

## APPENDIX F

### Economic Analysis Support

For the cost analysis, each proposed modification was analyzed for its cost impact. The following tables show the cost assessment for some of the key proposed modifications to the regulation for illustrative purposes. The assessment was done for an “average manufacturer” and “large manufacturer” and scaled to apply to the fleet. To simplify the analysis, only costs that were easily quantifiable based on information and data available to staff and had significant cost impact were quantified. Because modifications that had potential cost savings were never accounted for (e.g., diesel feedgas generation monitoring test-out criteria exemption for NMHC catalyst and catalyzed PM filter) staff believe the simplifying assumptions made are reasonable and balanced by any cost savings. Additionally, modifications that were associated with gasoline-powered engines were not separately assessed since these engines only account for one-quarter of the heavy-duty engine fleet and the changes impacting these engines are significantly less than those for diesel engines. Since the bulk of the regulatory changes impact diesel engines, assuming the entire heavy-duty engine fleet is made up entirely of diesel engines should result in a worse case cost estimate. Regulatory changes that were considered clarifications of the existing regulation to ensure consistent implementation of OBD systems across manufacturers were also assigned zero costs because the associated costs should have previously been accounted for and/or the number of systems needing modifications to ensure consistent implementation were difficult to quantify to estimate the potential cost impact.

Table F-1. Average Engine Manufacturer Major Costs of Proposal

HD OBD Proposal	Per Engine Hardware Cost	% that require tech for OBD proposal	Per Engine Warranty Costs	Per Engine Total Component Costs	Software/ Algo Dev/Cal Cost	% of Engines needing algo dev/cal work	Calibration Cost for other engines	% of Other engines needing cal work	Testing Cost	% of Engines w/ testing costs	Other Costs	% of Engines w/ other costs	# of total engines/OEM mfr	Total Cost	Total Annual Cost
IUMPR - Increase all monitors to 0.3 - 2022+MY					\$189,667	20%	\$52,975	80%					5	\$401,567	\$66,928
IUMPR - Require new diesel monitors to track and report data - 2022+MY	\$10	50%	\$0.01	\$5.01	\$1,000	100%			\$1,000	100%	\$200	100%	1	\$2,200	\$367
PHEVs - require 2 ignition cycle counters - 2022+MY	\$0	100%		\$0.00	\$2,000	100%			\$2,000	100%	\$200	100%	1	\$4,200	\$700
Change freeze frame requirements - 2022+MY	\$0	100%		\$0.00	\$2,000	100%			\$2,000	100%	\$200	100%	1	\$4,200	\$700
Monitoring Conditions - restrict SET cycle conditions to monitors that are IUMPR tracked and reported - 2022+MY	\$0				\$996,470	5%	\$438,818	50%					5	\$1,346,162	\$224,360
Limit emissions-increasing intrusive diagnostics to run only after MIL already on	\$0				\$1,000	50%			\$5,000	50%			5	\$15,000	\$2,500
Add NOx emission thresholds to PM filter filtering performance monitor and catalyzed PM filter conversion monitor - 2022+MY													5	\$0	\$0
EGR/Boost continuous monitors - add similar conditions requirements - 2022+MY	\$0				\$200	100%							5	\$1,000	\$167
New NOx sensor monitor requirement - indicate fault when goes "inactive" when it should be "active" - 2022+MY					\$105,504	20%	\$20,178	80%					5	\$186,216	\$31,036
Add more stringent CV monitoring requirements - 2025-2027 MY phase-in	\$8	10%	\$0.06	\$0.86	\$126,605	10%	\$24,214	10%					5	\$75,409	\$12,568
DDE - Change engine durability aging requirements	\$0				\$0				\$694,756	20%			5	\$694,756	\$694,756
PVE (1)(2) - Require testing of 10 monitors already tested during DDE testing	\$0				\$0				\$1,000	20%			5	\$1,000	\$1,000

Table F-1 continued.

HD OBD Proposal	Per Engine Hardware Cost	% that require tech for OBD proposal	Per Engine Warranty Costs	Per Engine Total Component Costs	Software/ Algo Dev/Cal Cost	% of Engines needing algo dev/cal work	Calibration Cost for other engines	% of Other engines needing cal work	Testing Cost	% of Engines w/ testing costs	Other Costs	% of Engines w/ other costs	# of total engines/OEM mfr	Total Cost	Total Annual Cost
Readiness - add separate diesel exhaust gas sensor heater readiness bit for J1939 vehicles and add gasoline O2/exhaust gas sensor heater bit; for 2022+MY, take PM filter frequent regen and active/intrusive injection out of readiness	\$0				\$200	100%			\$0		\$0		5	\$1,000	\$167
New NOx performance control tracking parameters - 2022+MY					\$8,500	20%	\$1,600	80%	\$5,000	20%	\$0		5	\$19,900	\$1,990
New GHG-related parameters - 2022+MY					\$2,000	20%	\$1,600	80%	\$5,000	20%	\$0		5	\$13,400	\$1,340
New over the air reprogramming requirements - 2022+MY	\$0	50%			\$2,000	20%	\$1,600	30%	\$2,000	20%	\$20,000	20%	5	\$26,400.00	\$2,640
New certification doc requirements (e.g., torque PIDs correlation, Nox sensor status flag, 1 Hz data showing the instantaneous NOx mass emission rate)	\$0				\$0				\$0		\$400	100%	5	\$2,000	\$2,000
Manufacturer self-testing - basic proposal (not "good performance" proposal)									\$305,000	20%			5	\$305,000	\$305,000
- Additional Phase 2 and 3 test costs														\$58,717	\$58,717
Manufacturer self-testing - "good performance" proposal									\$189,267	20%			5	\$189,267	\$189,267

Table F-2. Large Engine Manufacturer Major Costs of Proposal

HD OBD Proposal	Per Engine Hardware Cost	% that require tech for OBD proposal	Per Engine Warranty Costs	Per Engine Total Component Costs	Software/ Algo Dev/Cal Cost	% of Engines needing algo dev/cal work	Calibration Cost for other engines	% of Other engines needing cal work	Testing Cost	% of Engines w/ testing costs	Other Costs	% of Engines w/ other costs	# of total engines/OEM mfr	Total Cost	Total Annual Cost
IUMPR - Increase all monitors to 0.3 - 2022+MY					\$189,667	10%	\$52,975	90%					10	\$666,442.27	\$111,074
IUMPR - Require new diesel monitors to track and report data - 2022+MY	\$10	50%	\$0.01	\$5.01	\$1,000	100%			\$1,000	100%	\$200	100%	1	\$2,200	\$367
PHEVs - require 2 ignition cycle counters - 2022+MY	\$0				\$2,000	100%			\$2,000	100%	\$200	100%	1	\$4,200	\$700
Change freeze frame requirements - 2022+MY	\$0				\$2,000	100%			\$2,000	100%	\$200	100%	1	\$4,200	\$700
Monitoring Conditions - restrict SET cycle conditions to monitors that are IUMPR tracked and reported - 2022+MY	\$0				\$996,470	5%	\$438,818	50%					10	\$2,692,324.80	\$448,721
Limit emissions-increasing intrusive diagnostics to run only after MIL already on	\$0				\$1,000	50%			\$5,000	50%			10	\$30,000	\$5,000
Add NOx emission thresholds to PM filter filtering performance monitor and catalyzed PM filter conversion monitor - 2022+MY													10	\$0	\$0
EGR/Boost continuous monitors - add similar conditions requirements - 2022+MY	\$0				\$200	100%							10	\$2,000	\$333
New NOx sensor monitor requirement - indicate fault when goes "inactive" when it should be "active" - 2022+MY					\$105,504	10%	\$20,178	90%					10	\$287,106	\$47,851
Add more stringent CV monitoring requirements - 2025-2027 MY phase-in	\$8	10%	\$0.06	\$0.86	\$126,605	10%	\$24,214	10%					10	\$150,818	\$25,136
DDE - Change engine durability aging requirements	\$0				\$0				\$694,756	20%			10	\$1,389,513	\$1,389,513
PVE (1)(2) - Require testing of 10 monitors already tested during DDE testing	\$0				\$0				\$1,000	20%			10	\$2,000	\$2,000

Table F-2 continued.

	Per Engine Hardware Cost	% that require tech for OBD proposal	Per Engine Warranty Costs	Per Engine Total Component Costs	Software/ Algo Dev/Cal Cost	% of Engines needing algo dev/cal work	Calibration Cost for other engines	% of Other engines needing cal work	Testing Cost	% of Engines w/ testing costs	Other Costs	% of Engines w/ other costs	# of total engines/OEM mfr	Total Cost	Total Annual Cost
<b>HD OBD Proposal</b>															
Readiness - add separate diesel exhaust gas sensor heater readiness bit for J1939 vehicles and add gasoline O2/exhaust gas sensor heater bit; for 2022+MY, take PM filter frequent regen and active/intrusive injection out of readiness	\$0				\$200	100%			\$0		\$0		10	\$2,000	\$333
New NOx performance control tracking parameters - 2022+MY					\$8,500	10%	\$1,600	90%	\$5,000	10%	\$0		10	\$27,900	\$2,790
New GHG-related parameters - 2022+MY					\$2,000	10%	\$1,600	90%	\$5,000	10%	\$0		10	\$21,400	\$2,140
New over the air reprogramming requirements - 2022+MY	\$0	50%			\$2,000	10%	\$1,600	40%	\$2,000	10%	\$20,000	10%	10	\$30,400	\$3,040
New certification doc requirements (e.g., torque PIDs correlation, Nox sensor status flag, 1 Hz data showing the instantaneous NOx mass emission rate)	\$0				\$0				\$0		\$400	100%	10	\$4,000	\$4,000
Manufacturer self-testing - basic proposal (not "good performance" proposal)									\$305,000	20%			10	\$610,000	\$610,000
- Additional Phase 2 and 3 test costs														\$117,433	\$117,433
Manufacturer self-testing - "good performance" proposal									\$189,267	20%			10	\$378,533	\$378,533