total incremental costs on local government fleets from 2023 through 2037 would be $140M, as shown in Table D-1. In addition to costs, local government fleets would also have cost savings from the avoided smoke opacity testing need on their OBD-equipped vehicles, as discussed in Section B. Benefits. Staff applied the same 6.69 percent local government fleets' vehicles proportion to the total cost savings presented in Table B-3 for the estimated cost savings on local government fleets. The total cost savings for local government fleets from 2023 through 2037 would be $28M, as shown in Table D-1. The net fiscal impact on local government fleets in 2023 would be a cost of $6M; and the ongoing net fiscal impact on local government fleets would range from $6M to $21M per year in cost within the Proposed Regulation's lifetime of 15 years (i.e., from 2023 to 2037).

[111] Based on repair rate discussion in Section C.1.e., staff estimated there is an 8.76% chance an OBD-equipped vehicle requires repair and that each OBD-equipped vehicle repair costs on average $1,977 as shown in Table C-20. Heavy-duty vehicle repair cost = [1 OBD-equipped vehicles] x [8.76% OBD-repair probability] x [$1,977/OBD-vehicle repair] = $173

Table D- 1: Fiscal Impact on Local Government Fleets under the Proposed Regulation from 2023 through 2037[112]

Calendar Year	Incremental Costs	Cost Savings	Net Costs
2023	$5,607,000	$0	$5,607,000
2024	$22,207,000	$1,653,000	$20,555,000
2025	$12,022,000	$1,749,000	$10,273,000
2026	$10,216,000	$1,837,000	$8,379,000
2027	$9,048,000	$1,916,000	$7,133,000
2028	$8,619,000	$1,983,000	$6,635,000
2029	$8,405,000	$2,036,000	$6,368,000
2030	$8,247,000	$2,075,000	$6,172,000
2031	$8,149,000	$2,110,000	$6,039,000
2032	$8,075,000	$2,137,000	$5,938,000
2033	$8,006,000	$2,157,000	$5,848,000
2034	$7,941,000	$2,172,000	$5,769,000
2035	$7,875,000	$2,181,000	$5,694,000
2036	$7,844,000	$2,187,000	$5,657,000
2037	$7,826,000	$2,192,000	$5,635,000
Total	**$140,087,000**	**$28,384,000**	**$111,703,000**

Local Sales Tax Revenue

Sales taxes are levied in California to fund a variety of programs at the State and local level. The Proposed Regulation would increase testing devices, engine parts, and vehicle parts sale due to the projected increasing vehicle testing and repair demand, which would result in a direct increase in sales tax revenue collected by local governments. Table D-2 summarizes staff estimated local sales tax revenues from 2023 through 2037 as a result of the Proposed Regulation.

Table D- 2: Projected Local Sales Tax Revenues due to the Proposed Regulation

Calendar Year	Local Sales Tax Revenue
2023	$1,633,000
2024	$8,464,000
2025	$3,780,000
2026	$3,224,000
2027	$2,885,000
2028	$2,797,000
2029	$2,776,000
2030	$2,769,000
2031	$2,784,000

[112] Costs were rounded to the nearest thousand.

Calendar Year	Local Sales Tax Revenue
2032	$2,801,000
2033	$2,819,000
2034	$2,835,000
2035	$2,846,000
2036	$2,869,000
2037	$2,893,000
Total	**$48,175,000**

2. State Government

The Proposed Regulation would impose incremental costs to State government, which include:

- Costs on State government fleets that own heavy-duty non-gasoline combustion vehicles to comply with the Proposed Regulation, and
- Costs on State agencies to implement and enforce the Proposed Regulation.

Subsections a. and b. below describe each of the listed costs on State government above in further detail. Subsection c. discusses State sales tax revenue as a result of the Proposed Regulation.

a. State Government Fleets – Compliance Costs

To estimate costs on State government fleets that own heavy-duty non-gasoline combustion vehicles, staff followed the same cost calculation methodology discussed in Section D.1. for local government fleets. Similar to local government fleets, State government fleets would incur costs to have their vehicles comply with the Proposed Regulation and cost savings from the avoided smoke opacity testing need on their OBD-equipped vehicles. State government fleets are estimated to make up about 2.23 percent of the total affected heavy-duty vehicles operating in California. Staff applied the same 2.23 percent to the total costs presented in Table C-27 and the total cost savings presented in Table B-3 for the estimated costs and cost savings incurred by State government fleets from 2023 through 2037, as shown in Table D-3. The net fiscal impact on State government fleets in 2023 would be a cost of $1.87M; and the ongoing net fiscal impact on State government fleets would range from $1.88M to $6.85M per year in cost within the Proposed Regulation's lifetime of 15 years (i.e., from 2023 to 2037).

Table D- 3: Fiscal Impact on State Government Fleets under the Proposed Regulation from 2023 through 2037[113]

Calendar Year	Incremental Costs	Cost Savings	Net Costs
2023	$1,869,000	$0	$1,869,000

[113] Costs were rounded to the nearest thousand.

Calendar Year	Incremental Costs	Cost Savings	Net Costs
2024	$7,402,000	$551,000	$6,852,000
2025	$4,007,000	$583,000	$3,424,000
2026	$3,405,000	$612,000	$2,793,000
2027	$3,016,000	$639,000	$2,378,000
2028	$2,873,000	$661,000	$2,212,000
2029	$2,802,000	$679,000	$2,123,000
2030	$2,749,000	$692,000	$2,057,000
2031	$2,716,000	$703,000	$2,013,000
2032	$2,692,000	$712,000	$1,979,000
2033	$2,669,000	$719,000	$1,949,000
2034	$2,647,000	$724,000	$1,923,000
2035	$2,625,000	$727,000	$1,898,000
2036	$2,615,000	$729,000	$1,886,000
2037	$2,609,000	$731,000	$1,878,000
Total	**$46,696,000**	**$9,461,000**	**$37,234,000**

b. State Agencies - Implementation and Enforcement Costs

Under SB 210, the HD I/M program compliance certification fee collected on the affected heavy-duty vehicles (as described in Section C.1.d above) will be used to fund activities by State agencies to implement and enforce the Proposed Regulation. CARB is still working with other State agencies and vendors to ensure implementation costs fall within the allowable HD I/M compliance certificate fee fund. For the purpose of this cost assessment, staff has conservatively used a compliance certificate fee of $30 per affected vehicle per year as discussed in Section C.1.d to estimate all potential State implementation and enforcement costs. This is to ensure these State administration costs are covered, even though there is a possibility that the compliance fee could be lower than $30.

As shown in Table C-18, the Statewide implementation and enforcement costs could average up to $30M per year, with a total statewide cost of $453M from 2023 through 2037. These costs would be offset by the collection of the compliance certification fee.

The following subsections provide details CARB staffing resources to implement and enforce the program, as well as descriptions of contracts and actions by other State agencies that will be needed to implement and enforce the Proposed Regulation, and that would also be covered by the compliance certification fee.

i. CARB

<u>Staffing Resources</u>

California Department of Finance (DOF) approved CARB's request of 4.0 positions (1.0 Air Resources Supervisor (ARS) I and 3.0 Air Resources Engineers (ARE)) in fiscal year (FY) 2020-2021 to support the development of the Proposed Regulation. These positions will continue supporting the implementation of the Proposed Regulation once it takes effect starting in 2023.

CARB would need an additional 33.0 positions (1.0 SAPS, 4.0 AREs, 8.0 Air Pollution Specialists (APS), 8.0 Air Resources Technician (ART) IIs, 1.0 Information Technology Manager (ITM) II, 6.0 Information Technology Specialist (ITS) Is, 2.0 ITS IIIs, 2.0 Associate Governmental Program Analysts (AGPA), and 1.0 Attorney III) starting in 2022-2023 FY in order to effectively implement and enforce the Proposed Regulation. The staffing needs are described further below:

- 2.0 AGPA positions are requested to provide support for the Proposed Regulation implementation contracting[114] efforts. For example, duties could include serving as a liaison between program staff, contractors, legal, and control agencies, advising program staff on the most efficient and effective methods to obtain the contracting services needed, as well as reviewing and releasing contracting bids/proposals, coordinating evaluations of incoming proposals, and assisting with post-award issues and disputes.
- 1.0 APS, 1.0 ITM II, 6.0 ITS II, and 2.0 ITS III positions are requested to support the implementation of the CARB's HD I/M database system. The APS position would help develop data standardization, data security and data transfer protocols from the contractor to CARB. The ITM II, ITS II, and ITS III positions are needed for the overall design, implementation of the hosting environment for the HD I/M system. This system would need to be designed for high availability, performance within CARB's cloud environments. The Information Technology (IT) team would ensure that all security measures are met for security compliance and handling of sensitive data that resides in the system. The requested positions cover IT management for this effort to coordinate with the potential operational vendor and highly skilled staff available to support the hosting environment and implement system changes as needed.
- 2.0 ARE positions are requested to support the implementation of the proposed OBD testing device certification requirements, to help manage the activities of the heavy-duty implementation contractor, and to help combat fraud.
- 3.0 APS and 3.0 ART II positions are requested to be added to the call center to support additional call volumes as the proposed HD I/M program would affect more vehicles than the Truck and Bus Rule (approximately more than one million vehicles would be affected by the proposed program). Call volumes are expected to increase significantly.
- 1.0 APS position is requested for HD I/M related outreach efforts. Because the proposed HD I/M program impacts all vehicles entering California, it will be critical to constantly outreach not only to stakeholders within the State of California itself, but also OOS fleets whose vehicles may operate in California.
- 1.0 ARE, 2.0 APS, and 5.0 ART II positions are requested to help support the enforcement of HD I/M program via physical roadside emissions monitoring systems and data science, software development, and enforcement support.
- 1.0 SAPS and 1.0 ARE positions are requested to perform data analysis of incoming vehicle data, including performing quality assurance/quality control on vehicle emissions data collected from PEAQSs, analyzing submitted test data for any

[114] See following subsection for detailed discussion on implementation contractor

suspicious or fraudulent data submission activity, and assessing vehicle compliance based on the submitted vehicle data.

- 1.0 APS position is requested to support emissions assessments and modeling efforts. Such efforts are needed to determine emissions benefits and program validation of the HD I/M program to ensure the program is as effective at reducing emissions as possible.
- The requested 1.0 Attorney III position would help support establishing cases to prosecute potential fraudulent activity, support increased citation activity, and provide legal support related to staff's interaction and management of the implementation contractor.

Table D-4 summarizes the phase-in and costs of the approved and requested positions to support the Proposed Regulation implementation as discussed above.

Table D- 4: CARB Positions for the Proposed Regulation Implementation

Positions	FY 2020-2021	FY 2021-2022	FY 2022-2023	FY 2023-2024 and later
ARS I	1.0*	1.0*	1.0	1.0
ART II			8.0	8.0
ARE	3.0*	3.0*	7.0	7.0
APS			8.0	8.0
SAPS			1.0	1.0
AGPA			2.0	2.0
ITM II			1.0	1.0
ITS II			6.0	6.0
ITS III			2.0	2.0
Attorney III			1.0	1.0
Total Positions	**4.0***	**4.0***	**37.0**	**37.0**
Total Costs	**$856,000**	**$852,000**	**$6,566,000**	**$6,533,000**

*: positions were approved by DOF

PEAQS Deployment

To support CARB's deployment of PEAQS for roadside emissions monitoring, CARB would need a $180,000 in one-time equipment cost for remote sensing equipment for three high-emitter screening PEAQSs in FY 2022-2023. The PEAQS units cost $60,000 per system and would enable CARB to measure vehicle emissions under real world conditions. These systems will be used as a primary screening tool to identify vehicles with high amounts of emissions and require timely repairs, enhancing the success of the program.

Implementation Contractor

To support implementation of the Proposed Regulation, a third-party implementation contractor will be hired to develop the CARB's HD I/M database system and run the day-to-day operations once the HD I/M program is implemented. Staff is still in the process of developing the implementation contractor's duty requirements and working with vendors to

ensure the compliance certification fee would be adequate to pay for the implementation contract as well as to fund State agency implementation activities.

In general, the hired implementation contractor would be tasked with the following:

- Develop the HD I/M Database system,
- Perform maintenance & operation (M&O) of the database system,
- Establish and operate call center operations for the HD I/M Program,
- Institute a referee testing network for the HD I/M Program,
- Establish a statewide network of OBD testing quick stop locations,
- Procure testing devices for the referee network and physical testing network, and
- Conduct fraud detection based on submitted test data.

Funds to pay for the implementation contractor would be covered with the annual per vehicle compliance fee, conservatively estimated to be $30 per affected vehicle per year.

HD I/M Database development

The HD I/M database system will be a platform for receiving and managing incoming and outgoing vehicle test data and compliance information. The database system would receive incoming vehicle test data from various sources and assess the compliance status of each vehicle within the program. Additionally, the database system would establish specific user portals where vehicle owners, fleet representatives, and testers can log in, view, report vehicle testing information related to compliance status with the HD I/M program, as well as pay the vehicle compliance certificate fee. Finally, the database system would communicate vehicle compliance status to the DMV's vehicle registration database system to automatically block vehicle's DMV registration renewal for non-compliant vehicles.

M&O of the HD I/M Database system

In addition to building the HD I/M database system, the implementation contractor would maintain the system and ensure the system is operational at all times, while providing necessary support to keep the system functioning up to its required capabilities.

Establish and operate call center operations for the HD I/M Program

The implementation contractor would handle day-to-day call center operations to support the needs of the HD I/M program by assisting stakeholders with HD I/M program related questions and troubleshooting needs. The implementation contractor call center would be expected to handle the majority of stakeholder interaction with respect to the HD I/M program; however, complex and out of the ordinary situations would be referred to CARB staff for further follow up.

Institute a referee testing network for the HD I/M Program

The implementation contractor would establish a referee testing network responsible for performing vehicle inspection tests. Referee testers provide a critical backstop to ensure

vehicle compliance testing can effectively be completed when abnormalities or rare situations occur within the implementation of the proposed HD I/M program. Vehicles subject to referee testing would include vehicles suspected of fraudulent activity, frequent failing vehicles, vehicles frequently flagged by PEAQS/RSD as high emitters, vehicles with engine and/or fuel conversions, and vehicles with abnormalities that are difficult to test with the standard testing devices.

Establish a network of OBD testing quick stop locations

The contractor would establish a network of OBD testing locations spread throughout the State where vehicle owners could check out a CARB-certified OBD testing devices at a low cost to perform their compliance testing requirements. Such physical locations could include private truck stops and/or other trucking related businesses to house CARB-certified OBD testing devices.

Procure testing devices for the referee network and physical testing network

The implementation contractor would procure CARB-certified OBD testing devices for referee testing functions and to source physical testing locations throughout the State. The implementation contractor would also be responsible for ensuring the referee network has SAE 1667 approved smoke meters with the ability to electronically upload testing data results to a computer and then to the HD I/M Database system. Finally, the implementation contractor would maintain all testing devices operated by referees and used at physical testing locations and ensure any device that is damaged, tampered with, or starts malfunctioning gets taken out of service and replaced with a properly functioning device.

Fraud detection for submitted test data

Fraud detection and prevention are critical to the overall success of the HD I/M program. CARB staff envisions both the contractor and State administrative staff playing active roles in reducing fraudulent activity within the overall program.

ii. Other State Agencies

In addition to CARB, California DMV, CHP, and California Department of Transportation (Caltrans) would also help with the implementation of the Proposed Regulation, specifically:

- California DMV would coordinate with CARB for the HD I/M database system to establish in-state vehicles' HD I/M compliance status tie with California DMV vehicle registration. This would enable an automatic DMV vehicle registration block for vehicles that are non-compliant with the proposed HD I/M program.
- CHP would help inspect heavy-duty vehicles operating in California for valid HD I/M compliance certificates and vehicles' MIL status.
- Caltrans would help facilitate the installation of equipment necessary to implement the Proposed Regulation such as PEAQS/RSD systems and an ALPR network for monitoring on-road vehicles and emissions. Caltrans staff would work with CARB staff

to identify suitable locations and process encroachment permits to deploy the equipment on the State highway system.

Therefore, there would be additional resource needs from these State agencies. CARB is actively working with California DMV and CHP to determine their resource needs to ensure that the resulted costs can be covered by the available compliance certificate fees. Funds to cover these resource needs would come from the annual per vehicle compliance fee, conservatively estimated to be $30 per affected vehicle per year.

iii. HD I/M Compliance Certificate Fee Fund

As mentioned, the costs on State agencies to implement and enforce the Proposed Regulation as discussed in this subsection b. would be covered by the proposed HD I/M compliance certificate fee collected from owners of heavy-duty vehicles operating in California. CARB is still working with other State agencies and vendors to ensure implementation costs fall within the allowable HD I/M compliance certificate fee fund. Thus, for the purposes of this cost assessment, staff has conservatively used a compliance certificate fee of $30 as discussed in Section C.1.d. This is to ensure these State administration costs are covered, even though there is a possibility that the compliance fee could be lower than $30.

c. State Sales Tax Revenue

As mentioned earlier, the Proposed Regulation would increase testing devices, engine parts, and vehicle parts sale due to the projected increasing vehicle testing and repair demand, which would result in a direct increase in sales tax revenue collected by State governments. Table D-5 summarizes staff estimated State sales tax revenues from 2023 through 2037 as a result of the Proposed Regulation.

Table D- 5: Projected State Sales Tax Revenues under the Proposed Regulation

Calendar Year	State Sales Tax Revenue
2023	$1,376,000
2024	$7,131,000
2025	$3,185,000
2026	$2,716,000
2027	$2,430,000
2028	$2,355,000
2029	$2,338,000
2030	$2,331,000
2031	$2,343,000
2032	$2,357,000
2033	$2,371,000
2034	$2,385,000
2035	$2,392,000
2036	$2,411,000
2037	$2,431,000

Calendar Year	State Sales Tax Revenue
Total	$40,552,000

E. MACROECONOMIC IMPACTS

1. Methods for Determining Economic Impacts

This section describes the estimated total impact of the Proposed Regulation on the California economy. The Proposed Regulation would result in changes in expenditures by businesses to comply with its requirements. These changes in expenditures would affect employment, output, and investment in business sectors, classified by the North American Industry Classification System (NAICS), that supply goods and services in support of the trucking industry.

These impacts would lead to additional induced effects, like changes in personal income that would affect consumer expenditures across other spending categories. The incremental total economic impacts of the Proposed Regulation are simulated relative to the baseline scenario using the cost data and assumptions described in section C. The analysis focuses on the incremental changes in major macroeconomic indicators from 2023 to 2037 including employment, output, and gross state product (GSP). The years of the analysis were chosen to frame the simulation of the Proposed Regulation through 12 months post full implementation in 2025 to 2037, the final year of analysis.

CARB staff used Regional Economic Models, Inc. (REMI) Policy Insight Plus Version 2.5.0 to estimate the macroeconomic impacts of the Proposed Regulation on the California economy. REMI is a structural economic forecasting and policy analysis model that integrates input-output, computable general equilibrium, econometric and economic geography methodologies.[115] REMI Policy Insight Plus provides year-by-year estimates of the total impacts of the Proposed Regulation, pursuant to the requirements of SB 617 and the California Department of Finance. Staff used the REMI single region, 160 sector model with the model reference case adjusted to reflect California Department of Finance's most current publicly available economic and demographic projections.[116,117]

Specifically, REMI model's National and Regional Control was updated to conform to the most recent California Department of Finance economic forecasts which include U.S. Real Gross Domestic Product, income, and employment, as well as California population and civilian employment by industry, released with the May Revision budget on May 14, 2021.[118,]

[115] For further information and model documentation see: https://www.remi.com/model/pi/
[116] (SB617, 2011) California Legislature, Senate Bill 617. October 2011.
[117] (DOF, 2013) California Department of Finance, Chapter 1: Standardized Regulatory Impact Analysis for Major Regulations - Order of Adoption. December 2013.
[118] (DOF, 2021a) California Department of Finance. Economic Research Unit. National Economic Forecast – Annual & Quarterly. Sacramento: California. April 2021.

[119,120,121] After the Department of Finance forecasts end in 2024, CARB staff made assumptions that post-2024, economic variables would continue to grow at the same rate projected in the REMI baseline forecasts.

2. Inputs and Assumptions to the Assessment

The estimated economic impact of the Proposed Regulation incorporates modeling assumptions based on relevant data. This section provides a summary of the assumptions and inputs used to determine the suite of policy variables that best reflect the macroeconomic impacts of the Proposed Regulation. The direct costs estimated in Section C and the non-mortality health benefits estimated in Section B are translated into REMI policy variables and used as inputs for the macroeconomic analysis.[122]

The Proposed Regulation would impose direct costs on the Truck Transportation industry (484), which would be required to comply with the Proposed Regulation, as described above in Section C. Costs incurred by fleets would result in corresponding changes in demand for industries supplying those goods or services as shown in Table E-1.

Specifically, as costs for complying with the Proposed Regulation would be directly borne by the fleets, they are input as production costs to the Truck Transportation industry (484). The proposed required changes to testing methods and techniques are input as a change in final demand for Automotive Repair and Maintenance (8111), Measuring Equipment (3345) and Telecommunications (517). The demand impacts for the proposed reporting requirement are modeled as increased demand in the industries of Administrative Services (561) and Automotive Repair and Maintenance (8111). The proposed tester training requirements' impacts are modeled as increased demand in the Automotive Repair and Maintenance (8111) industry. The demand impacts for the proposed compliance fee are modeled as increased demand in the Data Processing (518), Measuring Equipment (3345), and Automotive Repair and Maintenance (8111) industries. Increased demand for vehicle repair under the Proposed Regulation are input as increased demand in the Engine Manufacturing (3336), Automotive Parts Manufacturing (3363), and Automotive Repair and Maintenance (8111) industries.

Table E- 1: Sources of Changes in Exogenous Final Demand by Industry

Sources of Costs	Industries (NAICS)
Heavy-Duty Vehicle Testing	• Automotive Repair and Maintenance (8111) • Measuring Equipment (3345) • Telecommunications (517)
Reporting	• Administrative Services (561) • Automotive Repair and Maintenance (8111)
Tester Training	• Automotive Repair and Maintenance (8111)

[119] (DOF, 2021b) California Department of Finance. Economic Research Unit. California Economic Forecast – Annual & Quarterly. Sacramento: California. April 2021.
[120] (DOF, 2021c) California Department of Finance. Economic Research Unit. National Deflators: Calendar Year averages: from 1929, April 2021. Sacramento: California. April 2021.
[121] (DOF, 2021d) California Department of Finance. Demographic Research Unit. Report P-3: Population Projections, California, 2010-2060 (Baseline 2019 Population Projections; Vintage 2020 Release). Sacramento: California. April 2021.
[122] Refer Section I. for a full list of REMI inputs for this analysis.

Sources of Costs	Industries (NAICS)
Compliance Certificate Fee	• Automotive Repair and Maintenance (8111) • Measuring Equipment (3345) • Data Processing & Hosting (518) • State spending and employment
Vehicle Repairs	• Engine Manufacturing (3336) • Automotive Parts Manufacturing (3363) • Automotive Repair and Maintenance (8111)

In addition to these changes in production costs and final demand for businesses, there would also be economic impacts because of the fiscal effects. The consumption changes due to compliance costs and activities would change the amount of revenue generated in State and local taxes. The corresponding change in government revenue from taxes is modeled as a change in state and local government spending, assuming this revenue increase is not offset elsewhere. As described in Section D., the compliance fees collected by CARB have been designed to offset implementation, enforcement, and employment costs of the Proposed Regulation. The compliance fee revenue, net of CARB position costs and the amount allocated to the Data Processing (518), Measuring Equipment (3345), and Automotive Repair and Maintenance (8111) industries, is input as an increase in state government spending.

The health benefits resulting from the emission reductions of the Proposed Regulation reduce healthcare costs for individuals on average. This reduction in healthcare cost is modeled as a decrease in spending for Hospitals (622), with a reallocation of this spending towards other goods and increased savings.

3. Results of the Assessment

The results from the REMI model provide estimates of the impact of the Proposed Regulation on the California economy. These results represent the annual incremental change from the implementation of the Proposed Regulation relative to the baseline scenario. The California economy is forecasted to grow through 2037. Therefore, negative impacts reported here should be interpreted as a slowing of growth and positive impacts as an acceleration of growth resulting from the Proposed Regulation. The results are reported here in tables for every year from 2023 through 2037.

a. California Employment Impacts

Table E-2 presents the impact of the Proposed Regulation on total employment in California across all industries. The employment impacts represent the net change in employment, which consist of positive impacts for some industries and negative impacts for others.

Across the California economy, the REMI simulation shows a small increase in job growth in 2023 followed by small decreases in job growth relative to the baseline in subsequent years of the analysis. It is important to note that the expected total number of jobs in California would still increase each year, and that the impact of the Proposed Regulation is insignificant when compared to the entire economy (never in any year registering a statewide impact of more than 0.00 percent). Job increases in 2023 are primarily due to increased demand from repair and testing which outweigh negative impacts associated with costs of the Proposed

Regulation with a positive impact of 225 jobs in 2023. The maximum negative impact is 686 fewer jobs in 2027.

Table E- 2: Total California Employment Impacts of the Proposed Regulation

Calendar Year	Change in Total Job Growth[123] (California fulltime jobs)	% Change	California Employment
2023	225	0.00%	24,872,942
2024	-171	0.00%	25,286,965
2025	-640	0.00%	25,438,251
2026	-690	0.00%	25,473,233
2027	-686	0.00%	25,474,184
2028	-643	0.00%	25,456,133
2029	-605	0.00%	25,493,487
2030	-575	0.00%	25,462,874
2031	-558	0.00%	25,474,161
2032	-547	0.00%	25,528,066
2033	-542	0.00%	25,588,792
2034	-539	0.00%	25,657,220
2035	-537	0.00%	25,732,116
2036	-535	0.00%	25,817,095
2037	-532	0.00%	25,912,754

Shown in Tables E-3 and E-4 are the impacts on the major sectors of the California economy.[124] Impacts on job growth appear to be largest from 2023-2028. As the requirements of the Proposed Regulation are implemented, the sectors that see direct increases in production costs or rely heavily on industries that see increases in production costs would see decreases in employment growth. Sectors that see increases in final demand or spending would see an increase in employment growth. The largest negative impacts are seen in the Transportation, Construction, and the Retail and Wholesale Trade sectors. These sectors rely most on services from the Truck Transportation industry, which bears the direct costs of the Proposed Regulation. Within these sectors, impacts never exceed 0.02 percent of the baseline.

The Services sector is estimated to have increased employment growth in the first few years of the assessment as businesses within this sector would be expected to benefit from increased demand for vehicle testing and repair. In later years of the assessment, the services sector is estimated to have a decrease in employment growth. This is due the decrease in final demand in the Automotive Repair and Maintenance industry associated with heavy-duty OBD-equipped vehicles no longer being required to perform the annual smoke opacity testing as currently required under the PSIP. This decrease in demand, along with the

[123] Negative value means decrease in number of fulltime jobs.

[124] Table E-3 shows impacts to the government, retail and wholesale trade, services, and construction sectors. Table E-4 shows impacts to the transportation, manufacturing, financial services, and natural resource sectors.

broader costs to the Truck Transportation industry, offsets the positive impacts associated with increased demand for vehicle testing and repair. The government sector is also estimated to see small increases in employment growth as compliance fee revenue is used to fund implementation and enforcement activities.

Table E- 3: California Employment Impacts of Proposed Regulation by Major Sector: Government, Retail & Wholesale Trade, Services, and Construction

Sector	Government	Government	Retail & Wholesale Trade	Retail & Wholesale Trade	Services	Services	Construction	Construction
Calendar Year	Change in Job Growth	%Change	Change in Job Growth	%Change	Change in Job Growth	%Change	Change in Job Growth	%Change
2023	109	0.00%	-63	0.00%	262	0.00%	-30	0.00%
2024	206	0.01%	-303	-0.01%	436	0.00%	-210	-0.02%
2025	125	0.00%	-200	-0.01%	50	0.00%	-222	-0.02%
2026	109	0.00%	-172	-0.01%	-54	0.00%	-177	-0.01%
2027	101	0.00%	-152	-0.01%	-125	0.00%	-128	-0.01%
2028	100	0.00%	-139	-0.01%	-154	0.00%	-86	-0.01%
2029	101	0.00%	-131	-0.01%	-172	0.00%	-55	0.00%
2030	102	0.00%	-125	-0.01%	-185	0.00%	-33	0.00%
2031	104	0.00%	-120	-0.01%	-199	0.00%	-20	0.00%
2032	106	0.00%	-117	-0.01%	-211	0.00%	-12	0.00%
2033	107	0.00%	-114	0.00%	-223	0.00%	-7	0.00%
2034	108	0.00%	-112	0.00%	-234	0.00%	-6	0.00%
2035	109	0.00%	-109	0.00%	-243	0.00%	-5	0.00%
2036	110	0.00%	-107	0.00%	-250	0.00%	-5	0.00%
2037	111	0.00%	-106	0.00%	-256	0.00%	-6	0.00%

Table E- 4: California Employment Impacts of Proposed Regulation by Major Sector: Transportation, Manufacturing, Financial Services, and Natural Resources

Sector	Transportation	Transportation	Manufacturing	Manufacturing	Financial Services	Financial Services	Natural Resources	Natural Resources
Calendar Year	Change in Job Growth	%Change	Change in Job Growth	%Change	Change in Job Growth	%Change	Change in Job Growth	%Change
2023	-45	0.00%	-1	0.00%	-7	0.00%	-1	0.00%
2024	-222	-0.02%	3	0.00%	-76	0.00%	-4	0.00%
2025	-243	-0.02%	-67	-0.01%	-78	0.00%	-5	0.00%
2026	-248	-0.02%	-75	-0.01%	-67	0.00%	-5	0.00%
2027	-244	-0.02%	-75	-0.01%	-59	0.00%	-5	0.00%
2028	-236	-0.02%	-72	-0.01%	-52	0.00%	-4	0.00%
2029	-229	-0.02%	-69	-0.01%	-47	0.00%	-4	0.00%
2030	-222	-0.02%	-66	-0.01%	-43	0.00%	-4	0.00%
2031	-215	-0.02%	-64	-0.01%	-41	0.00%	-3	0.00%
2032	-209	-0.01%	-62	-0.01%	-39	0.00%	-3	0.00%
2033	-204	-0.01%	-60	-0.01%	-38	0.00%	-3	0.00%
2034	-198	-0.01%	-58	-0.01%	-37	0.00%	-3	0.00%
2035	-193	-0.01%	-57	-0.01%	-37	0.00%	-3	0.00%
2036	-188	-0.01%	-56	-0.01%	-36	0.00%	-2	0.00%
2037	-183	-0.01%	-55	0.00%	-36	0.00%	-2	0.00%

b. California Business Impacts

Gross output is used as a measure for business impacts because it represents an industry's sales or receipts and tracks the quantity of goods or services at every stage of production in a given time period. Output is the sum of output in each private industry and State and local government as it contributes to California's GSP, and is affected by production cost and demand changes. As production cost increases or demand decreases, output is expected to contract, but as production costs decline or demand increases, industry would likely experience output growth.

The REMI analysis of the Proposed Regulation projects an initial increase in output growth in 2023 followed by a decrease in output growth in subsequent years of the analysis. There is an estimated decrease in statewide output growth of $151M in 2026, the year with greatest negative impact, which diminishes to a decrease that is between $120M to $126M each year from 2030 to 2037 as shown in Table E-5.

The trend in output changes by major sector is illustrated in Tables E-6 and E-7 and show similar patterns as the impacts to employment. The Proposed Regulation results in increased production costs to the Truck Transportation industry, resulting in negative impacts to output in the Transportation sector, approximately 0.02 percent in the years of greatest impact. The Proposed Regulation is anticipated to increase demand for Automotive Repair and Maintenance, and as a result, the model estimates increased output in the Services sector from 2023 to 2027. Like the results for employment, the Services sector is eventually estimated to see decreases in output growth because of decreased demand for annual smoke opacity testing and overall costs to the Truck Transportation industry that outweigh the positive impacts increases in demand for testing and repair.

The Proposed Regulation also results in increased demand for Motor Vehicle Manufacturing and Motor Vehicle Parts Manufacturing. As a result, the Manufacturing sector is estimated to see increases in output growth in the early years of the assessment. However, this positive impact is offset in later years by the impacts of the increased costs on Truck Transportation. For all sectors, except for Transportation and Construction, the impacts of the Proposed Regulation on output are never anticipated to exceed 0.01 percent of baseline levels of output.

Table E- 5: Change in California Output Growth Due to the Proposed Regulation

Calendar Year	Output Change (2020M$)	% Change	Aggregate Output (2020M$)
2023	34.57	0.00%	5,424,728
2024	-24.63	0.00%	5,575,003
2025	-142.53	0.00%	5,669,482
2026	-151.40	0.00%	5,734,567
2027	-149.06	0.00%	5,799,383
2028	-139.64	0.00%	5,867,005
2029	-131.80	0.00%	5,946,543
2030	-125.92	0.00%	6,010,062

Calendar Year	Output Change (2020M$)	% Change	Aggregate Output (2020M$)
2031	-122.74	0.00%	6,084,985
2032	-121.01	0.00%	6,166,768
2033	-120.75	0.00%	6,252,316
2034	-121.24	0.00%	6,342,778
2035	-122.05	0.00%	6,438,543
2036	-122.94	0.00%	6,540,906
2037	-123.83	0.00%	6,650,851

Table E- 6: California Output Impacts of Proposed Regulation by Major Sector (2020$M): Government, Retail & Wholesale Trade, Services, and Construction

Sector	Government	Government	Retail & Wholesale Trade	Retail & Wholesale Trade	Services	Services	Construction	Construction
Calendar Year	Change in Output	%Change	Change in Output	%Change	Change in Output	%Change	Change in Output	%Change
2023	20.07	0.00%	-9.89	0.00%	38.47	0.00%	-5.40	0.00%
2024	38.24	0.01%	-51.65	-0.01%	87.91	0.00%	-38.14	-0.02%
2025	23.50	0.00%	-37.40	-0.01%	22.95	0.00%	-40.89	-0.02%
2026	20.54	0.00%	-33.73	-0.01%	9.37	0.00%	-33.28	-0.01%
2027	19.19	0.00%	-31.03	-0.01%	0.35	0.00%	-24.50	-0.01%
2028	19.10	0.00%	-29.45	-0.01%	-3.15	0.00%	-16.84	-0.01%
2029	19.38	0.00%	-28.57	-0.01%	-5.36	0.00%	-11.15	-0.01%
2030	19.70	0.00%	-27.94	-0.01%	-7.16	0.00%	-7.15	0.00%
2031	20.16	0.00%	-27.70	0.00%	-9.07	0.00%	-4.58	0.00%
2032	20.57	0.00%	-27.61	0.00%	-10.80	0.00%	-3.04	0.00%
2033	20.91	0.00%	-27.66	0.00%	-12.61	0.00%	-2.23	0.00%
2034	21.21	0.00%	-27.78	0.00%	-14.34	0.00%	-1.86	0.00%
2035	21.44	0.00%	-27.92	0.00%	-15.88	0.00%	-1.74	0.00%
2036	21.76	0.00%	-28.19	0.00%	-17.17	0.00%	-1.76	0.00%
2037	22.14	0.00%	-28.52	0.00%	-18.28	0.00%	-1.85	0.00%

Table E- 7: California Output Impacts of Proposed Regulation by Major Sector (2020$M): Transportation, Manufacturing, Financial Services, and Natural Resources

Sector	Transportation	Transportation	Manufacturing	Manufacturing	Financial Services	Financial Services	Natural Resources	Natural Resources
Calendar Year	Change in Output	%Change	Change in Output	%Change	Change in Output	%Change	Change in Output	%Change
2023	-8.23	0.00%	3.84	0.00%	-4.15	0.00%	-0.16	0.00%
2024	-41.01	-0.02%	19.65	0.00%	-38.38	0.00%	-1.25	0.00%
2025	-45.73	-0.02%	-24.58	0.00%	-38.83	0.00%	-1.55	0.00%
2026	-47.76	-0.02%	-30.91	0.00%	-34.11	0.00%	-1.52	0.00%
2027	-47.85	-0.02%	-33.42	0.00%	-30.37	0.00%	-1.43	0.00%
2028	-47.47	-0.02%	-33.30	0.00%	-27.20	0.00%	-1.34	0.00%
2029	-47.01	-0.02%	-32.78	0.00%	-25.05	0.00%	-1.27	0.00%
2030	-46.43	-0.02%	-32.23	0.00%	-23.49	0.00%	-1.20	0.00%
2031	-45.97	-0.02%	-31.82	0.00%	-22.62	0.00%	-1.15	0.00%
2032	-45.51	-0.02%	-31.38	0.00%	-22.12	0.00%	-1.12	0.00%
2033	-45.10	-0.02%	-31.06	0.00%	-21.92	0.00%	-1.08	0.00%
2034	-44.72	-0.02%	-30.84	0.00%	-21.86	0.00%	-1.06	0.00%
2035	-44.34	-0.02%	-30.71	0.00%	-21.86	0.00%	-1.03	0.00%
2036	-44.03	-0.02%	-30.60	0.00%	-21.93	0.00%	-1.01	0.00%
2037	-43.76	-0.02%	-30.57	0.00%	-22.02	0.00%	-1.00	0.00%

c. Impacts on Investments in California

Private domestic investment consists of purchases of residential and nonresidential structures and of equipment and software by private businesses and nonprofit institutions. It is used as a proxy for impacts on investments in California because it provides an indicator of the future productive capacity of the economy.

The relative changes to growth in private investment for the Proposed Regulation are shown in Table E-8 and show a decrease of private investment of about $62M in 2025, the year with highest impact. The impacts are primarily linked to residential investment, which is indirectly impacted by the Truck Transportation industry. The impacts to private investment diminish over time until 2034. From 2035 to 2037, there is a slight increase in the magnitude of the impact due to the increase in direct costs on the Truck Transportation industry during these years. All impacts in the period of analysis do not exceed 0.01 of baseline investment in any year.

Table E- 8: Change in Gross Domestic Private Investment Growth Due to the Proposed Regulation

Calendar Year	Investment Change (2020M$)	% Change	Aggregate Investment Totals (2020M$)
2023	-10.24	0.00%	472,138
2024	-59.37	-0.01%	497,320
2025	-62.15	-0.01%	505,298
2026	-53.03	-0.01%	510,285
2027	-41.94	-0.01%	516,341
2028	-32.26	-0.01%	521,260
2029	-25.09	-0.01%	528,881
2030	-20.10	0.00%	534,369
2031	-16.99	0.00%	540,155
2032	-15.26	0.00%	547,182
2033	-14.48	0.00%	554,767
2034	-14.28	0.00%	562,902
2035	-14.39	0.00%	571,405
2036	-14.70	0.00%	580,216
2037	-15.11	0.00%	589,735

d. Impacts on Individuals in California

The Proposed Regulation would impose no direct costs on individuals in California. However, the costs incurred by affected businesses and the public sector would ripple through the economy and affect individuals. One measure of this impact is the change in real personal income.

Table E-9 shows estimated annual changes in real personal income across all individuals in California. The Proposed Regulation is anticipated to result in a decrease in personal income in all years of the assessment, with a decrease of approximately $252M in 2024, the year of

greatest impact. The impacts to personal income dimmish over time and the Proposed Regulation is estimated to result in a decrease in personal income of approximately $124M in 2037. While there are some positive impacts to personal income because of increased demand for testing and vehicle repair, the production cost increases to truck transportation have a larger negative impact on statewide personal income. The change in personal income can also be divided by the California population to show the average, or per capita, impact on personal income. Personal income decreases by about $6 per person in 2024 and decreases by less than $3 per person for most of the years of the assessment.

Table E- 9: Change in Personal Income Growth Due to the Proposed Regulation

Calendar Year	Personal Income Change (2020M$)	% Change	Aggregate Personal Income (2020M$)	Per Capita Personal Income Change (2020$)
2023	-47.05	0.00%	2,809,647	-1.17
2024	-251.93	-0.01%	2,896,664	-6.21
2025	-170.71	-0.01%	2,948,011	-4.18
2026	-147.74	-0.01%	2,992,423	-3.60
2027	-135.35	0.00%	3,038,031	-3.28
2028	-129.51	0.00%	3,100,253	-3.12
2029	-125.58	0.00%	3,136,703	-3.01
2030	-123.99	0.00%	3,199,075	-2.96
2031	-123.58	0.00%	3,263,511	-2.94
2032	-122.88	0.00%	3,310,391	-2.91
2033	-122.67	0.00%	3,359,223	-2.89
2034	-122.66	0.00%	3,410,529	-2.88
2035	-122.65	0.00%	3,463,587	-2.87
2036	-123.04	0.00%	3,518,592	-2.87
2037	-123.56	0.00%	3,576,439	-2.87

e. Impacts on Gross State Product (GSP)

GSP is the market value of all goods and services produced in their final ready for market stage in California and is one of the primary indicators used to gauge the health of an economy.[125] Table E-10 shows the estimated impact of the Proposed Regulation on GSP. The REMI analysis of the Proposed Regulation projects an initial increase in GSP growth in 2023 that reflects the increase in demand for repair and testing services. In subsequent years, the Proposed Regulation is estimated to result in a decrease in GSP growth. The statewide impacts on GSP are insignificant; both positive and negative impacts to GSP are not estimated to exceed 0.00 percent of baseline GSP.

Table E- 10: Change in Gross State Product due to the Proposed Regulation

Calendar Year	GSP Change (2020M$)	% Change	Aggregate GSP (2020M$)
2023	20.91	0.00%	3,227,898
2024	-7.68	0.00%	3,319,375
2025	-75.08	0.00%	3,377,239
2026	-78.66	0.00%	3,419,013
2027	-76.89	0.00%	3,463,570
2028	-71.63	0.00%	3,511,047
2029	-67.52	0.00%	3,567,037
2030	-64.48	0.00%	3,616,880
2031	-63.02	0.00%	3,672,781
2032	-62.38	0.00%	3,732,301
2033	-62.59	0.00%	3,793,442
2034	-63.22	0.00%	3,856,580
2035	-64.02	0.00%	3,921,375
2036	-64.81	0.00%	3,988,327
2037	-65.56	0.00%	4,057,756

f. Creation or Elimination of Businesses

Although the REMI model cannot directly estimate the creation or elimination of businesses, the changes in jobs and output for the California economy described above can be used to understand some potential impacts. The trend of increasing production costs for the Truck Transportation industry has the potential to result in a contraction or decrease in business in this industry if sustained over time. On the other hand, the projected increase in demand for automotive repair and services, motor vehicle parts manufacturing, testing equipment, and database management resulting from the Proposed Regulation has the potential to result in an increase in growth for businesses in those industries if maintained for a long duration.

[125] Output is a similar indicator but includes the value of intermediate goods used in the production process, which GSP excludes. GSP is one of the variables output by the REMI model, which was utilized to analyze the Proposed Regulation's impact on California's economy.

g. Incentives for Innovation

The Proposed Regulation would provide incentives for innovation. The proposed OBD testing requirement on heavy-duty OBD-equipped vehicles would promote innovation in remote OBD testing technologies such as telematics systems and OBD testing devices. Those telematics and OBD testing device vendors would be incentivized to further improve their OBD testing technologies and services for their fleet customers to better compete in the market. Additionally, there could also be opportunity for manufacturers to improve upon existing heavy-duty vehicle emission reduction technology to produce more durable vehicle emissions control parts to be more competitive in heavy-duty vehicle market. Given the more stringent vehicle inspection and maintenance requirements under the Proposed Regulation, fleet owners would tend to buy vehicles with more durable emissions control parts to prevent frequent repairs in order to comply with the Proposed Regulation.

h. Competitive Advantage or Disadvantage

All non-gasoline combustion heavy-duty vehicles with GVWR greater than 14,000 pounds operating in California (including OOS vehicles) would be subject to the Proposed Regulation. The Proposed Regulation would result in comparable operating cost increases for Californian and non-Californian fleet operators whose heavy-duty vehicles operate in California. The lack of a DMV registration link to program compliance for OOS vehicles (as opposed to in-state vehicles) creates an incentive for OOS fleets to not comply with the program in order to avoid the increased program compliance costs. Therefore, it is possible that certain non-compliant OOS fleets would see a competitive advantage under this Proposed Regulation compared to a compliant in-state fleet.

Certain enforcement measures proposed by staff may decrease the likelihood of non-compliance for both in-state and OOS vehicles. These include the proposed roadside monitoring systems (PEAQS/RSD and ALPR network) and CHP inspections. These would significantly increase CARB's enforcement coverage on non-compliant vehicles operating in California, including OOS vehicles, which would help level the playing field between in-state and OOS vehicles. Finally, the proposed vehicle compliance verification requirements for freight contractors before doing businesses with the dispatched vehicles in California would incentivize both in-state and OOS vehicles to be in compliant with the Proposed Regulation in order to do businesses in California.

Zero-emission heavy-duty vehicles would not be subject to the Proposed Regulation. Hence, fleets of these vehicles could see a competitive advantage under this Proposed Regulation compared to other heavy-duty combustion vehicles due to the avoided incremental compliance costs.

4. Summary and Agency Interpretation of the Assessment Results

The results of the macroeconomic analysis of the Proposed Regulation are summarized in Table E-11. As analyzed here, CARB estimates the Proposed Regulation is unlikely to have a significant impact on the California economy. The Proposed Regulation would result in increased production costs to the Truck Transportation industry. At the same time, the

Proposed Regulation would result in increased demand in the Automotive Repair and Maintenance industry in California, as well as Motor Vehicle Manufacturing and Motor Vehicle Parts Manufacturing industries. These impacts work to offset one another. In the first year of the assessment, there is anticipated to be increased growth in GSP, output, and employment as the positive impacts of increased demand for repair and testing increases economic activity in the State and counteracts the increased production costs to the Truck Transportation industry. In subsequent years, there is a small negative impact on all economic indicators that results from the sustained production cost increase to the Truck Transportation industry. In all years of the assessment, the impacts to the economic indicators are projected to be less than or equal to 0.01 percent of the baseline.

Table E- 11: Summary of Macroeconomic Impacts of the Proposed Regulation

Calendar Year	GSP	GSP	Personal Income	Personal Income	Employment	Employment	Output	Output	Investment	Investment
	Change (2020$M)	% Change	Change (2020$M)	% Change	Change	% Change	Change (2020$M)	% Change	Change (2020$M)	% Change
2023	20.91	0.00%	-47.05	0.00%	225	0.00%	34.57	0.00%	-10.24	0.00%
2024	-7.68	0.00%	-251.93	-0.01%	-171	0.00%	-24.63	0.00%	-59.37	-0.01%
2025	-75.08	0.00%	-170.71	-0.01%	-640	0.00%	-142.53	0.00%	-62.15	-0.01%
2026	-78.66	0.00%	-147.74	-0.01%	-690	0.00%	-151.40	0.00%	-53.03	-0.01%
2027	-76.89	0.00%	-135.35	0.00%	-686	0.00%	-149.06	0.00%	-41.94	-0.01%
2028	-71.63	0.00%	-129.51	0.00%	-643	0.00%	-139.64	0.00%	-32.26	-0.01%
2029	-67.52	0.00%	-125.58	0.00%	-605	0.00%	-131.80	0.00%	-25.09	-0.01%
2030	-64.48	0.00%	-123.99	0.00%	-575	0.00%	-125.92	0.00%	-20.10	0.00%
2031	-63.02	0.00%	-123.58	0.00%	-558	0.00%	-122.74	0.00%	-16.99	0.00%
2032	-62.38	0.00%	-122.88	0.00%	-547	0.00%	-121.01	0.00%	-15.26	0.00%
2033	-62.59	0.00%	-122.67	0.00%	-542	0.00%	-120.75	0.00%	-14.48	0.00%
2034	-63.22	0.00%	-122.66	0.00%	-539	0.00%	-121.24	0.00%	-14.28	0.00%
2035	-64.02	0.00%	-122.65	0.00%	-537	0.00%	-122.05	0.00%	-14.39	0.00%
2036	-64.81	0.00%	-123.04	0.00%	-535	0.00%	-122.94	0.00%	-14.70	0.00%
2037	-65.56	0.00%	-123.56	0.00%	-532	0.00%	-123.83	0.00%	-15.11	0.00%

F. ALTERNATIVES

Pursuant to SB 617, CARB staff solicited alternatives for the Proposed Regulation during workgroups, workshops, and individual meetings with industry representatives.[126] CARB staff encouraged public input on alternative approaches that may yield the same or greater benefits compared to staff's Proposed Regulation or may achieve the goals at a lower cost. Based on received public inputs, staff developed and evaluated two alternatives to the Proposed Regulation.

1. Alternative 1: Less Stringent Periodic Testing Requirements than the Proposed Regulation

Alternative 1 would include similar required elements as discussed in the Proposed Regulation, however, with less stringent periodic inspection requirements starting in 2024, specifically:

- Annual (rather than quarterly or biannual) periodic inspection would be required for heavy-duty vehicle fleets (both OBD and non-OBD vehicles)
    - Fleets would perform this annual periodic testing on a ten percent representative portion of their vehicles; and
- New vehicles would be exempted from the periodic testing requirement for the first two years.

Alternative 1 was developed based on feedback received from stakeholders who suggested reduced periodic testing requirements on fleets.

a. Costs

The total costs of Alternative 1 were assessed using the same baseline conditions as the Proposed Regulation. Similar to the Proposed Regulation, Alternative 1 would have the following direct costs:

- Reporting,
- Heavy-duty vehicle testing,
- HD I/M-approved tester training,
- Compliance certificate fee, and
- Heavy-duty vehicle repairs.

The compliance certificate fee costs of Alternative 1 would remain the same as in the Proposed Regulation as State administration and implementation costs would remain unchanged. Due to the less frequent periodic testing on a smaller proportion of the vehicle population, Alternative 1 would reduce the amount of tests performed on vehicles subject to the requirements of this Proposed Regulation. This in turn would reduce both the reporting and inspection costs for non-OBD vehicles and the OBD testing costs for OBD-equipped vehicles, as well as reduce the demand for HD I/M-approved testers. The reduced testing

[126] (CARB, 2021g) Heavy-Duty Inspection and Maintenance Program: Meetings & Workshops, California Air Resources Board, accessed May 2021. Heavy-Duty Inspection and Maintenance Program: Meetings & Workshops | California Air Resources Board

would also result in less non-compliant vehicles being identified, thus would reduce the amount of vehicle repairs that occur as part of the proposed regulatory requirements, and subsequently result in reduced vehicle repair costs and overall emission reduction benefits. In summary, Alternative 1 would be expected to have less reporting costs, vehicle testing costs, HD I/M-approved tester training costs, and vehicle repair costs relative to the Proposed Regulation.

The reporting costs, vehicle testing costs, and HD I/M-approved tester training costs under Alternative 1 were estimated using the same cost methodology as used for the Proposed Regulation and as discussed in Sections C.1.a., C.1.b., and C.1.c. However, staff scaled the costs down to reflect the effects of reduced periodic vehicle testing. Similarly, vehicle repair costs under Alternative 1 were estimated following the same cost methodology as for the Proposed Regulation as discussed in Section C.1.e. However, staff made modifications to the estimated percentage of non-compliant vehicles that would be identified and then repaired. For example, heavy-duty vehicle OBD test data suggests that up to 12 percent of vehicles within the first two years of life are potentially operating with illuminated MIL.[127] Such vehicles would not be caught under Alternative 1 as these vehicles would be exempt from the program. Additionally, the reduction in testing frequency and proposed testing of only ten percent of the relevant vehicle population per year would increase the percentage of non-compliant vehicles that would bypass testing requirements altogether. Furthermore, part of staff's fraud detection strategy development would rely on the submitted test data for data mining for anomalies. Thus, the reduced test data submission under Alternative 1 may significantly limit staff's ability to develop robust fraud detection mechanisms to limit fraudulent testing. Hence, based on these assessments, staff scaled down the estimated incremental percentage of non-compliant vehicles that could be identified by CARB in 2024 and later as shown in Table C-21 for the corresponding Alternative 1's values shown in Table F-1 below. As shown, staff projected the non-compliant vehicle identification rates under Alternative 1 would be reduced by about 60 percent relative to the Proposed Regulation in 2024 and beyond.

Table F- 1: Estimated Percentage of Non-Compliant Vehicles Identified under Alternative 1

Calendar Year	Non-Compliance Identification Rate for Heavy-Duty Non-OBD Vehicles	Non-Compliance Identification Rate for Heavy-Duty OBD-Equipped Vehicles
2023	21%	21%
2024-2025	31%	33%
2026 and later	31%	33%

The total incremental costs of Alternative 1, including reporting costs, vehicle testing costs, tester training costs, compliance certification fee, and heavy-duty vehicle repair costs, are

[127] (ERG, 2021) Heavy-Duty On-board Diagnostic Data Collection Demonstration and Repair Data Collection Study, Agreement Number – 18MSC001, Eastern Research Group, June 2021.

summarized in Table F-2. Alternative 1 is projected to cost $1.64B over the 2023-2037 period, with a maximum annual cost of $190M in 2024. Alternative 1 is estimated to cost $454M less than the Proposed Regulation, a 22 percent decrease in costs during the 2023-2037 period, with the decrease primarily due to the reduced vehicle testing and repair costs.

Table F- 2: Total Estimated Direct Incremental Costs Relative to the Baseline of Alternative 1 from 2023 through 2037[128]

Calendar Year	Reporting	Vehicle Testing	HD I/M-Approved Tester Training	Compliance Certificate	Heavy-Duty Vehicle Repairs	Total Costs
2023	$3,324,000	$2,541,000	$5,712,000	$23,765,000	$48,297,000	**$83,639,000**
2024	$449,000	$84,221,000	$3,105,000	$28,102,000	$74,465,000	**$190,341,000**
2025	$414,000	$33,928,000	$3,221,000	$28,740,000	$58,701,000	**$125,005,000**
2026	$379,000	$34,461,000	$3,318,000	$29,309,000	$47,964,000	**$115,432,000**
2027	$345,000	$34,954,000	$3,405,000	$29,807,000	$41,673,000	**$110,184,000**
2028	$310,000	$35,303,000	$3,474,000	$30,214,000	$37,128,000	**$106,430,000**
2029	$276,000	$35,481,000	$3,521,000	$30,526,000	$34,094,000	**$103,898,000**
2030	$244,000	$35,491,000	$3,545,000	$30,740,000	$31,924,000	**$101,943,000**
2031	$232,000	$35,869,000	$3,580,000	$31,011,000	$30,392,000	**$101,084,000**
2032	$210,000	$36,086,000	$3,601,000	$31,256,000	$29,356,000	**$100,509,000**
2033	$189,000	$36,335,000	$3,617,000	$31,471,000	$28,612,000	**$100,224,000**
2034	$171,000	$36,559,000	$3,627,000	$31,675,000	$28,070,000	**$100,101,000**
2035	$150,000	$36,625,000	$3,617,000	$31,830,000	$27,715,000	**$99,937,000**
2036	$141,000	$36,966,000	$3,621,000	$32,026,000	$27,498,000	**$100,250,000**
2037	$132,000	$37,307,000	$3,621,000	$32,255,000	$27,391,000	**$100,706,000**
Total	**$6,968,000**	**$552,124,000**	**$54,585,000**	**$452,727,000**	**$573,279,000**	**$1,639,684,000**

[128] Costs were rounded to the nearest thousand.

b. Benefits

The emission benefits of Alternative 1 are shown in Table F-3. Figure F-1 and Figure F-2, compare the yearly tons of PM and NOx reductions for Alternative 1 and the Proposed Regulation. As shown, Alternative 1 would achieve less emissions reductions every year between 2024 through 2037 compared to the Proposed Regulation. Overall, Alternative 1 is expected to reduce 949 less tons (or 33 percent less) of PM and 104,366 less tons (or 33 percent less) of NOx than the Proposed Regulation.

Table F- 3: Projected Statewide Emission Benefits under Alternative 1 from 2023 through 2037

Calendar Year	PM Benefits (tpy)	NOx Benefits (tpy)
2023	18	1,627
2024	38	3,491
2025	54	5,363
2026	99	9,801
2027	126	12,637
2028	142	14,421
2029	151	15,580
2030	156	16,371
2031	160	17,052
2032	163	17,603
2033	165	18,077
2034	167	18,513
2035	170	18,928
2036	171	19,270
2037	174	19,616
Total (2023-2037)	**1,955 tons**	**208,350 tons**

Figure F- 1: PM Emission Benefits for the Proposed Regulation and Alternative 1 (tpy)

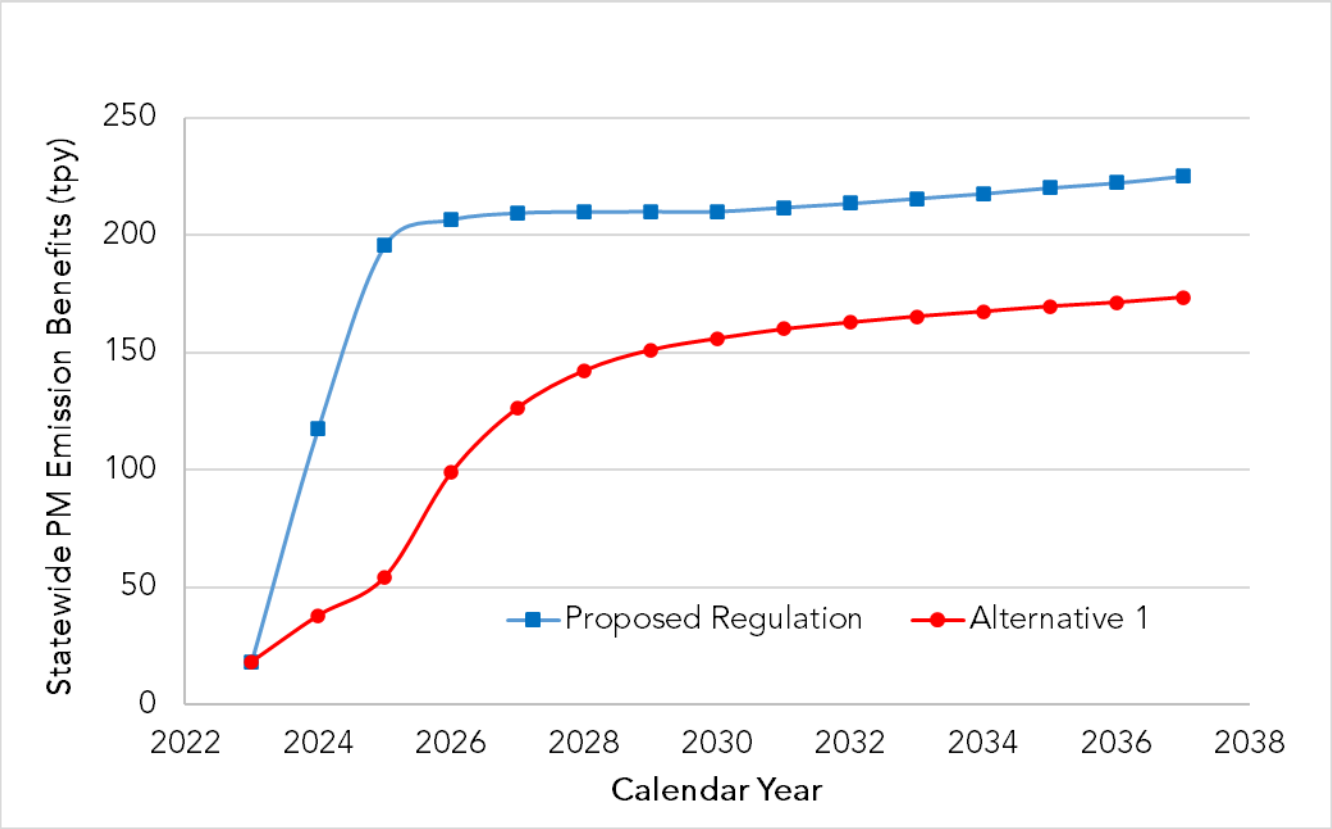
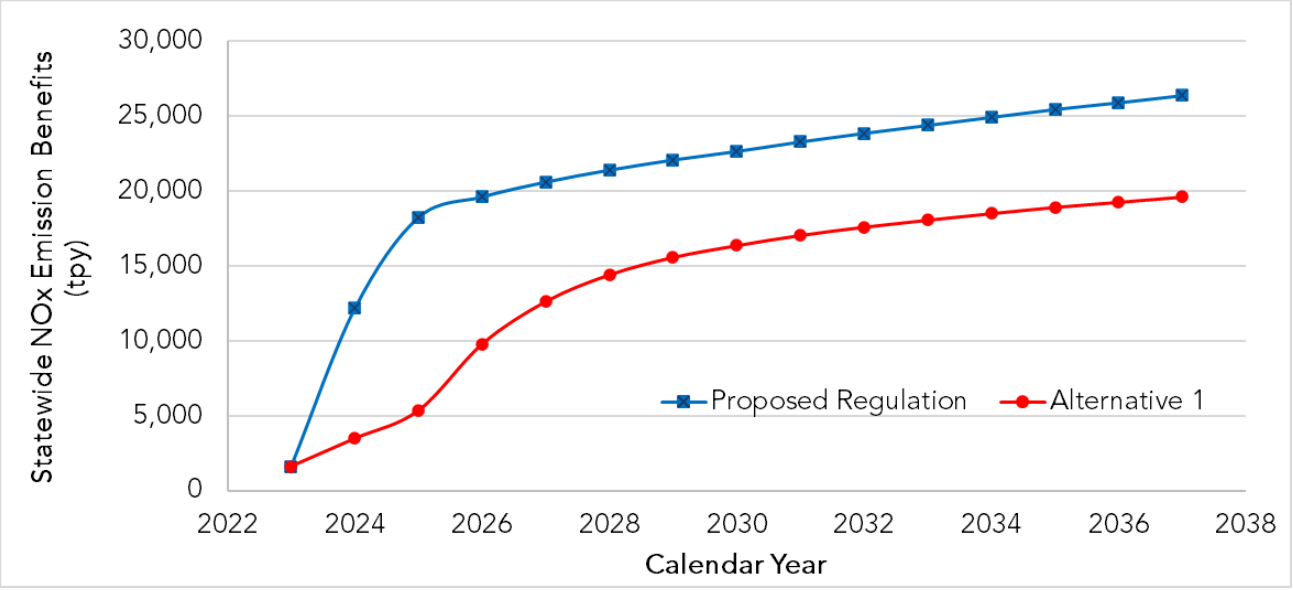


Figure F- 2: NOx Emission Benefits for the Proposed Regulation and Alternative 1



Alternative 1 would result in the same cost savings as the Proposed Regulation relative to the legal baseline on California heavy-duty vehicle owners due to the avoided smoke opacity testing need on heavy-duty OBD-equipped vehicles as shown in Table B-3. The statewide health benefits of Alternative 1 are presented in Table F-4. As shown, Alternative 1 is predicted to save 30 percent fewer lives compared to the Proposed Regulation, 2,316 premature deaths avoided compared to the 3,303 deaths avoided, respectively. Alternative 1's total monetized health benefits are 30 percent lower than the Proposed Regulation, $23.3B compared to $33.2B, respectively.

Table F- 4: Statewide Valuation from Avoided Health Outcomes under Alternative 1

Calendar Year	Avoided Premature Cardiopulmonary Mortality	Avoided Cardiovascular Hospitalizations	Avoided Acute Respiratory Hospitalizations	Avoided ER Visits	Valuation (2020$)[129]
2023	20	2	3	10	$196,116,000
2024	40	5	6	20	$406,592,000
2025	60	8	9	29	$605,401,000
2026	108	14	17	52	$1,082,581,000
2027	138	19	22	66	$1,382,118,000
2028	156	22	26	75	$1,568,577,000
2029	169	24	28	81	$1,694,457,000
2030	178	25	30	85	$1,787,672,000
2031	187	27	32	88	$1,874,819,000
2032	194	29	34	92	$1,950,825,000
2033	201	30	36	95	$2,021,034,000
2034	208	31	37	97	$2,086,957,000
2035	214	33	39	100	$2,151,412,000
2036	219	34	40	102	$2,204,418,000
2037	225	35	42	104	$2,257,404,000
Total	**2,316**	**338**	**403**	**1,096**	**$23,270,382,000**

c. Economic Impacts

Alternative 1 would implement less stringent periodic testing requirement on heavy-duty vehicles operating in California starting in 2024. This would result in less total direct costs on vehicle owners compared to the Proposed Regulation, a decrease of 22 percent (or $454M) from the Proposed Regulation's total direct costs. However, due to the reduced emission benefits as a result of the proposed less stringent vehicle inspection requirement, Alternative 1 is projected to have 30 percent less ($9.9B less) monetized health benefits compared to the Proposed Regulation.

Table F-5 indicates the change in growth of economic indicators for Alternative 1 relative to the baseline. The model estimates similar patterns as the Proposed Regulation with small increases in GSP, Employment and Output in the first year of the assessment, followed by decreases in all economic indicators in subsequent years of the assessment. Alternative 1 and

[129] Values were rounded to the nearest thousand.

the Proposed Regulation have similar impacts in the first year of the analysis. In the later years of the assessment, Alternative 1 is estimated to result in impacts that are smaller in magnitude than the Proposed Regulation. Alternative 1 is estimated to also have an insignificant impact on the California economy with impacts for all economic indicators never exceeding 0.01 percent of the baseline.

Table F- 5: Change in Growth of Economic Indicators for Alternative 1 Relative to Legal Baseline

	GSP	GSP	Personal Income	Personal Income	Employment	Employment	Output	Output	Private Investment	Private Investment
Calendar Year	Total Change (2020M$)	% Change	Total Change (2020M$)	% Change	Total Change (Jobs)	% Change	Total Change (2020M$)	% Change	Total Change (2020M$)	% Change
2023	20.80	0.00%	-47.01	0.00%	223	0.00%	34.40	0.00%	-10.24	0.00%
2024	-11.76	0.00%	-145.76	-0.01%	-254	0.00%	-30.28	0.00%	-36.97	-0.01%
2025	-44.42	0.00%	-106.50	0.00%	-412	0.00%	-83.86	0.00%	-38.83	-0.01%
2026	-48.87	0.00%	-100.39	0.00%	-456	0.00%	-93.18	0.00%	-35.20	-0.01%
2027	-49.97	0.00%	-97.84	0.00%	-467	0.00%	-95.75	0.00%	-30.30	-0.01%
2028	-49.37	0.00%	-95.87	0.00%	-462	0.00%	-94.89	0.00%	-25.36	-0.01%
2029	-48.35	0.00%	-93.60	0.00%	-451	0.00%	-92.98	0.00%	-21.18	0.00%
2030	-47.21	0.00%	-92.72	0.00%	-439	0.00%	-90.88	0.00%	-17.87	0.00%
2031	-46.57	0.00%	-92.78	0.00%	-431	0.00%	-89.55	0.00%	-15.58	0.00%
2032	-46.26	0.00%	-92.59	0.00%	-425	0.00%	-88.82	0.00%	-14.12	0.00%
2033	-46.47	0.00%	-92.90	0.00%	-423	0.00%	-88.90	0.00%	-13.33	0.00%
2034	-47.00	0.00%	-93.47	0.00%	-423	0.00%	-89.54	0.00%	-13.01	0.00%
2035	-47.73	0.00%	-94.09	0.00%	-423	0.00%	-90.53	0.00%	-12.98	0.00%
2036	-48.50	0.00%	-95.11	0.00%	-423	0.00%	-91.64	0.00%	-13.15	0.00%
2037	-49.32	0.00%	-96.24	0.00%	-423	0.00%	-92.87	0.00%	-13.45	0.00%

d. Cost-Effectiveness

Staff calculated cost-effectiveness of Alternative 1 as a function of the alternative's net cost[130] per pound emissions reduction. Table F-6 summarized staff's estimated Alternative 1's and the Proposed Regulation's cost-effectiveness. As shown, the Proposed Regulation is more cost-effective than Alternative 1.

Table F- 6: Cost-Effectiveness of Alternative 1 and the Proposed Regulation

Scenario	PM Cost-Effectiveness ($/pound)	NOx Cost-Effectiveness ($/pound)
Alternative 1	90.06	2.07
Proposed Regulation	83.62	1.89

e. Reason for Rejecting

Staff rejected Alternative 1 due to the following reasons:

- Alternative 1 would result in less PM and NOx emission reductions than the Proposed Regulation, i.e., a decrease in 33 percent PM and 33 percent NOx emissions reductions compared to the Proposed Regulation for the 2023-2037 period.
- Alternative 1 would be less cost effective than the Proposed Regulation. Even though Alternative 1's total direct costs are $454M less than the Proposed Regulation's, its reduced emission benefits still outweigh its cost savings. Additionally, Alternative 1 would result in a decrease in monetized health benefits of $9.9B compared to the Proposed Regulation for the 2023-2037 period.
- The limited periodic testing requirements of Alternative 1 would increase the likelihood that vehicles would be operating in California with malfunctioning emissions control systems and limit staff's ability to develop robust fraud detection mechanisms to identify testing anomalies.

2. Alternative 2: More Stringent Periodic Testing Requirement on Non-OBD Vehicles with 2010-2012 MY Engines

CARB staff developed Alternative 2 based on feedback from stakeholders who suggested testing beyond just opacity testing and visual inspection for vehicles with 2010-2012 MY engines, which have SCR systems and DPFs but lack OBD. In addition to the required elements in the Proposed Regulation, Alternative 2 would impose more stringent periodic testing requirements on heavy-duty non-OBD vehicles with 2010-2012 MY engines. Specifically, these non-OBD vehicles would be subjected to biannual (twice a year) chassis dynamometer testing for NOx emissions monitoring in addition to the proposed periodic smoke opacity and visual inspection requirements starting in 2024. Non-OBD vehicles with 2010-2012 MY engines are equipped with NOx emission control system (SCR). Thus, incorporating a testing method that more readily identifies malfunctioning NOx emissions control systems would lead to more NOx reduction benefits. Although an OBD test would be

[130] Net cost was calculated by subtracting the total cost savings from the total costs

the most effective way to diagnose NOx emissions control system issues, since these vehicles are not equipped with OBD systems, an alternative approach to diagnosing these malfunction issues is proposed in Alternative 2. As a result, chassis dynamometer testing on non-OBD vehicles with 2010-2012 MY engines for NOx emissions is included in Alternative 2, which would be similar to the current BAR-97 testing for light-duty non-OBD vehicles under BAR's Smog Check program.

a. Costs

The total costs of Alternative 2 were assessed using the same legal baseline conditions as the Proposed Regulation. The total costs of Alternative 2 include all the costs discussed above for the Proposed Regulation, as well as costs for additional periodic chassis dynamometer testing and vehicle repairs for heavy-duty non-OBD vehicles with 2010-2012 MY engines.

Chassis Dynamometer Testing Costs

The chassis dynamometer testing would require establishing a new network of brick-and-mortar heavy-duty testing stations throughout the State to support the proposed testing requirement as today's network could not support the anticipated testing demand. Note that such a network could resemble the current light-duty smog check station model; however, current light-duty stations do not have the capacity or size allowances to readily support heavy-duty vehicle testing. Staff estimated that in order to provide dynamometer testing services for all vehicles with 2010-2012 MY engines subject to these proposed requirements starting in 2024, the State would need at least 133 stations spread throughout the State testing at full capacity.[131] The costs of this station infrastructure development would eventually be passed on to vehicle owners in the form of testing costs. Staff used the following assumptions to estimate the costs passed on through to the vehicle owner:

- Upfront costs for purchasing one heavy-duty chassis dynamometer per station is about $178,000 for each station,[132] which are assumed to be recouped by testing station owners within five years of operation, and
- On-going costs of maintaining and operating the heavy-duty testing station such as hiring mechanic technicians, paying for testing facility rental, utility usage, and administrative costs, etc. plus business profits were estimated based on current light-duty smog check station operation cost data.
    - The current costs of light-duty BAR-97 testing is about $52.6 per test.[133] Staff assumed this $52.6 per test charged by smog check stations factors in the on-going costs for the station owner to maintain and operate the testing station, plus maintain adequate business profits when the station is at full testing capacity. For heavy-duty chassis dynamometer testing, the more sophisticated testing

[131] Assuming the testing station would operate 40 hours per week and each test would take one hour, in 2024, there would be [(138,778 vehicles with 2010-2012 MY engines) x (2 test per vehicle per year) x (1 hour per test)] / [(40 hours per week) x (52 weeks per year) per station] = 133 stations needed.
[132] (CE CERT, 2019) Final Report Heavy-duty On-Road Vehicle Inspection and Maintenance Program, Contract No. 15RD022, University of California, Riverside, January 2019. 2. Tech proposal (ca.gov)
[133] (BAR, 2020a) Executive Summary Report Smog Check Statewide, Bureau of Automotive Repair, 2020. Executive Summary Report Smog Check Statewide 2020 (ca.gov)

instrumentation would require a more skillful mechanic technician with the ability to operate commercial vehicles. It would also require a larger building with more square footage to adequately support heavy-duty vehicle testing relative to light-duty passenger cars. Hence, staff expects the on-going costs for a heavy-duty testing station owner to maintain and operate a heavy-duty testing station would be more expensive compared to current light-duty testing station. As heavy-duty chassis dynamometer costs are approximately double the costs of light-duty chassis dynamometer,[134] staff estimated the costs to operate a heavy-duty testing station to be double the operating cost of a current light-duty testing station. Thus, the costs passed on to the vehicle owner would be about double that of current light-duty smog check costs. Based on these assumptions, staff estimates a cost of about $105 per dynamometer test assuming the heavy-duty testing station would be at full testing capacity in 2024.

Based on the above assumptions, staff estimated that in 2024, it would cost vehicle owners about $122 per test, or $244 per vehicle per year for biannual chassis testing. Taking into account the current costs of dynamometer operation at the few locations in the State that already have heavy-duty vehicle dynamometers installed at their facility, this cost is on the low end of the range of the costs currently offered. For example, limited cost estimates for use of a dynamometer today for operations ranging from repair diagnosis support to vehicle research range from about $100-$200 per vehicle[135] for the use of repair grade and water brake dynamometers up to $683 per hour[136] for research grade dynamometers. It is expected that costs for this alternative would be towards the lower end of this cost spectrum as repair grade dynamometers would be needed to support the testing for Alternative 2. Staff's estimated $122 per dynamometer test costs would be in addition to the costs of the opacity and visual inspection also required of non-OBD vehicles; thus, the total testing costs for these vehicles could be up to about $511 per vehicle per year under Alternative 2.

Furthermore, it is important to note that the vehicle population operating in California with 2010-2012 MY engines would substantially decrease due to natural turnover over the years 2024 to 2037. For example, in 2024, about 12 percent of vehicles operating in California are projected to be vehicles with 2010-2012 MY engines; in 2030, this number would drop to six percent and by 2037, this number would drop further to two percent. This is a decrease of 44 percent and 76 percent, respectively, below the percentages of these vehicles in 2024 population numbers. Unlike the light-duty Smog Check program model which requires light-duty OBD-equipped vehicles to travel to a testing station to perform the required smog check, heavy-duty OBD testing can be done remotely in the proposed HD I/M model. Thus, once these heavy-duty non-OBD vehicles turn over to heavy-duty OBD-equipped vehicles, stations established to perform dynamometer tests in this Alternative 2 HD I/M program

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[134] (DynoComInc, 2021) Industries Chassis Dynamometer Systems Product Catalog, DynoCom Inc., assessed April 2021. DynoCom Industries Chassis Dynamometer Systems Product Catalog

(CE CERT, 2019) Final Report Heavy-duty On-Road Vehicle Inspection and Maintenance Program, Contract No. 15RD022, University of California, Riverside, January 2019. 2. Tech proposal (ca.gov)

[135] (TruckFreighter, 2021) Preventive Maintenance Checklist for Semi-Trucks, TruckFreighter.com, accessed April 2021. Preventive Maintenance Checklist for Semi-Trucks | TruckFreighter.com

[136] (UCR, 2021) HDC Emission Testing Rates, Center for Environmental Research and Technology, accessed April 2021. HDC Emission Testing Rates | Center for Environmental Research and Technology (ucr.edu)

would lose their market and have no way to replace their lost business. Therefore, under the Alternative 2 program structure, the establishment of these station-based testing facilities would result in an unsustainable business model that would become obsolete as the program is implemented. Either stations established at the beginning of this program to perform this proposed chassis dynamometer testing would go out of business or testing costs would have to substantially increase to account for the decreased demand. For example, accounting for the drop in vehicle population by 2030, the cost of the test would likely need to increase by 55 percent for all stations to maintain a profit margin. It would need to increase even further in subsequent years, eventually to a cost that would not be reasonable to require of a vehicle owner.

Vehicle Repair Costs

Alternative 2 is expected to result in more non-OBD vehicle repairs compared to the Proposed Regulation as more non-OBD vehicles with broken NOx emissions control systems could be identified; hence, there would be increase in vehicle repair costs compared to the Proposed Regulation. Staff estimated the number of additional non-OBD vehicle repairs following a methodology similar to that discussed in Section C.1.e. Staff assumed the needed repair for non-OBD vehicles that have high NOx emissions detected through the dynamometer test would include an SCR catalyst replacement with a cost of $4,969 per repair.[137]

The total incremental costs of Alternative 2, including reporting costs, vehicle testing costs, tester training costs, compliance certification fee, and heavy-duty vehicle repair costs, are summarized in Table F-7. Alternative 2 is projected to cost $2.66B over 2023-2037 period, with a maximum annual cost of $418M in 2024. Alternative 2 is estimated to cost $562M more than the Proposed Regulation, a 27 percent increase in costs during the 2023-2037 analysis, which would stem from the increased vehicle testing and repair costs.

[137] (ERG, 2021) Heavy-Duty On-board Diagnostic Data Collection Demonstration and Repair Data Collection Study, Agreement Number – 18MSC001, Eastern Research Group, June 2021.

Table F- 7: Total Estimated Direct Incremental Costs Relative to the Baseline of Alternative 2 from 2023 through 2037[138]

Calendar Year	Reporting	Vehicle Testing	HD I/M-Approved Tester Training	Compliance Certificate	Heavy-Duty Vehicle Repairs	Total Costs
2023	$3,324,000	$2,541,000	$5,889,000	$23,765,000	$48,297,000	**$83,816,000**
2024	$2,419,000	$150,741,000	$3,203,000	$28,102,000	$233,239,000	**$417,704,000**
2025	$2,199,000	$96,349,000	$3,321,000	$28,740,000	$104,831,000	**$235,440,000**
2026	$2,001,000	$94,294,000	$3,419,000	$29,309,000	$70,736,000	**$199,760,000**
2027	$1,815,000	$92,463,000	$3,508,000	$29,807,000	$49,374,000	**$176,967,000**
2028	$1,635,000	$90,678,000	$3,579,000	$30,214,000	$42,583,000	**$168,689,000**
2029	$1,468,000	$84,178,000	$3,626,000	$30,526,000	$40,049,000	**$159,848,000**
2030	$1,316,000	$82,456,000	$3,649,000	$30,740,000	$38,736,000	**$156,896,000**
2031	$1,194,000	$81,307,000	$3,685,000	$31,011,000	$37,724,000	**$154,921,000**
2032	$1,072,000	$80,118,000	$3,702,000	$31,256,000	$37,256,000	**$153,403,000**
2033	$953,000	$79,038,000	$3,718,000	$31,471,000	$36,802,000	**$151,982,000**
2034	$846,000	$78,044,000	$3,725,000	$31,675,000	$36,364,000	**$150,653,000**
2035	$744,000	$76,997,000	$3,714,000	$31,830,000	$36,055,000	**$149,340,000**
2036	$663,000	$76,382,000	$3,717,000	$32,026,000	$35,792,000	**$148,579,000**
2037	$592,000	$75,887,000	$3,716,000	$32,255,000	$35,608,000	**$148,058,000**
Total	**$22,240,000**	**$1,241,474,000**	**$56,171,000**	**$452,727,000**	**$883,446,000**	**$2,656,058,000**

[138] Costs were rounded to the nearest thousand.

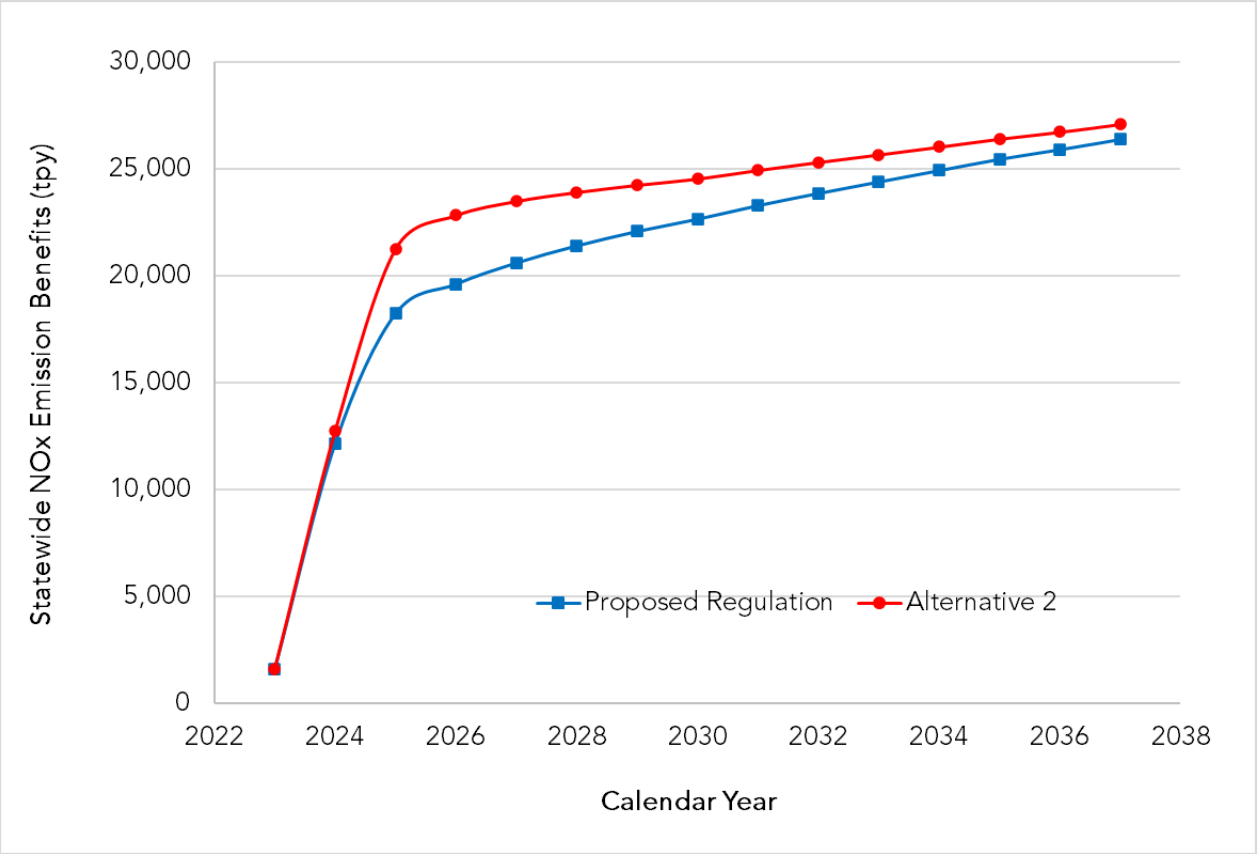
b. Benefits

The emission benefits of Alternative 2 are shown in Table F-8. As shown in Figure F-3, the inclusion of periodic chassis dynamometer testing on non-OBD vehicles in Alternative 2 would result in more NOx emission benefits compared to the Proposed Regulation, an increase in eight percent from the Proposed Regulation. (Note that the same PM emission benefits would be achieved under Alternative 2 and the Proposed Regulation). As the older non-OBD vehicles would eventually be retired and replaced due to natural turnover to newer OBD-equipped vehicles, the increased NOx emission benefits compared to the Proposed Regulation would diminish over time.

Table F- 8: Projected Statewide Emission Benefits under Alternative 2 from 2023 through 2037

Calendar Year	PM Benefits (tpy)	NOx Benefits (tpy)
2023	18	1,627
2024	117	12,771
2025	196	21,272
2026	207	22,833
2027	210	23,499
2028	210	23,918
2029	210	24,255
2030	210	24,545
2031	212	24,951
2032	214	25,323
2033	216	25,675
2034	218	26,038
2035	220	26,414
2036	222	26,736
2037	225	27,101
Total (2023-2037)	**2,904 tons**	**336,960 tons**

Figure F- 3: NOx Emission Benefits for the Proposed Regulation and Alternative 2



Alternative 2 would result in the same cost savings on California heavy-duty vehicle owners due to the avoided smoke opacity testing need on heavy-duty OBD-equipped vehicles as the Proposed Regulation, as shown in Table B-3. The statewide health benefits of Alternative 2 are presented in Table F-9. As shown, Alternative 2 is predicted to save eight percent more lives compared to the Proposed Regulation. Alternative 2's total monetized health benefits are eight percent higher than the Proposed Regulation.

Table F- 9: Statewide Valuation from Avoided Health Outcomes Under Alternative 2

Calendar Year	Avoided Premature Cardiopulmonary Mortality	Avoided Cardiovascular Hospitalizations	Avoided Acute Respiratory Hospitalizations	Avoided ER Visits	Valuation (2020$)[139]
2023	20	2	3	10	$196,116,000
2024	126	16	19	61	$1,264,126,000
2025	210	27	32	102	$2,111,696,000
2026	229	30	36	111	$2,298,226,000
2027	238	32	38	115	$2,395,540,000
2028	245	34	40	118	$2,464,158,000
2029	251	35	42	120	$2,523,831,000

[139] Values were rounded to the nearest thousand.

Calendar Year	Avoided Premature Cardiopulmonary Mortality	Avoided Cardiovascular Hospitalizations	Avoided Acute Respiratory Hospitalizations	Avoided ER Visits	Valuation (2020$)[139]
2030	257	37	44	122	$2,578,790,000
2031	263	38	46	125	$2,647,397,000
2032	270	40	47	127	$2,712,141,000
2033	276	41	49	130	$2,775,748,000
2034	282	43	51	132	$2,838,725,000
2035	289	44	53	135	$2,903,427,000
2036	294	45	54	137	$2,957,574,000
2037	300	47	56	139	$3,015,363,000
Total	**3,551**	**511**	**610**	**1,683**	**$35,682,858,000**

c. Economic Impacts

Alternative 2 would implement more stringent periodic testing requirement on heavy-duty non-OBD vehicles operating in California starting in 2024. The total cost of Alternative 2 ($2.66B) would be 27 percent more than the Proposed Regulation ($2.09B) over the years between 2023 and 2037.

Table F-10 indicates the change in statewide economic indicators for Alternative 2 relative to the baseline. The model estimates similar patterns as the Proposed Regulation with small increases in GSP, Employment, and Output in the first year of the assessment, followed by decreases in all economic indicators in subsequent years of the assessment. In general, the negative economic impacts associated with Alternative 2 are larger in magnitude than those estimated for the Proposed Regulation. Under alternative 2, impacts are not estimated to exceed 0.02 of the baseline.

Table F- 10: Change in Growth of Economic Indicators for Alternative 2 Relative to Legal Baseline

	GSP	GSP	Personal Income	Personal Income	Employment	Employment	Output	Output	Private Investment	Private Investment
Calendar Year	Total Change (2020M$)	% Change	Total Change (2020M$)	% Change	Total Change (Jobs)	% Change	Total Change (2020M$)	% Change	Total Change (2020M$)	% Change
2023	20.91	0.00%	-47.05	0.00%	225	0.00%	34.57	0.00%	-10.24	0.00%
2024	-4.57	0.00%	-317.19	-0.01%	-152	0.00%	-22.01	0.00%	-73.08	-0.02%
2025	-89.61	0.00%	-224.49	-0.01%	-745	0.00%	-172.18	0.00%	-79.09	-0.02%
2026	-98.95	0.00%	-197.84	-0.01%	-852	0.00%	-192.23	0.00%	-69.25	-0.01%
2027	-99.33	0.00%	-183.23	-0.01%	-872	0.00%	-194.23	0.00%	-55.97	-0.01%
2028	-94.49	0.00%	-177.18	-0.01%	-835	0.00%	-185.76	0.00%	-43.98	-0.01%
2029	-91.44	0.00%	-169.81	-0.01%	-803	0.00%	-179.45	0.00%	-34.30	-0.01%
2030	-87.18	0.00%	-167.80	-0.01%	-763	0.00%	-171.35	0.00%	-27.33	-0.01%
2031	-85.39	0.00%	-167.73	-0.01%	-743	0.00%	-167.44	0.00%	-22.94	0.00%
2032	-84.64	0.00%	-167.16	-0.01%	-732	0.00%	-165.40	0.00%	-20.41	0.00%
2033	-85.07	0.00%	-167.21	-0.01%	-729	0.00%	-165.36	0.00%	-19.19	0.00%
2034	-86.09	0.00%	-167.51	-0.01%	-729	0.00%	-166.34	0.00%	-18.79	0.00%
2035	-87.31	0.00%	-167.83	-0.01%	-730	0.00%	-167.69	0.00%	-18.83	0.00%
2036	-88.59	0.00%	-168.57	-0.01%	-731	0.00%	-169.25	0.00%	-19.17	0.00%
2037	-89.79	0.00%	-169.42	-0.01%	-730	0.00%	-170.77	0.00%	-19.64	0.00%

d. Cost-Effectiveness

Table F-11 summarizes staff's estimated Alternative 2's and the Proposed Regulation's cost-effectiveness. As shown, Alternative 2 is a less cost-effective alternative compared to the Proposed Regulation. Even though Alternative 2 would achieve slightly more NOx emissions reduction compare to the Proposed Regulation, staff rejected it for the reasons discussed below.

Table F- 11: Cost-Effectiveness of Alternative 2 and the Proposed Regulation

Scenario	PM Cost-Effectiveness ($/pound)	NOx Cost-Effectiveness ($/pound)
Alternative 2	111.25	2.35
Proposed Regulation	83.62	1.89

e. Reason for Rejecting

Staff rejected Alternative 2 due to the following reasons:

- Alternative 2 would be less cost effective than the Proposed Regulation. Although Alternative 2 would result in slightly higher NOx emissions reductions compared to the Proposed Regulation, an eight percent increase from the Proposed Regulation, its total direct costs would be 27 percent higher than the Proposed Regulation.
- Alternative 2 proposes to establish an unsustainable small business model that would become obsolete shortly after the proposed HD I/M program is implemented. Either the small businesses created as a result of these requirements would go out of business, or testing costs would increase substantially to cover the resulted loss of demand, neither of which are desirable.
- The large infrastructure development network needed to support this alternative would be difficult to achieve by the proposed 2024 implementation date for periodic testing, risking a delay in the rollout and its projected emissions benefits in the early years.

G. MODIFIED BASELINE ANALYSIS

As mentioned above, although the legal baseline used above in Sections B to F can only include regulations that have completed the rulemaking process, staff analyzed an additional SRIA scenario for the Proposed Regulation based on a modified baseline accounting for CARB's proposed Heavy-Duty Omnibus Regulation. The Omnibus Regulation was approved by the Board for adoption in August 2020. Including the Heavy-Duty Omnibus Regulation in the baseline offers a more realistic analysis of the Proposed Regulation's impacts. The proposed Heavy-Duty Omnibus Regulation would impose more stringent NOx emission standards for 2024 and newer MY heavy-duty engines installed on heavy-duty vehicles. Any of these vehicles operating in California during these future years would be subject to the Proposed Regulation detailed in this SRIA analysis. The proposed Heavy-Duty Omnibus Regulation is anticipated to be fully adopted into the California Code of Regulations by the time the Proposed Regulation is implemented in 2023. In general, staff used the same

benefit and cost impact analysis methodologies as described above for the legal baseline to analyze the scenario including the Heavy-Duty Omnibus Regulation in the baseline.

1. Benefits

a. Emission Benefits

The emission benefits for the Proposed Regulation with the modified baseline are shown in Table G-1. Figure G-1 and Figure G-2 compare the Proposed Regulation's PM and NOx emission benefits, respectively, for the legal and modified baseline scenarios. There is minimal difference between the two scenarios when projecting PM emission benefits (less than one percent in total PM emission benefits difference) as the proposed Heavy-Duty Omnibus Regulation would not have significant impacts on heavy-duty vehicle PM emissions (Figure G-1). The Proposed Regulation's total NOx emission benefits are projected to be about three percent lower using the modified baseline compared to the analysis using legal baseline (Figure G-2). Since heavy-duty vehicles installed with engines certified with the proposed Heavy-Duty Omnibus Regulation's more stringent NOx standards would emit about 90 percent lower NOx emissions compared to vehicles currently in production, including the Omnibus Regulation would lower the NOx emission benefits expected from the Proposed Regulation. Additionally, as shown, the difference in NOx emission benefits of the Proposed Regulation between the two baseline scenarios would be negligible for the first six years of the Proposed Regulation implementation. This is because Omnibus compliant vehicles would not account for a significant part of the vehicle population.

Table G- 1: Projected Statewide Emission Benefits for the Proposed Regulation versus the Modified Baseline from 2023 through 2037

Calendar Year	PM Benefits (tpy)	NOx Benefits (tpy)
2023	18	1,627
2024	117	12,178
2025	196	18,213
2026	207	19,524
2027	210	20,447
2028	210	21,131
2029	210	21,659
2030	210	22,092
2031	212	22,596
2032	213	23,042
2033	215	23,459
2034	217	23,876
2035	220	24,291
2036	221	24,638
2037	224	25,011
Total (2023-2037)	**2,900 tons**	**303,784 tons**

Figure G- 1: PM Emission Benefits for the Proposed Regulation relative to the Legal Baseline and Modified Baseline (tpy)

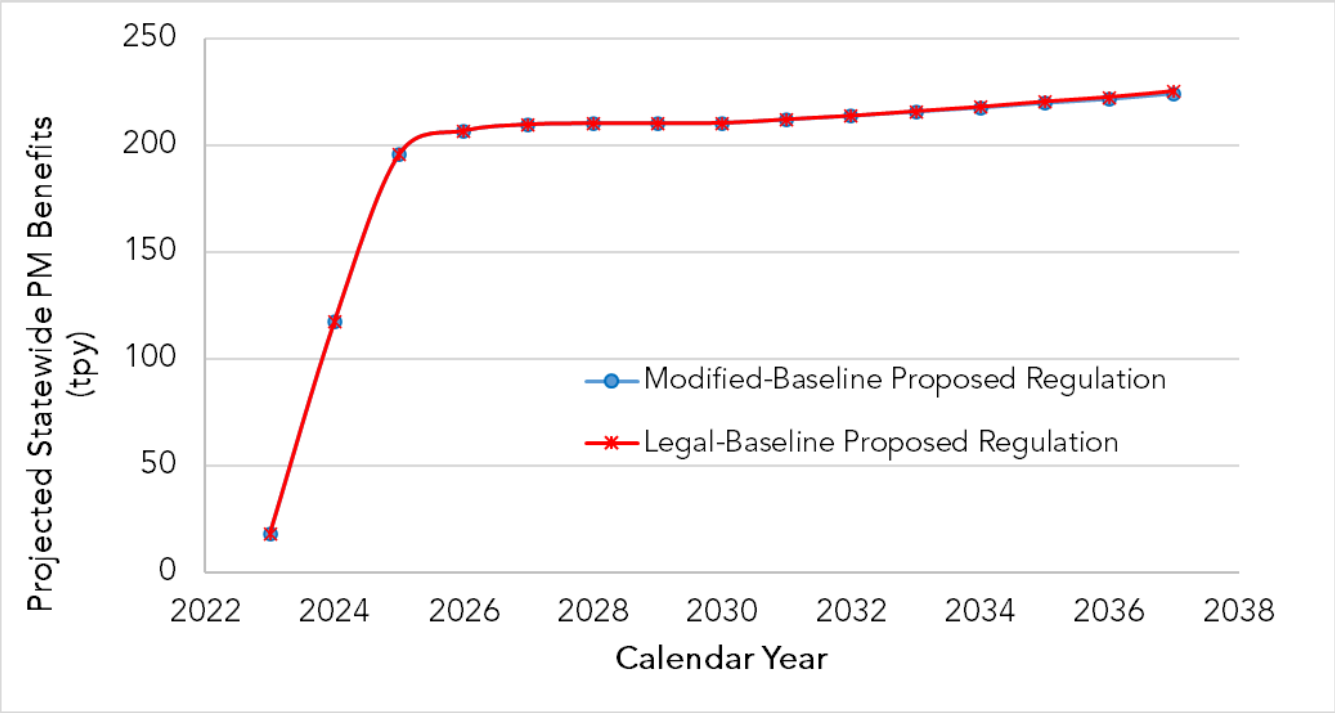
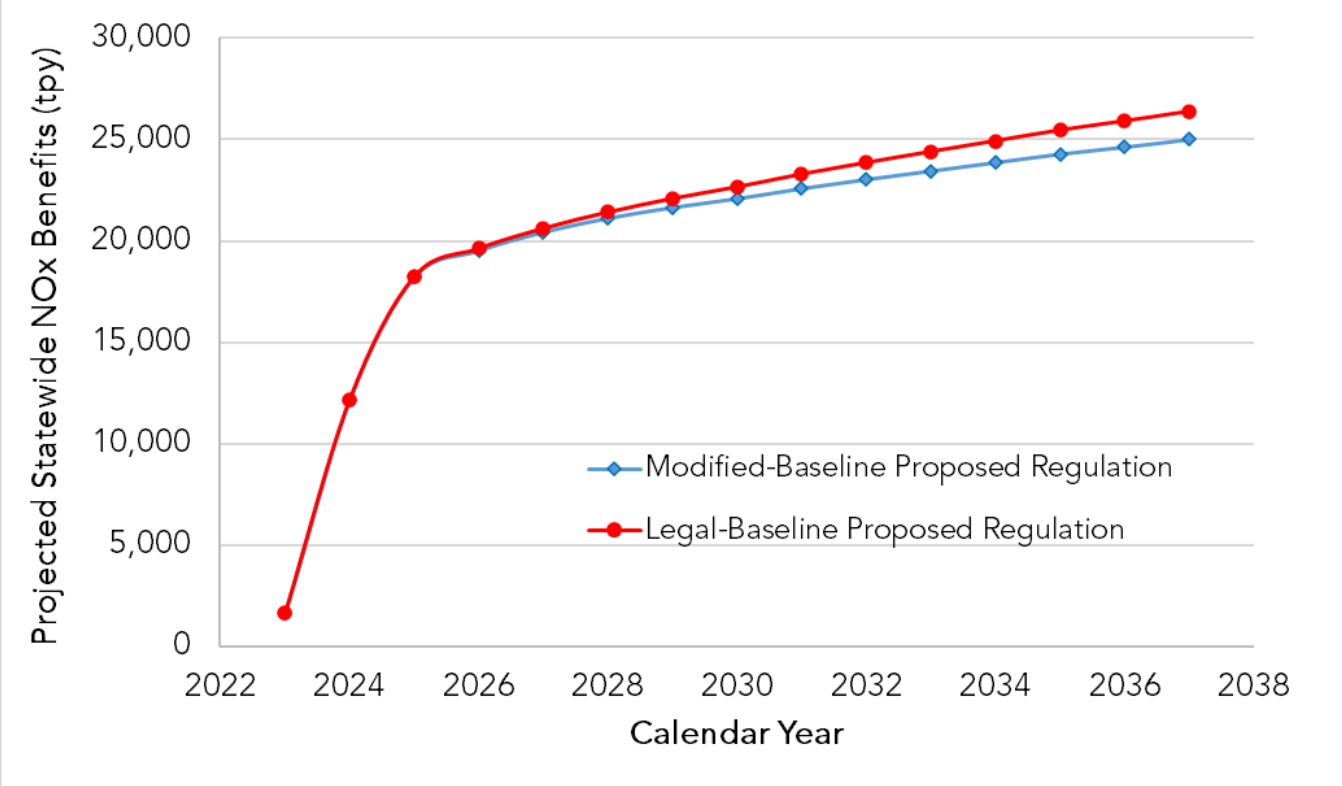


Figure G- 2: NOx Emission Benefits for the Proposed Regulation relative to the Legal Baseline and Modified Baseline (tpy)



b. Cost Savings

The Proposed Regulation's cost savings on California heavy-duty vehicle owners due to the avoided smoke opacity testing need on heavy-duty OBD-equipped vehicles relative to the modified baseline would be the same as the corresponding estimated Proposed Regulation's cost savings relative to the legal baseline as shown in Table B-3.

c. Health Benefit

Table G-2 summarizes staff's estimated reduction in statewide and regional premature mortality, hospitalizations, and ER visits associated with the Proposed Regulation relative to the modified baseline for 2023 through 2037. The total statewide valuation of health benefits of the Proposed Regulation with the modified baseline was estimated to be $32.3B as summarized in Table G-3. The health benefit result in about three percent lower monetized health benefit relative to the analysis using the legal baseline due to the lower projected NOx emission benefits.

Table G- 2: Cumulative Regional and Statewide Avoided Health Incidents from 2022 through 2037 for the Proposed Regulation versus the Modified Baseline*

Air Basin	Cardiopulmonary Mortality	Hospitalizations for Cardiovascular Illness	Hospitalizations for Respiratory Illness	Emergency Room Visits
Great Basin Valleys	1 (1 - 2)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)
Lake County	1 (1 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Lake Tahoe	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Mojave Desert	53 (42 - 65)	7 (0 - 14)	9 (2 - 16)	21 (13 - 29)
Mountain Counties	21 (17 - 26)	2 (0 - 4)	2 (1 - 4)	7 (5 - 10)
North Central Coast	13 (10 - 16)	2 (0 - 4)	2 (1 - 4)	8 (5 - 10)
North Coast	4 (3 - 5)	0 (0 - 1)	0 (0 - 1)	2 (1 - 2)
Northeast Plateau	1 (1 - 2)	0 (0 - 0)	0 (0 - 0)	1 (0 - 1)
Sacramento Valley	143 (112 - 175)	16 (0 - 32)	19 (5 - 34)	56 (35 - 76)
Salton Sea	39 (30 - 47)	5 (0 - 10)	6 (1 - 11)	19 (12 - 25)
San Diego County	118 (92 - 144)	15 (0 - 30)	18 (4 - 32)	49 (31 - 67)
San Francisco Bay	226 (176 - 277)	34 (0 - 67)	41 (10 - 72)	126 (80 - 173)
San Joaquin Valley	731 (573 - 891)	81 (0 - 159)	97 (23 - 170)	271 (172 - 370)
South Central Coast	34 (26 - 41)	5 (0 - 10)	6 (1 - 10)	15 (10 - 21)
South Coast	1,825 (1,428 – 2,228)	293 (0 - 575)	350 (82 - 618)	945 (598 – 1,292)
Statewide	**3,210 (2,512 – 3,921)**	**462 (0 - 906)**	**551 (129 - 973)**	**1,519 (962 – 2,077)**

*Values in parentheses represent the 95 percent CI. Totals may not add due to rounding but are within the 95 percent CI.

Table G- 3: Statewide Valuation from Avoided Health Outcomes for the Proposed Regulation versus the Modified Baseline

Calendar Year	Avoided Premature Cardiopulmonary Mortality	Avoided Cardiovascular Hospitalizations	Avoided Acute Respiratory Hospitalizations	Avoided ER Visits	Valuation (2020$)[140]
2023	20	2	3	10	$196,116,000
2024	120	15	18	59	$1,209,228,000
2025	181	23	28	88	$1,822,053,000
2026	197	26	31	95	$1,977,901,000
2027	208	28	34	100	$2,093,210,000
2028	217	30	36	104	$2,182,756,000
2029	225	32	38	107	$2,257,375,000
2030	231	33	39	110	$2,323,578,000
2031	239	35	41	113	$2,399,459,000
2032	246	36	43	116	$2,469,691,000
2033	253	38	45	119	$2,538,093,000
2034	259	39	47	121	$2,604,840,000
2035	266	41	48	124	$2,671,829,000
2036	271	42	50	126	$2,726,929,000
2037	277	43	51	128	$2,783,851,000
Total	**3,210**	**462**	**551**	**1,519**	**$32,256,909,000**

2. Costs

a. Direct Costs

Compared to the modified baseline, the Proposed Regulation's direct cost impacts would be the same as using the legal baseline except for the heavy-duty vehicle repair costs. The Heavy-Duty Omnibus Regulation would further lengthen warranty period for 2027 and newer MY heavy-duty diesel engines as shown in Table G-4. As discussed in Section C.1.e.ii., staff did not account for costs for vehicle repairs that are expected to occur while the vehicle is projected to still be under warranty, as these repairs would be covered by the manufacturer and come at no cost to the vehicle owner. Given the proposed extended warranty periods for 2027 and newer MY heavy-duty engines, a larger percentage of the overall vehicle repairs would still be within the vehicle warranty periods; such costs were subtracted from the costs presented in Section C.

Table G-5 summarizes the incremental costs of the Proposed Regulation compared to the modified baseline, including reporting costs, vehicle testing costs, tester training costs, compliance certification fee, and heavy-duty vehicle repair costs. Using the modified baseline, the Proposed Regulation is projected to cost $2.08B over 2023-2037 period, a 0.44 percent decrease from the analysis using legal baseline ($2.09B). The cost effectiveness of the Proposed Regulation using the modified baseline is about $83.82/pound PM and $1.93/pound NOx (vs. the legal baseline's cost effectiveness of $83.62/pound PM and

[140] Values were rounded to the nearest thousand.

$1.89/pound NOx), which is well within the range of previous CARB regulations. Using the modified baseline, the Proposed Regulation is shown to be slightly less cost effective than the analysis using the legal baseline, a decrease in cost effectiveness of 0.23 percent for PM and 2.09 percent for NOx.

Table G- 4: Heavy-Duty Warranty under the Proposed Heavy-Duty Omnibus Regulation[141]

Engine/Vehicle Categories	Existing Warranty Periods for 2022 and later MY Engines	Proposed Warranty Periods for 2027-2030 MY Engines	Proposed Warranty Periods for 2031 an later MY Engines
Heavy heavy-duty diesel (Class 8, >33,000 pounds GVWR)	350,000 miles or 5 years, whichever first occurs	450,000 miles, 7 years, or 22,000 hours, whichever first occurs	600,000 miles, 10 years, or 30,000 hours, whichever first occurs
Medium heavy-duty diesel (Class 6-7, 19,501-33,000 pounds GVWR)	150,000 miles or 5 years, whichever first occurs	220,000 miles, 7 years, or 11,000 hours, whichever firsts occurs	280,000 miles, 10 years, or 14,000 hours, whichever first occurs
Light heavy-duty diesel (Class 4-5, 14,001-19,500 pounds GVWR)	110,000 miles or 5 years, whichever first occurs	150,000 miles, 7 years, or 7,000 hours, whichever first occurs	210,000 miles, 10 years, or 10,000 hours, whichever first occurs
Heavy-duty otto (Class 4-8, >14,000 pounds GVWR)	50,000 miles or 5 years,* whichever first occurs	110,000 miles, 7 years, or 6,000 hours, whichever first occurs	160,000 miles, 10 years, or 8,000 hours, whichever first occurs

*Not included under recently adopted heavy-duty warranty amendments for 2022 and later MY engines, but current periods shown here for completeness.

[141] (CARB, 2020) Public Hearing to Consider the Proposed Heavy-Duty Engine and Vehicle Omnibus Regulation and Associated Amendments, Staff Report: Initial Statement of Reasons, California Air Resources Board, released June 23, 2020. HD Omnibus ISOR: Revised on 7-9-2020 for Errata (ca.gov)

Table G- 5: Total Estimated Direct Incremental Costs Relative to the Modified Baseline for the Proposed Regulation from 2023 through 2037[142]

Calendar Year	Reporting	Vehicle Testing	HD I/M-Approved Tester Training	Compliance Certificate	Heavy-Duty Vehicle Repairs	Total Costs
2023	$3,324,000	$2,541,000	$5,889,000	$23,765,000	$48,297,000	**$83,816,000**
2024	$2,419,000	$116,803,000	$3,203,000	$28,102,000	$181,441,000	**$331,969,000**
2025	$2,199,000	$62,412,000	$3,321,000	$28,740,000	$83,040,000	**$179,712,000**
2026	$2,001,000	$60,357,000	$3,419,000	$29,309,000	$57,627,000	**$152,713,000**
2027	$1,815,000	$58,525,000	$3,508,000	$29,807,000	$41,602,000	**$135,257,000**
2028	$1,635,000	$56,741,000	$3,579,000	$30,214,000	$36,640,000	**$128,809,000**
2029	$1,468,000	$54,991,000	$3,626,000	$30,526,000	$34,970,000	**$125,581,000**
2030	$1,316,000	$53,268,000	$3,649,000	$30,740,000	$34,231,000	**$123,204,000**
2031	$1,194,000	$52,120,000	$3,685,000	$31,011,000	$33,737,000	**$121,746,000**
2032	$1,072,000	$50,930,000	$3,702,000	$31,256,000	$32,854,000	**$119,814,000**
2033	$953,000	$49,850,000	$3,718,000	$31,471,000	$31,973,000	**$117,965,000**
2034	$846,000	$48,856,000	$3,725,000	$31,675,000	$31,994,000	**$117,095,000**
2035	$744,000	$47,809,000	$3,714,000	$31,830,000	$32,026,000	**$116,123,000**
2036	$663,000	$47,194,000	$3,717,000	$32,026,000	$32,054,000	**$115,654,000**
2037	$592,000	$46,700,000	$3,716,000	$32,255,000	$32,170,000	**$115,432,000**
Total	**$22,240,000**	**$809,095,000**	**$56,171,000**	**$452,727,000**	**$744,655,000**	**$2,084,889,000**

[142] Costs were rounded to the nearest thousand.

3. Macroeconomic Impacts

Table G-6 shows the impact of the Proposed Regulation relative to modified baseline on macroeconomic indicators in the economy. The results of the macroeconomic analysis of the Proposed Regulation using modified baseline are very similar to the results estimated using the legal baseline. Under the modified baseline, the Proposed Regulation is anticipated to have a slightly smaller impact on the economic indicators; on average, less than one percent smaller impact.

Table G- 6: Change in Growth of Economic Indicators for the Proposed Regulation Relative to the Modified Baseline

	GSP	GSP	Personal Income	Personal Income	Employment	Employment	Output	Output	Private Investment	Private Investment
Calendar Year	Total Change (2020M$)	% Change	Total Change (2020M$)	% Change	Total Change (Jobs)	% Change	Total Change (2020M$)	% Change	Total Change (2020M$)	% Change
2023	20.91	0.00%	-47.05	0.00%	225	0.00%	34.57	0.00%	-10.24	0.00%
2024	-7.68	0.00%	-251.93	-0.01%	-171	0.00%	-24.63	0.00%	-59.37	-0.01%
2025	-75.08	0.00%	-170.71	-0.01%	-640	0.00%	-142.53	0.00%	-62.15	-0.01%
2026	-78.66	0.00%	-147.74	-0.01%	-690	0.00%	-151.39	0.00%	-53.02	-0.01%
2027	-76.89	0.00%	-135.34	0.00%	-686	0.00%	-149.05	0.00%	-41.94	-0.01%
2028	-71.62	0.00%	-129.49	0.00%	-643	0.00%	-139.62	0.00%	-32.25	-0.01%
2029	-67.50	0.00%	-125.52	0.00%	-605	0.00%	-131.77	0.00%	-25.08	-0.01%
2030	-64.45	0.00%	-123.90	0.00%	-575	0.00%	-125.86	0.00%	-20.07	0.00%
2031	-62.98	0.00%	-123.49	0.00%	-557	0.00%	-122.65	0.00%	-16.96	0.00%
2032	-62.32	0.00%	-122.16	0.00%	-547	0.00%	-120.91	0.00%	-15.12	0.00%
2033	-62.30	0.00%	-121.18	0.00%	-542	0.00%	-120.27	0.00%	-14.14	0.00%
2034	-62.61	0.00%	-121.04	0.00%	-537	0.00%	-120.16	0.00%	-13.85	0.00%
2035	-63.23	0.00%	-120.97	0.00%	-534	0.00%	-120.63	0.00%	-13.93	0.00%
2036	-63.90	0.00%	-121.29	0.00%	-531	0.00%	-121.29	0.00%	-14.25	0.00%
2037	-64.58	0.00%	-121.78	0.00%	-527	0.00%	-122.03	0.00%	-14.69	0.00%

4. Fiscal Impacts

a. Local Government

The Proposed Regulation would have cost impacts versus the modified baseline on local government fleets that own non-gasoline combustion heavy-duty vehicles including the increased costs to comply with the Proposed Regulation as well as the cost savings from the avoided annual smoke opacity testing need on heavy-duty OBD-equipped vehicles, as summarized in Table G-7. Using the modified baseline, the Proposed Regulation's net fiscal impact on local government fleets is projected to be $111.1M over 2023-2037 period, 0.55 percent decrease from the analysis using legal baseline ($111.7M).

Table G- 7: Fiscal Impact on Local Government Relative to the Modified Baseline for the Proposed Regulation from 2023 through 2037[143]

Calendar Year	Incremental Costs	Cost Savings	Net Costs
2023	$5,607,000	$0	$5,607,000
2024	$22,207,000	$1,653,000	$20,555,000
2025	$12,022,000	$1,749,000	$10,273,000
2026	$10,216,000	$1,837,000	$8,379,000
2027	$9,048,000	$1,916,000	$7,133,000
2028	$8,617,000	$1,983,000	$6,634,000
2029	$8,401,000	$2,036,000	$6,365,000
2030	$8,242,000	$2,075,000	$6,167,000
2031	$8,144,000	$2,110,000	$6,034,000
2032	$8,015,000	$2,137,000	$5,878,000
2033	$7,891,000	$2,157,000	$5,734,000
2034	$7,833,000	$2,172,000	$5,661,000
2035	$7,768,000	$2,181,000	$5,587,000
2036	$7,737,000	$2,187,000	$5,550,000
2037	$7,722,000	$2,192,000	$5,530,000
Total	**$139,471,000**	**$28,384,000**	**$111,087,000**

Local Sales Tax Revenue

Sales taxes are levied in California to fund a variety of programs at the State and local level. The Proposed Regulation would increase testing devices, engine parts, and vehicle parts sale due to the projected increasing vehicle testing and repair demand, which would result in a direct increase in sales tax revenue collected by local governments. Table G-8 summarizes staff estimated local sales tax revenues from 2023 through 2037 relative to the modified baseline as a result of the Proposed Regulation.

[143] Costs were rounded to the nearest thousand.

Table G- 8: Projected Local Sales Tax Revenues Relative to the Modified Baseline under the Proposed Regulation

Calendar Year	Local Sales Tax Revenue
2023	$1,633,000
2024	$8,464,000
2025	$3,780,000
2026	$3,224,000
2027	$2,885,000
2028	$2,796,000
2029	$2,775,000
2030	$2,767,000
2031	$2,782,000
2032	$2,780,000
2033	$2,779,000
2034	$2,797,000
2035	$2,808,000
2036	$2,832,000
2037	$2,857,000
Total	**$47,959,000**

b. State Government

The Proposed Regulation would have cost impacts on State government relative to the modified baseline, which include:

- Cost impacts on State government fleets that own non-gasoline combustion heavy-duty vehicles included the costs to comply with the Proposed Regulation and the cost savings from the avoided annual smoke opacity testing need on heavy-duty OBD-equipped vehicles, as summarized in Table G-9. Using the modified baseline, there is a 0.55 percent decrease in net fiscal impact on State government fleets from the legal baseline analysis ($37.0M using modified baseline vs. $37.2M using legal baseline), and
- Cost impacts on State agencies to implement and enforce the Proposed Regulation as discussed in Section D.2.b.

Table G- 9: Fiscal Impact on State Government Fleets Relative to the Modified Baseline for the Proposed Regulation from 2023 through 2037[144]

Calendar Year	Incremental Costs	Cost Savings	Net Costs
2023	$1,869,000	$0	$1,869,000
2024	$7,402,000	$551,000	$6,852,000

[144] Costs were rounded to the nearest thousand.

Calendar Year	Incremental Costs	Cost Savings	Net Costs
2025	$4,007,000	$583,000	$3,424,000
2026	$3,405,000	$612,000	$2,793,000
2027	$3,016,000	$639,000	$2,378,000
2028	$2,872,000	$661,000	$2,211,000
2029	$2,800,000	$679,000	$2,122,000
2030	$2,747,000	$692,000	$2,056,000
2031	$2,715,000	$703,000	$2,011,000
2032	$2,672,000	$712,000	$1,959,000
2033	$2,630,000	$719,000	$1,911,000
2034	$2,611,000	$724,000	$1,887,000
2035	$2,589,000	$727,000	$1,862,000
2036	$2,579,000	$729,000	$1,850,000
2037	$2,574,000	$731,000	$1,843,000
Total	**$46,490,000**	**$9,461,000**	**$37,029,000**

State Sales Tax Revenue

As mentioned earlier, the Proposed Regulation would increase testing devices, engine parts, and vehicle parts sale due to the projected increasing vehicle testing and repair demand, which would result in a direct increase in sales tax revenue collected by State governments. Table G-10 summarizes staff estimated State sales tax revenues from 2023 through 2037 relative to the modified baseline as a result of the Proposed Regulation.

Table G- 10: Projected State Sales Tax Revenues Relative to the Modified Baseline under the Proposed Regulation

Calendar Year	State Sales Tax Revenue
2023	$1,376,000
2024	$7,131,000
2025	$3,185,000
2026	$2,716,000
2027	$2,430,000
2028	$2,355,000
2029	$2,336,000
2030	$2,329,000
2031	$2,342,000
2032	$2,339,000
2033	$2,338,000
2034	$2,353,000
2035	$2,361,000
2036	$2,380,000
2037	$2,400,000
Total	**$40,370,000**

H. HEALTH MODELING METHODOLOGY APPENDIX

1. Non-Cancer Health Impacts and Valuations

CARB staff evaluated a limited number of statewide non-cancer health impacts associated with exposure to PM2.5 and NOx emissions from heavy-duty vehicles. NOx includes nitrogen dioxide, a potent lung irritant, which can aggravate lung diseases such as asthma when inhaled.[145] However, the most serious quantifiable impacts of NOx emissions occur through the conversion of NOx to fine particles of ammonium nitrate aerosol through chemical processes in the atmosphere. PM2.5 formed in this manner is termed secondary PM2.5. Both directly emitted PM2.5 and secondary PM2.5 from heavy-duty vehicles is associated with adverse health outcomes, such as cardiopulmonary mortality, hospitalizations for cardiovascular illness and respiratory illness, and ER visits for asthma. As a result, reductions in PM2.5 and NOx emissions are associated with reductions in these health outcomes.

2. Incidence-Per-Ton Methodology

CARB uses the incidence-per-ton (IPT) methodology to quantify the health benefits of emission reductions in cases where dispersion modeling results are not available. A description of this method is included on CARB's webpage.[146] CARB's IPT methodology is based on a methodology developed by U.S. EPA.[147,148,149]

Under the IPT methodology, changes in emissions are approximately proportional to changes in health outcomes. IPT factors are derived by calculating the number of health outcomes associated with exposure to PM2.5 for a baseline scenario using measured ambient concentrations and dividing by the emissions of PM2.5 or a precursor. The calculation is performed separately for each air basin using the following equation:

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[145] (US EPA, 2016) Integrated Science Assessment for Oxides of Nitrogen – Health Criteria United States Environmental Protection Agency, EPA/600/R-15/068, January 2016. http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=526855

[146] (CARB, 2021j) CARB's Methodology for Estimating the Health Effects of Air Pollution, California Air Resources Board, accessed February 9, 2021. https://ww2.arb.ca.gov/resources/documents/carbs-methodology-estimating-health-effects-air-pollution

[147] (Fann et al., 2009) Fann N, Fulcher CM, Hubbell BJ., The influence of location, source, and emission type in estimates of the human health benefits of reducing a ton of air pollution, Air Quality, Atmosphere & Health, 2:169-176, 2009. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2770129/

[148] (Fann et al., 2012) Fann N, Baker KR, Fulcher CM., Characterizing the PM2.5-related health benefits of emission reductions for 17 industrial, area and mobile emission sectors across the U.S. Environ Int.; 49:141-51, November 15, 2012. https://www.sciencedirect.com/science/article/pii/S0160412012001985

[149] (Fann et al., 2018) Fann N, Baker K, Chan E, Eyth A, Macpherson A, Miller E, Snyder J., Assessing Human Health PM2.5 and Ozone Impacts from U.S. Oil and Natural Gas Sector Emissions in 2025, Environ. Sci. Technol. 52 (15), pp 8095–8103, 2018. https://pubs.acs.org/doi/abs/10.1021/acs.est.8b02050

$$IPT = \frac{number\ of\ health\ outcomes\ in\ air\ basin}{annual\ emissions\ in\ air\ basin}$$

Multiplying the emission reductions from the Proposed Regulation in an air basin by the IPT factor then yields an estimate of the reduction in health outcomes achieved by the Proposed Regulation. For future years, the number of outcomes is adjusted to account for population growth. CARB's current IPT factors are based on a 2014-2016 baseline scenario, which represents the most recent data available at the time the current IPT factors were computed. IPT factors are computed for the two types of PM2.5: primary PM2.5 and secondary PM2.5 of ammonium nitrate aerosol formed from precursors.

I. MACROECONOMIC INPUTS FOR REMI ANALYSIS

REMI Policy Variable	Industry		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Production Cost	Lagged Market Share Response: Truck transportation - 484	2020 Fixed National $ (M)	86.83	347.56	186.68	158.65	140.57	133.99	130.75	128.38	126.94	125.86	124.86	123.93	122.96	122.54	122.32
Production Cost	Lagged Market Share Response: Truck transportation - 484	2020 Fixed National $ (M)	0.00	-24.71	-26.15	-27.45	-28.63	-29.65	-30.44	-31.01	-31.54	-31.94	-32.25	-32.47	-32.60	-32.69	-32.76
Exogenous Final Demand	Automotive repair and maintenance - 8111	2020 Fixed National $ (M)	35.09	108.03	53.94	36.96	25.11	19.16	15.30	12.33	9.75	7.65	5.72	4.00	2.53	1.30	0.24
Exogenous Final Demand	Navigational, measuring, electromedical, and control instruments manufacturing - 3345	2020 Fixed National $ (M)	2.50	59.04	17.62	17.97	18.29	18.50	18.57	18.48	18.64	18.64	18.66	18.64	18.46	18.49	18.49
Exogenous Final Demand	Telecommunications - 517	2020 Fixed National $ (M)	0.00	26.29	16.67	17.13	17.56	17.93	18.25	18.53	18.93	19.31	19.70	20.09	20.46	20.89	21.34
Exogenous Final Demand	Office administrative services; Facilities support services - 5611, 5612	2020 Fixed National $ (M)	3.31	0.08	0.08	0.07	0.06	0.05	0.04	0.03	0.04	0.04	0.03	0.03	0.03	0.03	0.04
Exogenous Final Demand	Data processing, hosting, related services - 518	2020 Fixed National $ (M)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Exogenous Final Demand	Engine, turbine, and power transmission equipment manufacturing - 3336	2020 Fixed National $ (M)	12.07	45.36	20.76	14.41	10.40	9.17	8.76	8.58	8.45	8.44	8.42	8.40	8.41	8.41	8.43
Exogenous Final Demand	Motor vehicle parts manufacturing - 3363	2020 Fixed National $ (M)	12.07	45.36	20.76	14.41	10.40	9.17	8.76	8.58	8.45	8.44	8.42	8.40	8.41	8.41	8.43
State and Local Government Spending	State Government	2020 Fixed National $ (M)	8.58	18.70	15.39	15.49	15.70	16.04	16.33	16.54	16.82	17.08	17.31	17.53	17.69	17.90	18.15
State and Local Government Spending	Local Government	2020 Fixed National $ (M)	1.63	8.46	3.78	3.22	2.88	2.80	2.78	2.77	2.78	2.80	2.82	2.84	2.85	2.87	2.89
Consumer Spending	Reallocate Consumption: Hospitals	2020 Fixed National $ (M)	-0.30	-1.88	-2.91	-3.24	-3.51	-3.75	-3.98	-4.19	-4.40	-4.61	-4.82	-5.03	-5.25	-5.43	-5.59
State and Local Government Employment	State Government	Units	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00	37.00