Appendix F

Further Details on Costs and Economic Analysis

Proposed Heavy-Duty Inspection and Maintenance Regulation

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This appendix provides further details on the costs and economic analysis for the proposed heavy-duty inspection and maintenance (HD I/M) program. The calculations conducted for this analysis are contained in the Heavy-Duty Inspection and Maintenance Regulation Cost Spreadsheets (CARB, 2021n).

I. Direct Cost Impacts

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 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, with full implementation occurring in 2024. Staff performed economic impacts of the Proposed Regulation relative to the projected legal baseline from calendar year 2023 through 2050. All estimated costs are in calendar year 2020 dollar (2020$), unless otherwise specified.

The Proposed Regulation's cost impacts on heavy-duty vehicle owners include the following direct cost inputs, which are described in detail in sections A through F:

- Reporting (section A),
- Heavy-duty vehicle testing (section B),[1]
- HD I/M tester training (section C),
- Compliance fee (section D),
- Heavy-duty vehicle repairs (section E), and
- Freight contractors' verification of vehicle compliance (section F).

Staff estimated the number of affected heavy-duty vehicles using California Air Resources Board's (CARB) EMission FACtor (EMFAC) model. EMFAC projects annual heavy-duty vehicle population operating in California based on California Department of Vehicle (DMV) vehicle registration and International Registration Plan (IRP) datasets. For the purpose of this analysis, the heavy-duty vehicle population is categorized into in-state and out-of-state (OOS) vehicles,[2] and then further broken down into onboard diagnostic (OBD)-equipped and non-OBD vehicles for each vehicle category. In general, OBD-equipped vehicles refer to heavy-duty vehicles installed with 2013 and newer model year (MY) diesel engines or 2018 and

[1] 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.

[2] In-state vehicles are California-registered vehicles. OOS vehicles are those registered outside of California.

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 F-1 below.[3]

Table F- 1: Projected Annual Heavy-Duty Vehicle Population in California from 2023 through 2050

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[4]
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
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
2038	597,968	45,360	747,514	1,221	1,392,063
2039	599,345	40,338	768,557	969	1,409,208
2040	601,321	35,743	790,872	766	1,428,703
2041	604,094	31,537	814,558	607	1,450,796
2042	607,508	27,632	839,392	481	1,475,014
2043	611,470	24,100	865,347	381	1,501,298
2044	616,066	20,961	892,334	297	1,529,657
2045	621,943	18,277	920,186	237	1,560,644
2046	628,554	15,920	948,874	190	1,593,538
2047	635,988	13,810	978,365	152	1,628,316

[3] For purpose of this cost analysis, vehicles operating with off-road engines are considered negligible because there are so few of such vehicles.

[4] 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[4]
2048	644,300	11,955	1,008,636	123	1,665,014
2049	653,523	10,339	1,039,756	99	1,703,717
2050	663,629	8,886	1,071,736	80	1,744,332

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 testers.

1. 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 vehicle identification number. 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 F-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[5] for vehicle owners or a designee to report their vehicle and company information in the CARB's HD I/M database ((US BLS, 2021) & (US BLS, 2021a)). Table F-2 summarizes staff's estimated costs on affected owners due to the proposed vehicle owner reporting requirements from 2023 through 2050.

[5] 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 F- 2: Statewide Incremental Vehicle Owner Reporting Costs under the Proposed Regulation from 2023 through 2050

Calendar Year	Vehicle Reporting Time (hour)	Vehicle Reporting Costs[6]
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
2037	1,090	$38,000
2038	1,263	$44,000
2039	1,429	$49,000
2040	1,625	$56,000
2041	1,841	$63,000
2042	2,018	$70,000
2043	2,190	$76,000
2044	2,363	$81,000
2045	2,582	$89,000
2046	2,741	$94,000
2047	2,898	$100,000
2048	3,058	$105,000
2049	3,225	$111,000
2050	3,385	$117,000
Total	**145,361**	**$5,011,000**

2. Vehicle Inspection Result Reporting

In addition to vehicle owner reporting, vehicle compliance testing results for non-OBD vehicles performed by a HD I/M tester due to either the proposed periodic testing requirements or Portable Emission AcQuisition System (PEAQS)/Remote Sensing Device

[6] Costs were rounded to the nearest thousand.

(RSD) follow-up testing 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 B. below. Staff 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 for a HD I/M 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 F-3. The inspection result reporting costs for heavy-duty non-OBD vehicles are projected to be lowest in 2023 ($12,000) 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 F- 3: Statewide Incremental Heavy-Duty Non-OBD Vehicle Inspection Result Reporting Costs under the Proposed Regulation from 2023 through 2050

Calendar Year	Inspection Result Reporting Time (hour)	Inspection Result Reporting Costs[7]
2023	352	$12,000
2024	67,750	$2,335,000
2025	61,550	$2,122,000
2026	56,035	$1,932,000
2027	50,871	$1,754,000
2028	45,958	$1,584,000
2029	41,411	$1,428,000
2030	37,286	$1,285,000
2031	33,497	$1,155,000
2032	30,019	$1,035,000
2033	26,659	$919,000
2034	23,568	$812,000
2035	20,748	$715,000
2036	18,272	$630,000

[7] Costs were rounded to the nearest thousand.

Calendar Year	Inspection Result Reporting Time (hour)	Inspection Result Reporting Costs[7]
2037	16,083	$554,000
2038	14,193	$489,000
2039	12,542	$432,000
2040	11,048	$381,000
2041	9,696	$334,000
2042	8,451	$291,000
2043	7,335	$253,000
2044	6,349	$219,000
2045	5,521	$190,000
2046	4,800	$165,000
2047	4,159	$143,000
2048	3,598	$124,000
2049	3,109	$107,000
2050	2,668	$92,000
Total	**623,525**	**$21,494,000**

3. Total Reporting Costs

Table F-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 2050, which is the sum of the reporting costs shown in Table F-2 and F-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 F- 4: Statewide Incremental Reporting Costs under the Proposed Regulation from 2023 to 2050

Calendar Year	Total Reporting Costs[8]
2023	$3,321,000
2024	$2,416,000
2025	$2,198,000
2026	$2,000,000
2027	$1,814,000

[8] Costs were rounded to the nearest thousand.

Calendar Year	Total Reporting Costs[8]
2028	$1,635,000
2029	$1,468,000
2030	$1,315,000
2031	$1,193,000
2032	$1,071,000
2033	$953,000
2034	$845,000
2035	$743,000
2036	$663,000
2037	$592,000
2038	$533,000
2039	$482,000
2040	$437,000
2041	$398,000
2042	$361,000
2043	$328,000
2044	$300,000
2045	$279,000
2046	$260,000
2047	$243,000
2048	$229,000
2049	$218,000
2050	$209,000
Total	**$26,505,000**

B. Heavy-Duty Vehicle Testing Costs

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 Heavy-Duty Vehicle Inspection Program (HDVIP)/Periodic Smoke Inspection Program (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 affected heavy-duty 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.[9] Details on the incremental vehicle testing cost estimates for non-OBD and OBD-equipped vehicles are discussed in subsections 1. and 2., respectively. Subsection 3 summarizes the total incremental vehicle testing costs.

1. Heavy-Duty Non-OBD 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 semiannual (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 visual inspection requirement on their non-OBD vehicles twice a year. Table F-5 summarizes the proposed periodic testing requirements for non-OBD equipped vehicles and compares them to the current PSIP requirements.

Table F- 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

[9] There might be additional testing costs related to transfer of ownership events; however, these costs are projected to be negligible to the overall testing costs of the program.

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 testers[10] 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 testers to perform one additional smoke opacity test and two visual inspections[11] 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 testers about 30 minutes to complete a non-OBD vehicle compliance inspection. This would result in an additional 45 minutes[12] 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 $34.47 per hour[13] for a HD I/M tester to perform the proposed tests ((US BLS, 2021) & (US BLS, 2021a)).

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 $5,000 (2016$) (CARB, 2017), staff anticipates that it is more cost effective for fleets of these sizes to hire a contractor to perform PSIP testing 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 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 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 (ERG, 2021). Hence, staff

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[10] See subsection C. for more details on HD I/M testers

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

[12] [1 smoke opacity test] x [15 minutes per test] + [2 visual inspections] x [15 minutes per inspection] = 45 minutes

[13] 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.

estimated an average smoke opacity testing cost of $125 per test per vehicle for the purposes of this cost analysis (this assumed cost has not yet taken into account costs for HD I/M 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 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 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[14] for the HD I/M tester to perform the inspection ((US BLS, 2021) & (US BLS, 2021a)).

Table F-6 summarizes staff's estimated incremental per vehicle periodic testing costs for non-OBD vehicles from different fleet types under the Proposed Regulation. Table F-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 2050. 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 F-7. As shown, the periodic testing costs in 2023 are 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 2050 (from $31.7M to $1.05M) due to the retirement of the old non-OBD vehicles over time.

Table F- 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[15]	OOS Fleets Operating in California
Incremental Annual Smoke Opacity Testing Costs per Vehicle	$250	$125	$8.62	$250

[14] 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.

[15] 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.

Fleet Types	California-Registered Owner Operators	California-Registered Fleets of 2-20 Vehicles	California-Register Fleets of more than 20 Vehicles[15]	OOS Fleets Operating in California
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 F- 7: Statewide Incremental Periodic Testing Costs on Heavy-Duty Non-OBD Vehicles under the Proposed Regulation from 2023 to 2050[16]

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
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
2038	$4,973,000	$803,000	$5,776,000
2039	$4,363,000	$712,000	$5,075,000
2040	$3,817,000	$629,000	$4,446,000
2041	$3,329,000	$554,000	$3,883,000

[16] Costs were rounded to the nearest thousand.

Calendar Year	Incremental Periodic Smoke Opacity Testing Costs	Incremental Periodic Visual Inspection Costs	Total Costs
2042	$2,883,000	$485,000	$3,368,000
2043	$2,488,000	$422,000	$2,910,000
2044	$2,141,000	$366,000	$2,508,000
2045	$1,856,000	$319,000	$2,175,000
2046	$1,609,000	$278,000	$1,887,000
2047	$1,392,000	$241,000	$1,633,000
2048	$1,203,000	$208,000	$1,412,000
2049	$1,039,000	$180,000	$1,219,000
2050	$890,000	$155,000	$1,045,000
Total	**$236,469,000**	**$34,457,000**	**$270,926,000**

Follow-Up Testing Costs

Once the Proposed Regulation starts implementation in 2023, heavy-duty vehicles flagged as high-emitting vehicles as they pass through CARB's 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 the PEAQS/RSD follow-up testing requirement, staff used the estimated number of heavy-duty non-OBD vehicles repairs under the Proposed Regulation. (Such repairs are discussed in detail in section E. below.) Staff assumed that the estimated number of non-OBD vehicle repairs shown in Table F-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,[17] staff assumed all repairs in 2023 would be due to the required compliance verification follow-up test requirement to ensure all potential testing costs are included.

Once the periodic testing requirements take effect in 2024, some of these follow-up tests would be absorbed through the proposed periodic testing requirement. This is because sometimes the follow-up test due date would overlap 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 all testing costs are included, 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 F-8 summarizes per vehicle follow-up testing

[17] See section E. for staff's detailed number of heavy-duty repair estimate methodology.

costs for non-OBD vehicles from different fleet types. Table F-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 F-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 as these older vehicles are retired and due to the reduction in non-compliant vehicles over time as the Proposed Regulation takes effect.

Table F- 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[18]	OOS Fleets Operating in California
Per Vehicle Follow-Up Testing Costs	$134	$17.2	$134

Table F- 9: Statewide Incremental Follow-Up Testing Costs on Heavy-Duty Non-OBD Vehicles through PEAQS/RSD Screening under the Proposed Regulation from 2023 to 2050

Calendar Year	Number of Follow-Up Tests	Follow-Up Testing Costs[19]
2023	2,112	$219,000
2024	1,770	$183,000
2025	858	$89,000
2026	559	$58,000
2027	405	$42,000
2028	343	$35,000
2029	305	$31,000
2030	274	$28,000
2031	246	$25,000
2032	221	$22,000
2033	196	$20,000
2034	173	$17,000

[18] 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).

[19] Costs were rounded to the nearest thousand.

Calendar Year	Number of Follow-Up Tests	Follow-Up Testing Costs[19]
2035	151	$15,000
2036	133	$13,000
2037	117	$12,000
2038	103	$10,000
2039	90	$9,000
2040	79	$8,000
2041	69	$7,000
2042	60	$6,000
2043	52	$5,000
2044	45	$5,000
2045	39	$4,000
2046	34	$3,000
2047	29	$3,000
2048	25	$3,000
2049	22	$2,000
2050	19	$2,000
Total	**8,529**	**$875,000**

Total Heavy-Duty Non-OBD Vehicle Testing Costs

Table F-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 2050. The costs include the sum of periodic testing costs and PEAQS/RSD follow-up testing costs presented in Table F-7 and F-9 above, respectively. The vehicle testing costs are lowest in 2023 ($0.219M) as there would be only PEAQS/RSD follow-up testing on a small number of heavy-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 $1.05M in 2050, reflecting the retirement of older heavy-duty non-OBD vehicles over time.

Table F- 10: Statewide Incremental Vehicle Testing Costs on Heavy-Duty Non-OBD Vehicles under the Proposed Regulation from 2023 to 2050

Calendar Year	Vehicle Testing Costs[20]
2023	$219,000
2024	$31,866,000

[20] Costs were rounded to the nearest thousand.

Calendar Year	Vehicle Testing Costs[20]
2025	$28,421,000
2026	$25,447,000
2027	$22,770,000
2028	$20,316,000
2029	$18,108,000
2030	$16,141,000
2031	$14,390,000
2032	$12,786,000
2033	$11,270,000
2034	$9,884,000
2035	$8,634,000
2036	$7,549,000
2037	$6,598,000
2038	$5,786,000
2039	$5,084,000
2040	$4,454,000
2041	$3,890,000
2042	$3,374,000
2043	$2,915,000
2044	$2,512,000
2045	$2,179,000
2046	$1,890,000
2047	$1,636,000
2048	$1,414,000
2049	$1,221,000
2050	$1,046,000
Total	**$271,801,000**

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

Periodic Testing Costs

The Proposed Regulation would require semiannual 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. There would be three OBD data submission options for OBD-equipped vehicle owners: telematics, testing through a HD I/M tester, or using a 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 are currently required on most commercial buses and trucks, with limited exceptions for short-haul operations (FMCSA, 2018). 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 (ERG, 2021). In addition, discussions with OOS fleets indicate OOS fleets overwhelmingly use telematics services as well.[21] 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, the collection and submission of OBD data to meet CARB's requirements can be integrated into current telematics technology. Once the telematics device is installed on the vehicle, the required OBD data would be automatically collected and submitted to CARB without interfering in the 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 (ERG, 2021). 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. This monthly $2 fee would cover the costs of necessary software upgrade and OBD data streaming to the CARB's HD I/M database for the required OBD data submission. 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 and minimal cost addition. In this 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 estimates that smaller California fleets of 50 vehicles or less 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 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,

[21] Personal communication with ATA and national fleets in April and May 2020.

especially the smallest fleets, would be more likely to select one of the other two testing options.

Although the testing option at designated locations throughout the State could be available free of charge to vehicle owners, they would need to drive their vehicles to a designated location to perform the test. Such an option would suit the needs of vehicles that pass 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 do not match these designated testing locations are more likely to have a HD I/M tester perform vehicle testing outside of their normal business operations. To ensure all costs are included, staff assumed all vehicle owners not opting for the telematics submission approach would choose to hire a HD I/M tester instead of opting for the designated test location for this cost analysis. Nonetheless, since this designated testing location option would offer a cheaper alternative relative to hiring a HD I/M 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 all relevant costs are included.

Based on these assumptions, California fleets of 50 vehicles or less are assumed to perform the proposed OBD testing through a HD I/M tester. Such a tester could either be a third-party HD I/M tester hired by an owner to perform the OBD testing or an internal employee who has taken the adequate CARB training to become a HD I/M tester. All HD I/M 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 (ERG, 2021), 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 testers themselves instead of hiring third-party HD I/M 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 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 instruments (i.e., between $100 and $700 for an OBD testing device versus about $5,000 (2016$) for a smoke opacity testing device (CARB, 2017)).

Staff assumed an average cost of $400 per certified OBD testing device in this analysis.[22] 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 as staff expects these fleets might have multiple fleet base locations with their vehicles dispersed among the locations.

[22] Average of $100 and $700 of the discussed OBD testing device price range for the average price of $400 per OBD testing device.

Hence, it would be more practical for fleets to purchase multiple devices for different fleet base locations. Staff also assumed OBD testing device' longevity to be five years due to potential wear and tear over time (Shop24pro, 2020). For the 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. 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 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. For the HD I/M tester option, staff assumed an average OBD testing duration of 2.5 minutes per vehicle (ERG, 2021) for each OBD data submission (or five minutes per vehicle per year[23]). Staff also assumed total employee compensation costs of $34.47 per hour[24] for the HD I/M tester to perform the proposed OBD testing ((US BLS, 2021) & (US BLS, 2021a)).

Table F-11 summarizes staff's estimated incremental per vehicle periodic testing costs for OBD-equipped vehicles from different fleet types under the Proposed Regulation. Table F-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 2050.

In general, testing through a HD I/M approved tester has initial costs to purchase a testing device, plus the employee compensation cost of doing the test, whereas the telematics testing option is paid for through an annual telematics subscription fee between fleets and their telematics vendor. There would be no employee compensation cost to perform the OBD test through telematics as the test would be completed without the need for human intervention. 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 F-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 ($83.9M) 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 remain consistent throughout the analysis.

[23] [2.5 minutes per test] x [2 tests per vehicle per year] = 5 minutes per vehicle per year

[24] 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 F- 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[25]	OOS Fleets Operating in California[26]
One-Time OBD Testing Device Purchase Costs[27] per Fleet	$400	$800	$0	$0
On-Going Annual OBD Testing Costs per Vehicle	$2.87	$2.87	$24	$24

Table F- 12: Statewide Incremental Periodic OBD Testing Costs under the Proposed Regulation from 2023 to 2050[28]

Calendar Year	Periodic OBD Testing Costs through HD I/M Testers	Periodic OBD Testing Costs through Telematics	Total Periodic OBD Testing Costs
2023	$0	$0	$0
2024	$69,208,000	$14,647,000	$83,854,000
2025	$17,674,000	$15,202,000	$32,876,000
2026	$18,050,000	$15,698,000	$33,747,000
2027	$18,396,000	$16,150,000	$34,546,000
2028	$18,608,000	$16,564,000	$35,172,000
2029	$18,652,000	$16,943,000	$35,595,000
2030	$18,523,000	$17,291,000	$35,814,000
2031	$18,689,000	$17,706,000	$36,395,000

[25] 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.

[26] 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.

[27] Note that staff assumed the OBD's testing device would eventually be replaced due to potential wear and tear over time.

[28] Costs were rounded to the nearest thousand.

Calendar Year	Periodic OBD Testing Costs through HD I/M Testers	Periodic OBD Testing Costs through Telematics	Total Periodic OBD Testing Costs
2032	$18,674,000	$18,118,000	$36,792,000
2033	$18,681,000	$18,533,000	$37,214,000
2034	$18,644,000	$18,952,000	$37,595,000
2035	$18,427,000	$19,368,000	$37,796,000
2036	$18,461,000	$19,802,000	$38,263,000
2037	$18,458,000	$20,258,000	$38,717,000
2038	$18,495,000	$20,742,000	$39,237,000
2039	$18,538,000	$21,253,000	$39,791,000
2040	$18,637,000	$21,798,000	$40,435,000
2041	$18,773,000	$22,379,000	$41,152,000
2042	$18,911,000	$22,991,000	$41,902,000
2043	$19,054,000	$23,633,000	$42,687,000
2044	$19,219,000	$24,302,000	$43,521,000
2045	$19,472,000	$24,998,000	$44,470,000
2046	$19,694,000	$25,718,000	$45,412,000
2047	$19,944,000	$26,460,000	$46,405,000
2048	$20,220,000	$27,226,000	$47,446,000
2049	$20,521,000	$28,016,000	$48,537,000
2050	$20,841,000	$28,831,000	$49,671,000
Total	**$561,463,000**	**$563,578,000**	**$1,125,041,000**

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. 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 a methodology similar to that discussed above for non-OBD vehicles. Since the proposed periodic OBD testing requirement would not take effect until 2024, staff assumed that in 2023 fleets would hire a third-party HD I/M tester to perform the follow-up test if they are required to submit a follow-up OBD test to CARB. Additionally, staff assumed HD I/M testers would charge the same OBD testing fee as smoke opacity testing, i.e., $125 per test. Staff assumes that the costs of a HD I/M 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 a third-party HD I/M 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 (ERG, 2021) for each follow-up test through the purchased testing device with a total employee compensation cost of $34.47 per hour ((US BLS, 2021) & (US BLS, 2021a)).[29] Additional OBD test submissions through telematics would not impose additional costs on fleet owners (i.e., California-registered fleets of more than 50 vehicles and OOS fleets). Table F-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 to estimate the number of additional OBD tests associated with the PEAQS/RSD follow-up testing requirements. Table F-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 F- 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[30]	OOS Fleets Operating in California[31]
2023	$125	$125	$125
2024 and later	$1.44	$0	$0

[29] 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.

[30] 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.

[31] 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.

Table F- 14: Statewide Incremental Follow-Up Testing Costs on Heavy-Duty OBD-Equipped Vehicles through PEAQS/RSD Screening under the Proposed Regulation from 2023 to 2050

Calendar Year	Number of Follow-Up Tests	Follow-Up Testing Costs[32]
2023	13,781	$1,723,000
2024	13,273	$9,000
2025	5,801	$4,000
2026	3,552	$2,000
2027	2,587	$2,000
2028	2,360	$2,000
2029	2,313	$2,000
2030	2,311	$2,000
2031	2,313	$2,000
2032	2,347	$2,000
2033	2,380	$2,000
2034	2,411	$2,000
2035	2,443	$2,000
2036	2,472	$2,000
2037	2,503	$2,000
2038	2,533	$2,000
2039	2,568	$2,000
2040	2,603	$2,000
2041	2,643	$2,000
2042	2,687	$2,000
2043	2,739	$2,000
2044	2,791	$2,000
2045	2,851	$2,000
2046	2,912	$2,000
2047	2,975	$2,000
2048	3,041	$2,000
2049	3,111	$2,000
2050	3,183	$2,000
Total	**99,482**	**$1,777,000**

Total Heavy-Duty OBD-Equipped Vehicle Testing Costs

Table F-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 2050,

[32] Values were rounded to the nearest thousand.

which are the sum of periodic testing costs and PEAQS/RSD follow-up testing costs discussed above.

Table F- 15: Statewide Incremental Vehicle Testing Costs on Heavy-Duty OBD-Equipped Vehicles under the Proposed Regulation from 2023 to 2050[33]

Calendar Year	Vehicle Testing Costs
2023	$1,723,000
2024	$83,864,000
2025	$32,879,000
2026	$33,749,000
2027	$34,547,000
2028	$35,174,000
2029	$35,596,000
2030	$35,816,000
2031	$36,396,000
2032	$36,794,000
2033	$37,215,000
2034	$37,597,000
2035	$37,797,000
2036	$38,264,000
2037	$38,718,000
2038	$39,238,000
2039	$39,792,000
2040	$40,437,000
2041	$41,154,000
2042	$41,904,000
2043	$42,688,000
2044	$43,523,000
2045	$44,472,000
2046	$45,414,000
2047	$46,406,000
2048	$47,448,000
2049	$48,539,000
2050	$49,673,000
Total	**$1,126,818,000**

[33] Costs were rounded to the nearest thousand.

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

Table F-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 2050. The total vehicle testing costs are the sum of incremental smoke opacity testing and visual inspection costs and OBD testing costs shown in Table F-10 and F-15, respectively.

Table F- 16: Statewide Incremental Vehicle Testing Costs under the Proposed Regulation from 2023 to 2050[34]

Calendar Year	Vehicle Testing Costs
2023	$1,941,000
2024	$115,730,000
2025	$61,300,000
2026	$59,196,000
2027	$57,317,000
2028	$55,490,000
2029	$53,704,000
2030	$51,957,000
2031	$50,786,000
2032	$49,579,000
2033	$48,486,000
2034	$47,481,000
2035	$46,432,000
2036	$45,813,000
2037	$45,316,000
2038	$45,024,000
2039	$44,876,000
2040	$44,891,000
2041	$45,044,000
2042	$45,278,000
2043	$45,603,000
2044	$46,035,000
2045	$46,650,000
2046	$47,304,000
2047	$48,042,000
2048	$48,862,000
2049	$49,760,000

[34] Costs were rounded to the nearest thousand.

Calendar Year	Vehicle Testing Costs
2050	$50,720,000
Total	**$1,398,619,000**

C. HD I/M Tester Training Costs

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 tester. Once every two years, individuals who want to become HD I/M testers would be required to successfully complete an online testing training course approved by CARB. The training course is projected to take about five hours to complete. Staff assumed a total employee compensation cost of $34.47 per hour[35] for a heavy-duty technician or mechanic to take the CARB's training course ((US BLS, 2021) & (US BLS, 2021a)). Staff estimated the number of HD I/M 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 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 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 tester for every 20 vehicles. Finally, staff assumed a ratio of one third-party HD I/M smoke opacity tester for every 2,080 non-OBD vehicles[36] that are expected to have third-party testers perform the proposed smoke opacity tests.

Table F-17 summarizes staff's estimated incremental training costs due to the Proposed Regulation from calendar year 2023 through 2050. 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 F-17. The annual training costs range from $16M to $29M during the 2023-2050 period.

Table F- 17: Statewide Incremental Training Costs under the Proposed Regulation from 2023 to 2050[37]

Calendar Year	Training Costs
2023	$29,446,000

[35] 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.

[36] 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 reduced the third-party tester' testing capacity to 2,080 vehicles for each tester (reduced by 50 percent).

[37] Costs were rounded to the nearest thousand.

Calendar Year	Training Costs
2024	$16,015,000
2025	$16,606,000
2026	$17,096,000
2027	$17,541,000
2028	$17,894,000
2029	$18,132,000
2030	$18,243,000
2031	$18,423,000
2032	$18,511,000
2033	$18,589,000
2034	$18,625,000
2035	$18,571,000
2036	$18,583,000
2037	$18,581,000
2038	$18,592,000
2039	$18,606,000
2040	$18,647,000
2041	$18,712,000
2042	$18,789,000
2043	$18,877,000
2044	$18,983,000
2045	$19,136,000
2046	$19,293,000
2047	$19,473,000
2048	$19,676,000
2049	$19,903,000
2050	$20,150,000
Total	**$529,694,000**

D. Compliance Fee

Starting in July 2023, under the Proposed Regulation, heavy-duty vehicle owners would be required to pay an annual compliance fee of $30 per vehicle 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. Further details on compliance fee are discussed in Chapter III. Fiscal Impacts.

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 suggests an issued certificate percentage of approximately 90 percent (BAR, 2020a), 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 California Highway Patrol (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.[38] Table F-18 summarizes staff's estimated incremental HD I/M compliance fee costs on affected heavy-duty vehicle owners from calendar year 2023 through 2050.

Table F- 18: Statewide Incremental Compliance Fee Costs under the Proposed Regulation from 2023 to 2050[39]

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
2038	$17,370,000	$15,162,000	$32,532,000
2039	$17,271,000	$15,583,000	$32,854,000
2040	$17,201,000	$16,031,000	$33,231,000

[38] 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.
[39] Costs were rounded to the nearest thousand.

Calendar Year	Costs on In-State Heavy-Duty Vehicles	Costs on OOS Heavy-Duty Vehicles	Total Costs
2041	$17,162,000	$16,507,000	$33,669,000
2042	$17,149,000	$17,007,000	$34,156,000
2043	$17,160,000	$17,531,000	$34,691,000
2044	$17,200,000	$18,076,000	$35,275,000
2045	$17,286,000	$18,639,000	$35,925,000
2046	$17,401,000	$19,219,000	$36,619,000
2047	$17,545,000	$19,815,000	$37,360,000
2048	$17,719,000	$20,427,000	$38,146,000
2049	$17,924,000	$21,057,000	$38,981,000
2050	$18,158,000	$21,704,000	$39,862,000
Total	**$492,449,000**	**$423,580,000**	**$916,030,000**

E. Heavy-Duty Vehicle Repair Costs

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 a 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. 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.

1. 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 types of repairs and costs that were considered for vehicles that fail the vehicle inspection test in the HDVIP/PSIP Amendments'

cost analysis. Table F-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 diesel particulate filter (DPF) replacement, and 62 percent of the time, there would also be an upstream engine component replacement such as diesel oxidation catalyst (DOC), exhaust gas recovery (EGR) valve, EGR cooler, turbocharger, and fuel injector for a total average cost of $5,162 per vehicle repair (CARB, 2018).

Table F- 19: Repair Costs for Heavy-Duty Non-OBD Vehicles

Upstream Engine Part	Upstream Engine Part Repair Probability	Repair Costs
DOC	45%	$4,247
EGR Valve	21%	$1,341
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[40]		**$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 malfunction indicator light (MIL) (ERG, 2021). 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 F-20.

Table F- 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
Oxides of Nitrogen (NOx) Sensor	14.86%	$1,877
Particulate Matter (PM) Filter	11.75%	$2,305
PM Filter Frequent Regeneration	1.58%	$1,960

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

OBD Fault Code Group	OBD Fault Code Group Distribution	Repair Costs
Reductant Delivery	19.45%	$2,169
Selective Catalytic Reduction (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).

2. 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 below.

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, 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 (CARB, 2020b):

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

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 enforcement of high-emitters flagged through CARB's roadside emission monitoring network (PEAQS/RSD) and 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 14 PEAQS systems rolled out at major State highway routes in San Joaquin Valley and South Coast regions, about 29 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 16 percent[41] in 2023 due to the implementation of the Proposed Regulation using the existing PEAQS systems.

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 (BAR, 2020). 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 because these OBD-equipped vehicles would 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 the 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 F-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 F- 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	16%	16%
2024-2025	70%	82%

[41] [70% statewide vehicle coverage] x [81% PEAQS high-emitter identification efficacy] x [29% PEAQS vehicle capture rate] = 16% statewide high-emitter (or non-compliant vehicles) identification

Calendar Year	Non-Compliance Identification Rate for Heavy-Duty Non-OBD Vehicles	Non-Compliance Identification Rate for Heavy-Duty OBD-Equipped Vehicles
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 (CARB, 2020c). 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 (i.e., repair the cited vehicles to comply with the HDVIP).[42] 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 retired/sold out-of-state vehicles, the percentage of effective vehicle repairs for in-state vehicles is 90 percent, an increase of 16 percent from the 74 percent of in-state vehicles' citation resolve mentioned above. Hence, 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.

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.[43]

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

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

[43] 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.

Table F- 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 all years, the statewide HD I/M vehicle repair rate is the product of the discussed parameters A, B, and C. 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 failed 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. 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 F-19 and F-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 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 F-23).

Table F- 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[44]				**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 F-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. 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 2050 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 F-24) to determine the final number of vehicle repairs resulting in incremental repair costs attributed to this Proposed Regulation (Table F-25).

[44] 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 used the higher re-fail rate of upstream engine part repair for the overall heavy-duty non-OBD repair's re-fail rate.

As shown in Table F-24 and Table F-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 2050. 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 F- 24: Estimated Statewide Incremental Number of Heavy-Duty Vehicle Repair under the Proposed Regulation from 2023 through 2050

Calendar Year	Heavy-Duty Non-OBD Vehicle Repairs	Heavy-Duty OBD-Equipped Vehicle Repairs	Total Vehicle Repairs
2023	2,112	13,781	15,893
2024	7,953	79,582	87,535
2025	3,862	36,002	39,864
2026	2,863	24,888	27,751
2027	2,062	17,975	20,037
2028	1,737	16,188	17,925
2029	1,536	15,765	17,301
2030	1,374	15,714	17,089
2031	1,233	15,726	16,959
2032	1,102	15,968	17,070
2033	976	16,214	17,189
2034	859	16,451	17,309
2035	752	16,702	17,455
2036	659	16,944	17,603
2037	577	17,193	17,770
2038	507	17,448	17,955
2039	446	17,733	18,179
2040	392	18,024	18,415
2041	342	18,342	18,684
2042	297	18,697	18,995
2043	257	19,098	19,355
2044	222	19,513	19,734
2045	192	19,971	20,163
2046	167	20,439	20,606
2047	145	20,919	21,064
2048	125	21,422	21,547
2049	108	21,949	22,057

Calendar Year	Heavy-Duty Non-OBD Vehicle Repairs	Heavy-Duty OBD-Equipped Vehicle Repairs	Total Vehicle Repairs
2050	93	22,493	22,586

Table F- 25: Estimated Statewide Incremental Number of Heavy-Duty Vehicle Repair Resulting in Incremental Repair Costs Attributed to the Proposed Regulation from 2023 through 2050

Calendar Year	Heavy-Duty Non-OBD Vehicle Repairs	Heavy-Duty OBD-Equipped Vehicle Repairs	Total Vehicle Repairs
2023	2,112	13,148	15,260
2024	7,953	74,347	82,300
2025	3,862	33,127	36,989
2026	2,863	22,401	25,264
2027	2,062	16,182	18,243
2028	1,737	14,484	16,221
2029	1,536	14,171	15,706
2030	1,374	14,227	15,601
2031	1,233	14,341	15,574
2032	1,102	14,653	15,755
2033	976	14,951	15,926
2034	859	15,219	16,078
2035	752	15,507	16,259
2036	659	15,764	16,423
2037	577	16,015	16,592
2038	507	16,257	16,765
2039	446	16,511	16,957
2040	392	16,768	17,159
2041	342	17,049	17,391
2042	297	17,364	17,662
2043	257	17,723	17,980
2044	222	18,097	18,319
2045	192	18,516	18,708
2046	167	18,947	19,114
2047	145	19,389	19,534
2048	125	19,855	19,980
2049	108	20,343	20,451
2050	93	20,847	20,940

3. Statewide Repair Costs

The statewide repair costs were calculated by multiplying the estimated incremental statewide heavy-duty vehicle repairs presented in Table F-25 with the estimated costs per vehicle repair presented in Table F-19 and F-20 above. Table F-26 summarizes the incremental statewide repair costs for affected heavy-duty vehicles from 2023 through 2050. The repair costs are highest in 2024 ($188M) 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 F- 26: Statewide Incremental Heavy-Duty Vehicle Repair Costs under the Proposed Regulation from 2023 to 2050[45]

Calendar Year	Heavy-Duty Non-OBD Vehicle Repair Costs	Heavy-Duty OBD-Equipped Vehicle Repair Costs	Statewide Repair Costs
2023	$10,902,000	$25,998,000	36,900,000
2024	$41,052,000	$147,015,000	188,067,000
2025	$19,935,000	$65,506,000	85,441,000
2026	$14,780,000	$44,296,000	59,076,000
2027	$10,641,000	$31,998,000	42,639,000
2028	$8,966,000	$28,642,000	37,608,000
2029	$7,927,000	$28,021,000	35,949,000
2030	$7,093,000	$28,132,000	35,226,000
2031	$6,363,000	$28,359,000	34,722,000
2032	$5,686,000	$28,975,000	34,661,000
2033	$5,036,000	$29,564,000	34,600,000
2034	$4,432,000	$30,094,000	34,527,000
2035	$3,883,000	$30,664,000	34,546,000
2036	$3,403,000	$31,172,000	34,574,000
2037	$2,980,000	$31,668,000	34,648,000
2038	$2,618,000	$32,148,000	34,766,000
2039	$2,304,000	$32,649,000	34,953,000
2040	$2,022,000	$33,157,000	35,179,000
2041	$1,768,000	$33,712,000	35,480,000
2042	$1,534,000	$34,337,000	35,871,000
2043	$1,327,000	$35,045,000	36,372,000
2044	$1,144,000	$35,785,000	36,929,000
2045	$993,000	$36,613,000	37,606,000
2046	$862,000	$37,466,000	38,328,000

[45] Costs were rounded to the nearest thousand.

Calendar Year	Heavy-Duty Non-OBD Vehicle Repair Costs	Heavy-Duty OBD-Equipped Vehicle Repair Costs	Statewide Repair Costs
2047	$747,000	$38,341,000	39,088,000
2048	$646,000	$39,261,000	39,908,000
2049	$558,000	$40,227,000	40,785,000
2050	$479,000	$41,224,000	41,702,000
Total	**$170,082,000**	**$1,080,069,000**	**1,250,151,000**

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 (CARB, 2019), 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; fleets would 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 (CARB, 2007). 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 would also be negligible.

Under the existing in-use diesel regulations for heavy-duty vehicles (CARB, 2012), 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, and 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 Direct Costs

The total incremental costs of the Proposed Regulation, including reporting costs, vehicle testing costs, tester training costs, compliance fee, and heavy-duty vehicle repair costs, are

summarized in Table F-27. The Proposed Regulation is projected to cost $4.12B over 2023-2050 period, with a maximum annual cost of $350M in 2024.

Table F- 27: Total Estimated Direct Incremental Costs Relative to the Baseline of the Proposed Regulation from 2023 through 2050

Calendar Year	Reporting	Vehicle Testing	HD I/M Tester Training	Compliance Fee	Heavy-Duty Vehicle Repairs	Total Costs
2023	$3,321,000	$1,941,000	$29,446,000	$23,765,000	36,900,000	$95,373,000
2024	$2,416,000	$115,730,000	$16,015,000	$28,102,000	188,067,000	$350,331,000
2025	$2,198,000	$61,300,000	$16,606,000	$28,740,000	85,441,000	$194,285,000
2026	$2,000,000	$59,196,000	$17,096,000	$29,309,000	59,076,000	$166,677,000
2027	$1,814,000	$57,317,000	$17,541,000	$29,807,000	42,639,000	$149,119,000
2028	$1,635,000	$55,490,000	$17,894,000	$30,214,000	37,608,000	$142,841,000
2029	$1,468,000	$53,704,000	$18,132,000	$30,526,000	35,949,000	$139,779,000
2030	$1,315,000	$51,957,000	$18,243,000	$30,740,000	35,226,000	$137,481,000
2031	$1,193,000	$50,786,000	$18,423,000	$31,011,000	34,722,000	$136,135,000
2032	$1,071,000	$49,579,000	$18,511,000	$31,256,000	34,661,000	$135,079,000
2033	$953,000	$48,486,000	$18,589,000	$31,471,000	34,600,000	$134,098,000
2034	$845,000	$47,481,000	$18,625,000	$31,675,000	34,527,000	$133,154,000
2035	$743,000	$46,432,000	$18,571,000	$31,830,000	34,546,000	$132,122,000
2036	$663,000	$45,813,000	$18,583,000	$32,026,000	34,574,000	$131,659,000
2037	$592,000	$45,316,000	$18,581,000	$32,255,000	34,648,000	$131,392,000
2038	$533,000	$45,024,000	$18,592,000	$32,532,000	34,766,000	$131,446,000
2039	$482,000	$44,876,000	$18,606,000	$32,854,000	34,953,000	$131,771,000
2040	$437,000	$44,891,000	$18,647,000	$33,231,000	35,179,000	$132,385,000
2041	$398,000	$45,044,000	$18,712,000	$33,669,000	35,480,000	$133,302,000
2042	$361,000	$45,278,000	$18,789,000	$34,156,000	35,871,000	$134,455,000
2043	$328,000	$45,603,000	$18,877,000	$34,691,000	36,372,000	$135,872,000
2044	$300,000	$46,035,000	$18,983,000	$35,275,000	36,929,000	$137,523,000
2045	$279,000	$46,650,000	$19,136,000	$35,925,000	37,606,000	$139,596,000
2046	$260,000	$47,304,000	$19,293,000	$36,619,000	38,328,000	$141,805,000
2047	$243,000	$48,042,000	$19,473,000	$37,360,000	39,088,000	$144,206,000

Calendar Year	Reporting	Vehicle Testing	HD I/M Tester Training	Compliance Fee	Heavy-Duty Vehicle Repairs	Total Costs
2048	$229,000	$48,862,000	$19,676,000	$38,146,000	39,908,000	$146,821,000
2049	$218,000	$49,760,000	$19,903,000	$38,981,000	40,785,000	$149,648,000
2050	$209,000	$50,720,000	$20,150,000	$39,862,000	41,702,000	$152,643,000
Total	**$26,505,000**	**$1,398,619,000**	**$529,694,000**	**$916,030,000**	**1,250,151,000**	**$4,120,999,000**

H. Sensitivity Analysis

As staff estimated incremental vehicle repair costs due to the Proposed Regulation in subsection E. above, staff accounted for costs that vehicle repair mechanic would charge vehicle owners for the resulted repairs, which include vehicle repair part costs and labor costs. Staff did not, however, include fleet business opportunity costs due to vehicle repair downtime as part of the Proposed Regulation's cost impacts. The Proposed Regulation would allow for a vehicle compliance test submission window of 90 days prior to the proposed periodic testing due date. Hence, if vehicles fail the required compliance test, vehicle owners would still have plenty of time to arrange for having the vehicles repaired during the vehicles' normal scheduled downtime in advanced. Additionally, repairs that require long repair time usually indicate seriously broken emissions control parts, which would put vehicles out of service even in the absence of the Proposed Regulation, so the resultant opportunity costs would occur regardless of the Proposed Regulation. As a result, staff believes including fleet business opportunity costs due to vehicle repair downtime would be an overestimation of the Propose Regulation's cost impacts. However, for completeness, staff performed a sensitivity analysis of how the Proposed Regulation's direct cost impacts would change if staff quantified fleet business opportunity costs due to vehicle repair downtime.

Based on ERG's heavy-duty vehicle repair analysis, labor hours for each repair range from 0.3 to 8.3 hours (ERG, 2021). For a conservative (high) cost impact estimates, staff assumed it would take 8.3 hours for each identified vehicle repair resulted from the Propose Regulation (Table F-24), even though some repairs would take much less than 8.3 hours. FleetMaintenance estimated an average hourly cost for vehicle downtime of $90.68 (FleetMaintenance, 2015).[46] Hence, in this scenario, each identified vehicle repair under the Proposed Regulation would result in an opportunity cost of $753. The annual opportunity costs due to vehicle repair downtime were calculated by multiplying the estimated annual number of repairs shown in Table F-24 with the estimated opportunity costs of $753 per repair, as summarized in Table F-28 below.

Table F- 28: Projected Opportunity Costs due to Vehicle Repair Downtime under the Proposed Regulation

Calendar Year	Opportunity Costs[47]
2023	$11,962,000
2024	$65,885,000
2025	$30,005,000
2026	$20,888,000

[46] Presented costs were already adjusted for 2020$ value following the latest California Department of Finance's consumer Price Index forecast, dated April 2021.

[47] Costs were rounded to the nearest thousand.

Calendar Year	Opportunity Costs[47]
2027	$15,081,000
2028	$13,492,000
2029	$13,022,000
2030	$12,862,000
2031	$12,765,000
2032	$12,848,000
2033	$12,938,000
2034	$13,028,000
2035	$13,138,000
2036	$13,249,000
2037	$13,375,000
2038	$13,515,000
2039	$13,683,000
2040	$13,861,000
2041	$14,063,000
2042	$14,297,000
2043	$14,568,000
2044	$14,853,000
2045	$15,176,000
2046	$15,510,000
2047	$15,854,000
2048	$16,218,000
2049	$16,602,000
2050	$17,000,000
Total	**$469,738,000**

Including fleet business opportunity costs, the total direct costs under this approach would be about $4.59B, an 11 percent increase from the estimated total direct costs of $4.12B discussed in Section G. The resulting cost effectiveness for the scenario analyzed in this sensitivity analysis is $68.81/pound PM and $2.01/pound NOx (an increase of 11 percent and nine percent, respectively, from the Proposed Regulation), which are still well within cost-effectiveness range of previous CARB's regulations. This indicates the Proposed Regulation would still be considered cost-effective and worth pursuing, even if repair downtime costs were quantified in a conservative (high) manner.

II. Cost Savings

Even though the Proposed Regulation would result in incremental costs on heavy-duty vehicle owners as discussed above, 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. 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 discussed in Chapter I.B. above, 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. Fleets that have their annual smoke opacity tests performed by contracted testers pay an average estimated cost of $125 per test. Hence, these fleets 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. 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 F-29 summarizes staff's estimated smoke opacity testing cost savings on California vehicle owners under the Proposed Regulation from 2023 through 2050. The total cost savings on vehicle owners are approximately $869M for the 2023-2050 period.

Table F- 29: Smoke Opacity Testing Cost Savings on Heavy-Duty OBD-Equipped Vehicle Owners under the Proposed Regulation from 2023 through 2050

Calendar Year	Smoke Opacity Testing Cost Savings[48]
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

[48] Cost savings were rounded to the nearest thousand.

Calendar Year	Smoke Opacity Testing Cost Savings[48]
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
2038	$32,841,000
2039	$32,931,000
2040	$33,049,000
2041	$33,209,000
2042	$33,412,000
2043	$33,652,000
2044	$33,936,000
2045	$34,265,000
2046	$34,637,000
2047	$35,057,000
2048	$35,527,000
2049	$36,051,000
2050	$36,627,000
Total	**$869,491,000**

III. Fiscal Impacts

A. Local Government

1. Local Government Fleets

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 seven percent of the total affected heavy-duty vehicles operating in California. The same proportion of total costs presented in Table F-27 are assumed to be incurred by local government fleets. The total incremental costs on local government fleets from 2023 through 2050 would be $276M, as shown in Table F-30. In addition to costs, local government fleets would also have cost savings from the avoided smoke opacity testing need on their OBD-equipped vehicles. Staff applied the same seven percent local government fleets' vehicles proportion to the total cost savings presented in Table F-29 for the estimated cost savings on

local government fleets. The total cost savings for local government fleets from 2023 through 2050 would be $58M, as shown in Table F-30.

Table F- 30: Costs and Cost Savings on Local Government Fleets under the Proposed Regulation from 2023 through 2050

Calendar Year	Incremental Costs	Cost Savings
2023	$6,380,000	$0
2024	$23,436,000	$1,653,000
2025	$12,997,000	$1,749,000
2026	$11,150,000	$1,837,000
2027	$9,975,000	$1,916,000
2028	$9,555,000	$1,983,000
2029	$9,351,000	$2,036,000
2030	$9,197,000	$2,075,000
2031	$9,107,000	$2,110,000
2032	$9,036,000	$2,137,000
2033	$8,971,000	$2,157,000
2034	$8,907,000	$2,172,000
2035	$8,838,000	$2,181,000
2036	$8,807,000	$2,187,000
2037	$8,790,000	$2,192,000
2038	$8,793,000	$2,197,000
2039	$8,815,000	$2,203,000
2040	$8,856,000	$2,211,000
2041	$8,917,000	$2,222,000
2042	$8,995,000	$2,235,000
2043	$9,089,000	$2,251,000
2044	$9,200,000	$2,270,000
2045	$9,338,000	$2,292,000
2046	$9,486,000	$2,317,000
2047	$9,647,000	$2,345,000
2048	$9,822,000	$2,377,000
2049	$10,011,000	$2,412,000
2050	$10,211,000	$2,450,000
Total	**$275,679,000**	**$58,166,000**

2. 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. Staff assumed a local

sales tax rate of 4.7 percent. Staff applied this tax rate to the estimated taxable increased testing device sales and telematics service costs, increased vehicle reporting service costs, and increased repair part costs (as discussed in Chapter I. above) to get the total local sales tax revenue estimates. Table F-31 summarizes staff's estimated local sales tax revenues from 2023 through 2050 as a result of the Proposed Regulation.

Table F- 31: Projected Local Sales Tax Revenues due to the Proposed Regulation[49]

Calendar Year	Taxable Sales	Local Sales tax Revenue
2023	$39,459,000	$1,844,000
2024	$187,058,000	$8,741,000
2025	$84,700,000	$3,958,000
2026	$72,323,000	$3,380,000
2027	$64,844,000	$3,031,000
2028	$70,486,000	$3,296,000
2029	$62,447,000	$2,920,000
2030	$62,269,000	$2,912,000
2031	$62,582,000	$2,928,000
2032	$62,929,000	$2,944,000
2033	$70,889,000	$3,318,000
2034	$63,637,000	$2,979,000
2035	$63,838,000	$2,989,000
2036	$64,321,000	$3,013,000
2037	$64,813,000	$3,037,000
2038	$72,981,000	$3,421,000
2039	$66,045,000	$3,097,000
2040	$66,805,000	$3,134,000
2041	$67,674,000	$3,176,000
2042	$68,617,000	$3,222,000
2043	$77,234,000	$3,628,000
2044	$70,757,000	$3,325,000
2045	$72,038,000	$3,386,000
2046	$73,331,000	$3,447,000
2047	$74,692,000	$3,511,000
2048	$83,716,000	$3,935,000
2049	$77,644,000	$3,650,000
2050	$79,219,000	$3,724,000
Total		**$95,947,000**

[49] Values were rounded to the nearest thousand.

B. State Government

1. 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 as for local government fleets discussed above. 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 two percent of the total affected heavy-duty vehicles operating in California. Staff applied the same two percent to the total costs presented in Table F-27 and the total cost savings presented in Table F-29 for the estimated costs and cost savings incurred by State government fleets from 2023 through 2050, as shown in Table F-32. The total costs and cost savings on State government fleets from 2023 through 2050 would be $92M and $19M, respectively, as shown in Table F-32.

Table F- 32: Costs and Cost Savings on State Government Fleets under the Proposed Regulation from 2023 through 2050[50]

Calendar Year	Incremental Costs	Cost Savings
2023	$2,127,000	$0
2024	$7,812,000	$551,000
2025	$4,332,000	$583,000
2026	$3,717,000	$612,000
2027	$3,325,000	$639,000
2028	$3,185,000	$661,000
2029	$3,117,000	$679,000
2030	$3,066,000	$692,000
2031	$3,036,000	$703,000
2032	$3,012,000	$712,000
2033	$2,990,000	$719,000
2034	$2,969,000	$724,000
2035	$2,946,000	$727,000
2036	$2,936,000	$729,000
2037	$2,930,000	$731,000
2038	$2,931,000	$732,000
2039	$2,938,000	$734,000
2040	$2,952,000	$737,000
2041	$2,972,000	$741,000
2042	$2,998,000	$745,000

[50] Costs were rounded to the nearest thousand.

Calendar Year	Incremental Costs	Cost Savings
2043	$3,030,000	$750,000
2044	$3,067,000	$757,000
2045	$3,113,000	$764,000
2046	$3,162,000	$772,000
2047	$3,216,000	$782,000
2048	$3,274,000	$792,000
2049	$3,337,000	$804,000
2050	$3,404,000	$817,000
Total	**$91,893,000**	**$19,389,000**

2. State Implementation and Enforcement Costs

a. CARB

i. CARB Staff Resources

CARB was approved with the 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.

To effectively implement and enforce the Proposed Regulation, CARB would require additional staff resources of 26.0 full-time positions phased in from FY 2022-2023 through FY 2024-2025, specifically:

- 14.0 positions (2.0 AREs, 3.0 Air Pollution Specialists (APS), 4.0 Air Resources Technician (ART) IIs, 1.0 Information Technology Manager (ITM) II, 1.0 Information Technology Specialist (ITS) II, 1.0 ITS III, and 2.0 Associate Governmental Program Analysts (AGPA)) starting in FY 2022-2023
    - 1.0 ARE position is required 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.
    - 1.0 APS position is required to work on identifying data gaps needed to be filled to implement the HD I/M program and establish research efforts to remedy these gaps. Additionally, this APS will perform HD I/M emissions modeling (e.g., assessing the emissions impact and cost effectiveness of different regulatory proposals). This APS will also determine potential program validation methods utilizing advanced data collection techniques which could be used to assess the program success upon implementation. This position will also help to ensure that emission reductions attributed to this program will be accounted for and credited in planning and technical documents including, but not limited to, the SIP, scoping plans, and emission models such as California EMFAC model.

- 2.0 AGPA positions are required to provide support for the HD I/M regulation implementation contracting efforts such as 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 ITM II, 1.0 ITS II, and 1.0 ITS III positions are required for the overall design and implementation of the hosting environment for the HD I/M system. This system will need to be designed for high availability and performance within CARB's cloud environments. The Information Technology (IT) team will ensure that all security measures meet security compliance and all sensitive data that resides in the system is handled properly. The required positions cover IT management for this effort to coordinate with the heavy-duty implementation contractor and highly skilled staff available to support the hosting environment and implement system changes as needed.
- 1.0 ARE and 4.0 ART II positions are required to help support the enforcement of heavy-duty I/M program via physical roadside emissions monitoring systems, perform data science tasks, software development, and enforcement support. The Roadside Emissions Monitoring and Enforcement System (REMES) is envisioned to be a statewide network of Roadside Emissions Monitoring Devices (REMD), primarily consisting of the CARB developed PEAQS and potentially augmented with REMD developed by third-party vendors.
- 2.0 data analyst (APS) positions are required to begin developing the Enforcement Decision Support System (EDSS) by focusing on algorithms and methodologies to analyze all the data received from PEAQS and combining them with other data sources such as registration data and enforcement records to provide enforcement decision support. These positions will also perform ad-hoc data mining tasks as needed. Data science and software development are critical for a data and technology driven next-generation enforcement process. In order to successfully build the REMES to support the HD I/M program and data-driven heavy-duty vehicle enforcement in general, a team consisting of data analysts, system engineers and quality assurance/quality control (QA/QC) testers are required. REMES consists of three major components: PEAQS, Enforcement Decision Support System (EDSS), and the "Core Tracker" enforcement process management system. REMES also needs to interface with the HD I/M system to be built by MSCD to meet the HD I/M program requirements.

- 8.0 positions (4.0 APSs, 1.0 ART II, 2.0 ITS IIs, and 1.0 ITS III) starting in FY 2023-2024
  - 2.0 APS positions are required 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), and call volumes are

expected to increase significantly. These positions will provide expert-level call assistance for more complex calls, including researching compliance issues in order to advise callers. They will also analyze compliance data, coordinate and present at outreach events, offer one-on-one assistance to affected stakeholders, and participate in discussion panels.
    - 1.0 APS position is required 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 reach OOS fleets through avenues including, but not limited to, advertisements and articles in trucking magazines, and interviews with trucking related organizations and radio shows.
    - 1.0 APS position is required to provide data management oversight for HD I/M data extraction and processing to create useful and readily accessible versions of raw data collected through the HD I/M program, and data analytics to process data. This position will work with program subject matter experts and IT staff in developing data and business process documentation and will aid in planning, architecting, and implementing data pipelines, and managing data warehouses, storage, and access.
    - 1.0 ART II position is required to assist in performing data quality checks (QA/QC) of PEAQS, EDSS, and the Core Tracker enforcement process management system. This position will also monitor deployed REMES units to ensure units are working properly and maintain, calibrate, diagnose, and repair as necessary.
    - 2.0 ITS II and 1.0 ITS III positions are required to help support continued development of data security and data transfer protocols between the contractor and CARB, hosting environments, and the system architecture for serving data to other CARB stakeholders as the tasks become more complex. The positions will evaluate internal functions, business development strategies, and architecture, and provide systems processing guidance to ensure the program is operating as intended.
- 4.0 positions (3.0 ART IIs and 1.0 Attorney III) starting in FY 2024-2025
    - 3.0 ART II positions are required 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 (more than one million vehicles would be affected by the proposed program), and call volumes are expected to increase significantly.
    - 1.0 Attorney III position is required to help support efforts in 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 F-33 summarizes the phase-in and costs of the approved and required positions to support the Proposed Regulation implementation as discussed above.

Table F- 33: CARB Positions for the Proposed Regulation Implementation

Positions	FY 22-23[51]	FY 23-24	FY 24-25	FY 25-26 and later
ARS I	1.0*	1.0*	1.0*	1.0*
ART II	4.0	5.0	8.0	8.0
ARE	5.0 (3.0*)	5.0 (3.0*)	5.0 (3.0*)	5.0 (3.0*)
APS	3.0	7.0	7.0	7.0
AGPA	2.0	2.0	2.0	2.0
ITM II	1.0	1.0	1.0	1.0
ITS II	1.0	3.0	3.0	3.0
ITS III	1.0	2.0	2.0	2.0
Attorney III			1.0	1.0
Total Positions	**18.0 (4.0*)**	**26.0 (4.0*)**	**30.0 (4.0*)**	**30.0 (4.0*)**
Total Costs	**$4,867,000**	**$4,616,000**	**$5,144,000**	**$5,140,000**

*: previously awarded positions supporting the development of the Proposed Regulation

ii. CARB Outreach

CARB would need an annual funding of $275,000 starting in FY 2023-2024 to support the HD I/M program outreach efforts. These efforts would include media, mailings to stakeholders, and other forms of communication to ensure owners of heavy-duty vehicles operating in California are aware of the proposed HD I/M program requirements.

iii. Vehicle Enforcement Monitoring Technologies

To support CARB's enforcement efforts an implementation of Phase 1 of the Proposed Regulation, staff plans the deployment of PEAQS for roadside emissions monitoring. Staff projects an additional $180,000 in one-time equipment costs for three additional PEAQS units in FY 2022-2023. The PEAQS units cost $60,000 per system and would enable CARB to continue building out a statewide REMD network to measure vehicle emissions and increase enforcement effectiveness.[52] Furthermore, staff projects an additional $165,200 in one-time equipment costs for the purchase of 20 ALPR cameras in FY 2022-2023 to continue expanding critical enforcement related technologies throughout the State. An annual

[51] Note that costs in FY 2022-2023 include costs in previous FYs that were spent as seed money to support the proposed HD I/M program development and will be repaid to the State once the HD I/M compliance fee collections begin.

[52] Staff is currently in the process of deploying PEAQS units throughout the State with an early emphasis in the San Joaquin Valley and South Coast air basins. The requested three additional PEAQS unit purchases are part of 14 total PEAQS units planned for deployment. Note that costs related to the installation, maintenance, and operation this monitoring network will occur, however at this time, are not being constrained as part of costs allotted to the compliance fee.

maintenance and subscription cost of $23,200 starting from FY 2023-2024 is projected for the operation of these purchased ALPR cameras.

b. Other State Agencies

The implementation of the Proposed Regulation is a multi-agency effort including, but not limited to, coordination between CARB and other agencies such as California DMV, the California Department of Technology (CDT), BAR, and CHP. Implementation costs for these other agencies may also be supported through the compliance fee associated with the Proposed Regulation. As an example of some of the ongoing coordination efforts, the development of the IT systems required of the Proposed Regulation is supported by multiple State agencies. California DMV continues to coordinate with CARB on the development of the HD I/M database system to establish a tie between compliance demonstration with the Proposed Regulation and vehicle registration. This would enable an automatic DMV vehicle registration block for vehicles that are non-compliant with the proposed HD I/M program. This effort requires DMV to update their internal database systems to send and receive vehicle information from CARB, necessitating both additional costs to modify and build out their current systems as well as additional resources to accommodate the extra workload. Additionally, CDT is helping to support the development of these IT systems needed for the Proposed Regulation by providing critical IT expertise and oversight as both CARB and DMV plan out the requirements and build out each of their internal IT systems. Thus, resources are needed from CDT to participate in the implementation of this IT development effort. Table F-34 summarizes the currently projected costs associated with other State agencies supporting the implementation of the Proposed Regulation.

Table F- 34: Projected Costs for Other State Agencies for the Proposed Regulation

Fiscal Year	2022-2023[53]	2023-2024	2024-2025	2025-2026 and later
Total Costs	$14,200,000	$3,100,000	$2,300,000	$1,900,000

c. External Contractors

To support implementation of the Proposed Regulation, third-party implementation contractors 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. Additionally, external consulting experts are needed to assist with developing and managing the implementation contract.

i. Implementation Contractors

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

[53] Note that costs in FY 2022-2023 include costs in previous FYs that were spent as seed money to support the proposed HD I/M program development and will be repaid to the State once the HD I/M compliance fee collections begin.

- 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.

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 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 will provide a critical backstop to ensure vehicle compliance testing can effectively be completed when abnormalities or rare situations occur. 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.

Staff released a Request for Information to solicit information from private vendors regarding their ability to meet the proposed project requirements and to provide CARB with Rough Order of Magnitude (ROM) cost estimates for the efforts described above. Staff received ROM cost estimates from several vendors, which were used as the basis for staff's external contract cost estimates. The implementation contract is expected to be five years in length, whereby future contracts would go out for rebid.

ii. External Consulting Experts

As part of the State requirements for the new IT database system needed for the Proposed Regulation, CARB has included experts in the areas of project management, IT oversight, and requirements gathering as part of the planning and development efforts. To ensure success, CARB has hired this expertise through consulting contracts to supplement CARB's in-house expertise. These consulting experts would continue to be utilized through the implementation phases of the IT contract when it is in place.

iii. Total Costs for External Contractors

Staff's estimated total costs on all external contractors are summarized in Table F-35 below. As shown, the initial costs for external contractors are estimated to be approximately $18.2M, with annual on-going costs of approximately $10.4M.

Table F- 35: Projected Costs for External Contractors

Fiscal Year	2022-2023[54]	2023-2024	2024-2025	2025-2026	2026-2027
Total Costs	$18,200,000	$10,400,000	$10,400,000	$10,400,000	$10,400,000

d. Total State Implementation and Enforcement Costs

Table F-36 summarizes staff's estimated State implementation and enforcement costs from FY 2022-2023 through FY 2026-2027 as discussed above.

Table F- 36: State Implementation and Enforcement Costs due to the Proposed Regulation

Fiscal Year	CARB[55]	Other State Agencies	External Contractors[56]	Total
2022-2023[57]	$5,212,200	$14,200,000	$18,200,000	$37,612,200
2023-2024	$4,914,200	$3,100,000	$10,400,000	$18,414,200
2024-2025	$5,442,200	$2,300,000	$10,400,000	$18,142,200
2025-2026	$5,438,200	$1,900,000	$10,400,000	$17,738,200
2026-2027	$5,438,200	$1,900,000	$10,400,000	$17,738,200
Total	**$26,445,000**	**$23,400,000**	**$59,800,000**	**$109,645,000**

e. HD I/M Compliance Fee Determination

Under Senate Bill (SB) 210, the HD I/M program compliance fee collected on the affected heavy-duty vehicles will be used to fund the needed State agency efforts to implement and enforce the Proposed Regulation. The program compliance fee was estimated based on the estimated State implementation and enforcement costs, as discussed in subsections a.

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[54] Note that costs in FY 2022-2023 include costs in previous FYs that were spent as seed money to support the proposed HD I/M program development and will be repaid to the State once the HD I/M compliance fee collections begin.

[55] Costs on CARB includes costs for CARB staff resources, outreach, and vehicle enforcement monitoring technologies.

[56] Costs for external contractors include costs for hiring implementation contractors and external consulting experts needed to design and implement the IT database system.

[57] As mentioned earlier, costs in FY 2022-2023 include costs in previous FYs that were spent as seed money to support the proposed HD I/M program development and will be repaid to the State once the HD I/M compliance fee collections begin.

through d. above, and the estimated number of vehicles operating in California that would pay the proposed compliance fee, as discussed in Chapter I.D. State contracts are typically five years in length; thus, staff estimated the length of the initial contract to be five years long, starting in FY 2022-2023 and ending in FY 2026-2027. Table F-37 summarizes staff's estimated annual heavy-duty vehicle population that is expected to pay the proposed compliance fee and staff's estimated annual State implementation and enforcement costs in the first five years of the Proposed Regulation implementation (i.e., FY 2022-2023 through 2026-2027). The annual program compliance fee per vehicle was then calculated by dividing the total State costs by the projected total vehicle population paying the compliance fee over the five-year period.[58]

Table F- 37: Projected Annual HD I/M Program Compliance Fee

Fiscal Year	Projected Vehicle Population Paying Compliance Fee[59]	State Implementation and Enforcement Costs
2022-2023	0	$37,612,200
2023-2024	792,166	$18,414,200
2024-2025	936,750	$18,142,200
2025-2026	958,007	$17,738,200
2026-2027	976,980	$17,738,200
Total	**3,663,903**	**$109,645,000**
Annual Compliance Fee	**$30**	

Based on these projections, staff is proposing an annual compliance fee of $30 per affected vehicle for the Proposed Regulation. The proposed compliance fee would be adjusted annually 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. Except for annual changes based on the CCPI, staff anticipates the proposed $30 compliance fee would remain constant throughout the course of the Proposed Regulation's implementation. If a need arises to change the fee beyond the CCPI adjustments, staff would need to propose the change as part of a future rulemaking.

[58] An external contract duration is typically five years; hence, the annual program compliance fee was calculated based on vehicle population and State costs over the first five FY period. This would ensure State has enough fund from the collected fee to pay external contractors by end of the contract period of five years.

[59] The proposed compliance fee is projected to begin in July 2023, hence, as FY 2022-2023 goes from July 2022 to June 2023, staff projected no compliance fees in FY 2022-2023. Staff's projection for the vehicle population paying the proposed compliance fee follows staff's estimates for the number of vehicles projected to pay for the proposed compliance fee as discussed in Chapter I.D.

3. State Sales Tax Revenue

Similar to local governments, State government would also collect sales tax revenue from the projected increased testing devices, engine parts, and vehicle parts sale due to the projected increasing vehicle testing and repair demand as a result of the Proposed Regulation. Staff assumed a State sales tax rate of 3.9 percent and applied this tax rate to the estimated taxable increased testing device sales and telematics service costs, increased vehicle reporting service costs, as well as increased repair part costs (as shown in Table F-31 above) to estimate the total State sales tax revenue.

Table F-38 summarizes State sales tax revenue due to the Proposed Regulation.

Table F- 38: State Sales Tax Revenue due to the Proposed Regulation

Calendar Year	State Sales tax Revenue
2023	$1,554,000
2024	$7,365,000
2025	$3,335,000
2026	$2,848,000
2027	$2,553,000
2028	$2,775,000
2029	$2,459,000
2030	$2,452,000
2031	$2,464,000
2032	$2,478,000
2033	$2,791,000
2034	$2,506,000
2035	$2,513,000
2036	$2,532,000
2037	$2,552,000
2038	$2,873,000
2039	$2,600,000
2040	$2,630,000
2041	$2,664,000
2042	$2,702,000
2043	$3,041,000
2044	$2,786,000
2045	$2,836,000
2046	$2,887,000
2047	$2,941,000
2048	$3,296,000
2049	$3,057,000

Calendar Year	State Sales tax Revenue
2050	$3,119,000
Total	**$80,608,000**

IV. Macroeconomic Impacts

A. Method for Determining Economic Impacts

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 chapters I. through III. above. The analysis focuses on the incremental changes in major macroeconomic indicators from 2023 to 2050 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 2050, 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.[60] 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 DOF. Staff used the REMI single region, 160 sector model with the model reference case adjusted to reflect California DOF's most current publicly available economic and demographic projections (DOF, 2013).

Specifically, REMI model's National and Regional Control was updated to conform to the most recent California DOF economic forecasts which include United States 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 ((DOF, 2021a), (DOF, 2021b), (DOF, 2021c), & (DOF, 2021d)). After the DOF forecasts end in 2024,

[60] For further information and model documentation see: *https://www.remi.com/model/pi/*

CARB staff made assumptions that post-2024, economic variables would continue to grow at the same rate projected in the REMI baseline forecasts.

B. 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 estimated direct costs and the non-mortality health benefits are translated into REMI policy variables and used as inputs for the macroeconomic analysis.

The Proposed Regulation would impose direct costs on the Truck Transportation industry (484), which would be required to comply with the Proposed Regulation. Costs incurred by fleets would result in corresponding changes in demand for industries supplying those goods or services as shown in Table F-39.

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 F- 39: 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)
Compliance Fee	• Automotive Repair and Maintenance (8111) • Measuring Equipment (3345) • Data Processing & Hosting (518)

Sources of Costs	Industries (NAICS)
	• 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. 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.

C. 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 2050. 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 2050.

1. California Employment Impacts

Table F-40 presents the impact of the Proposed Regulation on total employment in California across all industries. The employment impacts represent the net change in employment relative to the baseline, which consists 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. The maximum negative impact is a decrease in job growth of 698 jobs in 2028.

Table F- 40: Total California Employment Impacts of the Proposed Regulation

Calendar Year	Change in Job Growth	% Change	California Employment
2023	324	0.00%	24,873,041
2024	-107	0.00%	25,287,029
2025	-605	0.00%	25,438,285
2026	-663	0.00%	25,473,259
2027	-664	0.00%	25,474,207
2028	-698	0.00%	25,456,078
2029	-585	0.00%	25,493,507
2030	-559	0.00%	25,462,890
2031	-541	0.00%	25,474,177
2032	-531	0.00%	25,528,082
2033	-600	0.00%	25,588,733
2034	-524	0.00%	25,657,236
2035	-526	0.00%	25,732,127
2036	-523	0.00%	25,817,107
2037	-520	0.00%	25,912,766
2038	-585	0.00%	26,025,237
2039	-506	0.00%	26,148,746
2040	-501	0.00%	26,273,567
2041	-492	0.00%	26,399,199
2042	-483	0.00%	26,550,034
2043	-543	0.00%	26,699,929
2044	-461	0.00%	26,852,933
2045	-454	0.00%	27,009,042
2046	-443	0.00%	27,171,047
2047	-434	0.00%	27,363,224
2048	-493	0.00%	27,557,353

Calendar Year	Change in Job Growth	% Change	California Employment
2049	-413	0.00%	27,753,970
2050	-403	0.00%	27,924,265

Shown in Tables F-41 and F-42 are the employment impacts on the major sectors of the California economy. 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 to 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 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 F- 41: 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	64	0.00%	-68	0.00%	427	0.00%	-35	0.00%
2024	211	0.01%	-318	-0.01%	540	0.00%	-218	-0.02%
2025	129	0.00%	-214	-0.01%	135	0.00%	-233	-0.02%
2026	111	0.00%	-185	-0.01%	28	0.00%	-188	-0.01%
2027	102	0.00%	-165	-0.01%	-44	0.00%	-137	-0.01%
2028	53	0.00%	-158	-0.01%	-77	0.00%	-105	-0.01%
2029	101	0.00%	-145	-0.01%	-90	0.00%	-62	-0.01%
2030	102	0.00%	-139	-0.01%	-107	0.00%	-39	0.00%
2031	104	0.00%	-135	-0.01%	-121	0.00%	-24	0.00%
2032	105	0.00%	-131	-0.01%	-134	0.00%	-15	0.00%
2033	60	0.00%	-133	-0.01%	-150	0.00%	-21	0.00%
2034	107	0.00%	-126	-0.01%	-157	0.00%	-9	0.00%
2035	108	0.00%	-124	-0.01%	-169	0.00%	-8	0.00%
2036	109	0.00%	-122	-0.01%	-177	0.00%	-7	0.00%
2037	110	0.00%	-120	-0.01%	-183	0.00%	-7	0.00%
2038	66	0.00%	-123	-0.01%	-191	0.00%	-17	0.00%
2039	114	0.00%	-117	-0.01%	-189	0.00%	-8	0.00%
2040	116	0.00%	-116	0.00%	-193	0.00%	-8	0.00%

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
2041	120	0.00%	-115	0.00%	-194	0.00%	-7	0.00%
2042	124	0.00%	-114	0.00%	-195	0.00%	-7	0.00%
2043	83	0.00%	-118	0.00%	-200	0.00%	-16	0.00%
2044	132	0.00%	-113	0.00%	-193	0.00%	-7	0.00%
2045	137	0.01%	-113	0.00%	-194	0.00%	-6	0.00%
2046	143	0.01%	-112	0.00%	-193	0.00%	-5	0.00%
2047	149	0.01%	-112	0.00%	-192	0.00%	-5	0.00%
2048	110	0.00%	-117	0.00%	-195	0.00%	-13	0.00%
2049	161	0.01%	-112	0.00%	-187	0.00%	-4	0.00%
2050	168	0.01%	-112	0.00%	-186	0.00%	-3	0.00%

Table F- 42: 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	-50	0.00%	-8	0.00%	-5	0.00%	-1	0.00%
2024	-236	-0.02%	-3	0.00%	-78	0.00%	-5	0.00%
2025	-260	-0.02%	-75	-0.01%	-81	0.00%	-6	0.00%
2026	-269	-0.02%	-84	-0.01%	-71	0.00%	-6	0.00%

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
2027	-266	-0.02%	-85	-0.01%	-63	0.00%	-5	0.00%
2028	-263	-0.02%	-84	-0.01%	-59	0.00%	-5	0.00%
2029	-255	-0.02%	-80	-0.01%	-50	0.00%	-4	0.00%
2030	-248	-0.02%	-77	-0.01%	-47	0.00%	-4	0.00%
2031	-242	-0.02%	-75	-0.01%	-44	0.00%	-4	0.00%
2032	-237	-0.02%	-73	-0.01%	-43	0.00%	-4	0.00%
2033	-233	-0.02%	-73	-0.01%	-45	0.00%	-4	0.00%
2034	-226	-0.02%	-70	-0.01%	-40	0.00%	-3	0.00%
2035	-221	-0.02%	-69	-0.01%	-40	0.00%	-3	0.00%
2036	-216	-0.01%	-67	-0.01%	-40	0.00%	-3	0.00%
2037	-211	-0.01%	-66	-0.01%	-39	0.00%	-3	0.00%
2038	-208	-0.01%	-66	-0.01%	-42	0.00%	-3	0.00%
2039	-201	-0.01%	-64	-0.01%	-38	0.00%	-3	0.00%
2040	-197	-0.01%	-63	-0.01%	-37	0.00%	-3	0.00%
2041	-193	-0.01%	-63	-0.01%	-37	0.00%	-2	0.00%
2042	-189	-0.01%	-62	-0.01%	-36	0.00%	-2	0.00%
2043	-188	-0.01%	-63	-0.01%	-38	0.00%	-2	0.00%
2044	-183	-0.01%	-61	-0.01%	-34	0.00%	-2	0.00%
2045	-181	-0.01%	-61	-0.01%	-34	0.00%	-2	0.00%
2046	-179	-0.01%	-61	-0.01%	-33	0.00%	-2	0.00%
2047	-177	-0.01%	-61	-0.01%	-33	0.00%	-2	0.00%

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
2048	-177	-0.01%	-63	-0.01%	-35	0.00%	-2	0.00%
2049	-174	-0.01%	-62	-0.01%	-32	0.00%	-2	0.00%
2050	-173	-0.01%	-62	-0.01%	-31	0.00%	-2	0.00%

2. 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 Gross State Product (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.

As shown in Table F-43, 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 $153M in 2028, the year with greatest negative impact. On average, the Proposed Regulation is estimated to result in a decrease in output growth of $126M per year.

Table F- 43: Change in California Output Growth Due to the Proposed Regulation

Calendar Year	Output Change (2020M$)	% Change	Aggregate Output (2020M$)
2023	48.38	0.00%	5,424,742
2024	-17.34	0.00%	5,575,010
2025	-141.47	0.00%	5,669,483
2026	-152.51	0.00%	5,734,566
2027	-151.53	0.00%	5,799,381
2028	-153.41	0.00%	5,866,991
2029	-135.58	0.00%	5,946,539
2030	-130.97	0.00%	6,010,057
2031	-128.02	0.00%	6,084,979
2032	-126.77	0.00%	6,166,762
2033	-137.39	0.00%	6,252,299
2034	-127.54	0.00%	6,342,772
2035	-129.53	0.00%	6,438,536
2036	-130.53	0.00%	6,540,898
2037	-131.70	0.00%	6,650,843
2038	-142.04	0.00%	6,772,152
2039	-131.91	0.00%	6,903,049
2040	-133.19	0.00%	7,037,888
2041	-133.35	0.00%	7,175,564

Calendar Year	Output Change (2020M$)	% Change	Aggregate Output (2020M$)
2042	-133.54	0.00%	7,316,795
2043	-144.39	0.00%	7,460,977
2044	-133.26	0.00%	7,610,326
2045	-134.30	0.00%	7,764,083
2046	-134.57	0.00%	7,922,921
2047	-135.10	0.00%	8,086,329
2048	-146.67	0.00%	8,254,039
2049	-136.05	0.00%	8,426,443
2050	-136.85	0.00%	8,602,012

Output changes by major sector are shown in Tables F-44 and F-45. 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 most of the years of the assessment. 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 2033. 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 due to 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 2024. However, this positive impact is offset in later years by the impacts of the increased costs on Truck Transportation. The government sector is estimated to see small increases in output growth as compliance fee revenue is used to fund implementation and enforcement activities. 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 F- 44: 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	11.73	0.00%	-10.67	0.00%	66.74	0.00%	-6.25	0.00%
2024	39.27	0.01%	-54.04	-0.01%	104.23	0.01%	-39.63	-0.02%
2025	24.13	0.00%	-39.75	-0.01%	36.86	0.00%	-42.92	-0.02%
2026	20.94	0.00%	-36.17	-0.01%	22.81	0.00%	-35.25	-0.02%
2027	19.44	0.00%	-33.59	-0.01%	13.59	0.00%	-26.30	-0.01%
2028	10.17	0.00%	-33.34	-0.01%	15.13	0.00%	-20.51	-0.01%
2029	19.38	0.00%	-31.32	-0.01%	7.99	0.00%	-12.65	-0.01%
2030	19.65	0.00%	-30.93	-0.01%	5.78	0.00%	-8.36	0.00%
2031	20.08	0.00%	-30.77	-0.01%	3.90	0.00%	-5.53	0.00%
2032	20.46	0.00%	-30.79	-0.01%	2.07	0.00%	-3.82	0.00%
2033	11.68	0.00%	-32.15	-0.01%	5.22	0.00%	-4.94	0.00%
2034	20.97	0.00%	-31.06	-0.01%	-1.41	0.00%	-2.56	0.00%
2035	21.18	0.00%	-31.42	-0.01%	-3.43	0.00%	-2.29	0.00%
2036	21.49	0.00%	-31.75	-0.01%	-4.76	0.00%	-2.18	0.00%
2037	21.86	0.00%	-32.15	-0.01%	-5.95	0.00%	-2.19	0.00%
2038	13.22	0.00%	-33.81	-0.01%	-1.78	0.00%	-4.21	0.00%

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
2039	22.89	0.00%	-32.95	0.00%	-7.27	0.00%	-2.36	0.00%
2040	23.61	0.00%	-33.62	0.00%	-8.17	0.00%	-2.31	0.00%
2041	24.44	0.00%	-34.18	0.00%	-8.57	0.00%	-2.23	0.00%
2042	25.37	0.00%	-34.79	0.00%	-8.90	0.00%	-2.16	0.00%
2043	17.12	0.00%	-36.81	0.00%	-4.15	0.00%	-4.03	0.00%
2044	27.42	0.00%	-36.00	0.00%	-8.92	0.00%	-2.11	0.00%
2045	28.66	0.00%	-36.95	0.00%	-9.29	0.00%	-1.98	0.00%
2046	29.96	0.00%	-37.78	0.00%	-9.31	0.00%	-1.86	0.00%
2047	31.33	0.00%	-38.68	0.00%	-9.34	0.00%	-1.77	0.00%
2048	23.39	0.00%	-41.10	0.00%	-4.43	0.00%	-3.57	0.00%
2049	34.23	0.01%	-40.52	0.00%	-9.06	0.00%	-1.70	0.00%
2050	35.96	0.01%	-41.59	0.00%	-9.16	0.00%	-1.45	0.00%

Table F- 45: California Output Impacts of Proposed Regulation by Major Sector (2020$M): Transportation, Manufacturing, Financial Services, and Natural Resources

	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	-9.14	0.00%	-0.37	0.00%	-3.46	0.00%	-0.20	0.00%
2024	-43.59	-0.02%	17.54	0.00%	-39.81	0.00%	-1.32	0.00%
2025	-49.08	-0.02%	-28.44	0.00%	-40.63	0.00%	-1.65	0.00%
2026	-51.68	-0.02%	-35.52	-0.01%	-36.01	0.00%	-1.64	0.00%
2027	-52.22	-0.02%	-38.54	-0.01%	-32.35	0.00%	-1.56	0.00%
2028	-52.65	-0.02%	-39.92	-0.01%	-30.74	0.00%	-1.55	0.00%
2029	-52.11	-0.02%	-38.51	-0.01%	-26.94	0.00%	-1.41	0.00%
2030	-51.83	-0.02%	-38.26	-0.01%	-25.67	0.00%	-1.36	0.00%
2031	-51.59	-0.02%	-38.03	-0.01%	-24.76	0.00%	-1.31	0.00%
2032	-51.34	-0.02%	-37.80	-0.01%	-24.27	0.00%	-1.28	0.00%
2033	-51.52	-0.02%	-38.81	-0.01%	-25.55	0.00%	-1.32	0.00%
2034	-50.86	-0.02%	-37.55	-0.01%	-23.84	0.00%	-1.22	0.00%
2035	-50.64	-0.02%	-37.59	-0.01%	-24.14	0.00%	-1.20	0.00%
2036	-50.41	-0.02%	-37.58	0.00%	-24.17	0.00%	-1.18	0.00%
2037	-50.21	-0.02%	-37.64	0.00%	-24.25	0.00%	-1.17	0.00%
2038	-50.44	-0.02%	-38.10	0.00%	-25.70	0.00%	-1.23	0.00%
2039	-49.90	-0.02%	-37.08	0.00%	-24.11	0.00%	-1.13	0.00%
2040	-49.85	-0.02%	-37.32	0.00%	-24.40	0.00%	-1.13	0.00%
2041	-49.81	-0.02%	-37.55	0.00%	-24.33	0.00%	-1.12	0.00%

	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
2042	-49.85	-0.02%	-37.83	0.00%	-24.27	0.00%	-1.11	0.00%
2043	-50.38	-0.02%	-39.36	0.00%	-25.61	0.00%	-1.18	0.00%
2044	-50.14	-0.02%	-38.51	0.00%	-23.90	0.00%	-1.10	0.00%
2045	-50.46	-0.02%	-39.03	0.00%	-24.15	0.00%	-1.10	0.00%
2046	-50.81	-0.02%	-39.59	0.00%	-24.08	0.00%	-1.10	0.00%
2047	-51.25	-0.02%	-40.23	0.00%	-24.06	0.00%	-1.10	0.00%
2048	-52.19	-0.02%	-42.16	0.00%	-25.42	0.00%	-1.19	0.00%
2049	-52.36	-0.02%	-41.67	0.00%	-23.86	0.00%	-1.11	0.00%
2050	-53.01	-0.02%	-42.51	0.00%	-23.97	0.00%	-1.12	0.00%

3. 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 F-46 and show a decrease of private investment of about $65M in 2025, the year with highest impact. The impacts are primarily linked to residential investment, which is indirectly impacted by the Truck Transportation industry. Over the analysis period, the Proposed Regulation is estimated to result in an annual average decrease in private investment growth of $24M. All impacts in the period of analysis do not exceed 0.01 percent of baseline investment in any year.

Table F- 46: Change in Gross Domestic Private Investment Growth Due to the Proposed Regulation

Calendar Year	Investment Change (2020M$)	% Change	Aggregate Investment Totals (2020M$)
2023	-10.08	0.00%	472,138
2024	-61.54	-0.01%	497,318
2025	-64.95	-0.01%	505,295
2026	-55.81	-0.01%	510,282
2027	-44.51	-0.01%	516,339
2028	-35.73	-0.01%	521,257
2029	-27.36	-0.01%	528,878
2030	-21.96	0.00%	534,367
2031	-18.53	0.00%	540,154
2032	-16.58	0.00%	547,181
2033	-16.75	0.00%	554,765
2034	-15.55	0.00%	562,901
2035	-15.45	0.00%	571,404
2036	-15.59	0.00%	580,215
2037	-15.91	0.00%	589,734
2038	-17.26	0.00%	599,825
2039	-16.78	0.00%	610,447
2040	-16.99	0.00%	621,263

Calendar Year	Investment Change (2020M$)	% Change	Aggregate Investment Totals (2020M$)
2041	-17.20	0.00%	632,166
2042	-17.44	0.00%	643,099
2043	-18.66	0.00%	654,052
2044	-18.11	0.00%	665,154
2045	-18.28	0.00%	676,489
2046	-18.49	0.00%	688,120
2047	-18.75	0.00%	700,064
2048	-19.96	0.00%	712,268
2049	-19.54	0.00%	724,798
2050	-19.63	0.00%	737,481

4. 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 F-47 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 $263M in 2024, the year of greatest impact. Over the analysis period, the Proposed Regulation is estimated to result in a decrease in personal income growth of approximately $145M per year, on average. 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 $4 per person for most of the years of the assessment. It is important to keep in mind that the results shown likely overstate the negative impact on personal income as CARB staff's macroeconomic modeling omits the value of avoided premature mortality. The valuation methods used to monetize the benefits associated with avoided premature mortality do not correspond to changes in expenditures and are not included in the macroeconomic modeling. To be conservative, the modeling also does not take into account the improvements to quality of life in California due to improved air quality and a decrease in air-quality related deaths. These improvements to quality of life in California would be expected to increase labor supply, labor productivity, and personal income in ways that offset the results shown above.

Table F- 47: Change in Personal Income Growth Due to the Proposed Regulation

Calendar Year	Personal Income Change (2020M$)	% Change	Aggregated Personal Income (2020M$)	Per Capita Personal Income Change (2020$)
2023	-50.05	0.00%	2,809,644	-1.24
2024	-263.48	-0.01%	2,896,653	-6.49
2025	-180.89	-0.01%	2,948,001	-4.43
2026	-157.78	-0.01%	2,992,413	-3.85
2027	-145.70	-0.01%	3,038,021	-3.53
2028	-146.59	-0.01%	3,100,236	-3.54
2029	-135.80	0.00%	3,136,693	-3.26
2030	-135.78	0.00%	3,199,063	-3.24
2031	-135.51	0.00%	3,263,499	-3.22
2032	-135.01	0.00%	3,310,379	-3.20
2033	-141.32	0.00%	3,359,205	-3.33
2034	-134.21	0.00%	3,410,517	-3.15
2035	-135.59	0.00%	3,463,574	-3.17
2036	-135.90	0.00%	3,518,580	-3.17
2037	-136.47	0.00%	3,576,426	-3.17
2038	-143.31	0.00%	3,638,150	-3.32
2039	-136.79	0.00%	3,702,839	-3.16
2040	-138.82	0.00%	3,768,828	-3.20
2041	-139.55	0.00%	3,836,272	-3.21
2042	-140.42	0.00%	3,904,722	-3.22
2043	-147.93	0.00%	3,974,774	-3.39
2044	-141.58	0.00%	4,046,569	-3.24
2045	-144.24	0.00%	4,119,972	-3.29
2046	-145.55	0.00%	4,195,576	-3.32
2047	-147.03	0.00%	4,272,671	-3.35
2048	-155.26	0.00%	4,351,402	-3.53
2049	-149.48	0.00%	4,432,358	-3.40
2050	-151.70	0.00%	4,514,162	-3.44

5. 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.[61] Table F-48 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 compared to the baseline; both positive and negative impacts to GSP are not estimated to exceed 0.00 percent of baseline GSP.

Table F- 48: Change in Gross State Product Due to the Proposed Regulation

Calendar Year	GSP Change (2020M$)	% Change	Aggregate GSP (2020M$)
2023	30.78	0.00%	3,227,908
2024	-2.79	0.00%	3,319,380
2025	-73.42	0.00%	3,377,241
2026	-78.05	0.00%	3,419,014
2027	-76.93	0.00%	3,463,570
2028	-77.78	0.00%	3,511,041
2029	-68.09	0.00%	3,567,036
2030	-65.76	0.00%	3,616,879
2031	-64.36	0.00%	3,672,780
2032	-63.95	0.00%	3,732,299
2033	-70.15	0.00%	3,793,434
2034	-65.00	0.00%	3,856,578
2035	-66.51	0.00%	3,921,373
2036	-67.35	0.00%	3,988,324
2037	-68.25	0.00%	4,057,753
2038	-73.99	0.00%	4,131,650
2039	-68.42	0.00%	4,208,616
2040	-69.27	0.00%	4,287,165
2041	-69.40	0.00%	4,367,087

[61] 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.

Calendar Year	GSP Change (2020M$)	% Change	Aggregate GSP (2020M$)
2042	-69.52	0.00%	4,448,858
2043	-75.52	0.00%	4,532,069
2044	-69.26	0.00%	4,617,341
2045	-69.83	0.00%	4,704,778
2046	-69.90	0.00%	4,794,817
2047	-70.08	0.00%	4,887,115
2048	-76.32	0.00%	4,981,472
2049	-70.29	0.00%	5,078,090
2050	-70.59	0.00%	5,176,001

6. Creation or Elimination of Businesses

The Proposed Regulation does not directly result in the creation or elimination of businesses. The REMI model cannot directly estimate the creation or elimination of businesses, but 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. However, the macroeconomic analysis results only show impacts up to 0.02 percent for the transportation sector. 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. The macroeconomic analysis results only show impacts up to 0.01 percent for these sectors.

7. Incentives for Innovation

The Proposed Regulation would provide incentive 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. Vendors of such devices 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. 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.

8. Competitive Advantage or Disadvantage

All non-gasoline combustion heavy-duty vehicles with gross vehicle weight rating 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. For in-state fleets, the DMV registration link to program compliance would provide a strong incentive to comply. However, since there is no link between registration for OOS vehicles and compliance, some OOS fleets may be tempted to not comply with the Proposed Regulation in order to avoid the testing and repair costs associated with the Regulation. 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.

Staff is proposing multiple enforcement measures to minimize any potential competitive advantage OOS vehicles may see due to the lack of a DMV registration hold. These include the proposed roadside monitoring systems and an increased field presence through enhanced coordination with CHP. 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. Additionally, the proposed vehicle compliance verification requirements for freight contractors, brokers, and facilities when doing businesses with vehicles subject to the Proposed Regulation would incentivize both in-state and OOS vehicles to be compliant with the Proposed Regulation 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.

9. Summary and Agency Interpretation of the Assessment Results

The results of the macroeconomic analysis of the Proposed Regulation are summarized in Table F-49. 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 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 one 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 statewide impacts to the economic indicators are projected to be less than or equal to 0.01 percent of the baseline.

Table F- 49: Summary of Macroeconomic Impacts of the Proposed Regulation

	GSP	GSP	Personal Income	Personal Income	Employment	Employment	Output	Output	Investment	Investment
Calendar Year	Change (2020$M)	% Change	Change (2020$M)	% Change	Change	% Change	Change (2020$M)	% Change	Change (2020$M)	% Change
2023	30.78	0.00%	-50.05	0.00%	324	0.00%	48.38	0.00%	-10.08	0.00%
2024	-2.79	0.00%	-263.48	-0.01%	-107	0.00%	-17.34	0.00%	-61.54	-0.01%
2025	-73.42	0.00%	-180.89	-0.01%	-605	0.00%	-141.47	0.00%	-64.95	-0.01%
2026	-78.05	0.00%	-157.78	-0.01%	-663	0.00%	-152.51	0.00%	-55.81	-0.01%
2027	-76.93	0.00%	-145.70	-0.01%	-664	0.00%	-151.53	0.00%	-44.51	-0.01%
2028	-77.78	0.00%	-146.59	-0.01%	-698	0.00%	-153.41	0.00%	-35.73	-0.01%
2029	-68.09	0.00%	-135.80	0.00%	-585	0.00%	-135.58	0.00%	-27.36	-0.01%
2030	-65.76	0.00%	-135.78	0.00%	-559	0.00%	-130.97	0.00%	-21.96	0.00%
2031	-64.36	0.00%	-135.51	0.00%	-541	0.00%	-128.02	0.00%	-18.53	0.00%
2032	-63.95	0.00%	-135.01	0.00%	-531	0.00%	-126.77	0.00%	-16.58	0.00%
2033	-70.15	0.00%	-141.32	0.00%	-600	0.00%	-137.39	0.00%	-16.75	0.00%
2034	-65.00	0.00%	-134.21	0.00%	-524	0.00%	-127.54	0.00%	-15.55	0.00%
2035	-66.51	0.00%	-135.59	0.00%	-526	0.00%	-129.53	0.00%	-15.45	0.00%
2036	-67.35	0.00%	-135.90	0.00%	-523	0.00%	-130.53	0.00%	-15.59	0.00%
2037	-68.25	0.00%	-136.47	0.00%	-520	0.00%	-131.70	0.00%	-15.91	0.00%
2038	-73.99	0.00%	-143.31	0.00%	-585	0.00%	-142.04	0.00%	-17.26	0.00%
2039	-68.42	0.00%	-136.79	0.00%	-506	0.00%	-131.91	0.00%	-16.78	0.00%
2040	-69.27	0.00%	-138.82	0.00%	-501	0.00%	-133.19	0.00%	-16.99	0.00%
2041	-69.40	0.00%	-139.55	0.00%	-492	0.00%	-133.35	0.00%	-17.20	0.00%
2042	-69.52	0.00%	-140.42	0.00%	-483	0.00%	-133.54	0.00%	-17.44	0.00%

	GSP	GSP	Personal Income	Personal Income	Employment	Employment	Output	Output	Investment	Investment
Calendar Year	Change (2020$M)	% Change	Change (2020$M)	% Change	Change	% Change	Change (2020$M)	% Change	Change (2020$M)	% Change
2043	-75.52	0.00%	-147.93	0.00%	-543	0.00%	-144.39	0.00%	-18.66	0.00%
2044	-69.26	0.00%	-141.58	0.00%	-461	0.00%	-133.26	0.00%	-18.11	0.00%
2045	-69.83	0.00%	-144.24	0.00%	-454	0.00%	-134.30	0.00%	-18.28	0.00%
2046	-69.90	0.00%	-145.55	0.00%	-443	0.00%	-134.57	0.00%	-18.49	0.00%
2047	-70.08	0.00%	-147.03	0.00%	-434	0.00%	-135.10	0.00%	-18.75	0.00%
2048	-76.32	0.00%	-155.26	0.00%	-493	0.00%	-146.67	0.00%	-19.96	0.00%
2049	-70.29	0.00%	-149.48	0.00%	-413	0.00%	-136.05	0.00%	-19.54	0.00%
2050	-70.59	0.00%	-151.70	0.00%	-403	0.00%	-136.85	0.00%	-19.63	0.00%

V. Alternatives

A. Alternative 1

Alternative 1 was developed based on feedback received from stakeholders who suggested reduced periodic testing requirements on fleets. 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 semiannual) periodic inspection would be required for heavy-duty vehicle fleets
    - Fleets would perform this annual periodic testing on only a ten percent representative portion of their vehicles, rather than all vehicles; and
- New vehicles would be exempted from the periodic testing requirement for the first two years.

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 tester training,
- Compliance fee, and
- Heavy-duty vehicle repairs.

The compliance 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 testers. The reduced testing would also result in less non-compliant vehicles being identified. It thus also 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 tester training costs, and vehicle repair costs relative to the Proposed Regulation.

The reporting costs, vehicle testing costs, and HD I/M tester training costs under Alternative 1 were estimated using the same cost methodology as used for the Proposed Regulation. 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. However, staff made modifications to the estimated percentage of non-compliant vehicles that would be identified and then repaired. For example, vehicles within the first two years of life would not be submitting test results, thus, it is expected these vehicles would not be readily repaired if they have emissions issues. Note that in recent OBD collection field studies performed by staff, data suggests that even newer vehicles currently in operation have MIL-on related issues. This recent data collection resulted in MIL-on rates of up to 12 percent for vehicles within the first two years of life had an illuminated MIL. 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 F-21 for the corresponding Alternative 1's values shown in Table F-50 below.

Table F- 50: 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	16%	16%
2024-2025	27%	29%
2026 and later	27%	29%

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 summarized in Table F-51. Alternative 1 is projected to cost $3.48B over the 2023-2050 period, with a maximum annual cost of $196M in 2024.

Table F- 51: Total Estimated Direct Incremental Costs Relative to the Baseline of Alternative 1 from 2023 through 2050[62]

Calendar Year	Reporting	Vehicle Testing	HD I/M Tester Training	Compliance Fee	Heavy-Duty Vehicle Repairs	Total Costs
2023	$3,321,000	$1,941,000	$28,559,000	$23,765,000	$36,900,000	$94,487,000
2024	$446,000	$84,172,000	$15,524,000	$28,102,000	$67,669,000	$195,914,000
2025	$413,000	$33,896,000	$16,106,000	$28,740,000	$55,154,000	$134,309,000
2026	$378,000	$34,439,000	$16,591,000	$29,309,000	$46,304,000	$127,022,000
2027	$345,000	$34,938,000	$17,025,000	$29,807,000	$41,107,000	$123,221,000
2028	$310,000	$35,290,000	$17,371,000	$30,214,000	$37,201,000	$120,386,000
2029	$276,000	$35,471,000	$17,605,000	$30,526,000	$34,534,000	$118,411,000
2030	$244,000	$35,482,000	$17,724,000	$30,740,000	$32,564,000	$116,754,000
2031	$232,000	$35,861,000	$17,902,000	$31,011,000	$31,145,000	$116,151,000
2032	$210,000	$36,079,000	$18,005,000	$31,256,000	$30,154,000	$115,704,000
2033	$189,000	$36,329,000	$18,086,000	$31,471,000	$29,420,000	$115,494,000
2034	$171,000	$36,554,000	$18,133,000	$31,675,000	$28,870,000	$115,403,000
2035	$150,000	$36,620,000	$18,086,000	$31,830,000	$28,498,000	$115,184,000
2036	$140,000	$36,961,000	$18,103,000	$32,026,000	$28,262,000	$115,493,000
2037	$132,000	$37,303,000	$18,106,000	$32,255,000	$28,138,000	$115,934,000
2038	$127,000	$37,723,000	$18,120,000	$32,532,000	$28,110,000	$116,611,000
2039	$123,000	$38,186,000	$18,138,000	$32,854,000	$28,159,000	$117,460,000
2040	$121,000	$38,742,000	$18,181,000	$33,231,000	$28,283,000	$118,559,000
2041	$121,000	$39,375,000	$18,247,000	$33,669,000	$28,484,000	$119,895,000
2042	$120,000	$40,042,000	$18,324,000	$34,156,000	$28,755,000	$121,397,000
2043	$119,000	$40,747,000	$18,413,000	$34,691,000	$29,104,000	$123,074,000
2044	$119,000	$41,506,000	$18,519,000	$35,275,000	$29,517,000	$124,937,000

[62] Costs were rounded to the nearest thousand.

Calendar Year	Reporting	Vehicle Testing	HD I/M Tester Training	Compliance Fee	Heavy-Duty Vehicle Repairs	Total Costs
2045	$122,000	$42,381,000	$18,669,000	$35,925,000	$30,021,000	$127,117,000
2046	$123,000	$43,252,000	$18,824,000	$36,619,000	$30,579,000	$129,397,000
2047	$125,000	$44,175,000	$19,000,000	$37,360,000	$31,179,000	$131,838,000
2048	$127,000	$45,147,000	$19,199,000	$38,146,000	$31,827,000	$134,446,000
2049	$130,000	$46,168,000	$19,421,000	$38,981,000	$32,520,000	$137,220,000
2050	$133,000	$47,231,000	$19,663,000	$39,862,000	$33,251,000	$140,141,000
Total	**$8,565,000**	**$1,096,012,000**	**$515,644,000**	**$916,030,000**	**$945,706,000**	**$3,481,957,000**

B. Alternative 2

CARB staff developed Alternative 2 based on feedback from stakeholders who suggested more stringent testing requirements beyond an opacity testing and visual inspection for vehicles non-OBD vehicles equipped with SCR systems (2010-2012 MY engines) and more frequent periodic testing for OBD-equipped vehicles, specifically:

- Non-OBD vehicles with 2010-2012 MY engines would be subjected to chassis dynamometer testing in addition to smoke opacity testing and visual inspection during their required periodic testing events to further assess a vehicle for potential NOx emissions control system issues.
    - Non-OBD vehicles with 2010-2012 MY engines are equipped with NOx emission control system (SCR). Thus, incorporating a testing method that potentially identify malfunctioning NOx emissions control systems using a data driven assessment method would lead to more NOx emission reduction benefits. The proposal of a chassis dynamometer test for non-OBD vehicles is similar to the approach used in BAR's Smog Check program prior to the implementation of vehicular OBD systems.
- OBD-equipped vehicles would be subjected to quarterly OBD data submission (instead of semiannual OBD data submission under the Proposed Regulation)

The total costs of Alternative 2 were assessed using the same legal baseline conditions as the Proposed Regulation. Similar to the Proposed Regulation, Alternative 2 would have the following direct costs:

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

The reporting costs, HD I/M tester training costs, and compliance fee of Alternative 2 would remain the same as in the Proposed Regulation. Due to the more frequent periodic testing on OBD-equipped vehicles as well as additional periodic chassis dynamometer testing for non-OBD vehicles with 2010-2012 MY engines, Alternative 2 would have higher vehicle testing and vehicle repair costs compared to the Proposed Regulation.

1. Heavy-Duty Vehicle Testing Costs

Periodic OBD Testing Costs

As discussed in Chapter I.B.2., the periodic OBD testing costs would include:

- Testing costs through a HD I/M tester option, which are initial costs to purchase a testing device, plus the employee compensation cost of doing the test, and
- Testing costs through telematics option, which is annual telematics subscription fee between fleets and their telematics vendor.

Under Alternative 2, the projected testing costs through a HD I/M tester option would increase due to the increased annual employee compensation cost of doing the test. This is because the total OBD testing duration would be ten minutes[63] per vehicle per year (instead of five minutes under the Proposed Regulation). Testing costs through telematics option would remain the same as the Proposed Regulation because the annual telematics subscription fee would be the same regardless of how often the OBD data is required to be submitted to CARB.

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.[64] 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 (CE CERT, 2019), 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

[63] [2.5 minutes per test] x [4 tests per vehicle per year] = 10 minutes per vehicle per year

[64] 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.

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 (CARB, 2020a). 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 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 (DynoComInc, 2021), 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 (TruckFreighter, 2021) for the use of repair grade and water brake dynamometers up to $683 per hour (UCR, 2021) 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 2050. 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 2050, this number would drop further to less than one percent. This is a decrease of 44 percent and 96 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 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.

2. Vehicle Repair Costs

Alternative 2 is expected to result in more vehicle repairs compared to the Proposed Regulation. For example, 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 vehicle repairs following a methodology similar to that discussed in Chapter I.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 (ERG, 2021).

3. Total Costs

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-52. Alternative 2 is projected to cost $5.09B over 2023-2050 period, with a maximum annual cost of $437M in 2024.

Table F- 52: Total Estimated Direct Incremental Costs Relative to the Baseline of Alternative 2 from 2023 through 2050[65]

Calendar Year	Reporting	Vehicle Testing	HD I/M Tester Training	Compliance Fee	Heavy-Duty Vehicle Repairs	Total Costs
2023	$3,321,000	$1,941,000	$29,446,000	$23,765,000	$36,900,000	$95,373,000
2024	$2,416,000	$150,692,000	$16,015,000	$28,102,000	$239,828,000	$437,054,000
2025	$2,198,000	$96,325,000	$16,606,000	$28,740,000	$107,052,000	$250,921,000
2026	$2,000,000	$94,278,000	$17,096,000	$29,309,000	$71,882,000	$214,565,000
2027	$1,814,000	$92,451,000	$17,541,000	$29,807,000	$50,043,000	$191,656,000
2028	$1,635,000	$90,668,000	$17,894,000	$30,214,000	$43,113,000	$183,525,000
2029	$1,468,000	$84,169,000	$18,132,000	$30,526,000	$40,522,000	$174,818,000
2030	$1,315,000	$82,448,000	$18,243,000	$30,740,000	$39,173,000	$171,919,000
2031	$1,193,000	$81,300,000	$18,423,000	$31,011,000	$38,135,000	$170,062,000
2032	$1,071,000	$80,112,000	$18,511,000	$31,256,000	$37,642,000	$168,592,000
2033	$953,000	$79,032,000	$18,589,000	$31,471,000	$37,165,000	$167,210,000
2034	$845,000	$78,038,000	$18,625,000	$31,675,000	$36,706,000	$165,890,000
2035	$743,000	$76,992,000	$18,571,000	$31,830,000	$36,378,000	$164,514,000
2036	$663,000	$76,378,000	$18,583,000	$32,026,000	$36,098,000	$163,747,000
2037	$592,000	$75,884,000	$18,581,000	$32,255,000	$35,899,000	$163,210,000
2038	$533,000	$75,594,000	$18,592,000	$32,532,000	$35,782,000	$163,033,000
2039	$482,000	$75,449,000	$18,606,000	$32,854,000	$35,768,000	$163,159,000
2040	$437,000	$75,469,000	$18,647,000	$33,231,000	$35,811,000	$163,595,000
2041	$398,000	$75,628,000	$18,712,000	$33,669,000	$35,941,000	$164,348,000
2042	$361,000	$75,870,000	$18,789,000	$34,156,000	$36,171,000	$165,347,000

[65] Costs were rounded to the nearest thousand.

Calendar Year	Reporting	Vehicle Testing	HD I/M Tester Training	Compliance Fee	Heavy-Duty Vehicle Repairs	Total Costs
2043	$328,000	$76,205,000	$18,877,000	$34,691,000	$36,524,000	$166,626,000
2044	$300,000	$76,647,000	$18,983,000	$35,275,000	$36,950,000	$168,156,000
2045	$279,000	$77,276,000	$19,136,000	$35,925,000	$37,514,000	$170,129,000
2046	$260,000	$77,945,000	$19,293,000	$36,619,000	$38,135,000	$172,253,000
2047	$243,000	$78,700,000	$19,473,000	$37,360,000	$38,802,000	$174,579,000
2048	$229,000	$79,539,000	$19,676,000	$38,146,000	$39,537,000	$177,129,000
2049	$218,000	$80,459,000	$19,903,000	$38,981,000	$40,337,000	$179,898,000
2050	$209,000	$81,442,000	$20,150,000	$39,862,000	$41,182,000	$182,845,000
Total	**$26,505,000**	**$2,246,931,000**	**$529,694,000**	**$916,030,000**	**$1,374,991,000**	**$5,094,151,000**