Attachment D

Addendum to the Initial Statement of Reasons for the Public Hearing to Consider the Proposed Revisions to the On-Board Diagnostic System Requirements and Associated Enforcement Provisions for Passenger Cars, Light-Duty Trucks, Medium-Duty Vehicles and Engines, and Heavy-Duty Engines

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Addendum to the Initial Statement of Reasons for the Public Hearing to Consider the Proposed Revisions to the On-Board Diagnostic System Requirements and Associated Enforcement Provisions for Passenger Cars, Light-Duty Trucks, Medium-Duty Vehicles and Engines, and Heavy-Duty Engines

On June 1, 2021, the California Air Resources Board (CARB) released the Notice of Public Hearing to Consider the Proposed Revisions to the On-Board Diagnostic System (OBD) Requirements and Associated Enforcement Provisions for Passenger Cars, Light-Duty Trucks, Medium-Duty Vehicles and Engines, and Heavy-Duty Engines. CARB staff has found a few inaccuracies and missing information in the Initial Statement of Reasons (ISOR) and has addressed them below. For modifications to the text in the ISOR that are described below, the modifications to the original text are shown in single underline to indicate additions and ~~single strikeout~~ to indicate deletions. This addendum does not alter the requirements, rights, responsibilities, conditions, or prescriptions contained in staff's proposal.

Diesel NOx Sensor Monitoring Requirements

As part of the 45-day notice, staff had proposed that manufacturers provide specific information and meet specific compliance criteria to support the malfunction criteria for the diesel oxides of nitrogen (NOx) sensor monitoring capability (i.e., "gap") monitors. This proposal was described for sections 1968.2(f)(5.2.2)(D) and 1971.1(e)(9.2.2)(D) in Chapter III, Section B. of the ISOR, pages 51-53. During the regulatory development process, industry expressed concerns about being required to meet these requirements for vehicles/engines equipped with dual selective catalytic reduction (SCR) systems and multiple NOx sensors. Specifically, industry indicated it is not technically feasible for the second and third NOx sensors to fully meet the monitoring capability requirements – specifically, to "close the gap" such that the NOx sensor monitor is able to detect a sensor fault that prevents the SCR monitor from detecting a threshold catalyst. CARB staff acknowledged this and had indicated that, based on the regulation language specifically stating the requirement is given to the extent feasible, relief from the proposed monitoring requirements for vehicles/engines with such systems could be provided and that a description of the discussion would be provided in the ISOR. However, staff mistakenly did not include such a description.

Therefore, CARB staff are adding that for systems such as dual SCR systems with multiple NOx sensors, CARB recognizes that there may be technical feasibility issues with meeting the monitoring capability requirements of sections 1968.2(f)(5.2.2)(D) and 1971.1(e)(9.2.2)(D) for the second and subsequent NOx sensors. So while manufacturers would still be required to develop monitors for these NOx sensors in accordance with sections 1968.2(f)(5.2.2)(D) and 1971.1(e)(9.2.2)(D), manufacturers would not be required to fully close the gap for the second and third NOx sensors when developing diagnostics for the rear SCR catalyst. For these NOx sensor monitors that have a "gap," CARB will consider these monitors compliant upon the manufacturer providing data that indicate the monitors have been calibrated with as small of a diagnostic gap as technically feasible for robust monitoring (i.e., to avoid false pass and false fail monitoring decisions). CARB will continue to work with manufacturers to improve the monitors for these NOx sensors that will fully meet the monitoring capability requirements in sections 1968.2(f)(5.2.2) and 1971.1(e)(9.2.2), with the understanding that the manufacturers may take several model years before they can close the "gap."

Diesel Feedgas Generation Monitoring Requirements

For sections 1968.2(f)(1.2.3)(B) and 1968.2(f)(9.2.4)(B) in Chapter III, Section C. of the ISOR, the descriptions of the proposal included statements referring to "complete deterioration" or "completely deteriorated" when referring to malfunctions of the diesel catalyst feedgas generation functionality. Industry indicated that the phrases were not correct, and that they should be replaced with "net zero feedgas" to more accurately reflect what is coming in versus what is coming out of the catalyst. Staff agrees that "net zero feedgas" is the more appropriate phrase to use, since the catalyst may still be generating a small amount of feedgas while also consuming feedgas, thus resulting in "net zero feedgas, while "complete deterioration" implies no feedgas is being generated.

Therefore, CARB is modifying the ISOR text on page 73 as follows:

> **Rationale**: The proposed amendments are needed to address manufacturers' concerns about the feedgas generation performance monitoring requirements. Presently, implementing a diagnostic that detects a malfunction when the catalyst is unable to generate the necessary feedgas constituents for proper SCR operation poses a challenge for industry. ~~Complete D~~Ddeterioration of the feedgas generation functionality in the catalyst to net zero feedgas occurs sooner than the level of deterioration in the catalyst when the OBD II system detects a hydrocarbon conversion performance malfunction. Industry has explained that the OBD II system could set a fault code for a feedgas generation performance malfunction for a catalyst that would not be deemed as a malfunctioned part with respect to the monitoring requirements for hydrocarbon conversion performance. Industry has also explained that even when a catalyst ceases to generate feedgas constituents, the catalyst is still able to deliver feedgas constituents from the engine-out exhaust gas to the SCR system for proper SCR operation. Furthermore, NMHC conversion efficiency monitoring requirements for NMHC converting catalysts and catalyzed PM filters include NOx (or NMOG+NOx, if applicable) emission thresholds. Thus, staff is proposing that OBD II systems with a diagnostic that fulfills the NMHC conversion efficiency monitoring requirement may use that diagnostic as a surrogate for detecting when the catalyst/catalyzed PM filter experiences a malfunction in feedgas generation performance.

Further, CARB is modifying the ISOR text on page 75 as follows:

> Presently manufacturers are having difficulty developing a diagnostic which can detect a malfunction when the catalyst is unable to generate the necessary feedgas constituents for proper SCR operation. Attempts have been made at correlating a

loss of feedgas generation capability to a loss in hydrocarbon conversion efficiency. However, manufacturers have been unable to robustly detect a malfunction in hydrocarbon conversion performance before feedgas generation in the catalyst ~~becomes completely~~ deteriorates~~d~~ to net zero feedgas. Furthermore, manufacturers' SCR systems rely on feedgas generation performance to such an extent that they experience difficulty in testing out of the feedgas generation diagnostic requirement. In 2018, CARB staff amended the HD OBD regulation to revise the NOx test out criteria from no more than 15 percent to no more than 30 percent of the applicable NOx standard as measured from an applicable emission test cycle. Staff is now proposing the same change to the OBD II regulation.

Production Vehicle/Engine Evaluation (PVE) Requirements

As part of the 45-day notice, staff proposed amendments to decrease the amount of PVE tests required in the OBD II regulation, including requiring testing of only "major monitors" plus 400 other monitors for some vehicles. This proposal was described in the justification for section 1968.2(j)(2.3.1) in Chapter III, Section C. of the ISOR (page 89). Neither the regulatory text itself nor the justification in the ISOR indicated a specific start date for the new testing requirements. The proposed amendments, including these PVE testing relaxations, do not go into effect until the quarter after the regulation is officially approved by the Office of Administrative Law and filed with the Secretary of State, or upon filing if a request for an early effective date is approved. CARB currently estimates the effective date will be some time in 2022. Therefore, a manufacturer may use these new testing provisions starting on or after the effective date.

The existing regulation requires manufacturers to submit a test plan for CARB approval that includes specifics about what monitors are going to be tested for a specific test vehicle, and the test plan is required to be submitted and approved before manufacturers actually perform the testing. Manufacturers are required to perform the testing in section 1968.2(j)(2) and submit the test results as a report to CARB within six months.

Therefore, if a test report for a test vehicle is due before the effective date of the regulation, manufacturers will not be able to use the PVE testing relaxations for that test vehicle, and the current testing requirements in section 1968.2(j)(2) would apply. If the report is due after the effective date, manufacturers may be able to use the proposed test requirements. Further, if the manufacturer had already submitted and received CARB approval for a test plan prior to the effective date, but the test report is due after the effective date, the manufacturer may be able to submit a new test plan for CARB approval that takes advantage of the new flexibilities. In any case, the test report submitted by the manufacturer must match the CARB approved test plan.

Economic Impacts Assessment

Staff is updating certain cost numbers in Chapter VIII of the ISOR, "Economic Impacts Assessment," to address stakeholder comments made during the 45-day public comment period. The scope of the update includes revisions to the per-hour testing costs and the labor rates for calibrators, which impact costs for multiple proposed regulatory changes, revisions to the costs for the modified particulate matter (PM) filter monitor in-use monitor performance ratio (IUMPR) and monitoring requirements, and revisions to the costs for modified diesel catalyst/adsorber malfunction criteria determination requirements. The updated cost numbers are reflected in the tables below for light-duty (LD), medium-duty (MD), and heavy-duty (HD) manufacturers.

Industry commented that calibrators are paid similarly to software developers. After reviewing pay scale differences, staff agrees with industry and is modifying the ISOR text on pages 118-119 as follows:

> Since software development costs primarily consist of labor costs, labor rates of $77 ~~and $45~~ per hour were assumed for both software developers and calibrators, ~~respectively,~~ including both salaries/wages and benefits.

Industry commented that staff underestimated the costs for algorithm development and calibration for the modified PM filter monitor IUMPR and monitoring requirements. Staff adjusted the hours of algorithm development and calibration needed to meet the proposed requirements for manufacturers electing to use electrostatic PM sensor technology. Combining these changes and the updated calibrator labor rates mentioned before, staff is updating Tables G (on page 119 of the ISOR) and H (on page 120 of the ISOR) as follows:

Table G: Software Development Costs for OBD II Requirements

Type of Costs	Software Algorithm Costs (2020 $)	Calibration Costs (2020 $)	Total Software Dev. Costs (2020 $)
Total Annual Incremental Costs for Large LD and MD Manufacturers	3,878,365	746,227	4,624,592
Incremental Costs per Vehicle for Large LD and MD Manufacturers	0.23	0.04	0.27
Total Annual Incremental Costs for Small LD and MD Manufacturers	56,848	21,182	78,030
Incremental Costs per Vehicle for Small LD and MD Manufacturers	3.30	1.23	4.53

Table H: Software Development Costs for HD OBD Requirements

Type of Costs	Software Algorithm Costs (2020 $)	Calibration Costs (2020 $)	Total Software Dev. Costs (2020 $)
Total Annual Incremental Costs for Large HD Manufacturers	979,067	387,734	1,366,800
Incremental Costs per Engine for Large HD Manufacturers	8.34	3.30	11.64
Total Annual Incremental Costs for Small HD Manufacturers	91,100	17,243	108,342
Incremental Costs per Engine for Small HD Manufacturers	13.97	2.64	16.61

Industry commented that staff underestimated the testing costs. Staff revisited the assumptions for per-hour testing costs and re-estimated the per-hour testing costs as explained in the modified text below. Staff is modifying the ISOR text on page 120 as follows:

> The cost impacts and cost savings were also estimated through discussions with manufacturers and engineering analysis. ~~The testing costs include the equipment and labor costs to conduct the tests and data analyses.~~ Staff assumed labor rates of $41 per hour for testing technicians. <u>Staff determined the per-hour testing rate for LD and MD manufacturers or HD manufacturers to be $308, which includes costs in labor to conduct the tests and data analyses, overhead costs for test cell management, equipment acquisition and installation costs, test cell maintenance costs, and utility costs.</u>

In addition to the revised per-hour testing costs discussed above, which impact the costs for several proposed regulatory changes, staff also updated the hours needed for testing to meet the modified PM filter monitor IUMPR and monitoring requirements and the modified diesel catalyst/adsorber malfunction criteria determination requirements. Thus, staff is updating Tables I and J (on page 122 of the ISOR) as follows:

Table I: Testing Costs for OBD II Requirements

Type of Costs	Testing Costs (2020 $)
Total Annual Incremental Costs for Large LD and MD Manufacturers	6,724,694
Incremental Costs per Vehicle for Large LD and MD Manufacturers	0.40
Total Annual Incremental Costs for Small LD and MD Manufacturers	188,426
Incremental Costs per Vehicle for Small LD and MD Manufacturers	10.94

Table J: Testing Costs for HD OBD Requirements

Type of Costs	Testing Costs (2020 $)
Total Annual Incremental Costs for Large HD Manufacturers	1,511,209
Incremental Costs per Engine for Large HD Manufacturers	12.87
Total Annual Incremental Costs for Small HD Manufacturers	256,491
Incremental Costs per Engine for Small HD Manufacturers	39.33

Combining changes in software development and testing costs as discussed above, staff is also updating Tables M, N, O, and P (on pages 124-126 of the ISOR) as follows:

Table M: Incremental Consumer Cost of LD and MD Vehicle OBD II Systems for Purchasing from Large Manufacturers

Category	Subcategory	Cost (2020 $)
Variable Costs	Component	0.27
Support Costs	Software Development	0.27
	Testing	0.40
	Reporting/Miscellaneous Documentation	0.00 [e]
Manufacturer Mark-up [a]		0.08
Dealership Holding Cost [b]		0.01
Dealership Mark-up [c]		0.06
Total Initial Incremental Cost to Consumers [d]		1.09

(a) Cost of manufacturer mark-up was estimated at 9 percent.
(b) Cost of dealership holding cost was estimated at 1.5 percent.
(c) Cost of dealership mark-up was estimated at 6 percent.
(d) Rounding of numbers to 2 significant figures may result in the total cost not matching the summation of the individual cost items shown in the table.
(e) Showing zero due to rounding

Table N: Incremental Consumer Cost of LD and MD Vehicle OBD II Systems for Purchasing from Small Manufacturers

Category	Subcategory	Cost (2020 $)
Variable Costs	Component	0.14
Support Costs	Software Development	4.53
	Testing	10.94
	Reporting/Miscellaneous Documentation	0.71
Manufacturer Mark-up [a]		1.47
Dealership Holding Cost [b]		0.24
Dealership Mark-up [c]		0.98
Total Initial Incremental Cost to Consumers [d]		19.01

(a) Cost of manufacturer mark-up was estimated at 9 percent.
(b) Cost of dealership holding cost was estimated at 1.5 percent.
(c) Cost of dealership mark-up was estimated at 6 percent.
(d) Rounding of numbers to 2 significant figures may result in the total cost not matching the summation of the individual cost items shown in the table.

Table O: Incremental Consumer Cost of HD OBD Systems for Purchasing from Large Manufacturers

Category	Subcategory	Cost (2020 $)
Variable Costs	Component	0.04
Support Costs	Software Development	11.64
	Testing	12.87
	Reporting/Miscellaneous Documentation	0.08
Engine Manufacturer Mark-up [a]		1.48
Truck Manufacturer Mark-up [a]		1.48
Dealership Holding Cost [b]		0.37
Dealership Mark-up [c]		1.48
Total Initial Incremental Cost to Consumers [d]		29.43

(a) Cost of engine/truck manufacturer mark-up was estimated at 6 percent.
(b) Cost of dealership holding cost was estimated at 1.5 percent.
(c) Cost of dealership mark-up was estimated at 6 percent.
(d) Rounding of numbers to 2 significant figures may result in the total cost not matching the summation of the individual cost items shown in the table.

Table P: Incremental Consumer Cost of HD OBD Systems for Purchasing from Small Manufacturers

Category	Subcategory	Cost (2020 $)
Variable Costs	Component	0.04
Support Costs	Software Development	16.61
	Testing	39.33
	Reporting/Miscellaneous Documentation	1.63
Engine Manufacturer Mark-up [a]		3.46
Truck Manufacturer Mark-up [a]		3.46
Dealership Holding Cost [b]		0.86
Dealership Mark-up [c]		3.46
Total Initial Incremental Cost to Consumers [d]		68.85

(a) Cost of engine/truck manufacturer mark-up was estimated at 6 percent.
(b) Cost of dealership holding cost was estimated at 1.5 percent.
(c) Cost of dealership mark-up was estimated at 6 percent.
(d) Rounding of numbers to 2 significant figures may result in the total cost not matching the summation of the individual cost items shown in the table.

As a result of the updated incremental per-vehicle costs, several other numbers need to be updated. First, the cost effectiveness numbers are updated, so staff is modifying the ISOR text on page 129 as follows:

> While the emission benefit numbers from the 2009 biennial review still apply, since the regulatory proposal added an incremental cost of ~~$14.34- 25.87~~$29.43- 68.85 per engine for heavy-duty engines, the cost effectiveness of the HD OBD program is updated as described below. As stated in the 2018 HD OBD Staff Report, the per-engine cost to implement OBD for the vehicle purchasers was estimated at $783 per engine. Adjusting this cost for inflation results in an estimated cost of $812 per engine in 2020 dollars. Adding the proposal's incremental cost of ~~$14.34- 25.87~~$29.43- 68.85 per engine results in a total estimated cost of ~~$826.34- 837.87~~$841.34- 880.85 per engine. Splitting that in half, ~~$413.17- 418.94~~$420.72- 440.42 is attributed to PM benefit for a cost-effectiveness of ~~$29.51- 29.92~~$30.05- 31.46 per pound of PM. The other half of the cost was attributed to ROG+NOx benefit for a cost-effectiveness of ~~$0.19~~$0.19- 0.20 per pound of ROG+NOx. If only NOx benefits were claimed, the cost-effectiveness for NOx is ~~$0.21~~$0.21- 0.22 per pound.

Second, staff is also updating Tables Q (on page 133 of the ISOR) and R (on page 135 of the ISOR) to account for the increased incremental vehicle costs to consumers as follows:

Table Q. Fiscal Effect on Local Government

Fiscal Year	Net Costs (2020 $)	Sales Tax Revenue (2020 $)	Total Fiscal Impact (2020 $)*
2028/2029	184,669	165,740	-18,929
2029/2030	168,087	158,686	-9,400
2030/2031	169,017	159,350	-9,667
2031/2032	160,772	156,129	-4,643
2032/2033	158,292	155,326	-2,965
2033/2034	155,539	154,394	-1,145
Total	**996,376**	**949,625**	**-46,750**

*Total Fiscal Impact is calculated as the change in revenue minus costs.

Table R. Fiscal Effect on State Government

Fiscal Year	Net Costs for Vehicle Purchases (2020 $)	Net Costs for I/M Program (2020 $)	Total Costs (2020 $)	Sales Tax Revenue (2020 $)	Total Fiscal Impact (2020 $)*
2025/2026	0	19,220	19,220	0	(19,220)
2026/2027	0	19,220	19,220	0	(19,220)
2028/2029	54,076	0	54,076	143,568	89,493
2029/2030	49,010	0	49,010	137,459	88,448
2030/2031	49,287	0	49,287	138,033	88,746
2031/2032	46,761	0	46,761	135,243	88,482
2032/2033	45,997	0	45,997	134,548	88,551
2033/2034	45,150	0	45,150	133,740	88,591
Total	**290,281**	**38,440**	**328,721**	**822,592**	**493,871**

*Total Fiscal Impact is calculated as the change in revenue minus costs.

Third, the cost impact of the alternatives are also updated. For the costs of the first alternative (adopting no amendment), staff is modifying the ISOR text on page 136 as follows:

> Compared to the baseline, this alternative would result in no costs to manufacturers or increase in vehicle purchase price for California businesses and individuals who purchase new light-, medium-, and heavy-duty vehicles. Compared to the proposed amendments, this alternative would result in a cost savings to businesses and individuals who purchase new light-, medium-, and heavy-duty vehicles in California of ~~$11.60~~$20.83 million over six years, or ~~$0.67-7.37~~$1.09-19.01 per light- or medium-duty vehicle and ~~$14.34- 25.87~~$29.43-68.85 per heavy-duty vehicle if manufacturers were able to pass on all costs and markup.

For the costs of the second alternative (adopting more stringent amendments), staff is modifying the ISOR text on page 137 as follows:

> When considering these changes, the costs result in an incremental cost to consumers of ~~$0.73-8.30~~$1.10-18.31 per light- or medium-duty vehicle and of ~~$17.00-30.38~~$30.86- 69.95 per heavy-duty vehicle with all markups applied, and a total of ~~$13.04~~$21.24 million over the 6-year lifetime. By comparison, the proposal's incremental cost to consumers is ~~$0.67-7.37~~$1.09-19.01 per light- or medium-duty vehicle or ~~$14.34- 25.87~~$29.43-68.85 per heavy-duty vehicle, and the total incremental cost is ~~$11.60~~$20.83 million. This represents a total lifetime savings of ~~$1.44~~$0.41 million over the 6 year lifetime for the proposed amendments.

Additionally, staff is updating Tables F-1, F-2, F-3, and F-4 that were provided in Appendix F "Economic Analysis Support" of the ISOR, which detail the cost assessment for some of the key proposed modifications to the regulations for a typical large LD and MD vehicle manufacturer, a typical small LD and MD vehicle manufacturer, a typical large HD engine manufacturer, and a typical small HD engine manufacturer. As explained before, multiple proposed modifications to the regulations are impacted due to the updated per-hour testing costs and the labor rates for calibrators, while the modified PM filter monitor IUMPR and monitoring requirements and the modified diesel catalyst/adsorber malfunction criteria determination requirements are additionally impacted due to the updated hours needed to meet these requirements. The updated tables are provided below.

Table F-1. Large LD and MD Vehicle Manufacturer Major Costs of the OBD II Proposal

OBD II Proposal	Total hardware costs ($)	Total software algo dev costs ($)	Total calibration costs ($)	Total testing costs ($)	Total reporting costs ($)	Total costs per manufacturer ($)	Total annual costs per manufacturer ($)
3-byte fault codes	252,004	922,560	0	620,966	0	1,795,530	299,255
Status bits	107,711	46,128	0	310,483	0	464,322	77,387
Fault code specific readiness	107,711	46,128	0	310,483	0	464,322	77,387
Additional freeze frames	41,662	18,451	0	776	0	60,889	10,148
Supplemental monitor activity data	201,197	110,707	0	465,724	4,889	782,517	130,420
Fault code specific IUMPR	15,445	59,966	0	232,862	7,333	315,607	52,601
Fault code specific test results	18,087	59,966	0	232,862	0	310,916	51,819
Additional data stream parameters	12,478	3,229	0	23,286	0	38,993	6,499
EVAP system sealing function	2,032	9,226	7,224	31,048	0	49,530	8,255
PVE testing relaxations	0	0	0	(185,032)	0	(185,032)	(30,839)
Gasoline CSERS modifications	0	6,458	0	0	0	6,458	1,076
Gasoline CSERS catalyst heating monitor	99,573	46,128	171,996	295,680	0	613,377	102,230
Gasoline stall monitor	99,573	92,256	103,198	295,680	0	590,707	98,451
Diesel PM filter monitor and IUMPR	850,937	15,376	5,740	19,408	0	891,462	148,577
Diesel feedgas generation monitoring	0	0	0	(1,850)	0	(1,850)	(308)
Diesel CSERS modifications	0	4,059	0	0	0	4,059	677
Diesel CSERS CWS monitor	2,042	73,805	6,888	5,921	0	88,656	14,776
Diesel CSERS trackers	417	36,902	3,444	5,921	0	46,684	7,781
Diesel NOx sensor monitor data	0	0	0	7,895	313	8,208	1,368
Diesel catalyst/adsorber malfunction criteria determination requirements	0	0	0	17,763	782	18,545	3,091
Total	**1,810,870**	**1,551,346**	**298,491**	**2,689,878**	**13,317**	**6,363,901**	**1,060,650**

Table F-2. Small LD and MD Vehicle Manufacturer Major Costs of the OBD II Proposal

OBD II Proposal	Total hardware costs ($)	Total software algo dev costs ($)	Total calibration costs ($)	Total testing costs ($)	Total reporting costs ($)	Total costs per manufacturer ($)	Total annual costs per manufacturer ($)
3-byte fault codes	641	36,902	0	44,408	0	81,951	13,658
Status bits	274	1,845	0	22,204	0	24,323	4,054
Fault code specific readiness	274	1,845	0	22,204	0	24,323	4,054
Additional freeze frames	106	738	0	56	0	899	150
Supplemental monitor activity data	512	4,428	0	33,306	4,889	43,134	7,189
Fault code specific IUMPR	39	2,399	0	16,653	7,333	26,424	4,404
Fault code specific test results	46	2,399	0	16,653	0	19,097	3,183
Additional data stream parameters	32	129	0	1,665	0	1,826	304
EVAP system sealing function	5	369	517	2,220	0	3,111.2038	519
PVE testing relaxations	0	0	0	(13,232)	0	(13,232)	(2,205)
Gasoline CSERS modifications	0	258	0	0	0	258	43
Gasoline CSERS catalyst heating monitor	253	1,845	12,916	21,145	0	36,159	6,027
Gasoline stall monitor	253	3,690	7,750	21,145	0	32,838	5,473
Diesel PM filter monitor and IUMPR	0	0	0	0	0	0	0
Diesel feedgas generation monitoring	0	0	0	0	0	0	0
Diesel CSERS modifications	0	0	0	0	0	0	0
Diesel CSERS CWS monitor	0	0	0	0	0	0	0
Diesel CSERS trackers	0	0	0	0	0	0	0
Diesel NOx sensor monitor data	0	0	0	0	313	313	52
Diesel catalyst/adsorber malfunction criteria determination requirements	0	0	0	0	0	0	0
Total	**2,435**	**56,848**	**21,182**	**188,426**	**12,535**	**281,425**	**46,904**

Table F-3. Large HD Engine Manufacturer Major Costs of the HD OBD Proposal

HD OBD Proposal	Total hardware costs ($)	Total software algo dev costs ($)	Total calibration costs ($)	Total testing costs ($)	Total reporting costs ($)	Total costs per manufacturer ($)	Total annual costs per manufacturer ($)
3-byte fault codes	828	395,383	0	161,091	0	557,302	92,884
Status bits	354	19,769	0	80,545	0	100,669	16,778
Fault code specific readiness	354	19,769	0	80,545	0	100,669	16,778
Additional freeze frames	137	7,908	0	201	0	8,246	1,374
Supplemental monitor activity data	661	47,446	0	120,818	2,095	171,021	28,503
Fault code specific IUMPR	51	25,700	0	60,409	3,143	89,302	14,884
Fault code specific test results	59	25,700	0	60,409	0	86,168	14,361
Additional data stream parameters	41	1384	0	6,041	0	7,466	1,244
EVAP system sealing function	30	9,226	4,373	18,794	0	32,423	5,404
Gasoline CSERS modifications	0	0	0	0	0	0	0
Gasoline CSERS catalyst heating monitor	0	0	0	0	0	0	0
Gasoline stall monitor	0	0	0	0	0	0	0
Diesel CSERS modifications	0	10,148	0	0	0	10,148	1,691
Diesel CSERS CWS monitor	1,395	184,512	218,647	187,939	0	592,493	98,749
Diesel CSERS trackers	285	92,256	109,323	187,939	0	389,803	64,967
Diesel NOx sensor monitor data	0	0	0	197,367	782	198,149	33,025
Diesel catalyst/adsorber malfunction criteria determination requirements	0	0	0	133,223	1,956	135,178	22,530
Total	**4,197**	**839,200**	**332,343**	**1,295,322**	**7,976**	**2,479,037**	**413,173**

Table F-4. Small HD Engine Manufacturer Major Costs of the HD OBD Proposal

HD OBD Proposal	Total hardware costs ($)	Total software algo dev costs ($)	Total calibration costs ($)	Total testing costs ($)	Total reporting costs ($)	Total costs per manufacturer ($)	Total annual costs per manufacturer ($)
3-byte fault codes	40	36,902	0	21,411	0	58,353	9,726
Status bits	17	1,845	0	10,705	0	12,568	2,095
Fault code specific readiness	17	1,845	0	10,705	0	12,568	2,095
Additional freeze frames	7	738	0	27	0	771	129
Supplemental monitor activity data	32	4,428	0	16,058	2095	22,614	3,769
Fault code specific IUMPR	2	2,399	0	8,029	3143	13,573	2,262
Fault code specific test results	3	2,399	0	8,029	0	10,431	1,738
Additional data stream parameters	2	129	0	803	0	934	156
EVAP system sealing function	1	369	581	2,498	0	3,450	575
Gasoline CSERS modifications	0	258	0	0	0	258	43
Gasoline CSERS catalyst heating monitor	6	1,845	969	18,734	0	21,554	3,592
Gasoline stall monitor	6	3,690	484	18,734	0	22,915	3,819
Diesel CSERS modifications	0	406	0	0	0	406	68
Diesel CSERS CWS monitor	68	7,380	7,265	6,245	0	20,958	3,493
Diesel CSERS trackers	14	3,690	3,633	6,245	0	13,581	2,264
Diesel NOx sensor monitor data	0	0	0	19,737	782	20,519	3,420
Diesel catalyst/adsorber malfunction criteria determination requirements	0	0	0	44,408	1956	46,363	7,727
Total	**215**	**68,325**	**12,932**	**192,368**	**7,976**	**281,816**	**46,969**