

APPENDIX C

ECONOMIC IMPACT ANALYSIS / ASSESSMENT

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I. Overview

As detailed in the Staff Report, staff is proposing to amend the emission control system warranty¹ regulations for new 2022 and subsequent model year on-road heavy-duty diesel engines used in California certified and registered vehicles with gross vehicle weight ratings (GVWR) greater than 14,000 pounds by increasing the minimum warranty periods. In addition to the longer minimum warranty periods, it is proposed that the 3,000 hour limit no longer be applicable under California's amended warranty period provisions for heavy-duty diesel engines and vehicles. The proposed warranty amendments would go into effect in 2022 and would be fully implemented December 31, 2022.

The scope of the warranty provisions is based on the vehicle, but the warranty period for the vehicle is based on the certified primary intended service class (40 CFR 1036.140) of the engine. Typically, heavy-duty engine and heavy-duty vehicle combinations² are straightforward, i.e., a heavy heavy-duty (HHD) engine is installed in a Class 8 heavy-duty vehicle greater than 33,000 pounds, for which the warranty would be 5 years/350,000 miles. However, there are instances where a medium heavy-duty (MHD) engine might be installed in a Class 8 heavy-duty vehicle such as when an engine downsizing strategy is employed by the manufacturer to enhance fuel efficiency and reduce emissions.³ In this case the warranty would be limited to 5 years/150,000 miles. The 150,000 mile warranty period is applicable because the warranty period is dependent on the certified primary intended service class of the MHD engine.

For the purposes of this analysis, staff assumes that the direct costs incurred by engine and vehicle manufacturers due to the proposed amendments would be passed on to the ultimate purchasers of California-certified heavy-duty vehicles in the form of an increase in the purchase price of the vehicle. Currently, warranty costs are either included in the original purchase price of the vehicle or by providing extended warranties at an additional cost at the time of purchase. While there would be additional costs to heavy-duty vehicle purchasers, there would also be repair cost savings that would offset those initial capital costs. The following sections, II. Baseline Information and III. Projected

¹ For the purposes of clarity, reference to "vehicle" in this Appendix includes the entire vehicle including the engine and the chassis, unless specifically stated otherwise.

² HHD engines are typically installed in Class 8 vehicles with GVWR greater than 33,000 lbs., MHD engines are typically installed in Class 6-7 vehicles with GVWR between 19,501 to 33,000 lbs., and LHD engines are typically installed in Class 4-5 vehicles with GVWR between 14,001 to 19,500 lbs.

³ Typically, commercial motor vehicles are categorized by GVWR or a numerical vehicle class (i.e., Classes 4-8 for heavy-duty vehicles greater than 14,000 lbs. GVWR), but to account for potential heavy-duty engine and vehicle combinations as described above, for the purposes of this cost analysis staff will use the following vehicle designations: Class 4 and 5 vehicles (14,000 to 19,500 lbs. GVWR) are considered "light heavy-duty vehicles" (LHDV), Class 6 through 8 vehicles (GVWR greater than 19,500 lbs.) are considered "heavy heavy-duty vehicles" (HHDV) if the installed engine's primary intended service class is HHD, and all other Class 6 through 8 vehicles are considered "medium heavy-duty vehicles" (MHDV). Staff believes that the impact of using MHD engines in Class 8 vehicles is currently low, but if the population of these vehicles increase over time the cost impact of the proposed amendments would decrease because the required warranty period would be shorter.

Costs, describe in detail staff's methodology in computing the statewide capital costs. All costs are evaluated relative to a baseline scenario in year 2017 dollars.

II. Baseline Information

To estimate the cost impacts of the proposed warranty amendments, a baseline characterization was developed. The cost impact of the proposed warranty amendments is then evaluated against the baseline scenario. The baseline scenario includes the current business practices for purchasing heavy-duty vehicles with CARB-required emission control system warranties, manufacturer-provided warranties, and customer-purchased extended warranties.

a. Length of Currently Purchased Warranties

Manufacturers are currently required to provide a 5 year/100,000 mile/3,000 hour emission control system warranty for heavy-duty diesel vehicles with GVWR greater than 14,000 pounds. However, due to the many miles that a heavy-duty vehicle travels on a yearly basis, many new vehicles fall out of the regulated warranty during the first couple years of use. Because of this, many owners purchase an extended warranty package concurrently with a new vehicle purchase which extends the amount of mileage the vehicle can travel before the warranty expires. To better understand the practices involved with current warranty purchases, staff contracted with the Sacramento Institute for Social Research (ISR), to survey vehicle owners and dealerships for warranty-related information (ISR, 2017). Staff also contacted manufacturers and third-party warranty providers to further understand warranty purchasing practices (EMA, 2017). Staff used this information to estimate the current warranty practices of heavy-duty vehicles, shown in Table 1.

From the survey data and information shared by the manufacturers and third-party warranty providers, staff estimates that 40 percent of heavy heavy-duty vehicle (HHDV) purchases include an extended warranty out to 500,000 miles, 45 percent of HHDV purchases include an extended warranty out to 250,000 miles, and only 15 percent of HHDV purchases consist of the minimum regulatory warranty of 100,000 miles. Additionally, staff estimates that 40 percent of light heavy-duty vehicle (LHDV) and medium heavy-duty vehicle (MHDV) purchases include extended warranties at least through useful life, whereas 60 percent of LHDV and MHDV purchases do not include an extended warranty.

Table 1: Current Warranty Practices for Heavy-Duty Vehicles⁴

HHDV		MHDV		LHDV	
Miles Warranted	% of Vehicle Population	Miles Warranted	% of Vehicle Population	Miles Warranted	% of Vehicle Population
500,000	40%				
250,000	45%	185,000	40%	110,000	40%
100,000	15%	100,000	60%	100,000	60%

b. Mileage Driven under Current Warranties

The current warranty expires when a vehicle exceeds either the mileage threshold, year threshold, or hour limit, whichever comes first. The majority of vehicles exhaust their warranties by either exceeding the mileage threshold or the year threshold rather than the current 3,000 hour limit. Only vehicles with extensive idling practices or worksite vehicles which primarily use power take-off applications as their main function, which represent about 5 percent of total vehicles (Calstart, 2013), have the potential to exhaust their warranties due to the current 3,000 hour limit. Since some of these vehicles have extended warranties without an hours of operation provision, the actual percentage of vehicles that exceed their warranties due to the 3,000 hour limit is likely significantly less. Base on this reasoning, staff concluded elimination of the 3,000 hour limit is likely to add only negligible cost to the regulatory costs of the proposed warranty amendments.⁵

Staff used the EMFAC⁶ on-road vehicle model to estimate which vehicle types sold in California typically exhaust their warranties due to the mileage threshold and which vehicle types typically exhaust their warranties due to the year threshold. For each vehicle subcategory in the EMFAC model, staff estimated the average odometer value after five years on the road and the corresponding percentage of each vehicle subcategory within the vehicle population. Staff deduced that owners of vehicle classes with the greatest mileage accumulation in the first five years purchased the longest extended warranties, and that owners of the vehicles with the lowest mileage accumulation in five years rely on only the regulated 5 year/100,000 mile warranty. For example, under the baseline scenario, an owner of a long-haul class 8 vehicle that averages 100,000 miles per year would purchase a 500,000 mile extended warranty, whereas an owner of a vocational vehicle that travels only an average of 15,000 miles per year would have only the regulated 100,000 mile warranty.

⁴ Warranties are assumed to expire in 5 years or once the mileage threshold has been reached, whichever comes first.

⁵ As discussed further in section II.c.2, staff provides a range of potential costs to stakeholders. Staff anticipates that any additional costs associated with vehicles currently affected by the 3,000 hour limit would be smaller than the range of costs provided.

⁶ CARB's Mobile Source Emissions Inventory Model for assessing the population, activity, and emissions from mobile sources. <https://www.arb.ca.gov/emfac/>

Table 2 shows the projected warranty coverages for HHDV subcategories in EMFAC. To be consistent with the warranty percentages shown in Table 1, certain vehicle subcategories are split into two warranty bins. For example, the T7 tractor subcategory is split into the “5 Years/250,000 Miles” warranty bin and the “5 Years/500,000 Miles” warranty bin to ensure that 40 percent of HHDVs have a 500,000 mile warranty and 45 percent of HHDVs have a 250,000 mile warranty as projected in Table 1.

Vehicle subcategories with five year odometer mileages less than their projected warranted mileage are expected to be covered fully under warranty for all travel done within the first five years. These are the vehicles that typically exhaust their warranties due to the year threshold. Vehicle subcategories that exceed their mileage threshold under warranty in the first five years are projected to be only covered for the warranted mileage because they exhaust their warranties due to the mileage threshold. For example, a HHDV which is projected to travel 550,000 miles within the first five years but has a 5 year/500,000 mile warranty would only be covered for 500,000 miles. A HHDV which is projected to travel 50,000 miles in five years but has a 5 year/100,000 mile warranty is projected to be fully covered for the 50,000 miles traveled before the warranty runs out at the five year threshold. The right-most column in Table 2 provides the estimated miles driven under warranty for each HHDV subcategory.

Table 2: Current Miles Covered Under Warranty for EMFAC HHDV Categories

5 Years/100,000 Miles				
	Population %	5 Year Odometer Mileage	Estimated Length of Warranty	Miles Covered Under Warranty
T7 Public	7.25%	50,000	100,000	50,000
T7 SWCV	4.96%	100,000	100,000	100,000
T7 Utility	0.47%	47,000	100,000	47,000
T7 Single Construction*	2.32%	212,000	100,000	100,000
Total	15.00%			
5 Years/250,000 Miles				
	Population %	5 Year Odometer Mileage	Estimated Length of Warranty	Miles Covered Under Warranty
Motor Coach	0.97%	353,000	250,000	250,000
T7 Ag	0.02%	299,000	250,000	250,000
T7 Single	10.78%	212,000	250,000	212,000
T7 Single Construction*	4.66%	212,000	250,000	212,000
T7 Tractor*	22.62%	489,000	250,000	250,000
T7 Tractor Construction	5.95%	489,000	250,000	250,000
Total	45.00%			
5 Years/500,000 Miles				
	Population %	5 Year Odometer Mileage	Estimated Length of Warranty	Miles Covered Under Warranty
T7 CAIRP	22.54%	585,000	500,000	500,000
T7 CAIRP Construction	1.56%	585,000	500,000	500,000
T7 Other Port	0.64%	489,000	500,000	489,000
T7 POAK	2.33%	489,000	500,000	489,000
T7 POLA	5.54%	489,000	500,000	489,000
T7 Tractor*	7.39%	489,000	500,000	489,000
Total	40.00%			

*Vehicle type is segregated into two warranty classes to align projected extended warranty purchases.

Staff performed a similar analysis for both MHDVs and LHDVs, as shown in Tables 3 and 4, respectively.

Table 3: Current Miles Covered Under Warranty for EMFAC MHDV Categories

5 Years/100,000 Miles				
	Population %	5 Year Odometer Mileage	Estimated Length of Warranty	Miles Covered Under Warranty
SBUS	3.60%	89,000	100,000	89,000
T6 Ag	0.02%	149,000	100,000	100,000
T6 Instate Small*	48.14%	153,000	100,000	100,000
T6 Public	6.72%	44,000	100,000	44,000
T6 Utility	1.52%	41,000	100,000	41,000
Total	60.00%			
5 Years/185,000 Miles				
	Population %	5 Year Odometer Mileage	Estimated Length of Warranty	Miles Covered Under Warranty
All Other Buses	2.79%	168,000	185,000	168,000
T6 CAIRP Heavy	1.10%	153,000	185,000	153,000
T6 CAIRP Small	0.54%	153,000	185,000	153,000
T6 Instate Construction Heavy	2.77%	153,000	185,000	153,000
T6 Instate Construction Small	12.54%	153,000	185,000	153,000
T6 Instate Heavy	14.72%	153,000	185,000	153,000
T6 Instate Small*	5.54%	153,000	185,000	153,000
Total	40.00%			

*Vehicle type is segregated into two warranty classes to align projected extended warranty purchases.

Table 4: Current Miles Covered Under Warranty for EMFAC LHDV Categories

5 Years/100,000 Miles				
	Population %	5 Year Odometer Mileage	Estimated Length of Warranty	Miles Covered Under Warranty
SBUS	3.60%	89,000	100,000	89,000
T6 Ag	0.02%	149,000	100,000	100,000
T6 Instate Small*	48.14%	153,000	100,000	100,000
T6 Public	6.72%	44,000	100,000	44,000
T6 Utility	1.52%	41,000	100,000	41,000
Total	60.00%			
5 Years/110,000 Miles				
	Population %	5 Year Odometer Mileage	Estimated Length of Warranty	Miles Covered Under Warranty
All Other Buses	2.79%	168,000	110,000	110,000
T6 CAIRP Heavy	1.10%	153,000	110,000	110,000
T6 CAIRP Small	0.54%	153,000	110,000	110,000
T6 Instate Construction Heavy	2.77%	153,000	110,000	110,000
T6 Instate Construction Small	12.54%	153,000	110,000	110,000
T6 Instate Heavy	14.72%	153,000	110,000	110,000
T6 Instate Small*	5.54%	153,000	110,000	110,000
Total	40.00%			

*Vehicle type is segregated into two warranty classes to align projected extended warranty purchases.

Based on the projected miles driven under warranty and the population percentages for each vehicle subcategory, staff estimated the average miles traveled under warranty for each vehicle category (Table 5).

Table 5: Current Average Miles Traveled Under Warranty for Each Vehicle Category

Vehicle Category	Avg. Miles Traveled Under Warranty
HHDV	316,000
MHDV	116,600
LHDV	99,000

c. Cost of Repairs under Current Warranty Requirements

1. Methodology – Using Unscreened Warranty Data

Staff estimated the costs to manufacturers under the current warranty practices by analyzing “unscreened” warranty claims⁷ data submitted to CARB by manufacturers. Manufacturers are required to submit warranty claims data to CARB under title 13, CCR, sections 2141 through 2146 (13 CCR 2141-2146) when their “unscreened” warranty claim rate for a specific part in an engine family is greater than or equal to one percent of sales, or 25 total parts. For example, if an original equipment manufacturer sells 1,000 engines in a certain engine family, warranty claims data must be submitted for any part that has 10 or more warranty claims. Manufacturers submit “unscreened” warranty data to CARB on a quarterly basis if they reach the one percent threshold.

Staff considered examining screened warranty claims data as an alternative approach to estimating the costs of repairs under warranty. However, manufacturers are not required to submit “screened” warranty information to CARB unless “unscreened” rates surpass four percent. Examining “screened” warranty claims data to estimate repair costs would potentially underestimate costs because some engine components do not exceed the four percent “unscreened” warranty claim level. The use of “unscreened” data provides a conservative estimate of costs that manufacturers face in repair costs under warranty.

Additionally, using “unscreened” warranty claims as a cost surrogate is more representative of today’s real-world repair practices than using “screened” data because dealerships typically replace parts under warranty at no cost to the owner before determining the failure mode of the part in question. Often it is only afterwards that the manufacturer determines whether the part replaced indeed had a warrantable issue.

Lastly, while there is a possibility that the costs associated with parts having warranty claim rates that are less than one percent are significant and therefore need to be addressed in the analysis, the data for such a determination is not readily available (i.e., manufacturers are not required to report for claim rates less than one percent). However, using both the more cost conservative “unscreened” warranty information, along with the 45 percent mark-up on the average warranty package (see discussion in

⁷ “Unscreened” refers to the tabulation of dealership emission warranty service records for emission-related components as they apply to individual engine families or test groups without verification that the part is actually defective.

section c.2), gives staff confidence the high end of the cost estimate range prepared would include any costs associated with parts having warranty claim rates that are less than one percent.

Manufacturers incur the cost to replace these parts regardless of whether they determine after the replacement that the part should not have been replaced under warranty. Staff assumes that manufacturers know they will incur these costs and pass them through to the customer. Therefore, the total number of parts replaced under warranty (“unscreened” warranty claims) is a better predictor of costs incurred under warranty than those costs only associated with broken parts determined to actually be warrantable (“screened” warranty claims).

2. Projected Per Vehicle Repair Costs under Warranty

Staff estimated repair costs for individual engine and aftertreatment components by analyzing repair shop data and through discussions with manufacturers and service providers (CARB, 2018b; Personal communication, 2017). These repair costs were applied to the rate of repairs determined through the analysis of warranty claims to estimate the average repair costs that a typical heavy-duty vehicle experiences while still under warranty.

Staff analyzed submitted warranty claims data for all 2012 MY heavy-duty diesel engines sold in California above a GVWR of 14,000 pounds. Because manufacturers are required to submit warranty claims data for a total of five years for each MY, staff chose to use the 2012 MY warranty claims as it is the most recent and complete data set with final reporting ending in 2017 for the 2012 MY engines.

To calculate the average cost of repairs, staff first isolated warranty claims for each engine component over the five year warranty period. Staff then divided the total warranty claims for each engine component by the number of vehicles sold in each vehicle category to estimate the rate of repair under warranty. Table 6 shows certification sales data for 2012 MY heavy-duty diesel vehicles sold in California.

Table 6: 2012 MY California Certification Sales by Vehicle Category

Vehicle Category	Sales
HHDV	9,817
MHDV	4,229
LHDV	4,788
Total	18,834

Tables 7 through 9 break down the estimated repair rates and costs for HHDVs, MHDVs, and LHDVs, respectively. The average cost of warranty repairs according to the ISR Warranty Survey yielded an average of \$2,131 per vehicle, which is consistent with and supports these calculated values.

Table 7: Estimated Current Warranty Repair Rates and Costs for HHDVs (2017\$)

Part	Total Claims	Claim %	Avg. Repair Cost	Weighted Avg. Repair Cost
DPF Filter	107	1.1%	\$2,600	\$28.60
DPF Doser	699	7.1%	\$500	\$35.50
DOC	153	1.6%	\$3,800	\$60.80
EGR Valve	1,114	11.3%	\$1,200	\$135.60
EGR Cooler	1,647	16.8%	\$3,100	\$520.80
Injector	1,037	10.6%	\$1,900	\$201.40
NOx Sensor	876	8.9%	\$670	\$59.63
SCR	777	7.9%	\$5,371	\$424.31
Turbo	808	8.2%	\$5,100	\$418.20
Other Sensors	1,315	13.4%	\$670	\$89.78
Exhaust Manifold	87	0.9%	\$850	\$7.65
Fuel System	472	4.8%	\$2,000	\$96.00
ECM	1,200	12.2%	\$1,725	\$210.45
Total:	10,292	104.8%	--	\$2,289

Table 8: Estimated Current Warranty Repair Rates and Costs for MHDVs (2017\$)

Part	Total Claims	Claim %	Avg. Repair Cost	Weighted Avg. Repair Cost
DPF Filter	105	2.5%	\$2,600	\$65.00
DPF Doser	165	3.9%	\$500	\$19.50
DOC	18	0.4%	\$3,800	\$15.20
EGR Valve	444	10.5%	\$1,200	\$126.00
EGR Cooler	423	10.0%	\$3,100	\$310.00
Injector	1,544	36.5%	\$1,900	\$693.50
NOx Sensor	0	0.0%	\$670	\$0.00
SCR	228	5.4%	\$5,371	\$290.03
Turbo	260	6.2%	\$5,100	\$316.20
Other Sensors	234	5.5%	\$670	\$36.85
Exhaust Manifold	199	4.7%	\$850	\$39.95
Fuel System	76	1.8%	\$2,000	\$36.00
ECM	374	8.8%	\$1,725	\$151.80
Total:	4,070	96.2%	--	\$2,100

Table 9: Estimated Current Warranty Repair Rates and Costs for LHDVs (2017\$)

Part	Total Claims	Claim %	Avg. Repair Cost	Weighted Avg. Repair Cost
DPF Filter	281	5.9%	\$2,600	\$153.40
DPF Doser	0	0.0%	\$500	\$0.00
DOC	19	0.4%	\$3,800	\$15.20
EGR Valve	310	6.5%	\$1,200	\$78.00
EGR Cooler	39	0.8%	\$3,100	\$24.80
Injector	221	4.6%	\$1,900	\$87.40
NOx Sensor	226	4.7%	\$670	\$31.49
SCR	598	12.5%	\$5,371	\$671.38
Turbo	993	20.7%	\$5,100	\$1,055.70
Other Sensors	2217	46.3%	\$670	\$310.21
Exhaust Manifold	266	5.6%	\$850	\$47.60
Fuel System	0	0.0%	\$2,000	\$0.00
ECM	226	4.7%	\$1,725	\$81.08
Total:	5,396	112.7%	--	\$2,556

To estimate the cost of current warranties, staff used the warranty claims data submitted to CARB by the manufacturers to establish repair costs that the manufacturers must consider when providing warranties for heavy-duty vehicles. Manufacturers and third-party warranty providers offer warranty packages at different prices depending on the relationship they have with a customer. For example, to secure a large purchase of many vehicles, a manufacturer may be more inclined to charge a lower price for an extended warranty purchase than for a single purchase. Staff has learned that warranties are sometimes included with the vehicle purchase at no charge for high-volume customers, whereas warranty packages can be marked up higher for other customers. Current practices make it difficult to project a specific cost to purchase an extended warranty package. Therefore, staff is providing a range of costs to cover the variability in potential costs. Overall, staff assumes that manufacturers and third-party warranty providers at least pass on the costs of repairs to their customers. This means that manufacturers at least make up for the costs of providing complementary warranties by making profits with the warranties for which they charge. Staff expects that warranty packages could also be marked up to include a profit. Staff estimates that the average warranty package may be marked up beyond the cost of repairs by as much as 45 percent (Fullbay, 2018).

Based on these assumptions, staff estimated the cost of warranty packages needed to cover the current average miles traveled in Table 5 for each vehicle category (Table 10), ranging from no profit for manufacturers at the low end and a 45 percent markup at the high end.

Table 10: Estimated Average Cost of a Current Warranty Package to Cover the Average Miles Traveled under Warranty (2017\$)

Vehicle Category	Minimum Average Cost	Maximum Average Cost
HHDV	\$2,289	\$3,319
MHDV	\$2,100	\$3,045
LHDV	\$2,556	\$3,706

d. Summary of Baseline Estimates

To estimate a baseline, staff used current extended warranty purchase practices, warranty claim rates, and average repair costs to establish the minimum cost that the manufacturer would need to recoup when providing warranties, plus a markup range of 0 to 45 percent. Staff performed a warranty survey, analyzed warranty claims data, and contacted manufacturers, third-party warranty providers, and repair shops to estimate the length of the average heavy-duty vehicle warranty and associated costs. Table 11 provides a summary of the average miles driven under warranty and the associated costs for each vehicle category.

Table 11: Summary of Baseline Estimates (2017\$)

Vehicle Category	Avg. Miles Traveled under Warranty	Avg. Cost of Current Extended Warranty Package	Repair Costs under Warranty
HHDV	316,000	\$2,289-\$3,319	\$2,289
MHDV	116,500	\$2,100-\$3,045	\$2,100
LHDV	99,000	\$2,556-\$3,706	\$2,556

III. Projected Costs

a. Warranty Practices under the Proposed Amendments

Staff is proposing to lengthen the minimum mileage warranties for diesel heavy-duty vehicles greater than 14,000 pounds GVWR based on the certified primary intended service class of the engines used in these vehicles. Table 12 provides the proposed minimum warranties for HHDVs, MHDVs, and LHDVs.

Table 12: Proposed Minimum Warranty Periods

Vehicle Category	Minimum Warranty
HHDV	5 years/350,000 miles
MHDV	5 years/150,000 miles
LHDV	5 years/110,000 miles

Staff projects that a vehicle buyer currently purchasing extended warranty coverage out to 5 years/500,000 miles would continue to purchase warranty coverage on their future vehicles out to 500,000 miles. Staff assumes that the costs of the proposed minimum warranties (5 years/350,000 miles for HDDVs) will be embedded into the new vehicle purchase price. Under the proposed amendments, an owner that wants warranty coverage on a new vehicle out to 500,000 miles would purchase a vehicle with a 350,000 mile warranty and then add on an extra 150,000 miles with the purchase of an extended warranty. In this example, the overall cost of the vehicle and warranty purchase out to 500,000 miles would remain the same between the baseline and the proposed warranty amendment scenarios. The vehicle purchase price would increase, but the extended warranty price would decrease resulting in an overall net change of \$0 in capital purchase price.

Under another scenario, a HDDV owner currently purchasing a 5 year/250,000 mile extended warranty would choose to stay with the minimum 5 year/350,000 mile warranty under the proposed amendments. In this example, staff projects a net increase in overall purchase cost to the owner. The increase in vehicle purchase price would outweigh the savings that results from not needing to purchase an extended warranty out to 250,000 miles that is currently done under the baseline scenario. As discussed above for the baseline scenario in section II.a., staff projected the warranty purchase practices for the proposed amendments as shown in Table 13.

Table 13: Projected Warranty Practices for Heavy-Duty Vehicles Under the Proposed Warranty Amendments

HDDV		MHDV		LHDV	
Miles Warranted	% of Vehicles	Miles Warranted	% of Vehicles	Miles Warranted	% of Vehicles
500,000	40%	185,000	40%	110,000	100%
350,000	60%	150,000	60%		

b. Projected Mileage Driven Under Proposed Warranties

As was done in section II.b. for the baseline analysis, staff used EMFAC model inputs to project the number of miles driven under the proposed warranty amendments. Staff determined whether each vehicle subcategory would exhaust their projected warranty via either the mileage threshold or the year threshold (as shown in Tables 14-16). Staff then estimated the average mileage driven while covered by warranty for each vehicle category under the proposed amendments (as shown in Table 17).

Table 14: Projected Miles Covered Under Proposed Warranty Amendments for EMFAC HHDV Categories

5 Years/350,000 Miles				
	Population %	5 Year Odometer Mileage	Estimated Length of Warranty	Miles Covered Under Warranty
T7 Public	7.25%	50,000	350,000	50,000
T7 SWCV	4.96%	100,000	350,000	100,000
T7 Utility	0.47%	47,000	350,000	47,000
T7 Single Construction	6.98%	212,000	350,000	212,000
Motor Coach	0.97%	353,000	350,000	350,000
T7 Ag	0.02%	299,000	350,000	299,000
T7 Single	10.78%	212,000	350,000	212,000
T7 Tractor*	22.61%	489,000	350,000	350,000
T7 Tractor Construction	5.95%	489,000	350,000	350,000
Total	60.00%			
5 Years/500,000 Miles				
	Population %	5 Year Odometer Mileage	Estimated Length of Warranty	Miles Covered Under Warranty
T7 CAIRP	22.54%	585,000	500,000	500,000
T7 CAIRP Construction	1.56%	585,000	500,000	500,000
T7 Other Port	0.64%	489,000	500,000	489,000
T7 POAK	2.33%	489,000	500,000	489,000
T7 POLA	5.54%	489,000	500,000	489,000
T7 Tractor*	7.40%	489,000	500,000	489,000
Total	40.00%			

*Vehicle type is segregated into two warranty classes to align projected extended warranty purchases.

Table 15: Projected Miles Covered Under Proposed Warranty Amendments for EMFAC MHDV Categories

5 Years/150,000 Miles				
	Population %	5 Year Odometer Mileage	Estimated Length of Warranty	Miles Covered Under Warranty
SBUS	3.60%	89,000	150,000	89,000
T6 Ag	0.02%	149,000	150,000	149,000
T6 Instate Small*	48.14%	153,000	150,000	150,000
T6 Public	6.72%	44,000	150,000	44,000
T6 Utility	1.52%	41,000	150,000	41,000
Total	60.00%			
5 Years/185,000 Miles				
	Population %	5 Year Odometer Mileage	Estimated Length of Warranty	Miles Covered Under Warranty
All Other Buses	2.79%	168,000	185,000	168,000
T6 CAIRP Heavy	1.10%	153,000	185,000	153,000
T6 CAIRP Small	0.54%	153,000	185,000	153,000
T6 Instate Construction	2.77%	153,000	185,000	153,000
T6 Instate Construction Small	12.54%	153,000	185,000	153,000
T6 Instate Heavy	14.72%	153,000	185,000	153,000
T6 Instate Small*	5.54%	153,000	185,000	153,000
Total	40.00%			

*Vehicle type is segregated into two warranty classes to align projected extended warranty purchases.

Table 16: Projected Miles Covered Under Proposed Warranty Amendments for EMFAC LHDV Categories

5 Years/110,000 Miles				
	Population %	5 Year Odometer Mileage	Estimated Length of Warranty	Miles Covered Under Warranty
SBUS	3.60%	89,000	110,000	89,000
T6 Ag	0.02%	149,000	110,000	110,000
T6 Public	6.72%	44,000	110,000	44,000
T6 Utility	1.52%	41,000	110,000	41,000
All Other Buses	2.79%	168,000	110,000	110,000
T6 CAIRP Heavy	1.10%	153,000	110,000	110,000
T6 CAIRP Small	0.54%	153,000	110,000	110,000
T6 Instate Construction Heavy	2.77%	153,000	110,000	110,000
T6 Instate Construction Small	12.54%	153,000	110,000	110,000
T6 Instate Heavy	14.72%	153,000	110,000	110,000
T6 Instate Small	53.68%	153,000	110,000	110,000
Total	100.00%			

Table 17: Average Miles Traveled While Covered by Warranty Under Proposed Warranty Amendments for Each Vehicle Category

Vehicle Category	Avg. Miles Traveled Under Warranty
HHDV	348,100
MHDV	140,600
LHDV	103,800

c. Cost of Repairs under Proposed Warranty Amendments

Staff extrapolated the warranty claims rates and costs of repairs under the baseline scenario to estimate costs under the proposed warranty amendments. Staff assumed a linear relationship between the vehicle odometer mileage and the warranty claims rate. For example, if an engine family has a turbocharger warranty claim rate of two percent within the first 100,000 miles of use, then staff assumes that the claim rate increases to six percent within the first 300,000 miles of use. Similarly, if warranted repair costs under the first 100,000 miles is estimated to be about \$800, staff estimates the costs of warranted repairs in the first 300,000 miles would be about \$2,400.

Under the baseline scenario, staff estimated the average HHDV travels about 316,000 miles under warranty and incurs about \$2,289 in warranted repair costs. Extrapolating this repair cost to 348,100 miles under the proposed warranty scenario, staff estimates a warranted repair cost of \$2,522, i.e., an additional \$233 in warranted repair costs associated with the proposed lengthened warranty period amendments, shown in Table 18.

Table 18: Estimated Repair Costs Covered Associated with the Proposed Lengthened Warranty Period Amendments (2017\$)

Vehicle Category	Current Warranty		Proposed Warranty		Additional Repair Costs Covered
	Avg. Miles	Repair Cost Covered	Projected Avg. Miles	Projected Repair Costs Covered	
HHDV	316,000	\$2,289	348,100	\$2,522	\$233
MHDV	116,600	\$2,100	140,600	\$2,534	\$434
LHDV	99,000	\$2,556	103,800	\$2,680	\$124

In addition to the repaired parts that are estimated to be covered between the baseline scenario and the proposed warranty scenario, there are components that are not currently covered by emission warranties that would now be covered due to the linking of HD OBD to heavy-duty warranty. As stated earlier, staff is proposing as part of this rulemaking to require warranty coverage for every component that causes the HD OBD MIL to illuminate, as is already the case for light- and medium-duty vehicle warranty. This means components that can illuminate the MIL, but that do not directly increase emissions, in and of themselves, when malfunctioning i.e., indirectly emission-related, would now be covered. These indirectly emission-related components are monitored because they provide necessary input for the monitoring of other components and systems, which can directly affect emissions (e.g., engine misfire monitoring, fuel system monitoring, selective catalytic reduction (SCR), etc.), and because they can be used to enable Auxiliary Emission Control Device⁸ operations. These indirectly emission-related components can contribute to severe emissions increases due to the improper monitoring of components and systems. The discussion below explains how staff estimated costs for these indirectly emission-related components that would now be warranted under staff's proposal.

⁸ An Auxiliary Emission Control Device is a design element which senses temperature, vehicle speed, engine RPM, transmission gear, manifold vacuum, or any other parameter for the purpose of activating, modulating, delaying, or deactivating the operation of any part of the emission control system.

To estimate the cost impact of these indirectly emission-related components, staff examined average prices and average labor rates for the proposed additionally warranted parts shown in Tables 19-21.

Table 19: Estimated HHDV Warranty Repair Rates and Costs for Additional Components Due to Linking HD OBD to Heavy-Duty Warranty (2017\$)

Component	Avg. Repair Cost	Claim %	Weighted Avg. Repair Cost
Accelerator pedal position (sensor) ¹	\$695	0.02%	\$0.16
Vehicle speed sensor ²	\$278	0.57%	\$1.58
Missing VIN - reflash ECU/ECM ²	\$400	0.14%	\$0.57
Battery voltage - wire replacement ²	\$470	0.02%	\$0.11
Battery voltage - battery replacement ²	\$290	0.02%	\$0.07
J1939/J1979 data link ²	\$1,725	0.11%	\$1.92
Thermostat ²	\$230	0.07%	\$0.16
Coolant level sensor ²	\$245	0.05%	\$0.12
Oil pressure sensor ²	\$220	0.60%	\$1.32
Crankcase pressure sensor ²	\$148	0.78%	\$1.16
Intake air heater ¹	\$715	0.02%	\$0.17
Total:			\$7.33

¹ (Class 8 Truck Parts, 2018)

² (CARB, 2018c)

Table 20: Estimated MHDV Warranty Repair Rates and Costs for Additional Components Due to Linking HD OBD to Heavy-Duty Warranty (2017\$)

Component	Avg. Repair Cost	Claim %	Weighted Avg. Repair Cost
Accelerator pedal position (sensor) ¹	\$695	0.01%	\$0.07
Vehicle speed sensor ²	\$278	0.23%	\$0.65
Missing VIN - reflash ECU/ECM ²	\$400	0.06%	\$0.24
Battery voltage - wire replacement ²	\$470	0.01%	\$0.04
Battery voltage - battery replacement ²	\$290	0.01%	\$0.03
J1939/J1979 data link ²	\$1,725	0.05%	\$0.79
Thermostat ²	\$230	0.03%	\$0.07
Coolant level sensor ²	\$245	0.02%	\$0.05
Oil pressure sensor ²	\$220	0.25%	\$0.54
Crankcase pressure sensor ²	\$148	0.32%	\$0.47
Intake air heater ¹	\$715	0.01%	\$0.07
Total:			\$3.01

¹ (Class 8 Truck Parts, 2018)

² (CARB, 2018c)

Table 21: Estimated LHDV Warranty Repair Rates and Costs for Additional Components Due to Linking HD OBD to Heavy-Duty Warranty (2017\$)

Component	Avg. Repair Cost	Claim %	Weighted Avg. Repair Cost
Accelerator pedal position (sensor) ¹	\$695	0.08%	\$0.56
Vehicle speed sensor ²	\$278	1.97%	\$5.47
Missing VIN - reflash ECU/ECM ²	\$400	0.50%	\$1.99
Battery voltage - wire replacement ²	\$470	0.08%	\$0.38
Battery voltage - battery replacement ²	\$290	0.08%	\$0.23
J1939/J1979 data link ²	\$1,725	0.38%	\$6.63
Thermostat ²	\$230	0.24%	\$0.55
Coolant level sensor ²	\$245	0.18%	\$0.43
Oil pressure sensor ²	\$220	2.07%	\$4.55
Crankcase pressure sensor ²	\$148	2.71%	\$3.99
Intake air heater ¹	\$715	0.08%	\$0.57
Total:			\$25.34

¹ (Class 8 Truck Parts, 2018)

² (CARB, 2018c)

Table 22 breaks down, for each vehicle category, the estimated repair costs associated with the proposed lengthened warranty period amendments and the additional repair costs covered due to linking HD OBD to heavy-duty warranty. Additional total repair costs due to the proposed amendments range from \$149 to \$437.

Table 22: Total Estimated Additional Repair Costs Covered Associated with the Proposed Warranty Amendments (2017\$)

Vehicle Category	Additional Repair Costs Covered Due to Lengthened Warranty	Additional Repair Costs Covered Due to Linking HD OBD	Total Additional Repair Costs Covered Due to Proposed Amendments
HHDV	\$233	\$7	\$240
MHDV	\$434	\$3	\$437
LHDV	\$124	\$25	\$149

d. Costs to the Vehicle Purchaser

As for the baseline scenario, staff assumes that the repair costs under warranty would be marked up between 0 percent and 45 percent to the end user. Staff assumes that these costs would be passed on to the vehicle purchasers through an increase in the vehicle purchase price. Table 23 lists the projected increase in costs to vehicle purchasers as a result of the proposed warranty amendments.

Table 23: Projected Increase in Costs Passed to the Vehicle Purchaser Due to Proposed Amendments on a Per-Vehicle Basis (2017\$)

Vehicle Category	Minimum Cost Increase	Maximum Cost Increase
HHDV	\$240	\$348
MHDV	\$437	\$633
LHDV	\$149	\$217

Staff assumes that vehicle purchasers would finance their purchases through a five year loan with a six percent interest rate (WF, 2018a; WF, 2018b). Therefore, the increase in capital costs to the vehicle purchaser is slightly higher than the costs passed through by the manufacturer because of loan interest costs. Table 20 projects the increase in total capital costs to the vehicle purchaser as a result of the proposed warranty amendments.

Table 24: Total Capital Cost Increase to the Vehicle Purchaser Due to Proposed Amendments on a Per-Vehicle Basis (2017\$)

Vehicle Category	Minimum Total Capital Costs	Maximum Total Capital Costs
HHDV	\$285	\$413
MHDV	\$519	\$752
LHDV	\$177	\$257

Although the vehicle purchaser would experience an increase in capital costs at the time of purchase, many will also experience a cost savings resulting from additional repairs that are covered under warranty. For simplicity, staff assumes that the vehicle purchaser receives these repair cost savings in the fifth year of vehicle ownership (i.e., the last year of a five year warranty). As mentioned previously, average repair savings for each vehicle category on a per vehicle basis are shown in Table 22. For example, staff estimates HHDVs will experience an average of about \$240 in additional repair costs covered under warranty. Table 25 indicates the total net increase in costs for the vehicle purchaser, including capital costs and repair savings throughout the proposed warranty period.

Table 25: Estimated Increase in Costs on a Per-Vehicle Basis for the End User as a Result of the Proposed Warranty Amendments (2017\$)

Vehicle Category	Minimum Net Increase in Costs	Maximum Net Increase in Costs
HHDV	\$45	\$173
MHDV	\$82	\$315
LHDV	\$28	\$108

e. Statewide Costs

Staff estimates statewide new vehicle purchases using EMFAC future vehicle purchase projections. Table 26 shows the projected new vehicle purchases in the state of California through 2040.⁹ EMFAC vehicle projections estimate HHDV purchases, but do not differentiate between MHDV and LHDV categories. To estimate the vehicle purchase populations in these two vehicle categories, staff analyzed recent California certification sales data to estimate the relative ratio between MHDV and LHDV purchases. Based on this analysis, staff estimates that 53 MHDVs were purchased for every 47 LHDVs, resulting in a 53/47 ratio. This ratio was applied to EMFAC vehicle population projections to estimate MHDV and LHDV future sales.

Table 26: Projected Sales of Heavy-Duty Vehicles in California 2022 through 2040

Purchase Year	HHDV	MHDV	LHDV
2022	6,050	6,802	6,032
2023	6,686	6,917	6,134
2024	6,217	7,157	6,347
2025	6,359	7,474	6,628
2026	6,596	7,511	6,661
2027	6,722	7,723	6,849
2028	6,859	7,771	6,892
2029	7,001	7,925	7,028
2030	7,162	8,048	7,137
2031	7,296	8,171	7,246
2032	7,495	8,400	7,449
2033	7,651	8,554	7,585
2034	7,895	8,826	7,827
2035	7,997	8,986	7,969
2036	8,019	9,027	8,005
2037	8,062	9,087	8,058
2038	8,122	9,131	8,097
2039	8,184	9,197	8,156
2040	8,275	9,241	8,195

Staff applied the per-vehicle capital costs in Table 24 to the projected vehicle sales to estimate the annual statewide costs. As capital costs are assumed to be purchased on a five year loan, the increased capital costs incurred by the vehicle purchaser is spread evenly through the first five years after purchase. Total amortized capital costs through 2040 are shown in Tables 27 and 28. Table 27 assumes no markup on costs passed

⁹ 2022 heavy-duty vehicle sales are projected to be less than the actual sales from 2012 used in the warranty claims analysis. From 2012 to 2016, heavy-duty vehicle sales experienced high volumes due to a post-recession boom, and then settled back to normal sales volumes following the boom. Staff also projects that many California fleets will purchase used trucks to comply with the Truck and Bus Rule turnover requirements, suppressing the demand for new in-state vehicle purchases in the early years of this analysis.

through to the vehicle purchaser, whereas Table 28 shows a 45 percent average markup on costs passed on to the vehicle purchaser.

The estimated total statewide capital costs (sum of amortized yearly costs) due to the proposed amendments is estimated to be between \$127,956,000 and \$185,417,000, as shown in Table 29.

Table 27: Estimated Annual Statewide Capital Costs for 2022 through 2040, without Markup (2017\$)

Year	HHDV	MHDV	LHDV	Total
2022	\$344,850	\$706,048	\$214,739	\$1,265,637
2023	\$725,952	\$1,424,032	\$433,110	\$2,583,094
2024	\$1,080,321	\$2,166,929	\$659,063	\$3,906,313
2025	\$1,442,784	\$2,942,730	\$895,020	\$5,280,534
2026	\$1,818,756	\$3,722,372	\$1,132,151	\$6,673,279
2027	\$1,857,060	\$3,817,972	\$1,161,236	\$6,836,268
2028	\$1,866,921	\$3,906,617	\$1,188,221	\$6,961,759
2029	\$1,911,609	\$3,986,335	\$1,212,465	\$7,110,409
2030	\$1,957,380	\$4,045,916	\$1,230,585	\$7,233,882
2031	\$1,997,280	\$4,114,424	\$1,251,411	\$7,363,116
2032	\$2,041,341	\$4,184,697	\$1,272,771	\$7,498,809
2033	\$2,086,485	\$4,265,972	\$1,297,442	\$7,649,899
2034	\$2,137,443	\$4,359,496	\$1,325,886	\$7,822,826
2035	\$2,185,038	\$4,456,861	\$1,355,506	\$7,997,404
2036	\$2,226,249	\$4,545,713	\$1,382,526	\$8,154,488
2037	\$2,258,568	\$4,617,024	\$1,404,206	\$8,279,798
2038	\$2,285,415	\$4,676,917	\$1,422,434	\$8,384,765
2039	\$2,301,888	\$4,715,426	\$1,434,146	\$8,451,460
2040	\$2,317,734	\$4,741,895	\$1,442,192	\$8,501,821
TOTAL (rounded to nearest thousand)				\$127,956,000

Table 28: Estimated Annual Statewide Capital Costs for 2022 through 2040, with 45 Percent Markup (2017\$)

Year	HHDV	MHDV	LHDV	Total
2022	\$499,730	\$1,023,021	\$311,251	\$1,834,002
2023	\$1,051,994	\$2,063,338	\$627,766	\$3,743,097
2024	\$1,565,518	\$3,139,750	\$955,271	\$5,660,539
2025	\$2,090,771	\$4,263,840	\$1,297,276	\$7,651,887
2026	\$2,635,601	\$5,393,494	\$1,640,983	\$9,670,078
2027	\$2,691,108	\$5,532,013	\$1,683,140	\$9,906,261
2028	\$2,705,398	\$5,660,454	\$1,722,253	\$10,088,105
2029	\$2,770,156	\$5,775,962	\$1,757,393	\$10,303,511
2030	\$2,836,484	\$5,862,291	\$1,783,657	\$10,482,432
2031	\$2,894,304	\$5,961,555	\$1,813,843	\$10,669,702
2032	\$2,958,154	\$6,063,376	\$1,844,803	\$10,866,333
2033	\$3,023,573	\$6,181,139	\$1,880,562	\$11,085,274
2034	\$3,097,417	\$6,316,650	\$1,921,790	\$11,335,857
2035	\$3,166,388	\$6,457,725	\$1,964,722	\$11,588,835
2036	\$3,226,108	\$6,586,467	\$2,003,886	\$11,816,461
2037	\$3,272,942	\$6,689,792	\$2,035,310	\$11,998,045
2038	\$3,311,847	\$6,776,573	\$2,061,730	\$12,150,149
2039	\$3,335,718	\$6,832,371	\$2,078,706	\$12,246,796
2040	\$3,358,681	\$6,870,723	\$2,090,368	\$12,319,772
TOTAL (rounded to nearest thousand)				\$185,417,000

Table 29: Total Statewide Capital Costs from 2022 to 2044 Due to Proposed Amendments for 2022 through 2040 MY Heavy-Duty Vehicles (2017\$)

Minimum Costs	Maximum Costs
\$127,956,000	\$185,417,000

* Rounded to nearest thousand

IV. Repair Cost Savings for Purchasers of Heavy-Duty Vehicles with Lengthened Warranties

Currently, heavy-duty vehicle owners have to pay for any emission-related repair once their current emissions control warranty coverage (paid for either with the original purchase price of the vehicle or with a purchased extended warranty) expires. Under the proposed amendments, the warranty periods would be lengthened which would cover emission-related repairs for longer periods of mileage and therefore, provide a cost savings to heavy-duty vehicle owners. These are average cost savings recognizing that some owners that purchase heavy-duty vehicles with the lengthened warranties will benefit more than others if many repairs are needed, and some may not benefit at all if repairs are not needed during the lengthened warranty periods. As already calculated in Table 22, the additional repair costs covered by the proposed

amendments is \$240 for a HHDV, \$437 for MHDVs, and \$149 for LHDVs. These values when multiplied by the new heavy-duty vehicle population per year for each vehicle category results in the total repair savings to the vehicle purchaser associated with the proposed warranty amendments, as shown in Table 30.

Table 30: Repair Savings to the End User Associated with the Proposed Warranty Amendments (2017\$)

Year	HHDV	MHDV	LHDV	Total
2022	-	-	-	-
2023	-	-	-	-
2024	-	-	-	-
2025	-	-	-	-
2026	\$1,450,742	\$2,971,560	\$901,312	\$5,323,614
2027	\$1,603,250	\$3,021,800	\$916,553	\$5,541,603
2028	\$1,490,788	\$3,126,647	\$948,380	\$5,565,815
2029	\$1,524,838	\$3,265,134	\$990,367	\$5,780,339
2030	\$1,581,669	\$3,281,298	\$995,298	\$5,858,265
2031	\$1,611,883	\$3,373,913	\$1,023,389	\$6,009,185
2032	\$1,644,734	\$3,394,883	\$1,029,815	\$6,069,432
2033	\$1,678,785	\$3,462,160	\$1,050,136	\$6,191,081
2034	\$1,717,391	\$3,515,895	\$1,066,423	\$6,299,709
2035	\$1,749,523	\$3,569,629	\$1,082,710	\$6,401,862
2036	\$1,797,242	\$3,669,671	\$1,113,042	\$6,579,956
2037	\$1,834,649	\$3,736,949	\$1,133,364	\$6,704,962
2038	\$1,893,159	\$3,855,776	\$1,169,524	\$6,918,459
2039	\$1,917,617	\$3,925,675	\$1,190,742	\$7,034,034
2040	\$1,922,893	\$3,943,586	\$1,196,121	\$7,062,600
TOTAL (rounded to nearest thousand)				\$93,341,000

As stated earlier, staff assumes that repair costs occur in the fifth year after a vehicle purchase. The total estimated repair savings is \$93,341,000.

V. Total Net Regulatory Costs

To determine the overall net cost of the proposed amendments to the warranty regulations, staff estimated the total net regulatory costs by subtracting repair cost savings in Table 30 from the estimated statewide costs in Table 29. Total net regulatory costs are estimated in Table 31. Staff estimates a total regulatory cost of about \$34,615,000 if costs passed through to the vehicle purchaser are not marked up and a cost of about \$92,076,000 if manufacturers markup pass-through costs by an average of 45 percent.

Table 31: Total Net Regulatory Costs due to the Proposed Amendments (2017\$)

Minimum Net Regulatory Costs	Maximum Net Regulatory Costs
\$34,615,000	\$92,076,000