variable geometry turbo position, commanded variable geometry turbo position, turbocharger compressor inlet temperature, turbocharger compressor inlet pressure, turbocharger turbine inlet temperature, turbocharger turbine outlet temperature, wastegate valve position, glow plug lamp status, oxygen sensor output, air/fuel ratio sensor output, NO_X sensor output, and evaporative system vapor pressure.

We are also proposing requirements for storage of ''freeze frame'' information at the time a malfunction is detected and a DTC is stored. The freeze frame provides the operating conditions of the vehicle at the time of malfunction detection and the DTC associated with the data. The parameters we are proposing for inclusion in the freeze frame are a subset of the parameters listed above for the data stream. Note that storage of only one freeze frame would be required. Manufacturers may choose to store additional frames, provided that the required frame can be read using a scan tool meeting SAE J1978 specifications or designed to communicate with an SAE J1939 network.

We are also proposing that the OBD system store the most recent monitoring results for most of the major monitors. Manufacturers would be required to store and make available to the scan tool certain test information—i.e., the minimum and maximum values that should occur during proper operation along with the actual test value—of the most recent monitoring event. ''Passing'' systems would store test results that are within the test limits, while ''failing'' systems would store test results that are outside the test limits. The storage of test results would assist technicians in diagnosing and repairing malfunctions and would help distinguish between components that are performing well below the malfunction thresholds from those that are passing the malfunction thresholds marginally.

viii. Identification Numbers

We are also proposing that manufacturers be required to report two identification numbers related to the software and specific calibration values in the onboard computer. The first item, Calibration Identification Number (CAL ID), would identify the software version installed in the onboard computer. Software is often changed following production of the engine. These software changes often make changes to the emissions control system or the OBD system. We are proposing that these changes include a new CAL ID and that it be communicated via the diagnostic connector to the scan tool. The second item, Calibration Verification Number (CVN), would help to ensure that the current software has not been corrupted, modified inappropriately, or otherwise tampered with. Both CAL ID and CVN help ensure the integrity of the OBD system. The CVN proposal would require manufacturers to develop sophisticated software algorithms that would essentially be a self-check calculation of all of the emissions-related software and calibration values in the onboard computer and would return the result of the calculation to a scan tool. If the calculated result did not equal the expected result for that CAL ID, one would know that the software had been corrupted or otherwise modified. The CVN result would have to be made available at all times to a generic scan tool.

We are also proposing that the Vehicle Identification Number (VIN) be communicated via the diagnostic connector to a generic scan tool in a standardized format. The VIN would be a unique number assigned by the vehicle manufacturer to every vehicle built. The VIN is commonly used for purposes of ownership and registration to uniquely identify every vehicle. By requiring the VIN to be stored in the onboard computer and available electronically to a generic scan tool, the possibility of a fraudulent inspection (e.g., by plugging into a different vehicle than an inspection citation was issued originally to generate a proof of correction) would be minimized. Electronic access to this number would also simplify the inspection process and reduce transcription errors from manual data entry.

We are proposing that the VIN be electronically stored in a control module on the vehicle, but not that it necessarily be stored in the engine control module. As long as the VIN is reported correctly and according to the selected reference document standards, we consider it irrelevant as to which control module (e.g., engine controller, instrument cluster controller) contains the information. Further, we are proposing that the ultimate responsibility would lie with the engine manufacturer to ensure that every vehicle manufactured with one of its engines satisfies this requirement. However, we would expect that the physical task of implementing this requirement would likely be passed from the engine manufacturer to the vehicle manufacturer via an additional build specification. Thus, analogous to how the engine manufacturer currently provides engine purchasers with detailed specifications regarding engine cooling requirements, additional sensor inputs, physical mounting specifications, weight limitations, etc., the engine manufacturer would likely include an additional specification dictating the need for the VIN to be made available electronically. It would be left to each engine manufacturer to determine the most effective method to achieve this, as long as the VIN requirement is met. Some manufacturers may find it most effective to provide the capability in the engine control module delivered with the engine coupled with a mechanism for the vehicle manufacturer to program the module with the VIN upon installation of the engine into an actual vehicle. Others may find it more effective to require the vehicle manufacturer to have the capability built into other modules installed on the vehicle such as instrument cluster modules, etc. We are aware of several current vehicles with engines from three different engine manufacturers that already have the VIN available through engine-manufacturer specific scan tools; this indicates that such arrangements already exist in one form or another and that they are working.

5. In-Use Performance Ratio Tracking Requirements

To separately report an in-use performance ratio for each applicable monitor as discussed in sections II.B through II.D, we are proposing that manufacturers be required to implement software algorithms to report a numerator and denominator in the standardized format specified below and in accordance with the specifications of the reference documents listed in section II.F.1.

For the numerator, denominator, general denominator, and ignition cycle counter:

- Each number must have a minimum value of zero and a maximum value of 65,535 with a resolution of one.
- Each number must be reset to zero only when a non-volatile random access memory (NVRAM) reset occurs (e.g., reprogramming event) or, if the numbers are stored in keep-alive memory (KAM), when KAM is lost due to an interruption in electrical power to the control module (e.g., battery disconnect). Numbers may not be reset to zero under any other circumstances including when commanded to do so via a scan tool command to clear DTCs or reset KAM.
- If either the numerator or denominator for a specific component reaches the maximum value of 65,535 ±2, both numbers should be divided by two before either is incremented again to avoid overflow problems.

• If the ignition cycle counter reaches the maximum value of 65,535 ±2, the ignition cycle counter should rollover and increment to zero on the next ignition cycle to avoid overflow problems.
• If the general denominator reaches the maximum value of 65,535 ±2, the general denominator should rollover and increment to zero on the next drive cycle that meets the general denominator definition to avoid overflow problems.
• If an engine is not equipped with a component (e.g., oxygen sensor bank 2, secondary air system), the corresponding numerator and denominator for that specific component should always be reported as zero.

For the in-use performance ratio:
• The ratio should have a minimum value of zero and a maximum value of 7.99527 with a resolution of 0.000122.
• A ratio for a specific component should be considered to be zero whenever the corresponding numerator is equal to zero and the corresponding denominator is not zero.
• A ratio for a specific component should be considered to be the maximum value of 7.99527 if the corresponding denominator is zero or if the actual value of the numerator divided by the denominator exceeds the maximum value of 7.99527.

For engine run time tracking on all gasoline and diesel engines, manufacturers would be required to implement software algorithms to individually track and report in a standardized format the engine run time while being operated in the following conditions:
• Total engine run time
• Total idle run time (with ''idle'' defined as accelerator pedal released by driver, vehicle speed less than or equal to one mile per hour, and PTO not active);
• Total run time with PTO active.

Each of the above engine run time counters would have the following numerical value specifications:
• Each numerical counter must be a four-byte value with a minimum value of zero at a resolution of one minute per bit.
• Each numerical counter must be reset to zero only when a nonvolatile memory reset occurs (e.g., a reprogramming event). Numerical counters cannot be reset to zero under any other circumstances including a scan tool (generic or enhanced) command to clear DTCs or reset KAM.
• When any of the individual numerical counters reaches its maximum value, all counters must be divided by two before any are incremented again. This is meant to avoid overflow problems.

6. Exceptions to Standardization Requirements

For alternative-fueled engines derived from a diesel-cycle engine, we are proposing that the manufacturer be allowed to meet the standardized requirements discussed in this section that are applicable to diesel engines rather than meeting the requirements applicable to gasoline engines.

G. Implementation Schedule, In-Use Liability, and In-Use Enforcement

1. Implementation Schedule and In-Use Liability Provisions

Table II.G–1 summarizes the proposed implementation schedule for the OBD monitoring requirements—i.e., the proposed certification requirements and in-use liabilities. More detail regarding the implementation schedule and liabilities can be found in the sections that follow.

TABLE II.G–1.—OBD CERTIFICATION REQUIREMENTS AND IN-USE LIABILITY FOR DIESEL FUELED AND GASOLINE FUELED ENGINES OVER 14,000 POUNDS: MONITORING REQUIREMENTS

Model year	Applicability	Certification requirement	In-use liability
2010–2012	Parent rating within 1 compliant engine family. [a]	Full liability to thresholds according to certification demonstration procedures. [b]	Full liability to 2x thresholds. [c]
	Child ratings within the compliant engine family.	Certification documentation only (i.e., no certification demonstration); no liability to thresholds.	Liability to monitor and detect as noted in certification documentation.
	All other engine families and ratings	None	None.
2013–2015	Parent rating from 2010–2012 and parent rating within 1–2 additional engine families.	Full liability to thresholds according to certification demonstration procedures.	Full liability to 2x thresholds.
	Child ratings from 2010–2012 and parent ratings from any remaining engine families or OBD groups.[d]	Full liability to thresholds but certification documentation only.	Full liability to 2x thresholds.
	Additional engine ratings	Certification documentation only; no liability to thresholds.	Liability to monitor and detect as noted in certification demonstration.
2016–2018	One rating from 1–3 engine families and/or OBD groups.	Full liability to thresholds according to certification demonstration procedures.	Full liability to thresholds.
	Remaining ratings	Full liability to thresholds but certification documentation only.	Full liability to 2x thresholds.
2019+	One rating from 1–3 engine families and/or OBD groups.	Full liability to thresholds according to certification demonstration procedures.	Full liability to thresholds.
	Remaining ratings	Full liability to thresholds but certification documentation only.	Full liability to thresholds.

Notes: (a) Parent and child ratings are defined in section II.G; which rating(s) serves as the parent rating and which engine families must comply is not left to the manufacturer, as discussed in section II.G. (b) The certification demonstration procedures and the certification documentation requirements are discussed in section VIII.B. (c) Where in-use liability to thresholds and 2x thresholds is noted, manufacturer liability to monitor and detect as noted in their certification documentation is implied. (d) OBD groups are groupings of engine families that use similar OBD strategies and/or similar emissions control systems, as described in the text.

For the 2010 through 2012 model years, manufacturers would be required to implement OBD on one engine family. All other 2010 through 2012 engine families would not be subject to any OBD requirements unless otherwise required to do so (e.g., to demonstrate that SCR equipped vehicles will not be operated without urea). For 2013, manufacturers would be required to implement OBD on all engine families.

We are proposing this implementation schedule for several reasons. First, industry has made credible arguments that their resources are stretched to the limit developing and testing strategies for compliance with the 2007/2010 heavy-duty highway emissions standards. We do not want to jeopardize their success toward that goal by being too aggressive with our OBD program. Second, OBD is a complex and difficult regulation with which to comply. We believe that our implementation schedule would give industry the opportunity to introduce OBD systems on a limited number of engines giving them and us very valuable learning experience. Should mistakes or errors in regulatory interpretation occur, the ramifications would be limited to only a subset of the new vehicle fleet rather than the entire new vehicle fleet. Lastly, the proposed OBD requirements outlined above, and the production vehicle evaluation provisions discussed in Section VIII, reflect 10 to 20 years of learning by EPA, CARB, and industry (primarily the light-duty gasoline industry) as to what works and what does not work. This is, perhaps, especially true for those OBD elements that involve the interface between the OBD system and service and I/M inspection personnel. Gasoline manufacturers have had the ability to evolve their OBD systems along with this learning process. However, diesel engine manufacturers have not really been involved in this learning process and, as a result, 100 percent implementation in 2010 would be analogous to implementing 10 to 20 years of OBD learning in one implementation step. We believe that implementing in two or three gradual steps rather than one big step will benefit everyone involved.

Table II.G–1 makes reference to ''parent'' and ''child'' ratings. In general, engine manufacturers certify an engine family that consists of several ratings having slightly different horsepower and/or torque characteristics but no differences large enough to require a different engine family designation. For emissions certification, the parent rating—i.e., the rating for which emissions data are submitted to EPA for the purpose of demonstrating emissions compliance—is defined as the ''worst case'' rating. This worst case rating is the rating considered as having the worst emissions performance and, therefore, its compliance demonstrates that all other ratings within the family must comply. For OBD purposes, we wanted to limit the burden on industry—hence the proposal for only one compliant engine family in 2010—yet maximize the impact of the OBD system. Therefore, for model years 2010 through 2012, we are defining the OBD parent rating as the rating having the highest weighted projected sales within the engine family having the highest weighted projected sales, with sales being weighted by the useful life of the engine rating. Table II.G–2 presents a hypothetical example for how this would work. Using this approach, the OBD compliant engine family in 2010 would be the engine family projected to produce the most in-use emissions (based on sales weighted by expected miles driven). Likewise, the fully liable parent OBD rating would be the rating within that family projected to produce the most in-use emissions.

TABLE II.G–2.—HYPOTHETICAL EXAMPLE OF HOW THE OBD PARENT AND CHILD RATINGS WOULD BE DETERMINED

OBD group	Engine family	Rating	Projected sales	Certified useful life	OBD weighting—engine rating [a] (billions)	OBD weighting—engine family [b] (billions)
I	A	1	10,000	285,000	2.85	14.25
		2	40,000	285,000	11.4	
	B	1	10,000	435,000	4.35	21.60
		2	20,000	435,000	8.70	
		3	30,000	285,000	8.55	
II	C	1	20,000	110,000	2.20	7.70
		2	50,000	110,000	5.50	

Notes: (a) For engine family A, rating 1, 10,000 × 285,000 / 1 billion = 2.85.
(b) For engine family A, 2.85 + 11.4 = 14.25.

In the example shown in Table II.G–2, the compliant engine family in 2010 would be engine family B and the parent OBD rating within that family would be rating 2. The other OBD compliant ratings within engine family B would be dubbed the ''child'' ratings. For model years 2013 through 2015, the parent ratings would be those ratings having the highest weighted projected sales within each of the one to three engine families having the highest weighted projected sales, with sales being weighted by the useful life of the engine rating. In the example shown in Table II.G–2, the parent ratings would be rating 2 of engine family A, rating 2 of engine family B, and rating 2 of engine family C (Note that this is only for illustration purposes since our proposal would not require that a manufacturer with only three engine families have three parent ratings and instead would require only one).

The manufacturer would not need to submit test data demonstrating compliance with the emissions thresholds for the child ratings. We would fully expect these child ratings to use OBD calibrations—i.e., malfunction trigger points—that are identical or nearly so to those used on the parent rating. However, we would allow manufacturers to revise the calibrations on their child ratings where necessary so as to avoid unnecessary or inappropriate MIL illumination. Such revisions to OBD calibrations have been termed ''extrapolated'' OBD calibrations and/or systems. The revisions to the calibrations on child ratings and the rationale for them would need to be very clearly described in the certification documentation.

For the 2013 and later model years, we are proposing that manufacturers certify one to three parent ratings. The actual number of parent ratings would depend upon the manufacturer's fleet and would be based on both the emissions control system architectures present in their fleet and the similarities/differences of the engine families in their fleet. For example, a manufacturer that uses a DPF with NO_X adsorber on each of the engines would have only one system architecture. Another manufacturer that uses a DPF with NO_X adsorber on some engines and a DPF with SCR on others would have at least two architectures. We would expect that manufacturers would group similar architectures and similar engine families into so called ''OBD groups.'' These OBD groups would consist of a combination of engines, engine families, or engine ratings that use the same OBD strategies and similar calibrations. The manufacturer would be required to submit details regarding their OBD groups as part of their certification documentation that shows the engine families and engine ratings within each OBD group for the coming model year. While a manufacturer may end up with more than three OBD groups, we do not intend to require a parent rating for more than three OBD groups. Therefore, in the example shown in Table II.G–2, rather than submitting test data for the three parent ratings as suggested above, the OBD grouping would result in the parent ratings being rating 2 of engine family B and rating 2 of engine family C. These parents would represent OBD groups I and II, and the manufacturer's product line. For 2013 through 2015, we intend to allow the 2010 parent to again act as a parent rating and, provided no significant changes had been made to the engine or its emissions control system, complete carryover would be possible. However, for model years 2016 and beyond, we would work closely with CARB staff and the manufacturer to determine the parent ratings so that the same ratings are not acting as the parents every year. In other words, our definitions for the OBD parent ratings as discussed here apply only during the years 2010 through 2012 and again for the years 2013 through 2015. We request comment on this approach.

In addition to this gradual certification implementation schedule, we are proposing some relaxations for in-use liability during the 2010 through 2018 model years. The first such relaxation is higher interim in-use compliance standards for those OBD monitors calibrated to specific emissions thresholds. For the 2010 through 2015 model years, an OBD monitor on an in-use engine would not be considered non-compliant (i.e., subject to enforcement action) unless emissions exceeded twice the OBD threshold without detection of a malfunction. For example, for an EGR monitor on an engine with a NO_X FEL of 0.2 g/bhp-hr and an OBD threshold of 0.5 g/bhp-hr (i.e., the NO_X FEL+0.3), a manufacturer would not be subject to enforcement action unless emissions exceeded 1.0 g/bhp-hr NO_X without a malfunction being detected. For the model years 2016 through 2018, parent ratings would be liable to the certification emissions thresholds, but child ratings and other ratings would remain liable to twice the certification thresholds. Beginning in the 2019 model year, all families and all ratings would be liable to the certification thresholds.

The second in-use relaxation is a limitation in the number of engines that would be liable for in-use compliance with the OBD emissions thresholds. For 2010 through 2012, we are proposing that manufacturers be fully liable in-use to twice the thresholds for only the OBD parent rating. The child ratings within the compliant engine family would have liability for monitoring in the manner described in the certification documentation, but would not have liability for detecting a malfunction at the specified emissions thresholds. For example, a child rating's DPF monitor designed to operate under conditions X, Y, and Z and calibrated to detect a backpressure within the range A to B would be expected to do exactly that during in-use operation. However, if the tailpipe emissions of the child engine were to exceed the applicable OBD in-use thresholds (i.e., 2x the certification thresholds during 2010–2015), despite having a backpressure within range A to B under conditions X, Y, and Z, there would be no in-use OBD failure nor cause for enforcement action. In fact, we would expect the OBD monitor to determine that the DPF was functioning properly since its backpressure was in the acceptable range. For model years 2013 through 2015, this same in-use relaxation would apply to those engine families that do not lie within an engine family for which a parent rating has been certified. For 2016 and later model years, all engines would have some in-use liability to thresholds, either the certification thresholds or twice those thresholds.

These in-use relaxations are meant to provide ample time for manufacturers to gain experience without an excessive level of risk for mistakes. They would also allow manufacturers to fine-tune their calibration techniques over a six to ten year period.

We are also proposing some a specific implementation schedule for the standardization requirements discussed in section II.F. We initially intended to require that any compliant OBD engine family would be required to implement all of the standardization requirements. However, we became concerned that, during model years 2010 through 2012, we could have a situation where OBD compliant engines from manufacturer A might be competing against non-OBD engines from manufacturer B for sales in the same truck. In such a case, the truck builder would be placed in a difficult position of needing to design their truck to accommodate OBD compliant engines—along with a standardized MIL, a specific diagnostic connector location specification, etc.—and non-OBD engines. After consideration of this almost certain outcome, we have decided to limit the standardization requirements that must be met during the 2010 through 2012 model years. Beginning in 2013, all engines will be OBD compliant and this would become a moot issue. Table II.G–3 shows the proposed implementation schedule for standardization requirements.

TABLE II.G–3.—OBD STANDARDIZATION REQUIREMENTS FOR DIESEL FUELED AND GASOLINE FUELED ENGINES OVER 14,000 POUNDS

Model year	Applicability	Required standardization features	Waived standardization features
2010–2012	Parent and Child ratings within 1 compliant engine family.[a]	Emissions related (II.F.4) except for the requirement to make the data available in a standardized format or in accordance with SAE J1979/1939 specifications). MIL activation and deactivation.[b] Performance tracking—calculation of numerators, denominators, ratios.	Standardized connector (II.F.2). Dedicated (i.e., regulated OBD-only) MIL. Communication protocols (II.F.3). Emissions related functions (II.F.4) with respect to the requirement to make the data available in a standardized format or in accordance with SAE J1979/1939 specifications)
	Other engine families	None	All.
2013+	All engine families and ratings	All	None.

Notes: (a) Parent and child ratings are defined in section II.G; which rating serves as the parent rating and which engine families must comply is not left to the manufacturer, as discussed in section II.G. (b) There would be no requirement for a dedicated MIL and no requirement to use a specific MIL symbol, only that a MIL be used and that it use the proposed activation/deactivation logic.

2. In-Use Enforcement

When conducting our in-use enforcement investigations into OBD systems, we intend to use all tools we have available to analyze the effectiveness and compliance of the system. These tools may include on-vehicle emission testing systems such as the portable emissions measurement systems (PEMS). We would also use scan tools and data loggers to analyze the data stream information to compare real world operation to the documentation provided at certification.

Importantly, we would not intend to pursue enforcement action against a manufacturer for not detecting a failure mode that could not have been reasonably predicted or otherwise detected using monitoring methods known at the time of certification. For example, we are proposing a challenging set of requirements for monitoring of DPF systems. As of today, engine manufacturers are reasonably confident in their ability to detect certain DPF failure modes at or near the proposed thresholds—e.g., a leaking DPF resulting from a cracked substrate—but are not confident in their ability to detect some other DPF failure modes—e.g., a leaking DPF resulting from a partially melted substrate. If a partially melted substrate indeed cannot be detected and this is known during the certification process, we cannot expect such a failure to be detected on an in-use vehicle.

We also want to make it clear who would be the responsible party should we pursue any in-use enforcement action with respect to OBD. We are very familiar with the heavy-duty industry and its tendency toward separate engine and component suppliers. This contrasts with the light-duty industry which tends toward a more vertically integrated structure. The non-vertically integrated nature of the heavy-duty industry can present unique difficulties for OBD implementation and for OBD enforcement. With the complexity of OBD systems, especially those meeting the requirements being proposed today, we would expect the interactions between the various parties involved—engine manufacturer, transmission manufacturer, vehicle manufacturer, etc.—to be further complicated. Nonetheless, in the end the vast majority of the proposed OBD requirements would apply directly to the engine and its associated emission controls, and the engine manufacturer would have complete responsibility to ensure that the OBD system performs properly in-use. Given the central role the engine and engine control unit would play in the OBD system, we are proposing that the party certifying the engine and OBD system (typically, the engine manufacturer) be the responsible party for in-use compliance and enforcement actions. In this role, the certifying party would be our sole point of contact for potential noncompliances identified during in-use or enforcement testing. We would leave it to the engine manufacturer to determine the ultimate party responsible for the potential noncompliance (e.g., the engine manufacturer, the vehicle manufacturer, or some other supplier). In cases where remedial action such as an engine recall would be required, the certifying party would take on the responsibility of arranging to bring the engines or OBD systems back into compliance. Given that heavy-duty engines are already subject to various emission requirements including engine emission standards, labels, and certification, engine manufacturers currently impose restrictions via signed agreements with engine purchasers to ensure that their engines do not deviate from their certified configuration when installed. We would expect the OBD system's installation to be part of such agreements in the future.

H. Proposed Changes to the Existing 8,500 to 14,000 Pound Diesel OBD Requirements

We are also proposing changes to our OBD requirements for diesel engines used in heavy-duty vehicles under 14,000 pounds (see 40 CFR 86.005–17 for engine-based requirements and 40 CFR 86.1806–05 for vehicle or chassis-based requirements). Table II.H–1 summarizes the proposed changes to under 14,000 pound heavy-duty diesel emissions thresholds at which point a component or system has failed to the point of requiring an illuminated MIL and a stored DTC. Table II.H–2 summarizes the proposed changes for diesel engines used in heavy-duty applications under 14,000 pounds. The proposed changes are meant to maintain consistency with the diesel OBD requirements we are proposing for over 14,000 pound applications.

TABLE II.H–1.—PROPOSED NEW, OR PROPOSED CHANGES TO EXISTING, EMISSIONS THRESHOLDS FOR DIESEL FUELED CI HEAVY-DUTY VEHICLES UNDER 14,000 POUNDS (G/MI)

Component/monitor	MY	NMHC	CO	NO_X	PM
NMHC catalyst system	2010–2012	2.5x.			
	2013+	2x.			
NO_X catalyst system	2007–2009			3x..	
	2010+			+0.3.	
DPF system	2010–2012	2.5x			4x.
	2013+	2x			+0.04.
Air-fuel ratio sensors upstream	2007–2009	2.5x	2.5x	3x	4x.
	2010–2012	2.5x	2.5x	+0.3	+0.02.
	2013+	2x	2x	+0.3	+0.02.
Air-fuel ratio sensors downstream	2007–2009	2.5x		3x	4x.
	2010–2012	2.5x		+0.3	4x.
	2013+	2x		+0.3	+0.04.
NO_X sensors	2007–2009			4x	5x.
	2010–2012			+0.3	4x.
	2013+			+0.3	+0.04.
"Other monitors" with emissions thresholds	2007–2009	2.5x	2.5x	3x	4x.
	2010–2012	2.5x	2.5x	+0.3	4x.
	2013+	2x	2x	+0.3	+0.02.

Notes: MY=Model Year; 2.5x means a multiple of 2.5 times the applicable emissions standard; +0.3 means the standard plus 0.3; not all proposed monitors have emissions thresholds but instead rely on functionality and rationality checks as described in section II.D.4.

TABLE II.H–2.—PROPOSED NEW, OR PROPOSED CHANGES TO EXISTING, EMISSIONS THRESHOLDS FOR DIESEL FUELED CI ENGINES USED IN HEAVY-DUTY VEHICLES UNDER 14,000 POUNDS (G/BHP-HR)

Component/Monitor	MY	Std/FEL	NMHC	CO	NO_X	PM
NMHC catalyst system	2010–2012	All	2.5x.			
	2013+	All	2x.			
NO_X catalyst system	2007–2009	>0.5 NO_X	....	....	1.75x.	
	2007–2009	<=0.5 NO_X	....	....	+0.5.	
	2010+	All	....	....	+0.3.	
DPF system	2010–2012	All	2.5x	....	....	0.05/+0.04.
	2013+	All	2x	....	....	0.05/+0.04.
Air-fuel ratio sensors upstream	2007–2009	>0.5 NO_X	2.5x	2.5x	1.75x	0.05/+0.04.
	2007–2009	<=0.5 NO_X	2.5x	2.5x	+0.5	0.05/+0.04.
	2010–2012	All	2.5x	2.5x	+0.3	0.03/+0.02.
	2013+	All	2x	2x	+0.3	0.03/+0.02.
Air-fuel ratio sensors downstream	2007–2009	>0.5 NO_X	2.5x	....	1.75x	0.05/+0.04.
	2007–2009	<=0.5 NO_X	2.5x	....	+0.5	0.05/+0.04.
	2010–2012	All	2.5x	....	+0.3	0.05/+0.04.
	2013+	All	2x	....	+0.3	0.05/+0.04.
NO_X sensors	2007–2009	>0.5 NO_X	....	....	1.75x	0.05/+0.04.
	2007–2009	<=0.5 NO_X	....	....	+0.5	0.05/+0.04.
	2010+	All	....	....	+0.3	0.05/+0.04.
"Other monitors" with emissions thresholds	2007–2009	>0.5 NO_X	2.5x	2.5x	1.75x	0.05/+0.04.
	2007–2009	<=0.5 NO_X	2.5x	2.5x	+0.5	0.05/+0.04.
	2010–2012	All	2.5x	2.5x	+0.3	0.03/+0.02.
	2013+	All	2x	2x	+0.3	0.03/+0.02.

Notes: MY=Model Year; 2.5x means a multiple of 2.5 times the applicable emissions standard or family emissions limit (FEL); +0.3 means the standard or FEL plus 0.3; 0.05/+0.04 means an absolute level of 0.05 or an additive level of the standard or FEL plus 0.04, whichever level is higher; not all proposed monitors have emissions thresholds but instead rely on functionality and rationality checks as described in section II.D.4.

1. Selective Catalytic Reduction and Lean NO_X Catalyst Monitoring

We are proposing that the 8,500 to 14,000 pound SCR and lean NO_X catalyst monitoring requirements mirror those discussed in section II.B.6. The current regulations require detection of a NO_X catalyst malfunction before emissions exceed 1.5x the emissions standards. We no longer believe that such a tight threshold level is appropriate for diesel SCR and lean NO_X catalyst systems. We believe that such a tight threshold could result in too many false failure indications. The required monitoring conditions with respect to performance tracking (discussed in section II.B.6.c) would not apply for under 14,000 pound heavy-duty applications since we do not have performance tracking requirements for under 14,000 pound applications. We are proposing this change for the 2007 model year.

2. NO_X Adsorber System Monitoring

We are proposing that the 8,500 to 14,000 pound NO_X adsorber monitoring requirements mirror those discussed in section II.B.7. The current regulations require detection of a NO_X adsorber malfunction before emissions exceed 1.5x the emissions standards. We no longer believe that such a tight threshold level is appropriate for diesel NO_X adsorber systems. We believe that such a tight threshold could result in too many false failure indications. The required monitoring conditions with respect to performance tracking (discussed in section II.B.7.c) would not apply for under 14,000 pound heavy-duty applications since we do not have performance tracking requirements for under 14,000 pound applications. We are proposing this change for the 2007 model year.

3. Diesel Particulate Filter System Monitoring

We are proposing that the 8,500 to 14,000 pound DPF monitoring requirements mirror those discussed in section II.B.8. Our current regulations require detection of a catastrophic failure only. The proposed monitoring requirements discussed in section II.B.8 would be far more comprehensive and protective of the environment than would a catastrophic failure monitor. The required monitoring conditions with respect to performance tracking (discussed in section II.B.8.c) would not apply for under 14,000 pound heavy-duty applications since we do not have performance tracking requirements for under 14,000 pound applications. We are proposing no changes to the DPF monitoring requirements in the 2007 to 2009 model years because there is not sufficient lead time for manufacturers to develop a new monitor. The new, more stringent monitoring requirements would begin in the 2010 model year, with a further tightening of the DPF NMHC threshold in the 2013 model year as is also proposed for over 14,000 pound applications.

4. NMHC Converting Catalyst Monitoring

We are proposing that the 8,500 to 14,000 pound NMHC converting catalyst monitoring requirements mirror those discussed in section II.B.5. Our current regulations do not require the monitoring of NMHC catalysts on diesel applications. The proposed monitoring requirements discussed in section II.B.5 would be far more comprehensive and protective of the environment than the current lack of any requirement. The required monitoring conditions with respect to performance tracking (discussed in section II.B.8.c) would not apply for under 14,000 pound heavy-duty applications since we do not have performance tracking requirements for under 14,000 pound applications. We are not proposing this new threshold for the 2007 to 2009 model years because there is not sufficient lead time for manufacturers to develop a new monitor. The new, more stringent monitoring requirements would begin in the 2010 model year, with a further tightening of the NMHC threshold in the 2013 model year as is also proposed for over 14,000 pound applications.

5. Other Monitors

We are also proposing changes to the emissions thresholds for all other diesel monitors in the 8,500 to 14,000 pound range (e.g., NO_X sensors, air fuel ratio sensors, etc.). These proposed changes are meant to maintain consistency with the proposed changes for over 14,000 pound applications. We believe that these proposed thresholds are far more appropriate for diesel applications than the thresholds we have in our current OBD requirements which are, generally, 1.5 times the applicable standards. None of the proposed thresholds represents a new threshold where none currently exists. Instead, they represent different thresholds that would require, in most cases, malfunction detection at different emissions levels than would be required by our current OBD requirements.

6. CARB OBDII Compliance Option and Deficiencies

We are also proposing some changes to our deficiency provisions for vehicles and engines meant for vehicles under 14,000 pounds. We have included specific mention of air-fuel ratio sensors and NO_X sensors where we had long referred only to oxygen sensors. We have also updated the referenced CARB OBDII document that can be used to satisfy the federal OBD requirements.[48]

I. How Do the Proposed Requirements Compare to California's?

The California Air Resources Board (CARB) has its own OBD regulations for engines used in vehicles over 14,000 pounds GVWR.[49] (13 CCR 1971.1) In August of 2004, EPA and CARB signed a memorandum of agreement to work together to develop a single, nationwide OBD program for engines used in vehicles over 14,000 pounds.[50] We believe that, for the most part, we have been successful in doing so at least for the early years of implementation. Nonetheless, there are differences in some of the details contained within each regulation. These differences are summarized here and we request comment on all of these differences.

The first difference is that the CARB regulation contains some more stringent thresholds beginning in the 2013 timeframe for some engines and 2016 for all engines. Specifically, CARB's PM threshold for diesel particulate filters (DPF) and exhaust gas sensors downstream of aftertreatment devices, and their NO_X threshold for NO_X aftertreatment devices and exhaust gas sensors downstream of aftertreatment devices, become more stringent in 2013 for some engines and 2016 for all. We are not proposing these more stringent thresholds—our proposed thresholds are shown in Table II.B–1. At this time, EPA is not in a position to propose these more stringent OBD thresholds for the national program. The industry believes that CARB's more stringent NO_X and PM thresholds for 2013 and 2016 are not technically feasible. EPA is reviewing these longer term OBD thresholds, but at this time we have not made a decision regarding the feasibility and the appropriateness of these longer term thresholds. Because these thresholds do not take effect until model year 2013 at the earliest, we do not believe it is necessary to make such a determination in this rulemaking. It would be our intention to monitor the progress made towards complying with the 2010 thresholds contained in today's proposal and potentially revisit the appropriateness of more stringent OBD thresholds for model year 2013 and later in the future. CARB has made commitments to review their HD OBD program every two years and they can consider making changes to their long-term program during this biennial review process. EPA's regulatory development process does not lend itself to making updates every two years because the Federal rulemaking process tends to be lengthier than CARB's. As mentioned above, we intend to monitor the CARB long-term thresholds during the coming years, and if we determine that more stringent thresholds are appropriate, we would consider changing our thresholds to include the more stringent thresholds through a notice and comment rulemaking process.

CARB also has some slightly different certification demonstration requirements in the 2011 and 2012 model years. They are requiring demonstration testing of the child ratings from the 2010 model year certified engine family for 2011 and 2012 model year certification. As Table II.B–1 shows, we are not requiring such demonstration testing in the 2011 and 2012 model years provided the child ratings meet the requirements of certification carry-over. Further, CARB is requiring that one engine rating from one to three engine families undergo full certification demonstration testing in the 2013 model year and every model year thereafter. In contrast, EPA is requiring that one to three engine ratings be fully demonstrated in the 2013 model year and then carry-over through the 2015 model year (again, provided the engine ratings meet the requirements of certification carry-over). In 2016 and subsequent model years, EPA would require that one to three engine ratings be fully demonstrated on an ''as needed'' basis. In the same vein, our evaluation protocol associated with certification demonstration testing, as discussed in section VIII.C, requires less testing than is required in CARB's regulation.

Our OBD requirements for over 14,000 pounds do not contain any provisions to monitor control strategies associated with idle emission control strategies because EPA does not have currently any regulatory requirements that specifically target idle emissions control strategies.[51] We are not proposing a provision to charge fees associated with OBD deficiencies as CARB does. We are also not proposing provisions for ''retroactive deficiencies'' as CARB has. Our deficiency provisions along with our misbuild and other in-use enforcement programs accomplish the same thing. Deficiencies are discussed in section VIII.D.[52]

For diesel engines used in heavy-duty vehicles under 14,000 pounds, our proposed OBD requirements are in line with those recently proposed by CARB.[53] Our proposed requirements are also in line—both the technical aspects and the implementation timing aspects—with our proposed requirements for over 14,000 pound diesel applications. We are also proposing diesel vehicle-based OBD requirements in line with the proposed diesel engine-based requirements. In contrast, CARB does not have diesel thresholds in terms of ''grams per mile'' specified in their regulation for the 8,500 to 14,000 pound range.

Specifically for gasoline engines meant for applications over 14,000 pounds, our proposal differs from CARB's in that we are not requiring detection of catalysts that are less than 50 percent effective at converting emissions.[54] We are not requiring this because we are relying on the emissions threshold of 1.75 times the applicable standard as a means of defining a catalyst system malfunction. We are also proposing some differences with respect to misfire monitoring. Most notably, we are not proposing a provision analogous

[48] See 13 CCR 1968.2, released August 11, 2006, Docket ID# EPA–HQ–OAR–2005–0047–0005.

[49] 13 CCR 1971.1, Docket ID# EPA–HQ–OAR–2005–0047–0006.

[50] ''Memorandum of Agreement: On-road Heavy-duty Diagnostic Regulation Development,'' signed by Chet France, U.S. EPA, and Tom Cackette, California ARB, August 11, 2004, Docket ID# EPA–HQ–OAR–2005–0047–0002.

[51] Note that, by idle emission control strategies we mean strategies that, for example, shut down the engine after 10 minutes of constant idle. We do not mean strategies that control emissions during engine idles that occur at stop lights or in congested traffic.

[52] See also proposed § 86.010–18(n).

[53] See 13 CCR 1968.2, released August 11, 2006, Docket ID# EPA–HQ–OAR–2005–0047–0005.

[54] See 13 CCR 1971.1(f)(6.2.1)(B) and compare to proposed § 86.010–18(h)(6)(ii).

to CARB's provision that allows the Executive Officer to approve misfire monitor disablement or alternative malfunction criteria on a case by case basis.[55] In general, we prefer to avoid having regulatory provisions that are implemented on a case by case basis. For similar reasons, we are also not proposing a provision analogous to CARB's provision that allows the Executive Officer to revise the orifice for evaporative leak detection if the most reliable monitoring strategy cannot detect the required orifice.[56]

III. Are the Proposed Monitoring Requirements Feasible?

Some of the OBD monitoring strategies discussed here would be intrusive monitors that would result in very brief emissions increases, or spikes, for the sake of determining if certain emissions control components/systems are working properly during the remaining 99 percent or more of the engine's operation. While these emissions spikes are brief, and their levels cannot be meaningfully predicted or estimated, we are concerned about strategies that might give little concern to emissions during such spikes in favor of an easier monitor. We request comment on this issue—should such strategies be allowed or should such strategies be prohibited? If a commenter has the latter opinion, then suggestions should be provided for how the monitoring requirements should be changed to allow for a non-intrusive monitor—i.e., one that could run during normal operation or operation ''on the cycle''—that may not provide the monitoring capability nor the control expected by the requirements we are proposing.

A. Feasibility of the Monitoring Requirements for Diesel/Compression-Ignition Engines

1. Fuel System Monitoring

a. Fuel Pressure Monitoring

Manufacturers control fuel pressure by using a closed-loop feedback algorithm that allows them to increase or decrease fuel pressure until the fuel pressure sensor indicates they have achieved the desired fuel pressure. For the common-rail OBD systems certified in the under 14,000 pound category, the manufacturers are monitoring the actual fuel system pressure sensed by a fuel rail pressure sensor, comparing it to the target fuel system pressure stored in a software table or calculated by an algorithm inside the onboard computer, and indicating a malfunction if the magnitude of the difference between these two exceeds an acceptable level. The error limits are established by engine dynamometer emission tests to ensure that a malfunction would be detected before emissions exceed the applicable thresholds.

In cases where no fuel pressure error can generate a large enough emission increase to exceed the applicable thresholds, manufacturers are required to set the malfunction trigger at their fuel pressure control limits (e.g., when they reach a point where they can no longer increase or decrease fuel pressure to achieve the desired fuel pressure). This monitoring requirement has been demonstrated as technically feasible given that several under 14,000 pound diesels already meet this requirement. Further, the nature of a closed-loop algorithm is that such a system is inherently capable of being monitored because it simply requires analysis of the same closed-loop feedback parameter being used by the system for control purposes.

Another promising technology is a pressure sensing glow plug. The glow plug is an electronic device in the cylinder of most diesel engines used to facilitate combustion during cold engine starting conditions. Glow plugs are being developed that incorporate a pressure sensor capable of detecting the quality of combustion within the cylinder.[57] Pressure-sensing glow plugs provide feedback to the engine-management system that controls the timing and quantity of fuel injected into the cylinder. This feedback allows the engine electronics to adjust the injection characteristics so the engine avoids fuel-mixture combinations that generate high levels of NO_X. In this sense, a feedback loop is available that works like the oxygen sensor in a gasoline engine exhaust system. By measuring the quality of combustion, a determination can also be made about the quality of the fuel injection event—the pressure of fuel delivered, quantity of fuel delivered, timing of fuel delivered.

b. Fuel Injection Quantity Monitoring

Absent combustion sensors and/or pressure sensing glow plugs mentioned above, there is currently no feedback sensor indicating that the proper quantity of fuel has been injected. Therefore, injection quantity monitoring will be more difficult than pressure monitoring. Nonetheless, a manufacturer has identified a strategy currently being used that verifies the injection quantity under very specific engine operating conditions and appears to be capable of determining that the system is accurately delivering the desired fuel quantity. This strategy entails intrusive operation of the fuel injection system during a deceleration event where fuel injection is normally shut off (e.g., coasting or braking from a higher vehicle speed down to a low speed or a stop). During the deceleration, fuel injection to a single cylinder is turned back on to deliver a very small amount of fuel. Typically, the amount of fuel would be smaller than, or perhaps comparable to, the amount of fuel injected during a pilot or pre-injection. If the fuel injection system is working correctly, that known injected fuel quantity will generate a known increase in fluctuations (accelerations) of the crankshaft that can be measured by the crankshaft position sensor. If too little fuel is delivered, the measured crankshaft acceleration will be smaller than expected. If too much fuel is delivered, the measured crankshaft acceleration will be larger than expected. This process can even be used to ''balance'' out each cylinder or correct for system tolerances or deterioration by modifying the commanded injection quantity until it produces the desired crankshaft acceleration and applying a correction or adaptive term to that cylinder's future injections. Each cylinder can, in turn, be cycled through this process and a separate analysis can be made for the performance of the fuel injection system for each cylinder. Even if this procedure would require only one cylinder be tested per revolution (to eliminate any change in engine operation or output that would be noticeable to the driver) and require each cylinder to be tested on four separate revolutions, this process would only take two seconds for a six cylinder engine decelerating through 1500 rpm.

The crankshaft position sensor is commonly used to identify the precise position of the piston relative to the intake and exhaust valves to allow for very accurate fuel injection timing control and, as such, there exists sufficient resolution and data sampling within the onboard computer to enable such measurement of crankshaft accelerations. Further, in addition to the current use of this strategy in an under 14,000 pound diesel application, a nearly identical crankshaft fluctuation technique has been used since 1997 on under 14,000 pound diesel engines

[55] See 13 CCR 1971.1(f)(2.3.4)(D) and compare to proposed § 86.010–18(h)(2)(iii)(D).

[56] See 13 CCR 1971.1(f)(7.2.3) and compare to proposed § 86.010–18(h)(7)(ii)(B) and (C).

[57] ''Spotlight on Technology: Smart glowplugs may make Clean Diesels cost-effective Pressure-sensing units could let designers cut NO_X aftertreatment,'' Tony Lewin, Automotive News, February 6, 2006.

during idle conditions to determine if individual cylinders are misfiring.

Another technique that may be used to achieve the same monitoring capability is some variation on the current cylinder balance tests used by many manufacturers to improve idle quality. In such strategies, fueling to individual cylinders is increased, decreased, or shut off to determine if the cylinder is contributing an equal share to the output of the engine. This strategy again relies on changes in crankshaft/engine speed to measure the individual cylinder's contribution relative to known good values and/or the other cylinders. Such an approach seems viable to determine whether the fuel injection quantity is correct for each cylinder, but it has the disadvantage of not necessarily being able to verify whether the system is able to deliver small amounts of fuel precisely (such as those commanded during a pilot injection).

One other approach that has been mentioned but not investigated thoroughly is the use of a wide-range air-fuel (A/F) sensor in the exhaust to confirm fuel injection quantity. The A/F sensor output could be compared to the measured air going into the engine and calculated fuel quantity injected to see if the two agree. Differences in the comparison may allow for the identification of incorrect fuel injection quantity.

c. Fuel Injection Timing Monitoring

In the same manner as described for quantity monitoring, we believe that fuel injection timing could be verified. By monitoring the crankshaft speed fluctuation and, most notably, the time at which such fluctuation begins, ends, or reaches a peak, the OBD system could compare the time to the commanded fuel injection timing point and verify that the crankcase fluctuation occurred within an acceptable time delay relative to the commanded fuel injection. If the system was working improperly and actual fuel injection was delayed relative to when it was commanded, the corresponding crankshaft speed fluctuation would also be delayed and would result in a longer than acceptable time period between commanded fuel injection timing and crankshaft speed fluctuation. A more detailed discussion of this possible monitoring method is presented in the technical support document contained in the docket.[58]

Another possible monitoring method that has been mentioned but not investigated thoroughly would be to look for an electrical feedback signal from the injector to the computer to confirm when the injection occurred. Such a technique would likely use an inductive signature to identify exactly when an injector opened or closed and verify that it was at the expected timing. We expect that further investigation would be needed to confirm that such a monitoring technique would be sufficient to verify fuel injection timing.

d. Fuel System Feedback Control Monitoring

The conditions necessary for feedback control (i.e., the feedback enable criteria) are defined as part of the control strategy in the engine computer. The feedback enable criteria are typically based on minimum conditions necessary for reliable and stable feedback control. When the manufacturer is designing and calibrating the OBD system, the manufacturer would determine, for the range of in-use operating conditions, the time needed to satisfy these feedback enable criteria on a properly functioning engine. In-use, the OBD system would evaluate the time needed for these conditions to be satisfied following an engine start, compare that to normal behavior for the system, and indicate a malfunction when the time exceeds a specified value (i.e., the malfunction criterion). For example, fuel pressure feedback control may be calibrated to begin once fuel system pressure has reached a minimum specified value. In a properly functioning system, pressure builds in the system during engine cranking and shortly after starting and the pressure enable criterion are reached within a few seconds. However, in a malfunctioning system (e.g., due to a faulty low-pressure fuel pump), it may take a significantly longer time to reach the feedback enable pressure. A malfunction would be indicated when the actual time to reach feedback enable pressure exceeds the malfunction criterion.

Malfunctions that cause open-loop or default operation can be readily detected as well. As discussed above, the feedback enable criteria are clearly defined in the computer and are based on what is necessary for reliable control. After feedback control has begun, the OBD system can detect these criteria and indicate a malfunction when they are no longer being satisfied. For example, one enable criterion could be a pressure sensor reading within a certain range where the upper pressure limit would be based on the maximum pressure that could be generated in a properly functioning system. A malfunction would be indicated if the pressure sensor reading exceeded the upper limit which would cause the fuel system to go open loop.

The feedback control system adjusts the base fuel strategy such that actual engine operating characteristics meet driver demand. But, the feedback control system has limits on how much adjustment can be made based, presumably, on the ability to maintain acceptable control. Like the feedback enable criteria, these control limits are defined in the computer. The OBD system would track the actual adjustments made by the control system and continuously compare them with the control limits. A malfunction would be indicated if the limits were reached.

2. Engine Misfire Monitoring

Diesel engines certified to the under 14,000 pound OBD requirements have been monitoring for misfire since the 1998 model year. The monitoring requirements we are proposing for over 14,000 pound applications are identical to the existing requirements for under 14,000 pound applications for those engines that do not use combustion sensors.[59] Therefore, technological feasibility has been demonstrated for these applications.

For engines that use combustion sensors, the misfire monitoring requirements are more stringent since the requirement calls for detection of malfunctions causing emissions to exceed the emissions thresholds. Nonetheless, detection on these engines should be straight forward since the combustion sensors would provide a direct measurement of combustion. Therefore, lack of combustion (i.e., misfire) could be measured directly. The combustion sensors are intended to measure various characteristics of a combustion event for feedback control. Such feedback is needed for engines that require very precise air and fuel metering controls such as would be required for homogeneous charge compression ignition (HCCI) engine. Accordingly, the resolution of sensors having that capability is well beyond what would be needed to detect a complete lack of combustion.

[58] Draft Technical Support Document, HDOBD NPRM, EPA420–D–06–006, Docket ID# EPA–HQ–OAR–2005–0047–0008.

[59] Technically, the EPA OBD diesel misfire monitoring requirement for under 14,000 pound applications is to detect a lack of combustion whereas the California OBDII diesel misfire monitoring requirement is identical to what we are proposing for over 14,000 pounds. Since all manufacturers to date are designing to the OBDII requirements, this statement is, for practical purposes, true.

3. Exhaust Gas Recirculation (EGR) Monitoring

a. EGR Low Flow/High Flow Monitoring

Typically, the EGR control system determines a desired EGR flow rate based on the engine operating conditions such as engine speed and engine load. The desired EGR flow rates, and the corresponding EGR valve positions needed to achieve the desired flow rates, are established when the manufacturer designs and calibrates the EGR system. Once established, manufacturers store the desired EGR flow rate/valve position in a lookup table in the onboard computer. During operation, the onboard computer commands the EGR valve to the position necessary to achieve the desired flow—i.e., the commanded EGR flow. The onboard computer then calculates or directly measures both the fresh air charge (fresh air intake) and total intake charge. The difference between the total intake charge and fresh air intake is the actual EGR flow. The closed-loop control system continuously adjusts the EGR valve position until the actual EGR flow equals the desired EGR flow.

Such closed-loop control strategies and their associated OBD monitoring strategies are used on many existing gasoline and diesel vehicles under 14,000 pounds. The OBD system evaluates the difference (i.e., error) between the look-up value—i.e., the desired flow rate—and the final commanded value needed to achieve the desired flow rate. Typically, as the feedback parameter or learned offset increases, there is an attendant increase in emissions. A correlation can be made between feedback adjustment and emissions. When the error exceeds a specific threshold, a malfunction would be indicated. This type of monitoring strategy could be used to detect both high and low flow malfunctions.

While the closed-loop control strategy described above is effective in measuring and controlling EGR flow, some manufacturers are currently investigating the use of a second control loop based on an air-fuel ratio (A/F) sensor (also known as wide-range oxygen sensors or linear oxygen sensors) to further improve EGR control and emissions. With this second control loop, the desired air-fuel ratio is calculated based on engine operating conditions (i.e., intake airflow, commanded EGR flow and commanded fuel). The calculated air-fuel ratio is compared to the air-fuel ratio from the A/F sensor and refinements can be made to the EGR and airflow rates—i.e., the control can be ‘‘trimmed’’—to achieve the desired rates. On systems that use the second control loop, flow rate malfunctions could also be detected using the feedback information from the A/F sensor and by applying a similar monitoring strategy as discussed above for the primary EGR control loop.

We are also proposing that two leaking EGR valve failure modes be detected. One type is the failure of the valve to seal when in the closed position. For example, if the valve or seating surface is eroded, the valve could close and seat, yet still allow some flow across the valve. A flow check is necessary to detect a malfunctioning valve that closes properly but still leaks. EGR flow—total intake charge minus fresh air charge—could be calculated using the monitoring strategy described above for high and low flow malfunctions. With the valve closed, a malfunction would be indicated when flow exceeds unacceptable levels. Or, some cooled EGR systems will incorporate an EGR temperature sensor that could be used to detect a leaking EGR valve by reacting to the presence of hot exhaust gases when none should be present. A leaking valve can also be caused by failure of the valve to close/seat. For example, carbon deposits on the valve or seat could prevent the valve from closing fully. The flow check described above could detect failure of the valve to close/seat, but this approach would require a repair technician to further diagnose whether the problem is a sealing or seating problem. Such a failure of the valve to close/seat could be more specifically monitored by closing the valve and checking the zero position of the valve with a position sensor. If the valve position is out of the acceptable range for a closed valve, a malfunction would be indicated. This type of zero position sensor check is commonly used to verify the closed position of valves/actuators used in gasoline OBD systems (e.g. gasoline EGR valves, electronic throttle) and should be feasible for diesel EGR valves.

b. EGR Slow Response Monitoring

While the flow rate monitor discussed above would evaluate the ability of the EGR system to achieve a commanded flow rate under relatively steady state conditions, the EGR slow response monitor would evaluate the ability of the EGR system to modulate (i.e., increase and decrease) EGR flow as engine operating conditions and, consequently, commanded EGR rates change. Specifically, as engine operating conditions and commanded EGR flow rates change, the monitor would evaluate the time it takes for the EGR control system to achieve the commanded change in EGR flow. This monitor could evaluate EGR response passively during transient engine operating conditions encountered during in-use operation. The monitor could also evaluate EGR response intrusively by commanding a change in EGR flow under a steady state engine operating condition and measuring the time it takes to achieve the new EGR flow rate. Similar passive and intrusive strategies have been developed for variable valve control and/or timing (VVT) monitoring on vehicles under 14,000 pounds.

c. EGR Feedback Control Monitoring

Monitoring of EGR feedback control could be performed using analogous strategies to those discussed in Section III.A.1 for monitoring of fuel system feedback control.

d. EGR Cooling System Monitoring

Some diesel engine manufacturers currently use exhaust gas temperature sensors as an input to their EGR control systems. On such systems—EGR temperature—which is measured downstream of the EGR cooler—could be used to monitor the effectiveness of the EGR cooler. For a given engine operating condition (e.g., a steady speed/load that generates a known exhaust mass flow and exhaust temperature to the EGR cooler), EGR temperature will increase as the performance of the EGR cooling system decreases. During the OBD calibration process, manufacturers could develop a correlation between increased EGR temperatures and cooling system performance (i.e., increased emissions). The EGR cooling system monitor would use such a correlation and indicate a malfunction when the EGR temperature increases to the level that would cause emissions to exceed the emissions thresholds.

While we anticipate that most, if not all, manufacturers will use EGR temperature sensors to meet future emissions standards, EGR cooling system monitoring may be feasible without such a temperature sensor. The monitor could be done using the intake manifold temperature (IMT) sensor by looking at the change in IMT (i.e., ‘‘delta’’ IMT) with EGR turned on and EGR turned off (IMT would be higher with EGR turned on). If there is significant cooling capacity with a normally functioning EGR cooling system, there would likely be a significant difference in IMT with EGR turned on versus turned off. Delta IMT could be correlated to decreased EGR cooling system performance and increased emissions.

4. Turbo Boost Control System Monitoring

a. Turbo Underboost/Overboost Monitoring

To monitor boost control systems, manufacturers are expected to look at the difference between the actual pressure sensor reading (or calculation thereof) and the desired/target boost pressure. If the error between the two is too large or persists for too long, a malfunction would be indicated. Manufacturers would need to calibrate the size of error and/or error duration to ensure robust malfunction detection occurs before the emissions thresholds are exceeded. Given that the purpose of a closed-loop control system with a feedback sensor is to measure continuously the difference between actual and desired boost pressure, the control system is already monitoring that difference and attempting to minimize it. As such, a monitoring requirement to indicate a malfunction when the difference gets large enough such that it can no longer achieve the desired boost is essentially an extension of the existing control strategy.

To monitor for malfunction or deterioration of the boost pressure sensors, manufacturers could validate sensor readings against other sensors present on the vehicle or against ambient conditions. For example, at initial key-on before the engine is running, the boost pressure sensor should read ambient pressure. If the vehicle is equipped with a barometric pressure sensor, the two sensors could be compared and a malfunction indicated when the two readings differ beyond the specific tolerances. A more crude rationality check of the boost pressure sensor could be accomplished by verifying that the pressure reading is within reasonable atmospheric limits for the conditions the vehicle will be subjected to.

b. VGT Slow Response Monitoring

The VGT slow response monitor would evaluate the ability of the VGT system to modulate (i.e., increase and decrease) boost pressure as engine operating conditions and, consequently, commanded boost pressure changes. Specifically, as engine operating conditions and commanded boost pressures change, the monitor would evaluate the time it takes for the VGT control system to achieve the commanded change in boost pressure. This monitor could evaluate VGT response passively during transient engine operating conditions encountered during in-use operation. The monitor could also evaluate VGT response intrusively by commanding a change in boost pressure under a steady state engine operating condition and measuring the time it takes to achieve the new boost pressure.

Rationality monitoring of VGT position sensors could be accomplished by comparing the measured sensor value to expected values for the given engine speed and load conditions. For example, at high engine speeds and loads, the position sensor should indicate that the VGT position is opened more than would be expected at low engine speeds and loads. Such rationality checks would need to be two-sided (i.e., position sensors should be checked for appropriate readings at both high and low engine speed/load operating conditions.

c. Turbo Boost Feedback Control Monitoring

Monitoring of boost pressure feedback control could be performed using analogous strategies to those discussed for fuel system feedback control monitoring in Section III.A.1.

d. Charge Air Undercooling Monitoring

We expect that most engines will make use of a temperature sensor downstream of the charge air cooler to protect against overcooling conditions that could cause excessive condensation, and to prevent undercooling that could result in loss of performance. A comparison of the actual charge air temperature to the expected, or design, temperature would indicate any errors that might be occurring. Manufacturers could correlate that error to an emissions impact and, when the error reached a level such that emissions would exceed the emissions thresholds, a malfunction would be indicated.

5. Non-Methane Hydrocarbon (NMHC) Converting Catalyst Monitoring

a. NMHC Converting Catalyst Conversion Efficiency Monitoring

Monitoring of the NMHC converting catalyst, or diesel oxidation catalyst (DOC), could be performed similar to three-way catalyst monitoring on gasoline engines. Three-way catalyst monitoring uses the concept that catalyst's oxygen storage capacity correlates well with its hydrocarbon conversion efficiency. Oxygen sensors located upstream and downstream of the catalyst can be used to determine when its oxygen storage capacity—and, hence, its conversion efficiency—has deteriorated below a predetermined level.

Determining the oxygen storage capacity would require lean air-fuel (A/F) operation followed by rich A/F operation or vice-versa during the catalyst monitoring event. Since a diesel engine normally operates lean of stoichiometry, lean A/F operation would be normal operation. However, rich A/F operation would have to be commanded intrusively when the catalyst monitor is active. The rich A/F operation could be achieved by injecting some fuel late enough in the four stroke process (i.e., late injection) that the raw fuel would not combust in-cylinder. Rich A/F operation could also be achieved using an in-exhaust fuel injector upstream of the catalyst. During normal lean operation, the catalyst would become saturated with stored oxygen. As a result, both the front and rear oxygen sensors should be reading lean. When rich A/F operation initiates, the front oxygen sensor would switch immediately to a "rich" indication. For a short time, the rear oxygen sensor should continue to read "lean" until such time as the stored oxygen in the catalyst is consumed by the rich fuel mixture in the exhaust and the rear oxygen sensor would read "rich." As the catalyst deteriorates, the delay time between the front and rear oxygen sensors switching from their normal lean state to a rich state would become progressively smaller because the deteriorated catalyst would have less oxygen storage capacity. Thus, by comparing the time difference between the responses of the front and rear oxygen sensors to the lean-to-rich or rich-to-lean A/F changes, the performance of the catalyst could be estimated. Although this discussion suggests the use of conventional oxygen sensors, these sensors could be substituted with A/F sensors which would also provide for additional engine control benefits such as EGR trimming and fuel trimming.

If a malfunction of the catalyst cannot cause emissions to exceed the emissions thresholds, then only a functional monitor would be required. A functional monitor could be done using temperature sensors. A functioning oxidation catalyst would be expected to provide some level of exotherm when it oxidizes HC and CO. The temperature of the catalyst could be measured by placing one or more temperature sensors at or near the catalyst. However, depending on the nominal conversion efficiency of the catalyst and the duty cycle of the vehicle, the exotherm may be difficult to discern from the inlet exhaust temperatures. To add robustness to the monitor, the functional monitor would need to be conducted during predetermined operating conditions where the amount of HC and CO entering the catalyst could be known. This may require an intrusive monitor that actively forces the fueling strategy richer (e.g., through late or post injection) than normal for a short period of time. If the measured exotherm does not exceed a predetermined amount that only a properly-working catalyst could achieve, a malfunction would be indicated. As noted, such an approach would require a brief period of commanded rich operation that would result in a very brief HC and perhaps a PM emissions spike.

b. Other Aftertreatment Assistance Function Monitoring

A functional monitor should be sufficient for monitoring the oxidation catalyst's ability to fulfill aftertreatment assistance functions such as generating an exotherm for DPF regeneration or providing a proper feedgas for SCR or NO_X adsorbers. We would expect that manufacturers would use the exotherm approach mentioned above either to measure directly for the proper exotherm or to correlate indirectly for the proper feedgas. For catalysts upstream of a DPF, we expect that this monitoring would be conducted during an active or forced regeneration event.[60] For catalysts downstream of the DPF, we expect that manufacturers would have to add fuel intrusively (either in-exhaust or through in-cylinder post-injection) to create a sufficient exotherm to distinguish malfunctioning from properly operating catalysts.

6. Selective Catalytic Reduction (SCR) and NO_X Conversion Catalyst Monitoring

a. SCR and NO_X Catalyst Conversion Efficiency Monitoring

We would expect manufacturers to use NO_X sensors to monitor a lean NO_X catalyst. NO_X sensors placed upstream and downstream of the lean NO_X catalyst could be used to determine directly the NO_X conversion efficiency. Manufacturers could potentially use a single NO_X sensor placed downstream of the catalyst to measure catalyst-out NO_X emissions. This would have to be done within a tightly controlled engine operation window where engine-out NO_X emissions (i.e., NO_X emissions at the lean NO_X catalyst inlet) performance is relatively stable and could be estimated reliably. Within this engine operation window, catalyst-out measurements could be compared to the expected engine-out NO_X emissions and a catalyst conversion efficiency could be calculated. Should the calculated conversion efficiency be insufficient to maintain emissions below the emissions thresholds, a malfunctioning or deteriorated lean NO_X catalyst would be indicated. If both an upstream and downstream NO_X sensor are used for monitoring, the upstream sensor could be used to improve the overall effectiveness of the catalyst by precisely controlling the air-fuel ratio in the exhaust to the levels where the catalyst is most effective.

For monitoring the SCR catalyst, care must be taken to account for the cross sensitivity of NO_X sensors to ammonia (NH_3). Current NO_X sensor technology tends to have such a cross-sensitivity to ammonia in that as much as 65 percent of ammonia can be read as NO_X.[61] However, urea SCR feedback control studies have shown that the NH_3 interference signal is discernable from the NO_X signal and can, in effect, allow the design of a better feedback control loop than a NO_X sensor that doesn't have any NH_3 cross-sensitivity. In one study, a signal conditioning method was developed that resulted in a linear output for both NH_3 and NO_X from the NO_X sensor downstream of the catalyst.[62] Monitoring of the catalyst can be done by using the same NO_X sensors that are used for SCR control. When the SCR catalyst is functioning properly, the upstream sensor should read ''high'' for high NO_X levels while the downstream sensor should read ''low'' for low NO_X and low ammonia levels. With a deteriorated SCR catalyst, the downstream sensor should read similar or higher values as the upstream sensor (i.e., high NO_X and high ammonia levels) since the NO_X reduction capability of the catalyst has diminished. Therefore, a malfunctioning SCR catalyst could be detected when the downstream sensor output is near to or greater than the upstream sensor output. A similar monitoring approach could be used if a manufacturer models upstream NO_X emissions instead of using an upstream NO_X sensor. In this case, the comparison would be made between the modeled upstream NO_X value and the downstream sensor value.

Manufacturers have expressed concern over both the sensitivity and the durability of NO_X sensors. They are concerned that NO_X sensors will not have the necessary sensitivity to detect NO_X at the low levels that will exist downstream of the NO_X catalyst. They are also concerned that NO_X sensors will not be durable enough to last the full useful life of big diesel trucks. We have researched NO_X sensors—the current state of development and future expectations—and summarized our findings in the technical support document in the docket for this rule.[63] Some of our findings are summarized here.

Regarding NO_X sensor sensitivity, we expect that 2010 and later model year engines will have average tailpipe NO_X emissions in the 0 to 50 ppm range. Current NO_X sensors have an accuracy of ±10 ppm in the 0 to 100 ppm range. This means that current NO_X sensors should be able to detect NO_X emissions that exceed the standard by two to three times the 2010 limit.[64] This should allow for compliance with our proposed threshold which is effectively 2.5 times the 2010 limit. Further, we expect that NO_X sensors in the 0 to 100 ppm range with ±5 ppm accuracy will be available by the middle of 2006. Regarding durability, improvements are being made and a test program is currently underway with the intent of aging several NO_X sensors placed at various exhaust system locations out to 6,000 hours (roughly equivalent to 360,000 miles). Results after 2,000 hours of aging are promising and results after 4,000 hours of aging are currently being analyzed.[65]

b. SCR and NO_X Catalyst Active/Intrusive Reductant Injection System Monitoring

If an active catalyst system is used—i.e., one that relies on injection of a reductant upstream of the catalyst to assist in emissions conversion—manufacturers would be required to monitor the mechanism for adding the fuel reductant. In the active catalyst system, a temperature sensor is expected to be placed near or at the catalyst to determine when the catalyst temperature is high enough to convert emissions. Because NO_X catalyst systems, especially lean NO_X catalyst systems, tend to have a narrow temperature range where they are most effective, adding reductant when the catalyst temperature is not sufficiently high would waste reductant. If fuel is

[60] An active or forced regeneration would be those regeneration events that are initiated via a driver selectable switch or activator and/or those initiated by computer software.

[61] Schaer, C.M., Onder, C.H., Geering, H.P., and Elsener, M., ''Control of a Urea SCR Catalytic Converter System for a Mobile Heavy-Duty Diesel Engine,'' SAE Paper 2003–01–0776 which may be obtained from Society of Automotive Engineers International, 400 Commonwealth Dr., Warrendale, PA, 15096–0001.

[62] *Ibid.*

[63] Draft Technical Support Document, HDOBD NPRM, EPA420–D–06–006, Docket ID# EPA–HQ–OAR–2005–0047–0008.

[64] Ibid.

[65] Ibid.

used as the reductant, this would adversely affect fuel economy without a corresponding reduction in emissions levels. Therefore, a temperature sensor is expected to be placed in the exhaust near or at the catalyst to help determine when reductant injection should occur. This same sensor could be used to determine if an exotherm resulted following reductant injection. The lack of an exotherm would indicate a malfunction of the reductant delivery system.

Alternatively, any NO_X sensors used to monitor conversion efficiency could be used to determine if reductant injection has occurred. NO_X sensors are also oxygen sensors so they could be used to determine the air-fuel ratio in the exhaust stream which would allow for verification of reductant injection into the exhaust. Further, with a properly functioning injector, the downstream NO_X sensor should see a change from high NO_X levels to low NO_X levels. In contrast, a lack of reductant injection would result in continuously high NO_X levels at the downstream NO_X sensor. Therefore, a malfunctioning injector could be indicated when the downstream NO_X sensor continues to measure high NO_X after an injection event has been commanded.

Reductant level monitoring could also be conducted by using the existing NO_X sensors that are used for control purposes. Specifically, the downstream NO_X sensor can be used to determine if the reductant tank no longer has sufficient reductant available. Similar to the fuel reductant injection functionality monitor described above, when the reductant tank has a sufficient reductant quantity and the injection system is working properly, the downstream NO_X sensor should see a change from high NO_X levels to low NO_X levels. If the NO_X levels remain constant both before and after reductant injection, then the reductant was not properly delivered and either the injection system is malfunctioning or there is no longer sufficient reductant available in the reductant tank. Alternatively, reductant level monitoring could be conducted by using a dedicated ''float'' type level sensor similar to the ones used in fuel tanks. Some manufacturers may prefer using a dedicated reductant level sensor in the reductant tank to inform the vehicle operator of current reductant levels via a gauge on the instrument panel. If such a sensor is used by the manufacturer for operator convenience, it could also be used to monitor the reductant level in the tank.

Monitoring the reductant itself—whether it be the wrong reductant or a poor quality reductant—could also be conducted using the NO_X sensors used for control purposes. If an improper reductant is injected, the NO_X catalyst system would not function properly. Therefore, NO_X emissions downstream from the catalyst would remain high both before and after injection. The downstream NO_X sensor would see the high NO_X levels after injection and a malfunction would be indicated. If the reductant tank level sensor indicated sufficient levels for injection and decreasing levels following injections (which would mean the injection system was working), then the probable cause of the malfunction would be the reductant itself. For urea SCR systems, another possible means of monitoring the reductant itself would be to use a urea quality sensor in the urea tank. First generation sensors show promise at verifying that urea is indeed in the tank, rather than water or some other fluid, and that the urea concentration is within the needed range (i.e., not diluted with water or some other fluid). The sensor could also be used in place of a urea level sensor. By 2010, we would expect subsequent generation sensors to provide even better capability.[66]

c. SCR and NO_X Catalyst Feedback Control Monitoring

Monitoring of feedback control could be performed using analogous strategies to those discussed for fuel system feedback control monitoring in Section III.A.1.

7. NO_X Adsorber Monitoring

a. NO_X Adsorber Capability Monitoring

We expect that either NO_X sensors or A/F sensors along with a temperature sensor will be used to provide the feedback necessary to control the NO_X adsorber system. These same sensors could also be used to monitor the NO_X adsorber system's capability. The use of NO_X sensors placed upstream and downstream of the adsorber system would allow the system's NO_X reduction performance to be continuously monitored. For example, the upstream NO_X sensor on a properly functioning adsorber system operating with lean fuel mixtures, will read high NO_X levels while the downstream NO_X sensor should read low NO_X levels. With a deteriorated NO_X adsorber system, the upstream NO_X levels will continue to be high while the downstream NO_X levels will also be high. Therefore, a malfunction of the system can be detected by comparing the NO_X levels measured by the downstream NO_X sensor versus the upstream sensor.

The possibility exists that an upstream NO_X sensor will not be used for NO_X adsorber control. Manufacturers may choose to model engine-out NO_X levels—based on engine operating parameters such as engine speed, fuel injection quantity and timing, EGR flow rate—thereby eliminating the need for the upstream NO_X sensor. In this case, we believe that monitoring of the system could be conducted using A/F sensors in place of NO_X sensors.[67] During lean engine operation with a properly operating NO_X adsorber system, both the upstream and downstream A/F sensors would indicate lean mixtures. When the exhaust gas is intrusively commanded rich to regenerate the NO_X adsorber, the upstream A/F sensor would quickly indicate a rich mixture while the downstream sensor should continue to see a lean mixture due to the chemical reaction of the reducing agents with NO_X and oxygen stored on the adsorber. Once all of the stored NO_X and oxygen has been released, the reducing agents in the exhaust would cause the downstream A/F sensor to indicate a rich reading. The more NO_X that is stored in the adsorber, the longer the delay between the rich indications from the upstream and downstream sensors. Thus, the time differential between the rich indications from the upstream and downstream A/F sensors is a gauge of the NO_X storage capacity of the adsorber. This delay could be correlated to an emissions increase and the monitor could be calibrated to indicate a malfunction upon detecting an unacceptably short delay. In fact, Honda currently uses a similar approach to monitor the NO_X adsorber on a 2003 model year gasoline vehicle which demonstrates the viability of the approach in a shorter lived application. We have studied A/F sensors and their durability with respect to longer lived diesel applications and our results are summarized in a report placed in the docket to this rule.[68]

[66] Crawford, John M., Mitsui Mining & Smelting Co., Ltd., presentation to EPA, October 2006, Docket ID# EPA–HQ–OAR–2005–0047–0007.

[67] Ingram, G.A. and Surnilla, G., ''On-Line Estimation of Sulfation Levels in a Lean NO_X Trap,'' SAE Paper 2002–01–0731 may be obtained from Society of Automotive Engineers International, 400 Commonwealth Dr., Warrendale, PA 15096–0001.

[68] Draft Technical Support Document, HDOBD NPRM, EPA420–D–06–006, Docket ID# EPA–HQ–OAR–2005–0047–0008.

b. NO_X Adsorber Active/Intrusive Reductant Injection System Monitoring

The injection system used to achieve NO_X regeneration of the NO_X adsorber could also be monitored with A/F sensors. When the control system injects extra fuel to achieve a rich mixture, the upstream A/F sensor would respond to the change in fueling and could measure directly whether or not the proper amount of fuel had been injected. If manufacturers employ a NO_X adsorber system design that uses only a single A/F sensor downstream of the adsorber, that downstream sensor could be used to monitor the performance of the injection system. As discussed above, the downstream sensor would switch from a lean reading to a rich reading when the stored NO_X has been completely released and reduced. If the sensor switches too quickly after rich fueling is initiated, then either too much fuel has been injected or the adsorber itself has poor storage capability. Conversely, if the sensor takes too long to switch after rich fueling is initiated, it may be an indication that the adsorber has very good storage capability. However, excessive switch times (i.e., times that exceed the maximum storage capability of the adsorber) could be indicative of an injection system malfunction (i.e., insufficient fuel has been injected) or a sensor malfunction (i.e., the sensor has a slow response).

c. NO_X Adsorber Feedback Control Monitoring

Monitoring of feedback control could be performed using analogous strategies to those discussed for fuel system feedback control monitoring in Section III.A.1.

8. Diesel Particulate Filter (DPF) Monitoring

a. PM Filtering Performance Monitoring

The PM filtering performance monitor is perhaps the monitor for which we have the most concern with respect to feasibility. Part of this concern stems from the difficulty in detecting the very low PM emissions levels required for 2007/2010 engines (i.e., 0.01 g/bhp-hr). While we have made changes to our test procedures that will allow for more accurate measurement of PM in the test cell, it is still very difficult to do. With today's proposal, we are expecting manufacturers to detect failures in the filtering performance of only a few times the actual standards. Success at doing so presents a very difficult challenge to manufacturers. Our concerns, in part, have led us to propose a different 2013 and later emissions threshold for this monitor than that proposed by ARB. This was discussed in more detail in section I.D.2.

We anticipate that manufacturers can meet the proposed PM filtering monitor requirements without adding hardware other than that used for control purposes. We believe that the same pressure and temperature sensors that are used to control DPF regeneration will be used for OBD monitoring. For control purposes, manufacturers generally use a differential or delta pressure sensor placed across the DPF and at least one temperature sensor located near the DPF. The differential pressure sensor is expected to be used on DPF systems to prevent damage that could be caused by delayed or incomplete regeneration. Such conditions could lead to excessive temperatures and melting of the DPF substrate. When the differential pressure exceeds a predetermined level, a regeneration event would be initiated to burn the trapped PM.

However, engine manufacturers have told us that differential pressure alone does not provide a robust indication of trapped PM in the DPF. For example, most if not all DPFs in the 2010 timeframe will be catalyzed DPFs that are designed to regenerate passively during most operation. Sometimes, conditions will not permit the passive regeneration and an active regeneration would have to be initiated. Relying solely on the differential pressure sensor to determine when an active regeneration event was necessary would not be sufficient. A low differential pressure could mean a low PM load and could also mean a leaking DPF substrate. A high differential pressure could mean a high PM load and could also mean a melted substrate. In the latter case, the system may continually attempt to regenerate the DPF despite a low PM load which would both waste fuel and increase HC emissions.

As a result, manufacturers will probably use some sort of soot-loading model to predict the PM load on the DPF as part of their regeneration strategy. Without a robust prediction, a regeneration event could be initiated too early (i.e., when too little PM was present which would be a waste of fuel and would increase HC emissions) or too late (i.e., when too much PM has been allowed to build and the regeneration event could cause a meltdown of the substrate). The model would estimate the PM load by tracking the difference between the modeled engine-out PM (i.e., the emissions that are being loaded on the DPF) and regenerated PM (i.e., the PM that is being burned off the DPF due to passive and/or active regenerations).

Given this, we believe that a comprehensive and accurate soot-loading model is also necessary for successful monitoring of DPF filtering performance. The model would predict the PM load on the DPF based on fuel consumption and engine operating conditions and would predict passively regenerated PM based on temperatures. This predicted PM load would be compared to the measured PM load taken from the differential pressure sensors. Differences would correspond to either a leaking substrate (i.e., predicted load greater than measured load) or melting of the substrate faceplate (i.e., measured load greater than predicted load).

Nonetheless, much development remains to be done and success is not guaranteed. Manufacturers have noted that a melted substrate through which a large channel has opened could have differential pressure characteristics identical to a good substrate despite allowing most of the engine-out PM to flow directly through. We agree that this is a difficult failure mode and have proposed language that would allow certification of DPF monitors that are unable to detect it. Possibly, a temperature sensor in the DPF could detect the extreme temperatures capable of causing such a severe substrate melting. Upon detecting such a temperature, a regeneration event could be initiated to burn off any trapped PM. Following that event, the soot model would expect a certain increase in differential pressure based on modeled engine-out PM and passive regeneration characteristics. Presumably, the measured differential pressure profile would not match the predicted profile because most PM would be flowing straight through the melted channel. This same approach, or perhaps a simple temperature sensor, should quite easily be able to detect a missing substrate.

Lastly, manufacturers have noted their concern that small differences in substrate crack size or location may generate large differences in tailpipe emission levels. They have also noted their lack of confidence that they will be able to reliably detect all leaks that would result in emissions exceeding the proposed thresholds. Accordingly, the manufacturers have suggested pursuing an alternate malfunction criterion independent of emission level. They have suggested criteria such as a percent of exhaust flow leakage or a specific leak or hole size that must be detected. We believe that pursuit of such alternate thresholds would not be appropriate at this time. Manufacturers have not yet completed work on initial widespread implementation of DPFs for the 2007 model year. We expect that during the year or two following that implementation, substantial refinement and optimization will occur based on field experiences and that correlation of sensor readings to emissions levels will be possible for at least some DPF failure modes by the 2010 model year.

b. DPF Regeneration Monitoring

Pressure sensing, in combination with the soot model, could also be used to determine if regeneration is functioning correctly. After a regeneration event, the differential pressure should drop significantly since the trapped PM has been removed. If it does not drop to within the soot model's predicted range after the regeneration event, either the regeneration did not function correctly or the filter could have excessive ash loading. Ash loading is a normal byproduct of engine operation (the ash loading is largely a function of oil consumption by the engine and the ash content of the engine oil). The ash builds up in the DPF and does not burnout as does the PM but rather must be removed or blown out of the DPF. Manufacturers are working with us to determine the necessary maintenance intervals at which this ash removal will occur. The soot model would have to account for ash buildup in the DPF with miles or hours of operation. Future engine oils will have lower ash content and have tighter quality control such that more accurate predictions of ash loading will be possible. By including ash loading in the soot model, we believe that its effects could be accounted for in the predicted differential pressure following a regeneration event.

As stated, manufacturers are projected to make use of temperature sensors for regeneration control. These same sensors could also be used to monitor active regeneration of the filter. If excess temperatures are seen by the temperature sensor during active regeneration, the regeneration process can be stopped or slowed down to protect the filter. If an active regeneration event is initiated and there a temperature rise commensurate with the amount of trapped PM is not detected, the regeneration system is not working and a malfunction would be indicated.

c. DPF NMHC Conversion Efficiency Monitoring

Given the stringency of the 2010 standards, we believe that manufactures may rely somewhat on the DPF to convert some of the HC emissions. The proposed requirement requires monitoring this function only if the system serves this function. We believe that, provided the filtering performance and regeneration system monitors have not detected any malfunctions, the NMHC conversion is probably working fine. Given the level of the threshold, and the expectation that the DPF will serve to control NMHC only marginally, we do not anticipate this monitor needing emissions correlation work. Instead, we expect that, with the DPF temperature sensor, it should be possible to infer adequate NMHC conversion by verifying an exotherm. Nonetheless, if a manufacturer relies so heavily on the DPF for NMHC conversion that its ability to convert could be compromised to the point of emissions exceeding the threshold, a more robust monitor may be required by correlating exotherm levels to NMHC impacts.

d. DPF Regeneration Feedback Control Monitoring

Monitoring of DPF regeneration feedback control could be performed using analogous strategies to those discussed for fuel system feedback control monitoring in Section III.A.1.

9. Exhaust Gas Sensor Monitoring

The under 14,000 pound OBD regulations have required oxygen sensor monitoring since the 1996 model year. Vehicles have been certified during that time meeting the requirements. The technological feasibility of monitoring oxygen sensors has been demonstrated. Additionally, A/F sensor monitoring has been required, manufacturers have complied, and the feasibility has been similarly demonstrated.

NO_X sensors are a recent technology and, as such, they are still being developed and improved. However, we would expect that manufacturers would design their upstream NO_X sensor monitors to be similar the A/F sensor monitors used in under 14,000 pound applications. Monitoring of downstream sensors may require modifications to existing A/F sensor strategies and/or new strategies. Since NO_X sensors are projected to be used only for control and monitoring of aftertreatment systems that reduce NO_X emissions (e.g., SCR systems), the OBD system would have to distinguish between deterioration of the aftertreatment system and the NO_X sensor itself. As the aftertreatment deteriorates, NO_X emissions downstream of the aftertreatment device will increase and, assuming there is no such deterioration in the NO_X sensor, the NO_X sensor will read these increasing NO_X levels. As discussed in sections III.A.6 and III.A.7, the increased NO_X levels can be the basis for monitoring the performance of the aftertreatment system. However, if the NO_X sensor does deteriorate with the aftertreatment device (i.e., its response rate slows with mileage/operating hours), the sensor may not properly read the increasing NO_X levels from the deteriorating aftertreatment system, and the aftertreatment monitor might conclude that the aftertreatment system is functioning properly. Similarly, the performance or level of deterioration of the NO_X aftertreatment device could affect the results of the NO_X sensor monitor. Therefore to achieve robust monitoring of aftertreatment and sensors, the OBD system has to distinguish between deterioration of the aftertreatment system and deterioration of the NO_X sensor. To properly monitor the NO_X sensor, the sensor monitor has to run under conditions where the aftertreatment performance can be quantified and compensated for or eliminated in the monitoring results.

For example, the effects of the SCR performance could be eliminated by monitoring the NO_X sensor under a steady-state operating condition during which engine-out NO_X emissions were stable. Under a relatively steady-state condition, reductant injection could be ''frozen'' (i.e., the reductant injection quantity could be held constant) which would also freeze the conversion efficiency of the SCR system. With SCR performance held constant, engine-out NO_X emissions could be intrusively increased by a known amount (e.g., by reducing EGR flow or changing fuel injection timing and allowing the engine-out NO_X model to determine the increase in emissions). The resulting increase in emissions would pass through the SCR catalyst unconverted, and the sensor response to the known increase in NO_X concentrations could be measured and evaluated. This strategy could be used to detect both response malfunctions (i.e., the sensor reads the correct NO_X concentration levels but the sensor reading does not change fast enough to keep up with changing exhaust NO_X concentrations) and rationality malfunctions (i.e., the sensor reads the wrong NO_X level). Rationality malfunctions could be detected by making sure the sensor reading changes by the same amount as the intrusive change in emissions. Lastly, the sensor response to decreasing NO_X concentrations could also be evaluated by measuring the response when the intrusive strategy is turned off and engine-out NO_X emissions are returned to normal levels. By correlating sensor response rates and the resulting emissions impacts, the malfunction criteria could then be determined.

B. Feasibility of the Monitoring Requirements for Gasoline/Spark-Ignition Engines

1. Fuel System Monitoring

For gasoline vehicles since the 1996 model year and gasoline engines since the 2005 model year, the under 14,000 pound OBD requirements have required fuel system monitoring identical to that being proposed. Over 100 million cars and light trucks have been built and sold in the U.S. to these fuel system monitoring requirements including some heavy-duty vehicles that use the exact same gasoline engines that are used in some over 14,000 pound applications. This clearly demonstrates the technological feasibility of the proposed requirements.

2. Engine Misfire Monitoring

For gasoline vehicles since the 1996 model year and gasoline engines since the 2005 model year, the under 14,000 pound OBD requirements have required misfire monitoring identical to that being proposed. One of the most reliable methods for detecting misfire is the use of a crankshaft position sensor—which measures the fluctuations in engine angular velocity to determine the presence of misfire—along with a camshaft position sensor—which can be used to identify the misfiring cylinder. This method has been shown to be technologically feasible and should work equally well on over 14,000 pound applications.

3. Exhaust Gas Recirculation (EGR) Monitoring

For vehicles since the 1996 model year and engines since the 2005 model year, the under 14,000 pound OBD requirements have required EGR system monitoring identical to that being proposed. The general approach has been to detect EGR flow rate malfunctions by looking at the change in fuel trim or manifold pressure under conditions when the EGR system is active. This demonstrates the technological feasibility of the proposed requirements.

4. Cold Start Emission Reduction Strategy Monitoring

We expect this monitoring to be done mainly via computer software. For example, if spark retard is used during cold starts, the commanded amount of spark retard would have to be monitored if the amount of spark retard can be restricted by external factors such as idle quality or driveability. This can be done with software algorithms that compare the actual overall commanded final ignition timing with the threshold timing that would result in emissions that exceed the emissions thresholds. Cold start strategies that always command a predetermined amount of ignition retard independent of all other factors and do not allow idle quality or other factors to override the desired ignition retard would not require monitoring of the commanded timing. Other methods that could be used to ensure that the actual timing has been reached include verifying other factors such as corresponding increases in mass air flow and idle speed indicative of retarded spark combustion. Both mass air flow and idle speed are used currently by the engine control system and the OBD system and, therefore, only minor software modifications should be required to analyze these signals while the cold start strategy is invoked.

5. Secondary Air System Monitoring

A/F sensors would most likely be required to monitor effectively the secondary air system when it is normally active. These sensors are currently installed on many new cars and their implementation is projected to increase in the future as more stringent emission standards are phased in. A/F sensors are useful in determining air-fuel ratio over a broader range than conventional oxygen sensors and are especially valuable in engines that require very precise fuel control. They would be useful for secondary air system monitoring because of their ability to determine air-fuel ratio with high accuracy. This would enable a correlation between secondary airflow rates and emissions.

6. Catalytic Converter Monitoring

A common method used for estimating catalyst efficiency is to measure the catalyst's oxygen storage capacity. This monitoring method has been used by all light-duty gasoline vehicles since the 1996 model year and most gasoline engines since the 2005 model year as a result of our under 14,000 OBD requirements. Generally, as the catalyst's oxygen storage capacity decreases, the conversion efficiencies of HC and NO_X also decrease. With this strategy, a catalyst malfunction would be detected when its oxygen storage capacity has deteriorated to a predetermined level. Manufacturers determine this by using the information from an upstream oxygen sensor and a downstream or mid-bed oxygen sensor (this second sensor is also used for trimming the front sensor to maintain more precise fuel control). By comparing the level of oxygen measured by the second sensor with that measured by the upstream sensor, manufacturers can determine the catalyst's oxygen storage capacity and estimate its conversion efficiency. With a properly functioning catalyst, the second oxygen sensor signal will be fairly steady since the fluctuating oxygen concentration (due to fuel system cycling around stoichiometry) at the inlet of the catalyst is damped by the storage and release of oxygen in the catalyst. When a catalyst is deteriorated it is no longer capable of storing and releasing oxygen. This causes the frequency and peak-to-peak voltage of the second oxygen sensor to simulate the signal from the upstream oxygen sensor at which time a malfunction would be indicated.

7. Evaporative System Monitoring

Our OBD requirements have required monitoring for evaporative system leaks for many years. The EPA OBD requirement has been the equivalent of a 0.040 inch hole, while the ARB requirement has gone as low as a 0.020 inch hole. These requirements have been met on applications such as incomplete trucks and engine dynamometer certified configurations equipped with similar and, in many cases, identical configurations as are used in over 14,000 pound applications. Manufacturers have successfully met these requirements by using engine vacuum to create a vacuum in both the fuel tank and evaporative system and then monitoring the system's ability to maintain that vacuum. The ramp down in vacuum (or ramp up in pressure) can then be correlated to leak size. In general, these systems require the addition of an evaporative system pressure sensor and a canister vent valve capable of closing the vent line.

Manufacturers of over 14,000 pound applications have expressed concerns with their ability to detect evaporative system leaks on these larger vehicles. One such concern relates to the relatively larger fuel tank sizes on the larger applications. These tanks can be on the order of 50 to 80 gallons, which makes the impact of a small hole, on a percentage basis, less severe and less easily detected. Another concern is the relatively large number of fuel tank and evaporative system configurations on the larger applications. Confounding both of these concerns is that the engine manufacturers quite often have no idea what tanks and configurations will ultimately be matched with their engine in the final vehicle product.

While we agree that these concerns are valid, they can also be said of the under 14,000 pound applications (except perhaps the tank size concern). The over 14,000 pound gasoline applications are expected to use near identical, if not equivalent, evaporative system components and we are not aware of any reason why the existing monitoring techniques would not continue to work on over 14,000 pound applications. Nonetheless, we do not want false failures in the field. By limiting the monitoring requirement to leaks of 0.150 inch or larger, we believe that manufacturers would be able to employ a single monitoring strategy to all possible tank sizes and configurations without much concern for false failures. Nonetheless, it may be necessary for manufacturers to impose tighter restrictions on their engine purchasers than is done currently with regards to tank specifications and evaporative system components.

8. Exhaust Gas Sensor Monitoring

Our light-duty OBD requirements since the 1996 model year and our 8,500 to 14,000 pound OBD requirements since the 2005 model year have required oxygen sensor monitoring similar to the requirements being proposed. Years of compliance with those requirements demonstrates the technological feasibility of the proposed requirements. Additionally, A/F sensor monitoring has been required and demonstrated on these vehicles for many years.

C. Feasibility of the Monitoring Requirements for Other Diesel and Gasoline Systems

1. Variable Valve Timing and/or Control (VVT) System Monitoring

VVT systems are already in general use in many under 14,000 pound applications. Further, under the California OBD II requirements, vehicles equipped with VVT systems have been monitoring those systems for proper function since the 1996 model year. More recently, manufacturers have employed monitoring strategies to detect VVT system malfunctions that detect not only proper function but also exceedances of emissions thresholds. Such strategies include the use of the crank angle sensor and camshaft position sensor to confirm that the valve opening and closing occurs within an allowable tolerance of the commanded crank angle. By calculating the difference between the commanded valve opening crank angle and the achieved valve opening crank angle, a diagnostic algorithm can differentiate between a malfunctioning system with too large of an error and a properly functioning system with very little to no error. By calibrating the size of this error (or integrating it over time), manufacturers can design the system to indicate a malfunction prior to the required emissions thresholds. In the same manner, system response can be measured by monitoring the length of time necessary to achieve the commanded valve timing. To ensure adequate resolution between properly functioning systems and malfunctioning systems, most manufacturers perform this type of monitor only when a sufficiently large ‘‘step change’’ in commanded valve timing occurs.

2. Engine Cooling System Monitoring

The existing OBD requirements have required identical ECT sensor and thermostat monitoring for several years. While the technical feasibility of the proposed requirements has been demonstrated on lighter applications which tend to be produced through a vertically integrated manufacturing process, the manufacturers of big diesel engines have expressed concerns that monitoring of the cooling system on over 14,000 pound applications would create unique and possibly insurmountable challenges. Generally, the cooling system is divided into two cooling circuits connected by the thermostat. The two circuits are the engine circuit and the radiator circuit. Since the big diesel engine industry tends to be horizontally integrated, the manufacturers contend that they do not know what types of devices will be added to the cooling system when the vehicle is manufactured or the vehicle is put into service. They are concerned that the unknown devices can add/remove unknown quantities of heat to/from the system which would prevent them from predicting reliably the proper system behavior (e.g., warm up). Without the ability to predict system behavior reliably, they fear that they cannot know when the system is malfunctioning (e.g., not warming up as expected).

The industry's concerns regarding unknown devices added on the radiator circuit of the system seem unwarranted. A properly functioning thermostat does not allow flow through the radiator during warm-up. Devices added to the radiator circuit could only affect coolant temperature when there is significant coolant flow through the radiator (i.e., after the engine is warmed-up and the thermostat is open, allowing coolant to flow through the radiator).

We agree that unknown devices added on the engine circuit (e.g., passenger compartment heaters) can affect the warm-up rate of the system. Manufacturers of under 14,000 pound applications have demonstrated robust thermostat monitoring with high capacity passenger heaters in the cooling system. To do so, they have to know the maximum rate of heat loss due to the heater. Manufacturers of over 14,000 pound applications have control over this by providing limits on such devices in the build specifications that they provide to the vehicle manufacturers. In some cases, an engine manufacturer might need multiple build specifications with corresponding thermostat monitoring calibrations to accommodate the ranges of heater capacities that are needed when a given engine is used in a range of vehicle applications (e.g., a local delivery truck having a passenger compartment for two people and a small capacity heater versus a bus having a passenger compartment for 20 people and a large capacity heater). The vehicle manufacturer would then select the appropriate calibration for the engine when installing it in the vehicle. Nonetheless, engine manufacturers have requested limited enable conditions for the thermostat monitor (e.g., to disable the thermostat monitor below 50 degrees F). This would help to minimize their resource needs to calibrate the thermostat monitor. While this may be directionally favorable to manufacturers, it would result in disabled thermostat monitoring during cold ambient conditions which occur in much of the country and, in some areas, during a large portion of the year. In such regions, a vehicle could experience a thermostat malfunction with no indication to the vehicle operator. Since many other OBD monitors will operate only after reaching a certain engine coolant temperature, a malfunctioning thermostat without any indication could effectively result in disablement of the OBD system.

3. Crankcase Ventilation System Monitoring

Crankcase ventilation system monitoring requirements have been met for years by manufacturers of under 14,000 pound gasoline applications. Therefore, the technological feasibility has been demonstrated for gasoline applications.

Effectively, diesel engine manufacturers would be required to meet design requirements for the entire system in lieu of actually monitoring any of the hoses for disconnection. Specifically, the proposed requirement would allow for an exemption for any portion of the system that is resistant to deterioration or accidental disconnection and not subject to disconnection during any of the manufacturer's repair procedures for non-crankcase ventilation system repair work. These safeguards would be expected to eliminate the chances of disconnected or improperly connected hoses while still allowing manufacturers to meet the requirements without adding any additional hardware meant solely for the purpose of meeting the monitoring requirements.

4. Comprehensive Component Monitoring

Both ARB and EPA OBD requirements have for year contained requirements to monitor computer input and output components. While these monitors are sometimes tricky and are not easy as many incorrectly assume, the many years of successful implementation and compliance with the existing requirements demonstrates their feasibility. The proposed requirements are equivalent to the under 14,000 pound requirements.

IV. What Are the Service Information Availability Requirements?

A. What Is the Important Background Information for the Proposed Service Information Provisions?

Section 202(m)(5) of the CAA directs EPA to promulgate regulations requiring OEMs to provide to:

> any person engaged in the repairing or servicing of motor vehicles or motor vehicle engines, and the Administrator for use by any such persons, * * * any and all information needed to make use of the [vehicle's] emission control diagnostic system * * * and such other information including instructions for making emission-related diagnoses and repairs.

Such requirements are subject to the requirements of section 208(c) regarding protection of trade secrets; however, no such information may be withheld under section 208(c) if that information is provided (directly or indirectly) by the manufacturer to its franchised dealers or other persons engaged in the repair, diagnosing or servicing of motor vehicles.

On June 27, 2003 EPA published a final rulemaking (68 FR 38428) which set forth the Agency's service information regulations for light- and heavy-duty vehicles and engines below 14,000 pounds GVWR. These regulations, in part, required each-covered Original Equipment Manufacturer (OEM) to do the following: (1) OEMs must make full text emissions-related service information available via the World Wide Web. (2) OEMs must provide equipment and tool companies with information that allows them to develop pass-through reprogramming tools. (3) OEMs must make available enhanced diagnostic information to equipment and tool manufacturers and to make available OEM-specific diagnostic tools for sale. These requirements were finalized to ensure that aftermarket service and repair facilities have access to the same emission-related service information, in the same or similar manner, as that provided by OEMs to their franchised dealerships.

As EPA moves forward proposing OBD requirements for the heavy-duty over 14,000 pounds sector, EPA is similarly moving forward with proposals to require the availability of service information to heavy-duty aftermarket service providers as required by section 202(m) of the Clean Air Act.

All of the following proposed provisions regarding the availability of service information for the heavy-duty industry are based on our extensive experience and regulatory history with the light-duty service industry. However, as discussed below, EPA understands that there may be significant differences between the light-duty service industry and the heavy-duty service industry. EPA welcomes comment on all of the proposed provisions and their need and/or applicability to the heavy-duty service industry.

B. How Do the Below 14,000 Pound and Above 14,000 Pounds Aftermarket Service Industry Compare?

As we consider proposing the availability of service information for the heavy-duty sector above 14,000 pounds, EPA recognizes that differences do exist between the industries that service vehicles above and below 14,000 pounds. On the below 14,000 pound side, estimates indicate that independent technicians perform up to 80% of all vehicle service and repairs once a vehicle exceeds the manufacturer warranty period.[69] On the above 14,000 pound side, the 1997 U.S. Census Bureau Vehicle Inventory and Use Survey, estimated that 25 percent of the general maintenance and over 30 percent of the major overhaul on heavy-duty vehicles was performed by the independent sector. According to the Census Bureau, these values represent a 16.7 percent increase in general maintenance and a 6.2 percent increase in major overhaul from 1992. Trucks and Parts Service Magazine provides the following information on the breakdown of the independent repair industry for vehicles above 14,000 pounds (not including any fuel injection shops):

U.S. independent machine shops for above 14,000 pounds—5,820
U.S. independent engine service shops for above 14,000 pounds—12,170
U.S. independent transmission repair shops for above 14,000 pounds—11,420
Technicians, independent repair shops for above 14,000 pounds—133,700
Technicians, truck parts distributors for vehicles above 14,000 pounds—41,600

Thus, the increase in business and the large number of independent aftermarket shops make it necessary that repair information is readily available for the aftermarket trucking industry.

On the light-duty side, vehicle manufacturers are entirely integrated in that they are responsible for the design and production of the entire vehicle from the chassis to the body. In comparison, the heavy-duty industry is mostly non-integrated. In other words, different manufacturers separately produce the engine, the chassis, and the transmission of a vehicle. This non-integration speaks to the fact that a completed vehicle is typically produced in response to the customized needs of owners/operators. In addition, the lack of integration indicates that a given engine will ultimately be part of many different engine, transmission, and chassis configurations. In addition, heavy-duty manufacturers have stated that diagnostic tool designs differ significantly from tools produced for light-duty vehicles as a result of this non-integration.

EPA requests comment and also additional data on the current state of the heavy-duty aftermarket industry.

C. What Provisions Are Being Proposed for Service Information Availability?

1. What Information Is Proposed To Be Made Available by OEMs?

Today's action proposes a provision that requires OEMs to make available to any person engaged in the repairing or servicing of heavy-duty motor vehicles or motor vehicle engines above 14,000 pounds all information necessary to make use of the OBD systems and any information for making emission-related repairs, including any emissions-related information that is provided by the OEM to franchised dealers beginning with MY2010. We are proposing that this information includes, but is not limited to, the following:

(1) Manuals, technical service bulletins (TSBs), diagrams, and charts (the provisions for training materials,

[69] Motor and Equipment Manufacturers Association, Automotive Industry Status Report, 1999.

including videos and other media are discussed in Sections II.C.3 and II.C.4 below.

(2) A general description of the operation of each monitor, including a description of the parameter that is being monitored.

(3) A listing of all typical OBD diagnostic trouble codes associated with each monitor.

(4) A description of the typical enabling conditions for each monitor to execute during vehicle operation, including, but not limited to, minimum and maximum intake air and engine coolant temperature, vehicle speed range, and time after engine startup. A listing and description of all existing monitor-specific drive cycle information for those vehicles that perform misfire, fuel system, and comprehensive component monitoring.

(5) A listing of each monitor sequence, execution frequency and typical duration.

(6) A listing of typical malfunction thresholds for each monitor.

(7) For OBD parameters that deviate from the typical parameters, the OBD description shall indicate the deviation for the vehicles it applies to and provide a separate listing of the typical values for those vehicles.

(8) Identification and scaling information necessary to interpret and understand data available to a generic scan tool through Diagnostic Message 8 pursuant to SAE Recommended Practice J1939–73, which is incorporated by reference in section X.

(9) For vehicles below 14,000 pounds, EPA requires that any information related to the service, repair, installation or replacement of parts or systems developed by third party (Tier 1) suppliers for OEMs, to the extent they are made available to franchise dealerships. EPA believes that Tier 1 suppliers are an important element of the market related to vehicles below 14,000 pounds and EPA is requesting comment on the role that Tier 1 suppliers play in the heavy-duty market above 14,000 pounds and the need to extend this provision to the heavy-duty industry above 14,000 pounds.

(10) Any information on other systems that can directly effect the emission system within a multiplexed system (including how information is sent between emission-related system modules and other modules on a multiplexed bus),

(11) Any information regarding any system, component, or part of a vehicle monitored by the OBD system that could in a failure mode cause the OBD system to illuminate the malfunction indicator light (MIL).

(12) Any other information relevant to the diagnosis and completion of an emissions-related repair. This information includes, but is not limited to, information needed to start the vehicle when the vehicle is equipped with an anti-theft or similar system that disables the engine described below in paragraph (13). This information also includes any OEM-specific emissions-related diagnostic trouble codes (DTCs) and any related service bulletins, trouble shooting guides, and/or repair procedures associated with these OEM-specific DTCs.

(13) For vehicles below 14,000 pounds, EPA requires that OEMs make available computer or anti-theft system initialization information necessary for the proper installation of on-board computers on motor vehicles that employ integral vehicle security systems or the repair or replacement of any other emission-related part. We did not finalize a provision that would require OEMs to make this information available on the OEM's Web site unless they chose to do so. However, we did finalize a provision requiring that the OEM's Web site contain information on alternate means for obtaining the information and/or ability to perform reintialization. EPA is proposing to expand this provision to OEMs for vehicles above 14,000 pounds and requests comment on the prevalence of this type of repair, the means and methods for performing this type of repair and the need to extend this provision to the heavy-duty industry.

In addition, EPA's current service information rules require that, beginning with the 2008 model year, all OEM systems will be designed in such a way that no special tools or processes will be necessary to perform re-initialization. In other words, EPA expects that the re-initialization of vehicles can be completed with generic aftermarket tools, a pass-through device, or an inexpensive OEM-specific cable. EPA finalized this provision for vehicles below 14,000 pounds to prevent the need for aftermarket service providers to invest in expensive OEM-specific or specialty tools to complete an emissions-related repair that does not occur very frequently, but does in fact occur. In the June 2003 final rule, EPA gave OEMs a significant amount of lead time to either separate the need for reinitialization from an emissions related repair or otherwise redesign the reinitialization process in such a way that it does not require the use of special tools. EPA requests comment on the need for such a provision for the above 14,000 pound market. To the extent that such a provision may be needed for the heavy-duty arena, EPA also requests comment and what lead-time might be needed to meet EPA's goal of not relying on special tools or processes to perform reinitialization.

Information for making emission-related repairs does not include information used to design and manufacture parts, but may include OEM changes to internal calibrations, and other indirect information, as discussed below.

2. What Are the Proposed Requirements for Web-Based Delivery of the Required Information?

a. OEM Web Sites

Today's action proposes a provision that would require OEMs to make available in full-text all of the information outlined above, on individual OEM Web sites. Today's action further proposes that each OEM launch their individual Web sites with the required information within 6 months of publication of the final rule for all 2010 and later model year vehicles. The only proposed exceptions to the full-text requirements are training information, anti-theft information, and indirect information.

b. Timeliness and Maintenance of Information on OEM Web Sites

Today's action proposes a provision that would require OEMs to make available the required information on their Web site within six months of model introduction. After this six month period, we propose that the required information for each model must be available and updated on the OEM Web site at the same time it is available by any means to their dealers.

For vehicles under 14,000 pounds, EPA finalized a provision that OEMs maintain the required information in full text on their Web sites for at least 15 years after model introduction. After this fifteen-year period, OEMs can archive the required service information, but it must be made available upon request, in a format of the OEM's choice (e.g. CD–ROM). Given the significantly longer lifetime of heavy-duty vehicles and engines above 14,000 pounds, EPA requests comment on the need to require that the required information be required to remain on the Web sites for a longer period of time.

c. Accessibility, Reporting and Performance Requirements for OEM Web Sites

Performance reports that adequately demonstrate that their individual Web sites meets the requirements outlined in Section C(1) above will be submitted to the Administrator annually or upon request by the Administrator. These reports shall also indicate the performance and effectiveness of the Web sites by using commonly used Internet statistics (e.g. successful requests, frequency of use, number of subscriptions purchased, etc). EPA will issue additional direction in the form of official manufacturer guidance to further specify the process for submitting reports to the Administrator.

In addition, EPA is proposing a provision that requires OEMs to launch Web sites that meet the following performance criteria:

(1) OEM Web sites shall possess sufficient server capacity to allow ready access by all users and have sufficient downloading capacity to assure that all users may obtain needed information without undue delay;

(2) Broken Web links shall be corrected or deleted weekly.

(3) Web site navigation does not require a user to return to the OEM home page or a search engine in order to access a different portion of the site.

(4) It is also proposed that any manufacturer-specific acronym or abbreviation shall be defined in a glossary webpage which, at a minimum, is hyperlinked by each webpage that uses such acronyms and abbreviations. OEMs may request Administrator approval to use alternate methods to define such acronyms and abbreviations. The Administrator shall approve such methods if the motor vehicle manufacturer adequately demonstrates that the method provides equivalent or better ease-of-use to the Web site user.

(5) Indicates the minimum hardware and software specifications required for satisfactory access to the Web site(s).

d. Structure and Cost of OEM Web Sites

In addition to the proposed requirements described above, EPA is proposing that OEMs establish a three-tiered approach for the access to their Web-based service information. These three tiers are proposed to include, but are not limited to short-term, mid-term, and long-term access to the required information.

(1) Short-Term Access

OEMs shall provide short-term access for a period of 24–72 hours whereby an aftermarket service provider will be able to access that OEM's Web site, search for the information they need, and purchase and/or print it for a set fee.

(2) Mid-Term Access

OEMs shall provide mid-term access for a period of 30 days whereby an aftermarket service provider will be able to access that OEM's Web site, search for the information they need, and purchase and/or print it for a set fee.

(3) Long-Term Access

OEMs shall provide long-term access for a period of 365 days whereby an aftermarket service provider will be able to access that OEM's Web site, search for the information they need, and purchase and/or print it for a set fee.

In addition, for each of the tiers, we propose that OEMs make their entire site accessible for the respective period of time and price. In other words, we propose that an OEM may not limit any or all of the tiers to just one make or one model.

EPA finalized the three-tiered information access approach in our June 2003 rulemaking to accommodate the wide variety of ways in which EPA believes aftermarket service providers utilize service information. On the under 14,000 side, aftermarket technicians approach the service of vehicles anywhere from servicing any make or model that comes into their shops to specializing in one particular manufacturer. In addition, EPA believes that there are other parties such as ''do-it-yourself'' mechanics or Inspection/Maintenance programs that may be interested in accessing such OEM web-sites. In addition, aftermarket service providers for vehicles below 14,000 pounds also relay on third party information consolidation entities such as Mitchell or All Data to supplement OEM-specific information. These factors, in addition to the fact that there are approximately 25ish (check this number) light-duty vehicle manufacturers, led EPA to the conclusion that a tiered approach to Web site access was necessary to ensure maximum availability to the aftermarket. EPA requests comment on the nature of aftermarket service for the heavy-duty above 14,000 pound industry and the need for a tiered approach to information availability.

Today's action also proposes that, prior to the official launch of OEM Web sites, each OEM will be required to present to the Administrator a specific outline of what will be charged for access to each of the tiers. We are further proposing that OEMs must justify these charges, and submit to the Administrator information on the following parameters, which include but are not limited to, the following:

(1) The price the manufacturer currently charges their branded dealers for service information. At a minimum, this must include the direct price charged that is identified exclusively as being for service information, not including any payment that is incorporated in other fees paid by a dealer, such as franchise fees. In addition, we propose that the OEM must describe the information that is provided to dealers, including the nature of the information (e.g., the complete service manual), etc.; whether dealers have the option of purchasing less than all of the available information, or if purchase of all information is mandatory; the number of branded dealers who currently pay for this service information; and whether this information is made available to any persons at a reduced or no cost, and if so, identification of these persons and the reason they receive the information at a reduced cost.

(2) The price the manufacturer currently charges persons other than branded dealers for service information. The OEM must describe the information that is provided, including the nature of the information (e.g., the complete service manual, emissions control service manual), etc.; and the number of persons other than branded dealers to whom the information is supplied.

(3) The estimated number of persons to whom the manufacturer would be expected to provide the service information following implementation of today's requirements. If the manufacturer is proposing a fee structure with different access periods (e.g., daily, monthly and annual periods), the manufacturer must estimate the number of users who would be expected to subscribe for the different access periods.

A complete list of the proposed criteria for establishing reasonable cost can be found in the proposed regulatory language for this final rule. We are also proposing that, subsequent to the launch of the OEM Web sites, OEMs would be required to notify the Administrator upon the increase in price of any one or all of the tiers of twenty percent or more accounting for inflation or that sets the charge for end-user access over the established price guidelines discussed above, including a justification based on the criteria for reasonable cost as established by this regulation.

Throughout the history of the current service information regulations, the price of service information and how price impacts the availability of service information has been a source of significant debate and discussion. In looking at the legislative history that led to the inclusion of the service information mandate in the Clean Air Act Amendments of 1990, it is clear that Congress did not intend for the pricing of information to be an artificial barrier to access. Further, Congress did not intend for information access charges to become a profit center for OEMs. However, EPA has interpreted that Congress did intend for OEMs to be able to recover reasonable costs for making information available. Since the initial implementation of the service information requirements beginning with original 1995 final rulemaking, EPA has continued to refine the provisions regulating the cost of service to try to balance the Congressional intent while understanding that OEMs should be able to recover reasonable costs for making the required information available to the aftermarket. In fact, the relatively prescriptive nature of some of the requirements stem directly from instances on the light-duty side where, in the past, we believe some manufacturers deliberately priced access to information in such a way that effectively made it unavailable to the aftermarket. The provisions being proposed today regarding the pricing of service information reflect many years of implementation experience, debate, and discussion on the light-duty side and EPA specifically requests comment from heavy-duty aftermarket service providers on current state of pricing of OEM heavy-duty service information and what else EPA should consider for heavy-duty that might be different from light-duty.

e. Hyperlinking to and From OEM Web Sites

Today's action proposes a provision that requires OEMs to allow direct simple hyperlinking to their Web sites from government Web sites and from all automotive-related Web sites, such as aftermarket service providers, educational institutions, and automotive associations.

f. Administrator Access to OEM Web Sites

Today's action proposes a provision that requires that the Administrator shall have access to each OEM Web site at no charge to the Agency. The Administrator shall have access to the site, reports, records and other information as provided by sections 114 and 208 of the Clean Air Act and other provisions of law.

g. Other Media

We are proposing a provision which would require OEMs to make available for ordering the required information in some format approved by the Administrator directly from their Web site after the proposed full-text window of 15 years has expired. It is proposed that each OEM shall index their available information with a title that adequately describes the contents of the document to which it refers. In the alternate, OEMs may allow for the ordering of information directly from their Web site, or from a Web site hyperlinked to the OEM Web site. We also propose that OEMs be required to list a phone number and address where aftermarket service providers can call or write to obtain the desired information. We also propose that OEMs must also provide the price of each item listed, as well as the price of items ordered on a subscription basis. To the extent that any additional information is added or changed for these model years, OEMs shall update the index as appropriate. OEMs will be responsible for ensuring that their information distributors do so within one regular business day of received the order. Items are less than 20 pages (e.g. technical service bulletins) shall be faxed to the requestor and distributors are required to deliver the information overnight if requested and paid for by the ordering party.

h. Small Volume Provisions for OEM Web Sites

In the July 2003 final rulemaking, EPA finalized a provision to provide flexibility for small volume OEMs. In particular, EPA finalized a provision that requires OEMs who are issued certificates of conformity with total annual sales of less than one thousand vehicles are be exempt from the full-text Internet requirements, provided they present to the Administrator and obtain approval for an alternative method by which emissions-related information can be obtained by the aftermarket or other interested parties. EPA also finalized a provision giving OEMs with total annual sales of less than five thousand vehicles an additional 12 months to launch their full-text Web sites.

These small-volume flexibilities are limited to the distribution and availability of service information via the World Wide Web under paragraph (4) of the regulations. All OEMs, regardless of volume, must comply with all other provisions as finalized in this rulemaking. EPA is requesting comment on the existence of small volume OEMs in the heavy-duty arena and the need for any provisions relating to small volume OEMs.

3. What Provisions Are Being Proposed for Service Information for Third Party Information Providers?

The nature of the light-duty aftermarket service industry is such that they rely to a great extent on consolidated service information that is development by third party information providers such as Mitchell and All-data. Third-party information providers will license OEM service information and consolidate that information for sale to the aftermarket. In the June 2003 final rule, EPA finalized a provision that will require OEMs who currently have, or in the future engage in, licensing or business arrangements with third party information providers, as defined in the regulations, to provide information to those parties in an electronic format in English that utilizes non-proprietary software. Further, EPA required that any OEM licensing or business arrangements with third party information providers are subject to fair and reasonable cost requirements. Lastly, we expect that OEMs will develop pricing structures for access to this information that make it affordable to any third party information providers with which they do business. EPA proposes to extend these provisions to the heavy-duty vehicle and engine manufacturers beginning with the 2010 model year.

However, EPA is specifically requesting comment on what role third-party consolidated information plays in the heavy-duty aftermarket. Further, EPA requests comment on the need for these, or additional provisions, related to third-party information providers.

4. What Requirements are Being Proposed for the Availability of Training Information?

a. Purchase of Training Materials for OEM Web Sites

In the light-duty service information final rule, EPA finalized two provisions for access to OEM emissions-related training. First, OEMs are required to make available for purchase on their Web sites the following items: Training manuals, training videos, and interactive, multimedia CD's or similar training tools available to franchised dealerships. Second, we finalized a provision that OEMs who transmit emissions-related training via satellite or the Internet must tape these transmissions and make them available for purchase on their Web sites within 30 days after the first transmission to franchised dealerships. Further, all of the items included in this provision must be shipped within 24 hours of the order being placed and are to be made available at a reasonable price. We also finalized a provision that will allow for an exception to the 24 hour shipping requirement in those circumstances where orders exceed supply and additional time is needed by the distributor to reproduce the item being ordered. For subsequent model years, the required information must be made available for purchase within three months of model introduction, and then be made available at the same time it is made available to franchised dealerships.

EPA is proposing to extend these provisions to the heavy-duty industry and requests comment on the need to so or to develop other provisions pertaining to the availability of training information for the heavy-duty aftermarket.

b. Third Party Access to OEM Training Material

In the light-duty final rule, we also finalized a provision that requires OEMs who utilize Internet and satellite transmissions to present emissions-related training to their dealerships to make these same transmissions available to third party training providers. In this way, we believe we are providing at least one opportunity for aftermarket technicians to receive similar emissions-related training information as provided to dealerships, thus furthering the goals and letter of section 202(m)(5). This requirement only requires OEMs to provide the same information to legitimate aftermarket training providers as is provided to dealerships and aftermarket service providers. It is not a requirement to license OEM copyrighted materials to these entities.

OEMs may take reasonable steps to protect their copyright to the extent some or all of this material may be copyrighted and may refuse to do business with any party that does not agree to such steps. However, we do expect OEMs to use fair business practices in its dealings with these third parties, in keeping with the ''fair and reasonable price'' requirements in these regulations. OEMs may not charge unreasonable up-front fees for access to these transmissions, but OEMs may require a royalty, percentage or other arranged fee based limits of on a per-use or enrollment subscription basis.

EPA requests comment on the need to expand the light-duty requirements to the heavy-duty sector. EPA also requests comments on any additional provisions it should consider to ensure that heavy-duty aftermarket service providers and trainers have sufficient access to OEM training information at a fair and reasonable price. EPA also requests comments on the types of training that is currently development by heavy-duty OEMs and what processes may already be in place for availability to the aftermarket.

5. What Requirements Are Being Proposed for Reprogramming of Vehicles?

The 2003 final rule required that light-duty OEMs comply with SAE J2534, ''Recommended Practice for Pass-Thru Vehicle Programming''. EPA understands that the heavy-duty industry has a similar standard in place that is similar to SAE J2534 specification for reprogramming. Therefore, today's action proposes two options for pass-thru reprogramming. We are proposing that heavy-duty OEMs comply with SAE J2534 beginning with 2010 model year. In the alternate, heavy-duty OEMs may comply with the Technology and Maintenance Council's Recommended Practice RP1210a, ''Windows Communication API,'' July 1999 beginning in the 2010 model year. We will also propose a provision that will require that reprogramming information be made available within 3 months of vehicle introduction for new models.

6. What Requirements are Being Proposed for the Availability of Enhanced Information for Scan Tools for Equipment and Tool Companies?

a. Description of Information That Must Be Provided

Today's action proposes a provision that requires OEMs to make available to equipment and tool companies all generic and enhanced information, including bi-directional control and data stream information. In addition, it is proposed that OEMs must make available the following information.

(i) The physical hardware requirements for data communication (e.g. system voltage requirements, cable terminals/pins, connections such as RS232 or USB, wires, etc.).

(ii) ECU data communication (e.g. serial data protocols, transmission speed or baud rate, bit timing requirements, etc.).

(iii) Information on the application physical interface (API) or layers. (i.e., processing algorithms or software design descriptions for procedures such as connection, initialization, and termination).

(iv) Vehicle application information or any other related service information such as special pins and voltages or additional vehicle connectors that require enablement and specifications for the enablement.

(v) Information that describes which interfaces, or combinations of interfaces, from each of the categories as described in paragraphs (g)(12)(vii)(A) through (D) of the regulatory language.

b. Distribution of Enhanced Diagnostic Information

Today's action proposes a provision that will require the above information for generic and enhanced diagnostic information be provided to aftermarket tool and equipment companies with whom appropriate licensing, contractual, and confidentiality agreements have been arranged. This information shall be made available in electronic format using common document formats such as Microsoft Excel, Adobe Acrobat, Microsoft Word, etc. Further, any OEM licensing or business arrangements with equipment and tool companies are subject to a fair and reasonable cost determination.

7. What Requirements Are Being Proposed for the Availability of OEM-Specific Diagnostic Scan Tools and Other Special Tools?

a. Availability of OEM-Specific Diagnostic Scan Tools

Today's action proposes a provision that OEMs must make available for sale to interested parties the same OEM-specific scan tools that are available to franchised dealerships, except as discussed below. It is proposed that these tools shall be made available at a fair and reasonable price. It is also proposed, that these tools shall also be made available in a timely fashion either through the OEM Web site or through an OEM-designated intermediary.

b. Decontenting of OEM-Specific Diagnostic Scan Tools

Today's action proposes a provision that requires OEMs who opt to remove non-emissions related content from their OEM-specific scan tools and sell them to the persons specified in paragraph (g)(2)(i) and (f)(2)(i) of the regulatory language for this final rule shall adjust the cost of the tool accordingly lower to reflect the decreased value of the scan tool. It is proposed that all emissions-related content that remains in the OEM-specific tool shall be identical to the information that is contained in the complete version of the OEM-specific tool. Any OEM who wishes to implement this option must request approval from the Administrator prior to the introduction of the tool into commerce.

c. Availability of Special Tools

The 2003 final rule precluded light-duty OEMs from using special tools to extinguish the malfunction indicator light (MIL) beginning with model year 2004. For model years 1994 through 2003, the final rule required OEMs who currently require such tools to extinguish the MIL must release the necessary information to equipment and tool companies to design a comparable generic tool. We also required that this information shall be made available no later than one month following the effective date of the Final Rule. EPA requests comment on this or other special tools that may be unique to the heavy-duty industry and on the need for provisions covering these tools.

8. Which Reference Materials are Being Proposed for Incorporation by Reference?

Today's action will finalize a provision requiring that OEMs comply with the following SAE Recommended Practices.

(1) SAE Recommended Practice J2403 (October 1998), ''Medium/Heavy-Duty EE Systems Diagnosis Nomenclature'' beginning with the 2010 model year.

(2) SAE Recommended Practice J2534 (February, 2002), ''Recommended Practice for Pass-Thru Vehicle Reprogramming''. EPA will require that OEMs comply with SAE J2534 beginning with the 2010 model year.

(3) SAE Recommended Practice J1939–73.

(4) ISO/DIS 15031–5 April 30, 2002.

V. What Are the Emissions Reductions Associated With the Proposed OBD Requirements?

In the 2007HD highway rule, we estimated the emissions reductions we expected to occur as a result of the emissions standards being made final in the rule. Since the OBD requirements contained in today's proposal are considered by EPA to be an important element of the 2007HD highway program and its ultimate success, rather than a new element being included as an addition to that program, we are not estimating emissions reductions associated with today's proposal. Instead, we consider the new 2007/2010 tailpipe emissions standards and fuel standards to be the drivers of emissions reductions and HDOBD to be part of the assurance we all have that those emissions reductions are indeed realized. Therefore, this analysis presents the emissions reductions estimated for the 2007HD highway program. Inherent in those estimates is an understanding that, while emissions control systems sometimes malfunction, they presumably are repaired in a timely manner. Today's proposed OBD requirements would provide substantial tools to assure that our presumption will be realized by helping to ensure that emission control systems continue to operate properly throughout their life. We believe that the OBD requirements proposed today would lead to more repairs of malfunctioning or deteriorating emission control systems, and may also lead to emission control systems that are more robust throughout the life of the engine and less likely to trigger illumination of MILs. The requirements would therefore provide greater assurance that the emission reductions expected from the Clean Diesel Trucks and Buses program will actually occur. Viewed from another perspective, while the OBD requirements would not increase the emission reductions that we estimated for the 2007HD highway rule, they would be expected to lead to actual emission reductions in-use compared with a program with no OBD system.

The costs associated with HDOBD were not fully estimated in the 2007HD highway rule. Those costs are more fully considered in section VI of this preamble. These newly developed HDOBD costs are added to those costs estimated for the 2007/2010 standards and a new set of costs for those standards are presented in section VII. Section VII also calculates a new set of costs per ton associated with the 2007/2010 standards which include the previously estimated costs and emissions reductions for the 2007/2010 standards and the newly estimated costs associated with today's HDOBD proposal.

Here we present the emission benefits we anticipate from heavy-duty vehicles as a result of our 2007/2010 NO_X, PM, and NMHC emission standards for heavy-duty engines. The graphs and tables that follow illustrate the Agency's projection of future emissions from heavy-duty vehicles for each pollutant. The baseline case represents future emissions from heavy-duty vehicles at present standards (including the MY2004 standards). The controlled case represents the future emissions from heavy-duty vehicles once the new 2007/2010 standards are implemented. A detailed analysis of the emissions reductions associated with the 2007/2010 HD highway standards is contained in the Regulatory Impact Analysis for that final rule.[70] The results of that analysis are presented in Table V.A–1 and in Figures V.A–1 through V.A–3.

TABLE V.A–1.—ANNUAL EMISSIONS REDUCTIONS ASSOCIATED WITH THE 2007HD HIGHWAY PROGRAM

[thousand short tons]

Year	NO_X	PM	NMHC
2007	58	11	2
2010	419	36	21
2015	1,260	61	54
2020	1,820	82	83
2030	2,570	109	115

[70] Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements; EPA420–R–00–026; December 2000.

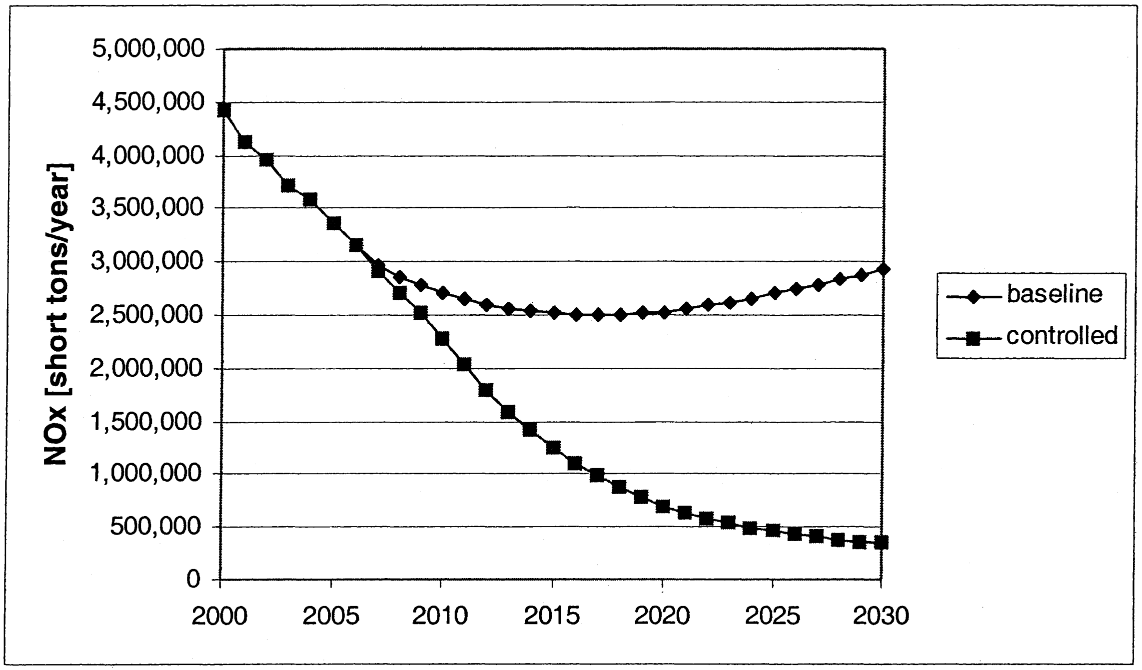

Figure V.A-1: Projected Nationwide Heavy-Duty Vehicle NOx Emissions; Control Case Represents the 2007/2010 Emissions Standards

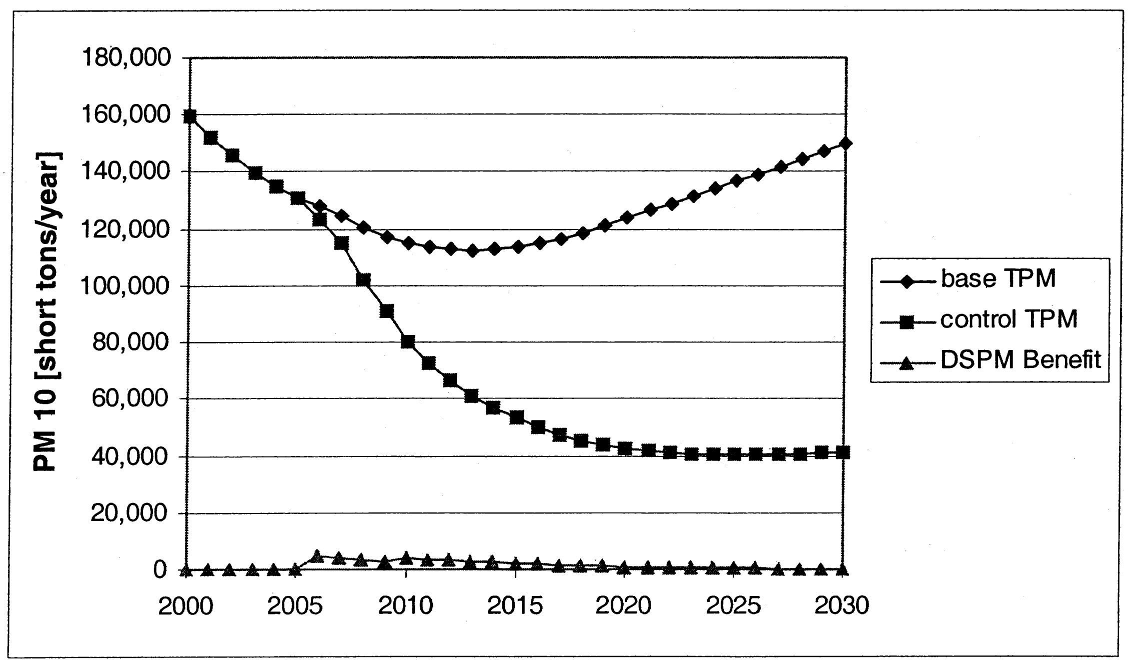

Figure V.A-2: Projected Nationwide Heavy-Duty Vehicle PM Emissions and Direct Sulfate PM Emission Reductions; Control Case Represents the 2007/2010 Emissions Standards

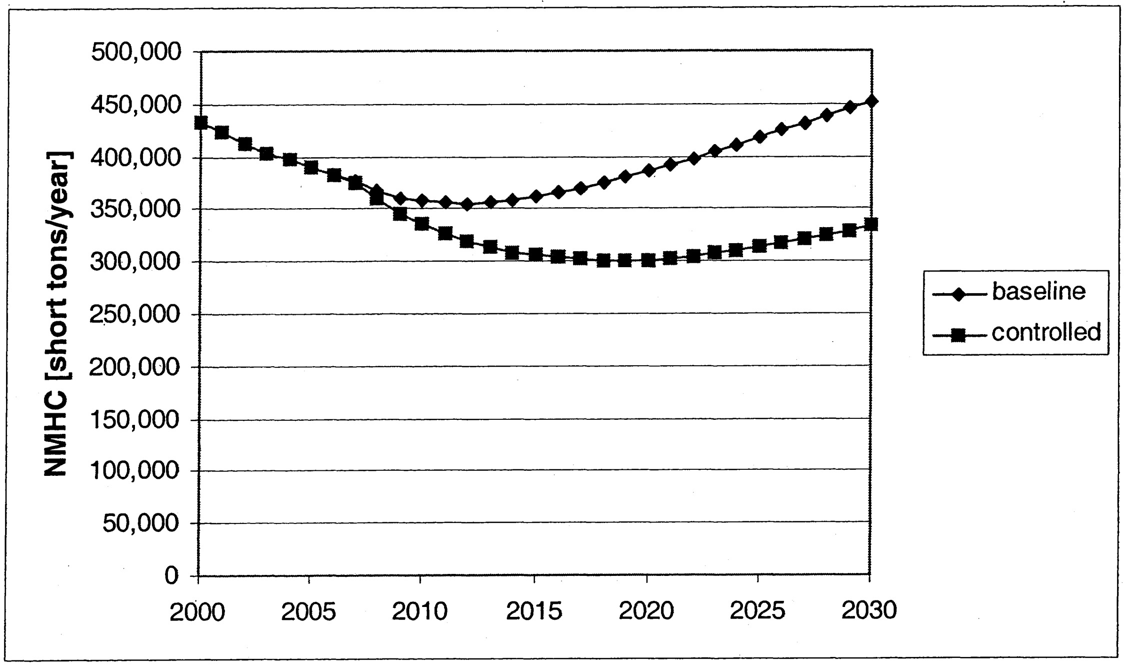

Figure V.A-3: Projected Nationwide Heavy-Duty Vehicle NMHC Emissions; Control Case Represents the 2007/2010 Emissions Standards

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There were additional estimated emissions reductions associated with the 2007HD highway rule—namely CO, SO_X, and air toxics. We have not presented those additional emissions reductions here since, while HDOBD will identify malfunctions and hasten their repair with the result of reducing all emissions constituents, these additional emissions are not those specifically targeted by OBD systems.

VI. What Are the Costs Associated With the Proposed OBD Requirements?

Estimated engine costs are broken into variable costs and fixed costs. Variable costs are those costs associated with any new hardware required to meet the proposed requirements, the associated assembly time to install that hardware, and the increased warranty costs associated with the new hardware. Variable costs are additionally marked up to account for both manufacturer and dealer overhead and carrying costs. The manufacturer's carrying cost was estimated to be four percent of the direct costs to account for the capital cost of the extra inventory and the incremental costs of insurance, handling, and storage. The dealer's carrying cost was estimated to be three percent of their direct costs to account for the cost of capital tied up in inventory. We adopted this same approach to markups in the 2007HD highway rule and our more recent Nonroad Tier 4 rule based on industry input.

Fixed costs considered here are those for research and development (R&D), certification, and production evaluation testing. The fixed costs for engine R&D are estimated to be incurred over the four-year period preceding introduction of the engine. The fixed costs for certification include costs associated with demonstration testing of OBD parent engines including the "limit" parts used to demonstrate detection of malfunctions at or near the applicable OBD thresholds, and generation of certification documentation. Production evaluation testing includes testing real world products for standardization features, monitor function, and performance ratios. The certification costs are estimated to be incurred one year preceding introduction of the engine while the production evaluation testing is estimated to occur in the same year as introduction.

The details of our cost analysis are contained in the technical support document which can be found in the docket for this rule.[71] We have only summarized the results of that analysis here and point the reader to the technical support document for details. We request comment on all aspects of our cost analysis.

A. Variable Costs for Engines Used in Vehicles Over 14,000 Pounds

The variable costs we have estimated represent those costs associated with various sensors that we believe would have to be added to the engine to provide the required OBD monitoring capability. For the 2010 model year, we believe that upgraded computers and the new sensors needed for OBD would result in costs to the buyer of $40 and $50 for diesel and gasoline engines, respectively. For the 2013 model year, we have included costs associated with the dedicated MIL and its wiring resulting in a hardware cost to the buyer of $50 and $60 for both diesel and gasoline engines, respectively. By multiplying these costs per engine by the projected annual sales we get annual costs of around $40–50 million for diesel engines and $3–4 million for gasoline engines, depending on sales. The 30 year net present value of the annual variable costs would be $666 million and $352 million at a three percent and a seven percent discount rate, respectively. These costs are summarized in Table VI.A–1.

[71] Draft Technical Support Document, HDOBD NPRM, EPA420–D–06–006, Docket ID# EPA–HQ–OAR–2005–0047–0008.

TABLE VI.A–1.—OBD VARIABLE COSTS FOR ENGINES USED IN VEHICLES OVER 14,000 POUNDS

[All costs in $millions except per engine costs; 2004 dollars]

	Diesel	Gasoline	Total
Cost per engine (2010–2012)	$40	$50	n/a
Cost per engine (2013+)	50	60	n/a
Annual Variable Costs in 2010 [a]	14	1	$15
Annual Variable Costs in 2013 [a]	38	3	40
Annual Variable Costs in 2030 [a]	48	4	52
30 year NPV at a 3% discount rate	620	47	666
30 year NPV at a 7% discount rate	328	25	352

[a] Annual variable costs increase as projected sales increase.

B. Fixed Costs for Engines Used in Vehicles Over 14,000 Pounds

We have estimated fixed costs for research and development (R&D), certification, and production evaluation testing. The R&D costs include the costs to develop the computer algorithms required to diagnose engine and emission control systems, and the costs for applying the developed algorithms to each engine family and to each variant within each engine family. R&D costs also include the testing time and effort needed to develop and apply the OBD algorithms. The certification costs include the costs associated with testing of durability engines (i.e., the OBD parent engines), the costs associated with generating the ''limit'' parts that are required to demonstrate OBD detection at or near the applicable emissions thresholds, and the costs associated with generating the necessary certification documentation. Production evaluation testing costs included the costs associated with the three types of production testing: standardization features, monitor function, and performance ratios.

Table VI.B–1 summarizes the R&D, certification, and production evaluation testing costs that we have estimated. The R&D costs we have estimated were totaled and then spread over the four year period prior to implementation of the requirements for which the R&D is conducted. By 2013, all of the R&D work would be completed in advance of 100 percent compliance in 2013; hence, R&D costs are zero by 2013. Certification costs are higher in 2013 than in 2010 because 2010 requires one engine family to comply while 2013 requires all engine families to comply. The 30 year net present value of the annual fixed costs would be $291 million and $241 million at a three percent and a seven percent discount rate, respectively.

TABLE VI.B–1.—OBD FIXED COSTS FOR ENGINES USED IN VEHICLES OVER 14,000 POUNDS

[All costs in $millions; 2004 dollars]

	Diesel			Gasoline			
	R&D	Certification & PE testing	Subtotal	R&D	Certification & PE testing	Subtotal	Total
Annual OBD Fixed Costs in given years:							
2010	$51	$0.2	$52	$0.9	<$0.1	$1	$53
2013	0	0.4	0.4	0	<0.1	<0.1	0.4
2030	0	3	3	0	<0.1	<0.1	3
30 year NPV at the given discount rate:							
3 percent	$263	$17	$280	$10	$0.3	$10	$291
7 percent	223	10	232	9	0.2	9	241

C. Total Costs for Engines Used in Vehicles Over 14,000 Pounds

The total OBD costs for engines used in vehicles over 14,000 pounds are summarized in Table VI.C–1. As shown in the table, the 30 year net present value cost is estimated at $1 billion and $594 million at a three percent and a seven percent discount rate, respectively. These costs are much lower than the 30 year net present value costs estimated for the 2007HD highway emissions standards which were $25 billion and $15 billion at a three percent and a seven percent discount rate, respectively, for diesel and gasoline engines. Including the cost for the diesel fuel changes resulted in 30 year net present value costs for that rule of $70 billion and $42 billion at a three percent and a seven percent discount rate, respectively. See section VII for more details regarding the cost estimates from the 2007HD highway final rule.

TABLE VI.C–1.—OBD TOTAL COSTS FOR ENGINES USED IN VEHICLES OVER 14,000 POUNDS

[All costs in $millions; 2004 dollars]

	Diesel	Gasoline	Total
Annual OBD Total Costs in given years			
2010	$65	$2	$67
2013	38	3	41
2030	51	4	55
30 year NPV at the given discount rate			
3%	900	57	957
7%	560	34	594

D. Costs for Diesel Heavy-Duty Vehicles and Engines Used in Heavy-duty Vehicles Under 14,000 Pounds

The total OBD costs for 8,500 to 14,000 pound diesel applications are summarized in Table VI.D–1. As shown in the table, the 30 year net present value cost is estimated at $6 million and $5 million at a three percent and a seven percent discount rate, respectively. These costs represent the incremental costs of the proposed additional OBD requirements, as compared to our current OBD requirements, for 8,500 to 14,000 pound diesel applications and do not represent the total costs for 8,500 to 14,000 pound diesel OBD. We are proposing no changes to the 8,500 to 14,000 pound gasoline requirements so, therefore, have estimated no costs for gasoline vehicles. Details behind these estimated costs can be found in the technical support document contained in the docket for this rule.[72]

TABLE VI.D–1.—TOTAL OBD COSTS FOR 8,500 TO 14,000 POUND DIESEL APPLICATIONS

[All costs in $millions; 2004 dollars]

	Diesel	Gasoline	Total
Annual OBD Total Costs in given years			
2010	$0.1	$0	$0.1
2013	0	0	0
2030	0.4	0	0.4
30 year NPV at the given discount rate			
3%	6	0	6
7%	5	0	5

VII. What are the Updated Annual Costs and Costs per Ton Associated With the 2007/2010 Heavy-duty Highway Program?

In the 2007HD highway rule, we estimated the costs we expected to occur as a result of the emissions standards being made final in that rule. As noted in section V, we consider the OBD requirements contained in today's proposal to be an important element of the 2007HD highway program and its ultimate success and not a new element being included as an addition to that program. In fact, without the proposed OBD requirements we would not expect the emissions reductions associated with the 2007/2010 standards to be fully realized because emissions control systems cannot be expected to operate without some need for repair which, absent OBD, may well never be done. However, as noted in section VI, because we did not include an OBD program in the 2007HD highway program, we did not estimate OBD related costs at that time. We have now done so and those costs are presented in section VI.

Here we present the OBD costs as part of the greater 2007HD highway program. To do this, we present both the costs developed for that program and the additional OBD costs presented in section VI. We also calculate a new set of costs per ton associated with the 2007/2010 standards which include the previously estimated costs and emissions reductions for the 2007/2010 standards and the newly estimated costs associated with today's HDOBD proposal.

Note that the costs estimates associated with the 2007HD highway program were done using 1999 dollars. We have estimated OBD costs in 2004 dollars. We consulted the Producer Price Index (PPI) for ''Motor vehicle parts manufacturing-new exhaust system parts'' developed by the Bureau of Labor Statistics and found that the PPI for such parts had actually decreased from 1999 to 2004.[73] This suggests that the cost to produce exhaust system parts has decreased since 1999. For clarity, rather than adjusting downward the 2007HD highway program costs from 1999 dollars, or adjusting upward the OBD costs from 2004 dollars, we have chosen to present the 2007HD highway rule costs as they were presented in that final rule alongside the OBD costs presented in section VI. In short, we are ignoring the PPI effect in the following tables.

A. Updated 2007 Heavy-Duty Highway Rule Costs Including OBD

Table VII.A–1 shows the 2007HD highway program costs along with the estimated OBD related costs.

TABLE VII.A–1.—UPDATED 2007HD HIGHWAY PROGRAM COSTS, INCLUDING NEW OBD-RELATED COSTS, NET PRESENT VALUE OF ANNUAL COSTS FOR THE YEARS 2006–2035

[All costs in $millions]

Discount rate	2007 HD Highway Final Rule				Proposed HD OBD	Updated total program costs
	Diesel engine costs	Gasoline engine & vehicle costs	Diesel fuel costs	Original total costs		
3 percent	$23,721	$1,514	$45,191	$70,427	$963	$71,389
7 percent	14,369	877	26,957	42,203	599	42,802

[72] Draft Technical Support Document, HDOBD NPRM, EPA420–D–06–006, Docket ID# EPA–HQ–OAR–2005–0047–0008.

[73] See *www.bls.gov/ppi;* All other motor vehicle parts mfg; Exhaust system parts, new; series ID PCU3363993363993; Base date 8812.

B. Updated 2007 Heavy-Duty Highway Rule Costs per Ton Including OBD

Table VII.B–1 shows the 2007HD highway program costs per ton of pollutant reduced. These numbers are straight from the 2007HD highway final rule which contains the details regarding the split between NO_X+NMHC and PM related costs.

TABLE VII.B–1.—ORIGINAL 2007HD HIGHWAY PROGRAM COSTS, EMISSIONS REDUCTIONS, AND $/TON REDUCED

[Net present values are for annual costs for the years 2006–2035]

Discount rate	Pollutant	30 year NPV cost ($billions)	30 year NPV reduction (million tons)	$/ton
3 percent	NO_X+NMHC	54.6	30.6	1,780
	PM	16.0	1.4	11,790
7 percent	NO_X+NMHC	34.9	16.2	2,150
	PM	10.3	0.8	13,610

Table VII.B–2 shows the updated 2007HD highway program costs per ton of pollutant reduced once the new OBD costs have been included. For the split between NO_X+NMHC and PM-related OBD costs, we have used a 50/50 allocation. As shown in Table VII.B–2, the OBD costs associated with the proposed OBD requirements have little impact on the overall costs and costs per ton of emissions reduced within the context of the 2007HD highway program.

TABLE VII.B–2.—UPDATED 2007HD HIGHWAY PROGRAM COSTS, EMISSIONS REDUCTIONS, AND $/TON REDUCED INCLUDING OBD RELATED COSTS

[Net present values are for annual costs for the years 2006–2035]

Discount rate	Pollutant	30 year NPV cost ($billions)	30 year NPV reduction (million tons)	$/ton
3 percent	NO_X+NMHC	55.1	30.6	1,800
	PM	16.5	1.4	12,210
7 percent	NO_X+NMHC	35.2	16.2	2,170
	PM	10.6	0.8	14,130

VIII. What Are the Requirements for Engine Manufacturers?

A. Documentation Requirements

The OBD system certification requirements would require manufacturers to submit OBD system documentation that represents each engine family. The certification documentation would be required to contain all of the information needed to determine if the OBD system meets the proposed OBD requirements. The proposed regulation lists the information that would be required as part of the certification package. If any of the information in the certification package is the same for all of a manufacturer's engine families (e.g., the OBD system general description), the manufacturer would only be required to submit one set of documents each model year for such items that would cover all of its engine families.

While the majority of the proposed OBD requirements would apply to the engine and be incorporated by design into the engine control module by the engine manufacturer, a portion of the proposed OBD requirements would apply to the vehicle and not be self-contained within the engine. Examples include the proposed requirements to have a MIL in the instrument cluster and a diagnostic connector in the cab compartment. As is currently done by the engine manufacturers, a build specification is provided to vehicle manufacturers detailing mechanical and electrical specifications that must be adhered to for proper installation and use of the engine (and to maintain compliance with emissions standards). We expect engine manufacturers would continue to follow this practice so that the vehicle manufacturer would be able to maintain compliance with the proposed OBD regulations. Installation specifications would be expected to include instructions regarding the location, color, and display icon of the MIL (as well as electrical connections to ensure proper illumination), location and type of diagnostic connector, and electronic VIN access. During the certification process, in addition to submitting the details of all of the diagnostic strategies and other information required, engine manufacturers would be required to submit a copy of the OBD-relevant installation specifications provided to vehicle manufacturers and a description of the method used by the engine manufacturer to ensure vehicle manufacturers adhere to the provided installation specifications (e.g., required audit procedures or signed agreements to adhere to the requirements). We are requiring that this information be submitted to us to provide a reasonable level of verification that the proposed OBD requirements would indeed be satisfied. In summary, engine manufacturers would be responsible for submitting a certification package that includes:

- A detailed description of all OBD monitors, including monitors on signals or messages coming from other modules upon which the engine control unit relies to perform other OBD monitors; and,
- A copy of the OBD-relevant installation specifications provided to vehicle manufacturers/chassis builders and the method used to reasonably ensure compliance with those specifications.

As was discussed in the context of our implementation schedule (see section II.G.1), the proposed regulations would allow engine manufacturers to establish

OBD groups consisting of more than one engine family with each having similar OBD systems. The manufacturer could then submit only one set of representative OBD information from each OBD group. We anticipate that the representative information would normally consist of an application from a single representative engine rating within each OBD group. In selecting the engine ratings to represent each OBD group, consideration should be given to the exhaust emission control components for all engine families and ratings within an OBD group. For example, if one engine family within an OBD group has additional emission control devices relative to another family in the group (e.g., the first family has a DPF+SCR while the second has only a DPF), the representative rating should probably come from the first engine family. Manufacturers seeking to consolidate several engine families into one OBD group would be required to get approval of the grouping prior to submitting the information for certification.

Two of the most important parts of the certification package would be the OBD system description and summary table. The OBD system description would include a complete written description for each monitoring strategy outlining every step in the decision-making process of the monitor, including a general explanation of the monitoring conditions and malfunction criteria. This description should include graphs, diagrams, and/or other data that would help our compliance staff understand how each monitor works and interacts. The OBD summary table would include specific parameter values. This table would provide a summary of the OBD system specifications, including: the component/system, the DTC identifying each related malfunction, the monitoring strategy, the parameter used to detect a malfunction and the malfunction criteria limits against which the parameter is evaluated, any secondary parameter values and the operating conditions needed to run the monitor, the time required to execute and complete a monitoring event for both a pass decision and a fail decision, and the criteria or procedure for illuminating the MIL. In these tables, manufacturers would be required to use a common set of engineering units to simplify and expedite the review process.

We are also proposing that the manufacturer submit a logic flowchart for each monitor that would illustrate the step-by-step decision process for determining malfunctions. Additionally, we would need any data that supports the criteria used to determine malfunctions that cause emissions to exceed the specified malfunction thresholds (see Tables II.B–1 and II.C–1). The manufacturer would have to include data that demonstrates the probability of misfire detection by the misfire monitor over the full engine speed and load operating range (for gasoline engines only) or the capability of the misfire monitor to correctly identify a ''one cylinder out'' misfire for each cylinder (for diesel engines only), a description of all the parameters and conditions necessary to begin closed-loop fuel control operation (for gasoline engines only), closed-loop EGR control (for diesel engines only), closed-loop fuel pressure control (for diesel engines only), and closed-loop boost control (for diesel engines only). We would also need a listing of all electronic powertrain input and output signals (including those not monitored by the OBD system) that identifies which signals are monitored by the OBD system, and the emission data from the OBD demonstration testing (as described below). Lastly, the manufacturer would be expected to provide any other OBD-related information necessary to determine the OBD compliance status of the manufacturer's product line.

B. Catalyst Aging Procedures

For purposes of determining the catalyst malfunction criteria for diesel NMHC converting catalysts, SCR catalysts, and lean NO_X catalysts, and for gasoline catalysts, where those catalysts are monitored individually, the manufacturer must use a catalyst deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning engine operating conditions. For purposes of determining the catalyst malfunction criteria for diesel NMHC converting catalysts, SCR catalysts, and lean NO_X catalysts, and for gasoline catalysts, where those catalysts are monitored in combination with other catalysts, the manufacturer would have to submit their catalyst system aging and monitoring plan to the Administrator as part of their certification documentation package. The plan would include the description, emission control purpose, and location of each component, the monitoring strategy for each component and/or combination of components, and the method for determining the applicable malfunction criteria including the deterioration/aging process.

C. Demonstration Testing

While the proposed certification documentation requirements discussed above would require manufacturers to submit technical details of each monitor (e.g., how each monitor worked, when the monitor would run), we would still need some assurance that the manufacturer's OBD monitors are indeed calibrated correctly and are able to detect a malfunction before an emissions threshold is exceeded. Thus, we are proposing that manufacturers conduct certification demonstration testing of the major monitors to verify the malfunction threshold values. This testing would be required on one to three demonstration engines per year. Before receiving a certificate of compliance, the manufacturer would be required to submit documentation and emissions data demonstrating that the major OBD monitors are able to detect a malfunction when emissions exceed the emissions thresholds. On each demonstration engine, this testing would consist of the following two elements:

- Testing the OBD system with ''threshold'' components (i.e., components that are deteriorated or malfunctioning right at the threshold required for MIL illumination); and,
- Testing the OBD system with ''worst case'' components. This element of the demonstration test would have to be done for the DPF and any NO_X aftertreatment system only.

By testing with both threshold components (i.e., the best performing malfunctioning components) and with worst case components (i.e., the worst performing malfunctioning components), we would be better able to verify that the OBD system should perform as expected regardless of the level of deterioration of the component. This could become increasingly important with new technology aftertreatment devices that could be subject to complete failure (such as DPFs) or even to tampering by vehicle operators looking to improve fuel economy or vehicle performance. We believe that, given the likely combinations of emissions control hardware, a diesel engine manufacturer would likely need to conduct 8 to 10 emissions tests per demonstration engine to satisfy these requirements and a gasoline engine manufacturer would likely need to conduct five to seven emissions tests per demonstration engine.[74]

[74] For diesel engines these would include: the fuel system; misfire (HCCI engines); EGR, turbo boost control, DPF, NO_X adsorber or SCR system,

Continued

1. Selection of Test Engines

To minimize the test burden on manufacturers, we are proposing that this testing be done on only one to three demonstration engines per year per manufacturer rather than requiring that all engines be tested. Such an approach should still allow us to be reasonably sure that manufacturers have calibrated their OBD systems correctly on all of their engines. This also spreads the test burden over several years and allows manufacturers to better utilize their test cell resources. This approach is consistent with our approach to demonstration testing to existing emissions standards where a parent engine is chosen to represent each engine family and emissions test data for only that parent engine are submitted to EPA.[75]

The number of demonstration engines manufacturers would be required to test would be aligned with the phase-in of OBD in the 2010 and 2013 model years and based on the year and the total number of engine families the manufacturer would be certifying for that model year. Specifically, for the 2010 model year when a manufacturer is only required to implement OBD on a single engine family, demonstration testing would be required on only one engine (a single engine rating within the one engine family). This would be the OBD parent rating as discussed in section II.G. For the 2013 model year, manufacturers would be required to conduct demonstration testing on one to three engines per year (i.e., one to three OBD parent ratings). The number of parent ratings would be chosen depending on the total number of engine families certified by the manufacturer. A manufacturer certifying one to five engine families in the given year would be required to test one demonstration engine. A manufacturer certifying six to ten engine families in the given year would be required to test two demonstration engines, and a manufacturer certifying more than ten engine families in the given year would be required to test three demonstration engines. For the 2016 and subsequent model years, we would work closely with CARB staff and the manufacturer to determine the parent ratings so that the same ratings are not acting as the parents every year. In other words, our definitions for the OBD parent ratings as discussed here apply only during the years 2010 through 2012 and again for the years 2013 through 2015.

Given the difficulty and expense in removing an in-use engine from a vehicle for engine dynamometer testing, this demonstration testing would likely represent nearly all of the OBD emission testing that would ever be done on these engines. Requiring a manufacturer who is fully equipped to do such testing, and already has the engines on engine dynamometers for emission testing, to test one to three engines per year would be a minimal testing burden that provides invaluable and, in a practical sense, otherwise unobtainable proof of compliance with the OBD emissions thresholds.

Regarding the selection of which engine ratings would have to be demonstrated, manufacturers would be required to submit descriptions of all engine families and ratings planned for the upcoming model year. We would review the information and make the selection(s) in consultation with CARB staff and the manufacturer. For each engine family and rating, the information submitted by the manufacturer would need to identify engine model(s), power ratings, applicable emissions standards or family emissions limits, emissions controls on the engine, and projected engine sales volume. Factors that would be used in selecting the one to three engine ratings for demonstration testing include, but are not limited to, new versus old/carryover engines, emissions control system design, possible transition point to more stringent emissions standards and/or OBD emissions thresholds, and projected sales volume.

2. Required Testing

Regarding the actual testing, the manufacturer would be required to perform ''single fault'' testing using the applicable test procedure and with the appropriate components/systems set at the manufacturer defined malfunction criteria limits for the following monitors:

- For diesel engines: Fuel system; misfire; EGR; turbo boost control; NMHC catalyst; NO_X catalyst/adsorber; DPF; exhaust gas sensors; VVT; and any other monitor that would fall within the discussion of section II.D.5.
- For gasoline engines: Fuel system; misfire; EGR; cold start strategy; secondary air; catalyst; exhaust gas sensors; VVT; and any other monitor that would fall within the discussion of section II.D.5.

Such ''single fault'' testing would require that, when performing a test for a specific parameter, that parameter must be operating at the malfunction criteria limit while all other parameters would be operating within normal characteristics (unless the malfunction prohibits some other parameter from operating within its normal characteristics). Also, the manufacturer would be allowed to use computer modifications to cause the specific parameter to operate at the malfunction limit provided the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction. Lastly, for each of these testing requirements, wherever the manufacturer has established that only a functional check is required because no failure or deterioration of the specific tested component/system could result in an engine's emissions exceeding the applicable emissions thresholds, the manufacturer would not be required to perform a demonstration test. In such cases, the manufacturer could simply provide the data and/or engineering analysis used to determine that only a functional test of the component/system was required.

Manufacturers required to submit data from more than one engine rating would be granted some flexibility by allowing the data to be collected under less rigorous testing requirements than the official FTP or SET certification test. That is, for the possible second and third engine ratings required for demonstration testing, manufacturers would be allowed to submit data using internal sign-off test procedures that are representative of the official FTP or SET in lieu of running the official test. Commonly used procedures include the use of engine emissions test cells with less rigorous quality control procedures than those required for the FTP or SET or the use of forced cool-downs to minimize time between tests. Manufacturers would still be liable for meeting the OBD emissions thresholds on FTPs and/or SETs conducted in full accordance with the Code of Federal Regulations. Nonetheless, this latitude would allow them to use some short-cut methods that they have developed to assure themselves that the system is calibrated to the correct level without incurring the additional testing cost and burden of running the official FTP or SET on every demonstration engine.

For the demonstration engine(s), a manufacturer would be required to use an engine(s) aged for a minimum of 125

NMHC catalyst, exhaust gas sensors, VVT, and possible other emissions controls (see section II.D.5). For gasoline engines these would include: the fuel system, misfire, EGR, cold start strategy, secondary air system, catalyst, exhaust gas sensors, VVT, and possible other emissions controls (see section II.D.5). Some of these may require more than one emissions test while others may not require any due to the use of a functional monitor rather than an emissions threshold monitor.

[75] For over 14,000 pound OBD, we are proposing a different definition of a ''parent'' engine than is used for emissions certification. This is discussed at length in section II.G.

hours plus exhaust aftertreatment devices aged to be representative of full useful life. Manufacturers would be expected to use, subject to approval, an aging process that ensures that deterioration of the exhaust aftertreatment devices is stabilized sufficiently such that it properly represents the performance of the devices at the end of their useful life.

3. Testing Protocol

We are proposing that the manufacturer be allowed to use any applicable test cycle for preconditioning test engines prior to conducting each of the emissions tests discussed above. Additional preconditioning can be done if the manufacturer has provided data and/or engineering analyses that demonstrate that additional preconditioning is necessary.

The manufacturer would then set the system or component of interest at the criteria limit(s) prior to conducting the applicable preconditioning cycle(s). If more than one preconditioning cycle is being used, the manufacturer may adjust the system or component of interest prior to conducting the subsequent preconditioning cycle. However, the manufacturer may not replace, modify, or adjust the system or component of interest following the last preconditioning cycle.

After preconditioning, the test engine would be operated over the applicable test cycle to allow for the initial detection of the tested system or component malfunction. This test cycle may be omitted from the testing protocol if it is unnecessary. If required by the designated monitoring strategy, a cold soak may be performed prior to conducting this test cycle. The test engine would then be operated over the applicable exhaust emission test.

A manufacturer required to test more than one test engine may use internal calibration sign-off test procedures (e.g., forced cool downs, less frequently calibrated emission analyzers) instead of official test procedures to obtain this emissions test data for all but one of the required test engines. However, the manufacturer should use sound engineering judgment to ensure that the data generated using such alternative test/sign-off procedures are good data because manufacturers would still be responsible for meeting the malfunction criteria when emissions tests are performed in accordance with official test procedures.

Manufacturers would be allowed to use alternative testing protocols, even chassis testing, for demonstration of MIL illumination if the engine dynamometer emissions test cycle does not allow all of a monitor's enable conditions to be satisfied. Manufacturers wanting to do so would be required to demonstrate the technical necessity for using their alternative test cycle and that using it demonstrates that the MIL would illuminate during in-use operation with the malfunctioning component.

4. Evaluation Protocol

For all demonstration tests on parent engines, we would expect that the MIL would activate upon detecting the malfunctioning system or component, and that it should occur before the end of the first engine start portion of the emissions test. If the MIL were to activate prior to emissions exceeding the applicable malfunction criteria, no further demonstration would be required. With respect to the misfire monitor demonstration test, if the manufacturer has elected to use the minimum misfire malfunction criterion of one percent (as is allowed), then no further demonstration would be required provided the MIL were to illuminate during a test with an implanted misfire of one percent.

If the MIL does not activate when the system or component being tested is set at its malfunction criteria limits, then the criteria limits or the OBD system would not be considered acceptable. Retesting would be required with more tightly controlled criteria limits (i.e., recalibrated limits) and/or another suitable system or component that would result in MIL activation. If the criteria limits are recalibrated, the manufacturer would be required to confirm that the systems and components that were tested prior to recalibration would still function properly and as required.

5. Confirmatory Testing

We may choose to confirmatory test a demonstration engine to verify the emissions test data submitted by the manufacturer. Any such confirmatory testing would be limited to the engine rating represented by the demonstration engine(s) (i.e., the parent engine(s)). To do so, we, or our designee, would install appropriately deteriorated or malfunctioning components (or simulate a deteriorated or malfunctioning component) in an otherwise properly functioning engine of the same engine family and rating as the demonstration engine. Such confirmatory testing would be done on those OBD monitors for which demonstration testing had been conducted as described in this section. The manufacturer would be required to make available, upon Administrator request, a test engine and all test equipment—e.g., malfunction simulators, deteriorated components—necessary to duplicate the manufacturer's testing.

D. Deficiencies

Our under 14,000 pound OBD requirements have contained a deficiency provision for years. The OBD deficiency provision was first introduced on March 23, 1995 (60 FR 15242), and was revised on December 22, 1998 (63 FR 70681). Consistent with that provision, we are proposing a deficiency provision for over 14,000 pound OBD. We believe that, like has occurred and even still occurs with under 14,000 pound OBD, some manufacturers will encounter unforeseen and generally last minute problems with some of their OBD monitoring strategies despite having made a good faith effort to comply with the requirements. Therefore, we are proposing a provision that would permit certification of an over 14,000 pound OBD system with ''deficiencies'' in cases where a good faith effort to fully comply has been demonstrated. In making deficiency determinations, we would consider the extent to which the proposed OBD requirements have been satisfied overall based on our review of the certification application, the relative performance of the given OBD system compared to systems that truly are fully compliant with the proposed OBD requirements, and a demonstrated good-faith effort on the part of the manufacturer to both meet the proposed requirements in full and come into full compliance as expeditiously as possible.

We believe that having the proposed deficiency provision is important because it would facilitate OBD implementation by allowing for certification of an engine despite having a relatively minor shortfall. Note that we do not expect to certify engines with OBD systems that have more than one deficiency, or to allow carryover of any deficiency to the following model year unless it can be demonstrated that correction of the deficiency requires hardware and/or software modifications that cannot be accomplished in the time available, as determined by the Administrator.[76] Nonetheless, we recognize that there may be situations where more than one deficiency is necessary and appropriate, or where carry-over of a deficiency or deficiencies for more than one year is necessary and

[76] The CARB HDOBD rulemaking has a provision to charge fees associated with OBD deficiencies 13 CCR 1971.1(k)(3), Docket ID# EPA–HQ–OAR–2005–0047–0006. We have never had and are not proposing any such fee provision.

appropriate. In such situations, more than one deficiency, or carry-over for more than one year, may be approved, provided the manufacturer has demonstrated an acceptable level of effort toward full OBD compliance. Most importantly, the deficiency provisions cannot be used as a means to avoid compliance or delay implementation of any OBD monitors or as a means to compromise the overall effectiveness of the OBD program.

There has often been some confusion by manufacturers regarding what CARB has termed ''retroactive'' deficiencies. The CARB rule states that, ''During the first 6 months after commencement of normal production, manufacturers may request that the Executive Officer grant a deficiency and amend an engine's certification to conform to the granting of the deficiencies for each aspect of the monitoring system: (a) Identified by the manufacturer (during testing required by section (l)(2) or any other testing) to be functioning different than the certified system or otherwise not meeting the requirements of any aspect of section 1971.1; and (b) reported to the Executive Officer.'' [77] We have never had and are not proposing any such retroactive deficiency provision. We have regulations in place that govern situations, whether they be detected by EPA or by the manufacturer, where in-use vehicles or engines are determined to be functioning differently than the certified system.[78] We refer to these regulations as our defect reporting requirements and manufacturers are required to comply with these regulations, even for situations deemed by CARB to be ''retroactive'' deficiencies, unless the defect is corrected prior to the sale of engines to an ultimate purchaser. In other words, a retroactive deficiency granted by the Executive Officer does not preclude a manufacturer from complying with our defect reporting requirements.

E. Production Evaluation Testing

The OBD system is a complex software and hardware system, so there are many opportunities for unintended interactions that can result in certain elements of the system not working as intended. We have seen many such mistakes in the under 14,000 pound arena ranging from OBD systems that are unable to communicate any information to a scan tool to monitors that are unable to store a DTC and illuminate the MIL. While over 14,000 pound heavy-duty vehicles are very different from light-duty vehicles in terms of emission controls and OBD monitoring strategies, among other things, these types of problems do not depend on these differences and, as such, are as likely to occur with over 14,000 pound OBD as they are with under 14,000 pound OBD. Additionally, we believe that there is great value in having manufacturers self-test actual production end products that operate on the road, as opposed to pre-production products, where errors can be found in individual subsystems that may work fine by themselves but not when integrated into a complete product (e.g., due to mistakes like improper wiring).

Therefore, we are proposing that manufacturers self-test a small fraction of their product line to verify compliance with the OBD requirements. The test requirements are divided into three distinct sections with each section representing a test for a different portion of the OBD requirements. These three sections being: compliance with the applicable SAE and/or ISO standardization requirements; compliance with the monitoring requirements for proper DTC storage and MIL illumination; and, compliance with the in-use monitoring performance ratios.

1. Verification of Standardization Requirements

An essential part of the OBD system is the requirement for standardization. The proposed standardization requirements include items as simple as the location and shape of the diagnostic connector (where technicians can ''plug in'' a scan tool to the onboard computer) to more complex subjects concerning the manner and format in which DTC information is accessed by technicians via a ''generic'' scan tool. Manufacturers must meet these standardization requirements to facilitate the success of the proposed OBD program because they ensure consistent access by all repair technicians to the stored information in the onboard computer. The need for consistency is even greater when considering the potential use of OBD system checks in inspection and maintenance (I/M) programs for heavy-duty. Such OBD base I/M checks would benefit from having access to the diagnostic information in the onboard computer via a single ''generic'' scan tool instead of individual tools for every make and model of truck that might be inspected. For OBD based inspections to work effectively and efficiently, all engines/vehicles must be designed and built to meet all of the applicable standardization requirements.

While we anticipate that the vast majority of vehicles would comply with all of the standardization requirements, some problems involving the communication between vehicles and ''generic'' scan tools are likely to occur in the field. The cause of such problems could range from differing interpretations of the existing standardization requirements to possible oversights by design engineers or hardware inconsistencies or even last-minute production changes on the assembly line.

To minimize the chance for such problems on future over 14,000 pound trucks, we are proposing that engine manufacturers be required to test a sample of production vehicles from the assembly line to verify that the vehicles have indeed been designed and built to the required specifications for communication with a ''generic'' scan tool. We are proposing that manufacturers be required to test complete vehicles to ensure that they comply with some of the basic ''generic'' scan tool standardization requirements, including those that are essential for proper inspection in an I/M setting. Ideally, manufacturers would be required to test one vehicle for each truck and engine model combination that is introduced into commerce. However, for a large engine manufacturer, this can be in the neighborhood of 5,000 to 10,000 unique combinations making it unreasonable to require testing of every combination. Therefore, we are proposing that manufacturers test 10 such combinations per engine family. Given that a typical engine family has roughly five different engine ratings, this works out to testing only around two vehicles per engine rating.

More specifically, manufacturers would be required to test one vehicle per software ''version'' released by the manufacturer. With proper demonstration, manufacturers would be allowed to group different calibrations together to be demonstrated by a common vehicle. Prior to acquiring these data, the proposal would require engine manufacturers to submit for approval a test plan verifying that the vehicles scheduled for testing would be representative of all vehicle configurations (e.g., each engine control module variant coupled with and without the other available vehicle components that could affect scan tool communication such as automatic transmission or hybrid powertrain control modules). The plan would have to include details on all the different applications and configurations that would be tested.

[77] See 13 CFR 1971.1(k)(6)), Docket ID# EPA–HQ–OAR–2005–0047–0006.

[78] See 40 CFR 85.1903.

As noted, manufacturers would be required to conduct this testing on actual production vehicles, not stand-alone engines. This is important since controllers that work properly in a stand alone setting (e.g., the engine before it is installed in a vehicle) may have interaction problems when installed and attempting to communicate with other vehicle controllers (e.g., the transmission controller). In such a case, separate testing of the controllers would be blind to the problem. Since heavy-duty engine manufacturers are expected to sell the same engine (with the same calibration) to various vehicle manufacturers who would put them in different final products (e.g., with different transmission control modules), the same communication problem would be expected in each final product.

This testing should occur soon enough in the production cycle to provide manufacturers with early feedback regarding the existence of any problems and time to resolve the problem prior to the entire model year's products being introduced into the field. We are proposing that the testing be done and the data submitted to us within either three months of the start of normal engine production or one month of the start of vehicle production, whichever is later.

To be sure that all manufacturers are testing vehicles to the same level of stringency, we are proposing that engine manufacturers submit documentation outlining the testing equipment and methods they intend to use to perform this testing. We anticipate that engine manufacturers and scan tool manufacturers would probably develop a common piece of hardware and software that could be used by all engine manufacturers at the end of the vehicle assembly line to meet this requirement. Two different projects (SAE J1699 and LOC3T) have developed such equipment in response to California OBD II requirements.[79] The equipment is currently being used to test 2005 and 2006 model year vehicles under 14,000 pounds. We believe that similar equipment could be developed for vehicles over 14,000 pounds in time for the 2013 model year. Ideally, the equipment and the test procedure would verify each and every requirement of the communication specifications including the various physical layers, message structure, response times, and message content. Presumably, any such verification equipment would not replace the function of existing ''generic'' scan tools used by repair technicians or I/M inspectors. The equipment would likely be custom-designed and be used for the express purpose of this assembly line testing (i.e., it would not include all of the necessary diagnostic features needed by repair technicians).

2. Verification of Monitoring Requirements

As noted above, the OBD system is a complex software and hardware system, so there are many opportunities for unintended interactions that can result in certain elements of the system not working as intended. The causes of possible problems vary from simple typing errors in the software code to component supplier hardware changes late in development or just prior to start of production. Given the complexity of OBD monitors and their associated algorithms, there can be thousands of lines of software code required to meet the diagnostic requirements. Implementing that code without interfering with the software code required for normal operation is and will be a very difficult task with many opportunities for human error. We expect that manufacturers will conduct some validation testing on end products to ensure that there are no problems that would be noticed by the vehicle operator. We believe that manufacturers should include in such verification testing an evaluation of the OBD system (e.g., does the MIL illuminate as intended in response to a malfunction?).

Therefore, we are proposing that engine manufacturers be required to perform a thorough level of validation testing on at least one production vehicle and up to two more production engines per model year. The production vehicles/engines required for testing would have to be equipped with/be from the same engine families and ratings as used for the certification demonstration testing described in section VIII.B.3. If a manufacturer demonstrated one, two, or three engines for certification, then at least one production vehicle and perhaps an additional one to two engines would have to be tested, respectively. We would work with the manufacturer and CARB staff to determine the actual vehicles and engines to test.

The testing itself would consist of implanting or simulating malfunctions to verify that virtually every single engine-related OBD monitor on the vehicle correctly identifies the malfunction, stores an appropriate DTC, and illuminates the MIL. Manufacturers would not be required to conduct any emissions testing. Instead, for those malfunctions designed against an emissions threshold, the manufacturer would simply implant or simulate a malfunction and verify detection, DTC storage, and MIL illumination. Actual ''threshold'' parts would not be needed for such testing. Implanted malfunctions could use severely deteriorated parts if desired by the manufacturer since the point of the testing is to verify detection, DTC storage, and MIL illumination. Upon submitting the data to the Administrator, the manufacturer would be required to also provide a description of the testing and the methods used to implant or simulate each malfunction. Note that testing of specific monitors would not be required if the manufacturer can show that no possible test exists that could be done on that monitor without causing physical damage to the production vehicle. We are proposing that the testing be completed and reported to us within six months after the manufacturer begins normal engine production. This should provide early feedback on the performance of every monitor on the vehicle prior to too many entering production. Upon good cause, we may extend the time period for testing.

Note that, in their HDOBD rule,[80] CARB allows, as an incentive to perform a thorough validation test, a manufacturer to request that any problem discovered during this self-test be treated as a ''retroactive'' deficiency. As discussed in section VIII.B.4, we do not have a provision for retroactive deficiencies. Importantly, a retroactive deficiency granted by the Executive Officer does not preclude a manufacturer from complying with our defect reporting requirements. This issue was discussed in more detail in section VIII.B.4.

3. Verification of In-Use Monitoring Performance Ratios

We are proposing that manufacturers track the performance of several of the most important monitors on the engine to determine how often they are monitoring during in-use operation. These requirements are discussed in more detail in section II.E. To summarize that discussion, monitors would be expected to execute in the real world and meet a minimum acceptable performance level determined as the ratio of the number of good monitoring events to the number of actual trips. The ratio being proposed is 10 percent, meaning that monitors should execute during at least 10 percent of the trips taken by the engine/vehicle. Monitors

[79] 13 CCR 1968.2, August 11, 2006, Docket ID# EPA–HQ–OAR–2005–0047–0005.

[80] 13 CCR 1971.1, Docket ID# EPA–HQ–OAR–2005–0047–0006.

that perform below the minimum ratio would be subject to remedial action and possibly recall. However, the minimum ratio is not effective until the 2013 and later model years. For the 2010 through 2012 model year engines certified to today's proposed OBD requirements, we are proposing that the data be collected even though the minimum ratio is not yet effective. The data gathered on these engines will help to determine whether the 10 percent ratio is appropriate for all applications and, if not, we would intend to propose a change to the proposed requirement to reflect that learning.

We are proposing that manufacturers gather these data on production vehicles rather than engines. Since not every vehicle can be evaluated, we are proposing that manufacturers generate groups of engine/vehicle combinations to ensure adequate representation of the fleet. Specifically, manufacturers would be required to separate production vehicles into monitoring performance groups based on the following criteria and submit performance ratio data representative of each group:

• Emission control system architecture type—All engines that use the same or similar emissions control system architecture and associated monitoring system would be in the same emission architecture category. By architecture we mean engines with EGR+DPF+SCR, or EGR+DPF+NO_X Adsorber, or EGR+DPF-only, etc.

• Application type—Within an emission architecture category, engines would be separated by vehicle application. The separate application categories would be based on three classifications: engines intended primarily for line-haul chassis applications, engines intended primarily for urban delivery chassis applications, and all other engines.

We are proposing that these data be submitted to us within 12 months of the production vehicles entering the market. Upon submitting the collected data to us, the manufacturer would also be required to provide a detailed description of how the data were gathered, how vehicles were grouped to represent sales of their engines, and the number of engines tested per monitoring performance group. Manufacturers would be required to submit performance ratio data from a sample of at least 15 vehicles per monitoring performance group. For example, a manufacturer with two emission control system architectures sold into each of the line-haul, urban delivery, and ''other'' groupings, would be required to submit data on up to 90 vehicles (i.e., $2 \times 3 \times 15$). We are proposing that these data be collected every year. Some manufacturers may find it easiest to collect data from vehicles that come in to its authorized repair facilities for routine maintenance or warranty work during the time period required, while others may find it more advantageous to hire a contractor to collect the data. Upon good cause, we may extend the time period for testing.

As stated before, the data collected under this program are intended primarily to provide an early indication that the systems are working as intended in the field, to provide information to ''fine-tune'' the proposed requirement to track the performance of monitors, and to provide data to be used to develop a more appropriate minimum ratio for future regulatory revisions. The data are not intended to substitute for testing that we would perform for enforcement reasons to determine if a manufacturer is complying with the minimum acceptable performance ratios. In fact, the data collected would not likely meet all the required elements for testing to make an official determination that the system is noncompliant. As such, we believe the testing would be of most value to manufacturers since monitor performance problems can be corrected prior to EPA conducting a full enforcement action that could result in a recall.

IX. What are the Issues Concerning Inspection and Maintenance Programs?

A. Current Heavy-Duty I/M Programs

While there are currently no regulatory requirements for heavy-duty inspection and maintenance (I/M), and no State Implementation Plan (SIP) credit given for heavy-duty I/M, a recent review shows that programs in the United States as well as abroad are currently testing heavy-duty diesel and heavy-duty gasoline vehicles as part of their Inspection and Maintenance programs. A recent study found that the mandated vehicle emission I/M programs in the CAAA of 1990, originally required in areas where ambient levels of ozone and CO exceeded the national standards, are being utilized as a framework as diesel PM becomes increasingly recognized as an important health concern in the United States.[81] Some countries outside the U.S., particularly developing countries, have been seeking to improve air quality by implementing both light-duty and heavy-duty I/M programs.

In the U.S., the light-duty fleet has become cleaner. As a result, heavy-duty vehicles are responsible for an increasing contribution of the mobile source emission inventory. EPA has responded to the increased contribution by promulgating technology-promoting standards, to be phased in during the years leading up to 2010. Some non-attainment areas are implementing HD vehicle I/M programs to improve their regional air quality. The current tailpipe emissions measurements result in a number of issues, so other technologies such as remote sensing are being examined. Interrogation of the OBD system on over 14,000 pound vehicles would likely be a candidate I/M test method.

As of 2004, according to the aforementioned study, many I/M programs in the U.S. have developed a wide range of emission tests for HD diesel vehicles and HD gasoline vehicles. 19 States currently test HD diesel vehicles (these are: AZ, CA, CO, CT, ID, IL, KY, ME, MD, MA, NV, NH, NJ, NM, NY, OH, UT, VT, WA); 25 states test HD gasoline vehicles (these are: AK, AZ, CA, CO, CT, ID, IL, IN, KY, MD, MA, NV, NJ, NM, NY, NC, OH, OR, PA, TN, TX, UT, VA, WA, WI). Canada, China, Singapore, Sweden, and the United Kingdom test HD diesel vehicles. Lastly, Germany, Singapore, and Sweden test HD gasoline vehicles.

Whether or not voluntary or regulated inspection and maintenance programs become prominent, heavy-duty OBD should be designed to allow ease of interrogation to maximize the potential of this technology to help realize environmental benefit. There is evidence that localities are utilizing this strategy in their air quality protection programs. There is also a wealth of light-duty OBD experience to support making an I/M-type test as user-friendly as possible so technician training and scan tool designs do not limit the ability to assess a vehicle's status.

B. Challenges for Heavy-Duty I/M

There are a number of challenges that are being discovered as programs implement heavy-duty I/M. Existing HD I/M programs utilize of a number of different emission test types, such as snap-idle testing (based on SAE J1667), loaded cruise testing (chassis dynamometer), ASM testing, Transient IMXXX, Two-Speed Idle or Curb Idle, and Lug-down testing. Projections of heavy-duty vehicle inventory contributions for VOC, NO_X, PM, and toxics have substantiated the need for more stringent regulations. Repairs

[81] Review of Light-Duty Diesel and Heavy-Duty Diesel/Gasoline Inspection Programs, St. Denis and Lindner, Journal of the Air and Waste Management Association, December 2005.

based on individual emission test types, such as opacity testing, may target and reduce one pollutant (e.g., PM) while neglecting or increasing others (e.g., NO_X). A sound test should effectively control all harmful pollutants, thus must be able to measure multiple pollutants—specifically PM and NO_X emissions.

Systems capable of measuring both pollutants at the same time have to date been prohibitively expensive for I/M programs, and traditionally require a heavy-duty dynamometer so that vehicles can be tested under load. Recent work has begun to investigate the use of remote sensing and other technologies for measuring heavy-duty gaseous and PM emissions. While this technology has not yet been routinely implemented in HD vehicle I/M programs to date, the impetus to identify more robust or user-friendly emission testing strategies exists. Portable emissions measurement systems (PEMS) are not really conducive to an I/M environment at this time because the units are very costly, require a great deal of expertise to operate, and require considerable time for completing a test. Such systems are best suited for intensive analysis of emissions performance on a limited number of vehicles rather than the widespread testing of nearly all vehicles as is the attempt in most I/M programs. All these factors heighten the potential that OBD systems will be utilized in I/M programs for vehicles over 14,000 pounds.

C. Heavy-Duty OBD and I/M

Heavy-duty OBD should be designed with the anticipation that there may be new use of OBD to help insure local or regional emission benefits. If multiple individuals are querying OBD, standardization of testing equipment and protocol, and information format and availability should be considered to maximize the effective use of this technology. Many of the lessons learned from the use of light-duty OBD in I/M programs point to a need to ensure standard protocols for testing, so that test equipment and data collection requirements can be accommodated in system designs. Along with common connectors, data formats, and specific parameter monitoring requirements, future technologies enabling standardization of data stream logic (e.g., built-in checks, broadcasted updates, etc.) and other currently non-existing strategies may be attractive to minimize training requirements for test personnel and data management for model year-specific information.

Due to the regional or national registrations of many heavy-duty vehicles, there is the potential that eventual I/M use of OBD to control heavy-duty vehicle emission exceedences could be at the fleet or corporate level, rather than at the state level as is the current light-duty convention. Stakeholders will need to inform the debate but today's HD I/M programs may not follow the same development pattern as light-duty I/M programs did a decade ago. The lessons learned from light-duty OBD I/M should be complemented with early data on HD I/M programs being piloted in the U.S. and globally.

As one example, Ontario's Ministry of the Environment has prepared a report on their Heavy-Duty Drive Clean program. This study developed estimates of emissions benefits for inspected diesel vehicles and compares them to estimated baseline emissions for the case with no Drive Clean program, for calendar years 2000, 2001, and 2002. According to this study, over the three years of the program the total accumulated emission reductions generated by the program's operation were estimated to be 1092 tonnes of PM10 emissions, 654 tonnes of HC emissions, and 721 tonnes of NO_X emissions.[82] This particular study utilized opacity testing, and compared failed and fixed vehicles for different model year vehicles and for different weight classes. The malperformance model developed originally by Radian Corporation for ARB in 1986 was utilized since the statistical correlation between smoke opacity an mass emissions is weak, especially in newer vehicles; and the EPA MOBILE model assume zero deterioration of emissions for most HD diesel engines, thereby implying no benefit for I/M. The relationship between maintenance and emission deterioration is complicated by the use of high efficiency aftertreatment devices, which lose emission conversion efficiency with age, so this model's basic premise is likely appropriate only until the year 2008. Nevertheless, as the benefits of inspection and maintenance become more clearly articulated, the interest in assessing test methodologies that provide ease of use as well as multi-pollutant screening will likely increase. For these reasons consideration of potential I/M program use of OBD for the heavy-duty fleet is warranted, and should include lessons-learned from the light-duty fleet as well as anticipate new strategies for utilizing OBD information.

We request comment with respect to the level of interest in I/M programs that make use of the proposed OBD system on over 14,000 pound vehicles. Specifically, are states interested in I/M for over 14,000 pound vehicles that mirrors existing programs for passenger cars and other light trucks? For those that might be interested, does the proposed OBD system meet the needs of their potential I/M program?

X. Statutory and Executive Order Reviews

A. Executive Order 12866: Regulatory Planning and Review

This action is not a ''significant regulatory action'' under the terms of Executive Order (EO) 12866 (58 FR 51735, October 4, 1993) and is, therefore, not subject to review under the EO.

EPA prepared an analysis of the potential costs associated with this action. This analysis is contained in the technical support document.[83] A copy of the analysis is available in the docket and was summarized in section VI of this preamble.

B. Paperwork Reduction Act

The proposed information collection requirements for this action have been submitted for approval to the Office of Management and Budget (OMB) under the *Paperwork Reduction Act*, 44 U.S.C. 3501 *et seq.* The Information Collection Request (ICR) document prepared by EPA has been assigned EPA ICR number 1684.09. Under Title II of the Clean Air Act (42 U.S.C. 7521 *et seq.*; CAA), EPA is charged with issuing certificates of conformity for those engines that comply with applicable emission standards. Such a certificate must be issued before engines may be legally introduced into commerce. EPA uses certification information to verify that the proper engine prototypes have been selected and that the necessary testing has been performed to assure that each engine complies with emission standards. In addition, EPA also has the authority under Title II of the Clean Air to ensure compliance by require in-use testing of vehicles and engines. EPA is proposing to require additional information at the time of certification to ensure that that on-board diagnostic (OBD) requirements are being met. EPA is also proposing that manufacturers conduct and report the results of in-use testing of the OBD systems to

[82] ''Drive Clean Program Emission Benefit Analysis and Reporting—Heavy-Duty Diesel Vehicles,'' Canada Ministry of the Environment, October 2003.

[83] Draft Technical Support Document, HDOBD NPRM, EPA420–D–06–006, Docket ID# EPA–HQ–OAR–2005–0047–0008.

demonstrate that they are performing properly. Therefore, EPA is proposing 207 hours of annual burden per each of the 12 respondents to conduct the OBD certification, compliance, and in-use testing requirements proposed by this action. EPA estimates that the total of the of the 2484 hours of annual cost burden will be $16,018 per respondent for a total annual industry cost burden for the 12 respondents of $1,236,481.

Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. technology and systems for the purposes of collecting, validating, and verifying. This includes the time needed to review instructions; develop, acquire, install, and utilize information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information.

An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations in 40 CFR are listed in 40 CFR part 9.

To comment on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including the use of automated collection techniques, EPA has established a public docket for this rule, which includes this ICR, under Docket ID number EPA–HQ–OAR–2005–0047. Submit any comments related to the ICR for this proposed rule to EPA and OMB. See the **ADDRESSES** section at the beginning of this notice for where to submit comments to EPA. Send comments to OMB at the Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th Street, NW., Washington, DC 20503, Attention: Desk Office for EPA. Since OMB is required to make a decision concerning the ICR between 30 and 60 days after January 24, 2007, a comment to OMB is best assured of having its full effect if OMB receives it by February 23, 2007. The final rule will respond to any OMB or public comments on the information collection requirements contained in this proposal.

C. Regulatory Flexibility Act (RFA), as Amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), 5 U.S.C. 601 et. seq.

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of today's proposed rule on small entities, small entity is defined as: (1) A motor vehicle manufacturer with fewer than 1,000 employees; (2) a motor vehicle converter with fewer than 750 employees; (3) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (4) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field. After considering the economic impacts of today's proposed rule on small entities, we have determined that this action would not have a significant economic impact on a substantial number of small entities. This proposed rule would not have any adverse economic impact on small entities. Today's rule places new requirements on manufacturers of large engines meant for highway use. These are large manufacturers. Today's rule also changes existing requirements on manufacturers of passenger car and smaller heavy-duty engines meant for highway use. These changes place no meaningful new requirements on those manufacturers.

D. Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), Public Law 104–4, establishes requirements for federal agencies to assess the effects of their regulatory actions on state, local, and tribal governments, and the private sector. Under section 202 of the UMRA, EPA generally must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with ''Federal mandates'' that may result in expenditures to state, local, and tribal governments, in the aggregate, or to the private sector, of $100 million or more for any single year. Before promulgating a rule for which a written statement is needed, section 205 of the UMRA generally requires EPA to identify and consider a reasonable number of regulatory alternatives and to adopt the least costly, most cost-effective, or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows EPA to adopt an alternative that is not the least costly, most cost-effective, or least burdensome alternative if the Administrator publishes with the final rule an explanation of why such an alternative was not adopted.

Before EPA establishes any regulatory requirement that may significantly or uniquely affect small governments, including tribal governments, it must have developed under section 203 of the UMRA a small government agency plan. The plan must provide for notifying potentially affected small governments, enabling officials of affected small governments to have meaningful and timely input in the development of EPA regulatory proposals with significant Federal intergovernmental mandates, and informing, educating, and advising small governments on compliance with the regulatory requirements.

This rule contains no federal mandates (under the regulatory provisions of Title II of the UMRA) for State, local, or tribal governments or the private sector. The rule imposes no enforceable duties on any of these entities. Nothing in the rule would significantly or uniquely affect small governments. We have determined that this rule does not contain a federal mandate that may result in estimated expenditures of more than $100 million to the private sector in any single year. Therefore, the requirements of the UMRA do not apply to this action.

E. Executive Order 13132: Federalism

Executive Order 13132, entitled ''Federalism'' (64 FR 43255, August 10, 1999), requires EPA to develop an accountable process to ensure ''meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications.'' ''Policies that have federalism implications'' is defined in the Executive Order to include regulations that have ''substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government.''

This proposed rule does not have federalism implications. It will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. This proposed rule places new requirements on manufacturers of large engines meant for highway use and changes existing requirements on manufacturers of passenger car and smaller heavy-duty engines meant for highway use. These changes do not affect States or the relationship between the national government and the States. Thus, Executive Order 13132 does not apply to this rule.

In the spirit of Executive Order 13132, and consistent with EPA policy to promote communications between EPA and State and local governments, EPA specifically solicits comment on this proposed rule from State and local officials.

F. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments

Executive Order 13175, entitled ''Consultation and Coordination with Indian Tribal Governments'' (65 FR 67249, November 9, 2000), requires EPA to develop an accountable process to ensure ''meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications.'' This proposed rule does not have tribal implications, as specified in Executive Order 13175. Today's rule does not uniquely affect the communities of American Indian tribal governments since the motor vehicle requirements for private businesses in today's rule would have national applicability. Furthermore, today's rule does not impose any direct compliance costs on these communities and no circumstances specific to such communities exist that would cause an impact on these communities beyond those discussed in the other sections of today's document. Thus, Executive Order 13175 does not apply to this rule.

G. Executive Order 13045: Protection of Children From Environmental Health and Safety Risks

Executive Order 13045, ''Protection of Children from Environmental Health Risks and Safety Risks'' (62 FR 19885, April 23, 1997) applies to any rule that: (1) Is determined to be ''economically significant'' as defined under Executive Order 12866; and, (2) concerns an environmental health or safety risk that EPA has reason to believe may have a disproportionate effect on children. If the regulatory action meets both criteria, the Agency must evaluate the environmental health or safety effects of the planned rule on children, and explain why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the Agency.

This proposed rule is not subject to the Executive Order because it is not an economically significant regulatory action as defined by Executive Order 12866, and because the Agency does not have reason to believe the environmental health or safety risks addressed by this action present a disproportionate risk to children.

H. Executive Order 13211: Actions That Significantly Affect Energy Supply, Distribution, or Use

This rule is not subject to Executive Order 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use'' (66 FR 28355, May 22, 2001) because it is not a significant regulatory action under Executive Order 12866.

I. National Technology Transfer Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 (NTTAA), Section 12(d) of Public Law 104–113, directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) developed or adopted by voluntary consensus standards bodies. The NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

This proposed rule references technical standards. The technical standards being proposed are listed in Table II.F–1 of this preamble, and directions for how they may be obtained are provided in section II.F.1. EPA welcomes comments on this aspect of the proposed rulemaking and, specifically, invites the public to identify other potentially-applicable voluntary consensus standards and to explain why such standards should be used in this regulation.

XI. Statutory Provisions and Legal Authority

Statutory authority for today's proposed rule is found in the Clean Air Act, 42 U.S.C. 7401 *et seq.*, in particular, sections 202 and 206 of the Act, 42 U.S.C. 7521, 7525. This rule is being promulgated under the administrative and procedural provisions of Clean Air Act section 307(d), 42 U.S.C. 7607(d).

List of Subjects in 40 CFR Part 86

Environmental Protection, Administrative practice and procedure, Motor vehicle pollution.

Dated: December 11, 2006.

Stephen L. Johnson,

Administrator.

For the reasons set out in the preamble, part 86 of title 40 of the Code of Federal Regulations is proposed to be amended as follows:

PART 86—CONTROL OF EMISSIONS FROM NEW AND IN-USE HIGHWAY VEHICLES AND ENGINES

1. The authority citation for part 86 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

2. Section 86.1 is amended as follows:

a. In the table to paragraph (b)(2) by adding new entries to the end of the table.

b. In the table to paragraph (b)(5) by adding a new entry to the end of the table.

§ 86.1 Reference materials.

* * * * *

(b) * * *

(2) * * *

Document No. and name	40 CFR part 86 reference
* * * * * *	*
SAE J1930, Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms—Equivalent to ISO/TR 15031–2: April 2002.	86.010–18
SAE J1939, MONTH 2006, Recommended Practice for a Serial Control and Communications Vehicle Network	86.010–18; 86.010–38
SAE J1939–13, MONTH 2006, Off-Board Diagnostic Connector	86.013–18
SAE J1962, Diagnostic Connector—Equivalent to ISO/DIS	86.013–18
15031–3: April 2002	
SAE J1978, OBD II Scan Tool—Equivalent to ISO/DIS 15031–4: April 2002	86.010–18

Document No. and name	40 CFR part 86 reference
SAE J1979, E/E Diagnostic Test Modes—Equivalent to ISO/DIS 15031–5: April 2002	86.010–18; 86.010–38
SAE J2012, Diagnostic Trouble Code Definitions—Equivalent to ISO/DIS 15031–6: April 2002	86.010–18
SAE J2403, Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature; August 2004	86.007–17; 86.010–18; 86.010–38; 86.1806–07
SAE J2534, Recommended Practice for Pass-Thru Vehicle Reprogramming: February 2002	86.010–18; 86.010–38

* * * * *

(5) * * *

Document No. and name	40 CFR part 86 reference
* * * * * * *	
ISO 15765–4:2001, Road Vehicles—Diagnostics on Controller Area Network (CAN)—Part 4: Requirements for emission-related systems: December 2001.	86.010–18

* * * * *

3. Section 86.007–17 is added to Subpart A to read as follows:

§ 86.007–17 On-board Diagnostics for engines used in applications less than or equal to 14,000 pounds GVWR.

Section 86.007–17 includes text that specifies requirements that differ from § 86.005–17. Where a paragraph in § 86.005–17 is identical and applicable to § 86.007–17, this may be indicated by specifying the corresponding paragraph and the statement ''[Reserved]. For guidance see § 86.005–17.''

(a)(1) [Reserved]. For guidance see § 86.005–17.

(a)(2) An OBD system demonstrated to fully meet the requirements in § 86.1806–07 may be used to meet the requirements of this section, provided that the Administrator finds that a manufacturer's decision to use the flexibility in this paragraph (a)(2) is based on good engineering judgment.

(b) introductory text and (b)(1)(i) [Reserved]. For guidance see § 86.005–17.

(b)(1)(ii) *Diesel.*

(A) If equipped, catalyst deterioration or malfunction before it results in exhaust NO_X emissions exceeding either: 1.75 times the applicable NO_X standard for engines certified to a NO_X FEL greater than 0.50 g/bhp-hr; or, the applicable NO_X FEL+0.5 g/bhp-hr for engines certified to a NO_X FEL less than or equal to 0.50 g/bhp-hr. This requirement applies only to reduction catalysts; monitoring of oxidation catalysts is not required. This monitoring need not be done if the manufacturer can demonstrate that deterioration or malfunction of the system will not result in exceedance of the threshold.

(b)(1)(ii)(B) and (b)(2) [Reserved]. For guidance see § 86.005–17.

(b)(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices.*

(A) *Otto-cycle.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NO_X or CO.

(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NO_X standard for engines certified to a NO_X FEL greater than 0.50 g/bhp-hr; or, the applicable NO_X FEL+0.5 g/bhp-hr for engines certified to a NO_X FEL less than or equal to 0.50 g/bhp-hr; or, 2.5 times the applicable NMHC standard.

(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices.*

(A) *Otto-cycle.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NO_X or CO.

(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NO_X standard for engines certified to a NO_X FEL greater than 0.50 g/bhp-hr; or, the applicable NO_X FEL+0.5 g/bhp-hr for engines certified to a NO_X FEL less than or equal to .50 g/bhp-hr; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(iii) NO_X *sensors.*

(A) *Otto-cycle.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NO_X or CO.

(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: The applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NO_X standard for engines certified to a NO_X FEL greater than 0.50 g/bhp-hr; or, the applicable NO_X FEL+0.5 g/bhp-hr for engines certified to a NO_X FEL less than or equal to 0.50 g/bhp-hr.

(b)(4) [Reserved]. For guidance see § 86.005—17.

(b)(5) *Other emission control systems and components.*

(i) *Otto-cycle.* Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, the secondary air system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding 1.5 times the applicable emission standard or FEL for NMHC, NO_X or CO. For engines equipped with a secondary air system, a functional check, as described in § 86.005–17(b)(6), may satisfy the requirements of this paragraph (b)(5) provided the manufacturer can demonstrate that deterioration of the flow distribution system is unlikely. This demonstration is subject to Administrator approval and, if the demonstration and associated functional check are approved, the diagnostic system must indicate a malfunction when some degree of secondary airflow is not detectable in the exhaust system during the check. For engines equipped with positive crankcase ventilation (PCV), monitoring of the PCV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the PCV system is unlikely to fail.

(ii) *Diesel.* Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: The applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NO_X standard for engines certified to a NO_X FEL greater than 0.50 g/bhp-hr; or, the applicable NO_X FEL+0.5 g/bhp-hr for engines certified to a NO_X FEL less than or equal to 0.50 g/bhp-hr; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard. A functional check, as described in § 86.005–17(b)(6), may satisfy the requirements of this paragraph (b)(5) provided the manufacturer can demonstrate that a malfunction would not cause emissions to exceed the applicable levels. This demonstration is subject to Administrator approval. For engines equipped with crankcase ventilation (CV), monitoring of the CV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the CV system is unlikely to fail.

(b)(6) [Reserved]. For guidance see § 86.005–17.

(b)(7) *Performance of OBD functions.* Any sensor or other component deterioration or malfunction which renders that sensor or component incapable of performing its function as part of the OBD system must be detected and identified on engines so equipped.

(c), (d), (e), (f), (g), and (h)(1)(i) through (h)(1)(iv) [Reserved]. For guidance see § 86.005–17.

(h)(1)(v) All acronyms, definitions and abbreviations shall be formatted according to SAE J1930 ''Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms Equivalent to ISO/TR 15031–2: April 30, 2002'', (Revised, April 2002), or SAE J2403, ''Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature: August 2004.''

(h)(1)(vi) through (h)(3) [Reserved]. For guidance see § 86.005–17.

(i) *Deficiencies and alternative fueled engines.* Upon application by the manufacturer, the Administrator may accept an OBD system as compliant even though specific requirements are not fully met. Such compliances without meeting specific requirements, or deficiencies, will be granted only if compliance would be infeasible or unreasonable considering such factors as, but not limited to: Technical feasibility of the given monitor and lead time and production cycles including phase-in or phase-out of engines or vehicle designs and programmed upgrades of computers. Unmet requirements should not be carried over from the previous model year except where unreasonable hardware or software modifications would be necessary to correct the deficiency, and the manufacturer has demonstrated an acceptable level of effort toward compliance as determined by the Administrator. Furthermore, EPA will not accept any deficiency requests that include the complete lack of a major diagnostic monitor (''major'' diagnostic monitors being those for exhaust aftertreatment devices, oxygen sensor, air-fuel ratio sensor, NO_X sensor, engine misfire, evaporative leaks, and diesel EGR, if equipped), with the possible exception of the special provisions for alternative fueled engines. For alternative fueled heavy-duty engines (e.g. natural gas, liquefied petroleum gas, methanol, ethanol), manufacturers may request the Administrator to waive specific monitoring requirements of this section for which monitoring may not be reliable with respect to the use of the alternative fuel. At a minimum, alternative fuel engines must be equipped with an OBD system meeting OBD requirements to the extent feasible as approved by the Administrator.

(j) *California OBDII compliance option.* For heavy-duty engines used in applications weighing 14,000 pounds GVWR or less, demonstration of compliance with California OBD II requirements (Title 13 California Code of Regulations section 1968.2 (13 CCR 1968.2)), as modified and released on August 11, 2006, shall satisfy the requirements of this section, except that compliance with 13 CCR 1968.2(e)(4.2.2)(C), pertaining to 0.02 inch evaporative leak detection, and 13 CCR 1968.2(d)(1.4), pertaining to tampering protection, are not required to satisfy the requirements of this section. Also, the deficiency provisions of 13 CCR 1968.2(k) do not apply. The deficiency provisions of paragraph (i) of this section and the evaporative leak detection requirement of § 86.005–17(b)(4) apply to manufacturers selecting this paragraph for demonstrating compliance. In addition, demonstration of compliance with 13 CCR 1968.2(e)(15.2.1)(C), to the extent it applies to the verification of proper alignment between the camshaft and crankshaft, applies only to vehicles equipped with variable valve timing.

(k) [Reserved]. For guidance see § 86.005–17.

4. Section 86.007–30 is added to Subpart A to read as follows:

Section 86.007–30 includes text that specifies requirements that differ from §§ 86.094–30, 86.095–30, 86.096–30, 86.098–30, 86.001–30 or 86.004–30. Where a paragraph in § 86.094–30, § 86.095–30, § 86.096–30, § 86.098–30, § 86.001–30 or § 86.004–30 is identical and applicable to § 86.007–30, this may be indicated by specifying the corresponding paragraph and the statement ''[Reserved]. For guidance see § 86.094–30.'' or ''[Reserved]. For guidance see § 86.095–30.'' or ''[Reserved]. For guidance see § 86.096–30.'' or ''[Reserved]. For guidance see § 86.098–30.'' or ''[Reserved]. For guidance see § 86.001–30.'' or ''[Reserved]. For guidance see 86.004–30.''

§ 86.007–30 Certification.

(a)(1) and (a)(2) [Reserved]. For guidance see § 86.094–30.

(a)(3)(i) through (a)(4)(ii) [Reserved]. For guidance see § 86.004–30.

(a)(4)(iii) introductory text through (a)(4)(iii)(C) [Reserved]. For guidance see § 86.094–30.

(a)(4)(iv) introductory text [Reserved]. For guidance see § 86.095–30.

(a)(4)(iv)(A)–(a)(9) [Reserved]. For guidance see § 86.094–30.

(a)(10) and (a)(11) [Reserved]. For guidance see § 86.004–30.

(a)(12) [Reserved]. For guidance see § 86.094–30.

(a)(13) [Reserved]. For guidance see § 86.095–30.

(a)(14) [Reserved]. For guidance see § 86.094–30.

(a) (15)–(18) [Reserved]. For guidance see § 86.096–30.

(a)(19) [Reserved]. For guidance see § 86.098–30.

(a)(20) [Reserved]. For guidance see § 86.001–30.

(a)(21) [Reserved]. For guidance see § 86.004–30.

(b)(1) introductory text through (b)(1)(ii)(A) [Reserved]. For guidance see § 86.094–30.

(b)(1)(ii)(B) [Reserved]. For guidance see § 86.004–30.

(b)(1)(ii)(C) [Reserved]. For guidance see § 86.094–30.

(b)(1)(ii)(D) [Reserved]. For guidance see § 86.004–30.

(b)(1)(iii) and (b)(1)(iv) [Reserved]. For guidance see § 86.094–30.

(b)(2) [Reserved]. For guidance see § 86.098–30.

(b)(3)–(b)(4)(i) [Reserved]. For guidance see § 86.094–30.

(b)(4)(ii) introductory text [Reserved]. For guidance see § 86.098–30.

(b)(4)(ii)(A) [Reserved]. For guidance see § 86.094–30.

(b)(4)(ii)(B)–(b)(4)(iv) [Reserved]. For guidance see § 86.098–30.

(b)(5)–(e) [Reserved]. For guidance see § 86.094–30.

(f) introductory text through (f)(1)(i) [Reserved]. For guidance see § 86.004–30.

(f)(1)(ii) *Diesel.*

(A) If monitored for emissions performance—a catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust emissions exceeding 1.75 times the applicable NO_X standard for engines certified to a NO_X FEL greater than 0.50 g/bhp-hr; or, the applicable NO_X FEL+0.5 g/bhp-hr for engines certified to a NO_X FEL less than or equal to 0.50 g/bhp-hr. This requirement applies only to reduction catalysts.

(B) If monitored for performance—a particulate trap is replaced with a trap that has catastrophically failed, or an electronic simulation of such.

(f)(2) [Reserved]. For guidance see § 86.004–30.

(f)(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices.*

(A) *Otto-cycle.* If so equipped, any oxygen sensor or air-fuel ratio sensor located downstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NO_X or CO.

(B) *Diesel.* If so equipped, any oxygen sensor or air-fuel ratio sensor located downstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NO_X standard for engines certified to a NO_X FEL greater than 0.50 g/bhp-hr; or, the applicable NO_X FEL+0.5 g/bhp-hr for engines certified to a NO_X FEL less than or equal to 0.50 g/bhp-hr; or, 2.5 times the applicable NMHC standard.

(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices.*

(A) *Otto-cycle.* If so equipped, any oxygen sensor or air-fuel ratio sensor located upstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NO_X or CO.

(B) *Diesel.* If so equipped, any oxygen sensor or air-fuel ratio sensor located upstream of aftertreatment devices is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NO_X standard for engines certified to a NO_X FEL greater than 0.50 g/bhp-hr; or, the applicable NO_X FEL+0.5 g/bhp-hr for engines certified to a NO_X FEL less than or equal to 0.50 g/bhp-hr; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(iii) NO_X *sensors.*

(A) *Otto-cycle.* If so equipped, any NO_X sensor is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NO_X or CO.

(B) *Diesel.* If so equipped, any NO_X sensor is replaced with a deteriorated or defective sensor, or an electronic simulation of such, resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NO_X standard for engines certified to a NO_X FEL greater than 0.50 g/bhp-hr; or, the applicable NO_X FEL+0.5 g/bhp-hr for engines certified to a NO_X FEL less than or equal to 0.50 g/bhp-hr.

(f)(4) [Reserved]. For guidance see § 86.004–30.

(f)(5)(i) *Otto-cycle.* A malfunction condition is induced in any emission-related engine system or component, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, the secondary air system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding 1.5 times the applicable emission standard or FEL for NMHC, NO_X, or CO.

(ii) *Diesel.* A malfunction condition is induced in any emission-related engine system or component, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, 1.75 times the applicable NO_X standard for engines certified to a NO_X FEL greater than 0.50 g/bhp-hr; or, the applicable NO_X FEL+0.5 g/bhp-hr for engines certified to a NO_X FEL less than or equal to 0.50 g/bhp-hr; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(f)(6) [Reserved]. For guidance see § 86.004–30.

5. Section 86.010–2 is added to Subpart A to read as follows:

§ 86.010–2 Definitions.

The definitions of § 86.004–2 continue to apply to 2004 and later model year vehicles. The definitions listed in this section apply beginning with the 2010 model year.

Drive cycle or driving cycle means operation that consists of engine startup and engine shutoff during which a given onboard diagnostic (OBD) monitor makes a diagnostic decision. A drive cycle need not consist of all OBD monitors making a diagnostic decision during the engine startup and engine shutoff cycle. An engine restart following an engine shutoff that has been neither commanded by the vehicle operator nor by the engine control strategy but caused by an event such as an engine stall may be considered a new drive cycle or a continuation of the existing drive cycle.

DTC means diagnostic trouble code.

Engine start as used in § 86.010–18 means the point when the engine reaches a speed 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission). For hybrid vehicles or for engines employing alternative engine start hardware or strategies (e.g., integrated starter and generators.), the manufacturer may use an alternative definition for engine start (e.g., key-on) provided the alternative definition is based on equivalence to an engine start for a conventional vehicle.

Functional check, in the context of onboard diagnostics, means verifying that a component and/or system that receives information from a control computer responds properly to a command from the control computer.

Ignition cycle as used in § 86.010–18 means a cycle that begins with engine start, meets the engine start definition for at least two seconds plus or minus one second, and ends with engine shutoff.

Limp-home operation as used in § 86.010–18 means an operating mode that an engine is designed to enter upon determining that normal operation cannot be maintained. In general, limp-home operation implies that a component or system is not operating properly or is believed to be not operating properly.

Malfunction means the conditions have been met that require the activation of an OBD malfunction indicator light and storage of a DTC.

MIL-on DTC means the diagnostic trouble code stored when an OBD system has detected and confirmed that a malfunction exists (e.g., typically on the second drive cycle during which a given OBD monitor has evaluated a system or component). Industry standards may refer to this as a confirmed or an active DTC.

Pending DTC means the diagnostic trouble code stored upon the detection of a potential malfunction.

Permanent DTC means a DTC that corresponds to a MIL-on DTC and is stored in non-volatile random access memory (NVRAM). A permanent DTC can only be erased by the OBD system itself and cannot be erased through human interaction with the OBD system or any onboard computer.

Previous-MIL-on DTC means a DTC that corresponds to a MIL-on DTC but is distinguished by representing a malfunction that the OBD system has determined no longer exists but for which insufficient operation has occurred to satisfy the DTC erasure provisions.

Potential malfunction means that conditions have been detected that meet the OBD malfunction criteria but for which more drive cycles are allowed to provide further evaluation prior to confirming that a malfunction exists.

Rationality check, in the context of onboard diagnostics, means verifying that a component that provides input to a control computer provides an accurate input to the control computer while in the range of normal operation and when compared to all other available information.

Similar conditions, in the context of onboard diagnostics, means engine conditions having an engine speed within 375 rpm, load conditions within 20 percent, and the same warm up status (i.e., cold or hot). The manufacturer may use other definitions of similar conditions based on comparable timeliness and reliability in detecting similar engine operation.

6. Section 86.010–17 is added to Subpart A to read as follows:

§ 86.010–17 On-board Diagnostics for engines used in applications less than or equal to 14,000 pounds GVWR.

Section 86.010–17 includes text that specifies requirements that differ from § 86.005–17 and § 86.007–17. Where a paragraph in § 86.005–17 or § 86.007–17 is identical and applicable to § 86.010–17, this may be indicated by specifying the corresponding paragraph and the statement ''[Reserved]. For guidance see § 86.005–17.'' or ''[Reserved]. For guidance see § 86.007–17.''

(a) *General.*

(1) All heavy-duty engines intended for use in a heavy-duty vehicle weighing 14,000 pounds GVWR or less must be equipped with an on-board diagnostic (OBD) system capable of monitoring all emission-related engine systems or components during the applicable useful life. All monitored systems and components must be evaluated periodically, but no less frequently than once per applicable certification test cycle as defined in Appendix I, paragraph (f), of this part, or similar trip as approved by the Administrator.

(2) An OBD system demonstrated to fully meet the requirements in § 86.1806–10 may be used to meet the requirements of this section, provided that the Administrator finds that a manufacturer's decision to use the flexibility in this paragraph (a)(2) is based on good engineering judgment.

(b) Introductory text and (b)(1)(i) [Reserved]. For guidance see § 86.005–17.

(b)(1)(ii) *Diesel.*

(A) If equipped, reduction catalyst deterioration or malfunction before it results in exhaust NO_X emissions exceeding the applicable NO_X FEL+0.3 g/bhp-hr. If equipped, oxidation catalyst deterioration or malfunction before it results in exhaust NMHC emissions exceeding 2.5 times the applicable NMHC standard. These catalyst monitoring requirements need not be done if the manufacturer can demonstrate that deterioration or malfunction of the system will not result in exceedance of the threshold.

(B) If equipped, diesel particulate trap deterioration or malfunction before it results in exhaust emissions exceeding any of the following levels: The applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, exhaust NMHC emissions exceeding 2.5 times the applicable NMHC standard. Catastrophic failure of the particulate trap must also be detected. In addition, the absence of the particulate trap or the trapping substrate must be detected.

(b)(2) [Reserved]. For guidance see § 86.005–17.

(b)(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices.*

(A) *Otto-cycle.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NO_X or CO.

(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, the applicable NO_X FEL+0.3 g/bhp-hr; or, 2.5 times the applicable NMHC standard.

(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices.*

(A) *Otto-cycle.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NO_X or CO.

(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.02 g/bhp-hr or 0.03 g/bhp-hr PM, whichever is higher; or, the applicable NO_X FEL+0.3 g/bhp-hr; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(iii) *NO_X sensors.*

(A) *Otto-cycle.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC, NO_X or CO.

(B) *Diesel.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, the applicable NO_X FEL+0.3 g/bhp-hr.

(b)(4) [Reserved]. For guidance see § 86.005–17.

(b)(5) *Other emission control systems and components.*

(i) *Otto-cycle.* Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, the secondary air system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding 1.5 times the applicable emission standard or FEL for NMHC, NO_X or CO. For engines equipped with a secondary air system, a functional check, as described in § 86.005–17(b)(6), may satisfy the requirements of this paragraph (b)(5) provided the manufacturer can demonstrate that deterioration of the flow distribution system is unlikely. This demonstration is subject to Administrator approval and, if the demonstration and associated functional check are approved, the diagnostic system must indicate a malfunction when some degree of secondary airflow is not detectable in the exhaust system during the check. For engines equipped with positive crankcase ventilation (PCV), monitoring of the PCV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the PCV system is unlikely to fail.

(ii) *Diesel.* Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the exhaust gas recirculation (EGR) system, if equipped, and the fuel control system, singularly resulting in exhaust emissions exceeding any of the following levels: the applicable PM FEL+0.02 g/bhp-hr or 0.03 g/bhp-hr PM, whichever is higher; or, the applicable NO_X FEL+0.3 g/bhp-hr; or, 2.5x the applicable NMHC standard; or, 2.5x the applicable CO standard. A functional check, as described in § 86.005–17(b)(6), may satisfy the requirements of this paragraph (b)(5) provided the manufacturer can demonstrate that a malfunction would not cause emissions to exceed the applicable levels. This demonstration is subject to Administrator approval. For engines equipped with crankcase ventilation (CV), monitoring of the CV system is not necessary provided the manufacturer can demonstrate to the Administrator's satisfaction that the CV system is unlikely to fail.

(b)(6) [Reserved]. For guidance see § 86.005–17.

(b)(7) [Reserved]. For guidance see § 86.007–17.

(c) [Reserved]. For guidance see § 86.005–17.

(d) *MIL illumination.*

(1) The MIL must illuminate and remain illuminated when any of the conditions specified in paragraph (b) of this section are detected and verified, or whenever the engine control enters a default or secondary mode of operation considered abnormal for the given engine operating conditions. The MIL must blink once per second under any period of operation during which engine misfire is occurring and catalyst damage is imminent. If such misfire is detected again during the following driving cycle (i.e., operation consisting of, at a minimum, engine start-up and engine shut-off) or the next driving cycle in which similar conditions are encountered, the MIL must maintain a steady illumination when the misfire is not occurring and then remain illuminated until the MIL extinguishing criteria of this section are satisfied. The MIL must also illuminate when the vehicle's ignition is in the ''key-on'' position before engine starting or cranking and extinguish after engine starting if no malfunction has previously been detected. If a fuel system or engine misfire malfunction has previously been detected, the MIL may be extinguished if the malfunction does not reoccur during three subsequent sequential trips during which similar conditions are encountered and no new malfunctions have been detected. Similar conditions are defined as engine speed within 375 rpm, engine load within 20 percent, and engine warm-up status equivalent to that under which the malfunction was first detected. If any malfunction other than a fuel system or engine misfire malfunction has been detected, the MIL may be extinguished if the malfunction does not reoccur during three subsequent sequential trips during which the monitoring system responsible for illuminating the MIL functions without detecting the malfunction, and no new malfunctions have been detected. Upon Administrator approval, statistical MIL illumination protocols may be employed, provided they result in comparable timeliness in detecting a malfunction and evaluating system performance, i.e., three to six driving cycles would be considered acceptable.

(2) *Drive cycle or driving cycle,* in the context of this section § 86.010–17, the definition for drive cycle or driving cycle given in § 86.010–2 is enhanced. A drive cycle means an OBD trip that consists of engine startup and engine shutoff and includes the period of engine off time up to the next engine startup. For vehicles that employ engine shutoff strategies (e.g., engine shutoff at idle), the manufacturer may use an alternative definition for drive cycle (e.g., key-on followed by key-off). Any alternative definition must be based on equivalence to engine startup and engine shutoff signaling the beginning and ending of a single driving event for a conventional vehicle. For applications that span 14,000 pounds GVWR, the manufacturer may use the drive cycle definition of § 86.010–18 in lieu of the definition in this paragraph.

(e), (f), (g), and (h)(1)(i) through (h)(1)(iv) [Reserved]. For guidance see § 86.005–17.

(h)(1)(v) [Reserved]. For guidance see § 86.007–17.

(h)(1)(vi) through (h)(3) [Reserved]. For guidance see § 86.005–17.

(i) and (j) [Reserved]. For guidance see § 86.007–17.

(k) [Reserved.]

7. Section 86.010–18 is added to Subpart A to read as follows:

§ 86.010–18 On-board Diagnostics for engines used in applications greater than 14,000 pounds GVWR.

(a) *General.* According to the implementation schedule shown in paragraph (o) of this section, heavy-duty engines intended for use in a heavy-duty vehicle weighing more than 14,000 pounds GVWR must be equipped with an on-board diagnostic (OBD) system capable of monitoring all emission-related engine systems or components during the life of the engine. The OBD system is required to detect all malfunctions specified in paragraphs (g), (h), and (i) of this section although the OBD system is not required to use a unique monitor to detect each of those malfunctions.

(1) When the OBD system detects a malfunction, it must store a pending, a MIL-on, or a previous-MIL-on diagnostic trouble code (DTC) in the onboard computer's memory. A malfunction indicator light (MIL) must also be activated as specified in paragraph (b) of this section.

(2) The OBD system must be equipped with a data link connector to provide access to the stored DTCs as specified in paragraph (k)(2) of this section.

(3) The OBD system cannot be programmed or otherwise designed to deactivate based on age and/or mileage. This requirement does not alter existing law and enforcement practice regarding a manufacturer's liability for an engine beyond its regulatory useful life, except where an engine has been programmed or otherwise designed so that an OBD system deactivates based on age and/or mileage of the engine.

(4) *Drive cycle or driving cycle*, in the context of this section, the definition for drive cycle or driving cycle given in § 86.010–2 is enhanced. A drive cycle means an OBD trip that meets any of the conditions of paragraphs (a)(4)(i) through (a)(4)(iv) of this section. Further, for OBD monitors that run during engine-off conditions, the period of engine-off time following engine shutoff and up to the next engine start may be considered part of the drive cycle for the conditions of paragraphs (a)(4)(i) and (a)(4)(iv) of this section. For engines/vehicles that employ engine shutoff OBD monitoring strategies that do not require the vehicle operator to restart the engine to continue vehicle operation (e.g., a hybrid bus with engine shutoff at idle), the manufacturer may use an alternative definition for drive cycle (e.g., key-on followed by key-off). Any alternative definition must be based on equivalence to engine startup and engine shutoff signaling the beginning and ending of a single driving event for a conventional vehicle. For engines that are not likely to be routinely operated for long continuous periods of time, a manufacturer may also request approval to use an alternative definition for drive cycle (e.g., solely based on engine start and engine shutoff without regard to four hours of continuous engine-on time). Administrator approval of the alternative definition will be based on manufacturer-submitted data and/or information demonstrating the typical usage, operating habits, and/or driving patterns of these vehicles.

(i) Begins with engine start and ends with engine shutoff;

(ii) Begins with engine start and ends after four hours of continuous engine-on operation;

(iii) Begins at the end of the previous four hours of continuous engine-on operation and ends after four hours of continuous engine-on operation; or

(iv) Begins at the end of the previous four hours of continuous engine-on operation and ends with engine shutoff.

(b) *Malfunction indicator light (MIL) and Diagnostic Trouble Codes (DTC).* The OBD system must incorporate a malfunction indicator light (MIL) or equivalent and must store specific types of diagnostic trouble codes (DTC).

(1) *MIL specifications.*

(i) [Reserved.]

(ii) The OBD system must activate the MIL when the ignition is in the key-on/engine-off position before engine cranking to indicate that the MIL is functional. The MIL shall be activated continuously during this functional check for a minimum of 5 seconds. During this MIL key-on functional check, the data stream value (see paragraph (k)(4)(ii) of this section) for MIL status must indicate ''commanded off'' unless the OBD system has detected a malfunction and has stored a MIL-on DTC. This MIL key-on functional check is not required during vehicle operation in the key-on/engine-off position subsequent to the initial engine cranking of an ignition cycle (e.g., due to an engine stall or other non-commanded engine shutoff).

(iii) As an option, the MIL may be used to indicate readiness status (see paragraph (k)(4)(i) of this section) in a standardized format in the key-on/engine-off position.

(iv) A manufacturer may also use the MIL to indicate which, if any, DTCs are currently stored (e.g., to ''blink'' the stored DTCs). Such use must not activate unintentionally during routine driver operation.

(v) [Reserved.]

(2) *MIL activation and DTC storage protocol.*

(i) Within 10 seconds of detecting a potential malfunction, the OBD system must store a pending DTC that identifies the potential malfunction.

(ii) If the potential malfunction is again detected before the end of the next drive cycle during which monitoring occurs (i.e., the potential malfunction has been confirmed as a malfunction), then within 10 seconds of such detection the OBD system must activate the MIL continuously and store a MIL-on DTC. If the potential malfunction is not detected before the end of the next drive cycle during which monitoring occurs (i.e., there is no indication of the malfunction at any time during the drive cycle), the corresponding pending DTC should be erased at the end of the drive cycle. Similarly, if a malfunction is detected for the first time and confirmed on a given drive cycle without need for further evaluation, then within 10 seconds of such detection the OBD system must activate the MIL continuously and store a MIL-on DTC.

(iii) A manufacturer may request Administrator approval to employ alternative statistical MIL activation and DTC storage protocols to those specified in paragraphs (b)(2)(i) and (b)(2)(ii) of this section. Approval will depend upon the manufacturer providing data and/or engineering evaluations that demonstrate that the alternative protocols can evaluate system performance and detect malfunctions in a manner that is equally effective and timely. Strategies requiring on average more than six drive cycles for MIL activation will not be accepted.

(iv) The OBD system must store a ''freeze frame'' of the operating conditions (as defined in paragraph (k)(4)(iii) of this section) present upon detecting a malfunction or a potential malfunction. In the event that a pending DTC has matured to a MIL-on DTC, the manufacturer shall either retain the currently stored freeze frame conditions or replace the stored freeze frame with freeze frame conditions regarding the MIL-on DTC. Any freeze frame stored in conjunction with any pending DTC or MIL-on DTC should be erased upon erasure of the corresponding DTC.

(v) If the engine enters a limp-home mode of operation that can affect emissions or the performance of the OBD system, or in the event of a malfunction of an onboard computer(s) itself that can affect the performance of the OBD system, the OBD system must activate the MIL and store a MIL-on DTC within 10 seconds to inform the vehicle operator. If the limp-home mode of operation is recoverable (i.e., operation automatically returns to normal at the beginning of the following ignition cycle), the OBD system may wait to activate the MIL and store the MIL-on DTC if the limp-home mode of operation is again entered before the end of the next ignition cycle rather than activating the MIL within 10 seconds on the first drive cycle during which the limp-home mode of operation is entered.

(vi) Before the end of an ignition cycle, the OBD system must store a permanent DTC(s) that corresponds to any stored MIL-on DTC(s).

(3) *MIL deactivation and DTC erasure protocol.*

(i) *Deactivating the MIL.* Except as otherwise provided for in paragraph (g)(6)(iv)(B) of this section for empty reductant tanks, and paragraphs (h)(1)(iv)(F), (h)(2)(viii), and (h)(7)(iv)(B) of this section for gasoline fuel system, misfire, and evaporative system malfunctions, once the MIL has been activated, it may be deactivated after three subsequent sequential drive cycles during which the monitoring system responsible for activating the MIL functions and the previously detected malfunction is no longer present and provided no other malfunction has been detected that would independently activate the MIL according to the requirements outlined in paragraph (b)(2) of this section.

(ii) *Erasing a MIL-on DTC.* The OBD system may erase a MIL-on DTC if the identified malfunction has not again been detected in at least 40 engine warm up cycles and the MIL is presently not activated for that malfunction. The OBD system may also erase a MIL-on DTC upon deactivating the MIL according to paragraph (b)(3)(i) of this section provided a previous-MIL-on DTC is stored upon erasure of the MIL-on DTC. The OBD system may erase a previous-MIL-on DTC if the identified malfunction has not again been detected in at least 40 engine warm up cycles and the MIL is presently not activated for that malfunction.

(iii) *Erasing a permanent DTC.* The OBD system can erase a permanent DTC only if either of the following conditions occur:

(A) The OBD system itself determines that the malfunction that caused the corresponding MIL-on DTC to be stored is no longer present and is not commanding activation of the MIL, concurrent with the requirements of paragraph (b)(3)(i) of this section.

(B) Subsequent to erasing the DTC information from the on-board computer (i.e., through the use of a scan tool or a battery disconnect), the OBD monitor for the malfunction that caused the permanent DTC to be stored has executed the minimum number of monitoring events necessary for MIL activation and has determined that the malfunction is no longer present.

(4) *Exceptions to MIL and DTC requirements.*

(i) If a limp-home mode of operation causes an overt indication (e.g., activation of a red engine shut-down warning light) such that the driver is certain to respond and have the problem corrected, a manufacturer may choose not to activate the MIL as required by paragraph (b)(2)(v) of this section. Additionally, if an auxiliary emission control device has been properly activated as approved by the Administrator, a manufacturer may choose not to activate the MIL.

(ii) For gasoline engines, a manufacturer may choose to meet the MIL and DTC requirements in § 86.010–17 in lieu of meeting the requirements of paragraph (b) of § 86.010–18.

(a) *Monitoring conditions.* The OBD system must monitor and detect the malfunctions specified in paragraphs (g), (h), and (i) of this section under the following general monitoring conditions. The more specific monitoring conditions of paragraph (d) of this section are sometimes required according to the provisions of paragraphs (g), (h), and (i) of this section.

(1) As specifically provided for in paragraphs (g), (h), and (i) of this section, the monitoring conditions for detecting malfunctions must be technically necessary to ensure robust detection of malfunctions (e.g., avoid false passes and false indications of malfunctions); designed to ensure monitoring will occur under conditions that may reasonably be expected to be encountered in normal vehicle operation and normal vehicle use; and, designed to ensure monitoring will occur during the FTP transient test cycle contained in Appendix I paragraph (f), of this part, or similar drive cycle as approved by the Administrator.

(2) Monitoring must occur at least once per drive cycle in which the monitoring conditions are met.

(3) Manufacturers may request approval to define monitoring conditions that are not encountered during the FTP cycle as required in paragraph (c)(1) of this section. In evaluating the manufacturer's request, the Administrator will consider the degree to which the requirement to run during the FTP transient cycle restricts monitoring during in-use operation, the technical necessity for defining monitoring conditions that are not encountered during the FTP cycle, data and/or an engineering evaluation submitted by the manufacturer that demonstrate that the component/system does not normally function during the FTP, whether monitoring is otherwise not feasible during the FTP cycle, and/or the ability of the manufacturer to demonstrate that the monitoring conditions satisfy the minimum acceptable in-use monitor performance ratio requirement as defined in paragraph (d) of this section.

(d) *In-use performance tracking.* As specifically required in paragraphs (g), (h), and (i) of this section, the OBD system must monitor and detect the malfunctions specified in paragraphs (g), (h), and (i) of this section according to the criteria of this paragraph (d). The OBD system is not required to track and report in-use performance for monitors other than those specifically identified in paragraph (d)(1) of this section.

(1) The manufacturer must implement software algorithms in the OBD system to individually track and report the in-use performance of the following monitors, if equipped, in the standardized format specified in paragraph (e) of this section: NMHC converting catalyst (paragraph (g)(5) of this section); NO_X converting catalyst (paragraph (g)(6) of this section); gasoline catalyst (paragraph (h)(6) of this section); exhaust gas sensor (paragraph (g)(9) or (h)(8) of this section); evaporative system (paragraph (h)(7) of this section); EGR system (paragraph (g)(3) or (h)(3) of this section); VVT system (paragraph (g)(10) or (h)(9) of this section); secondary air system (paragraph (h)(5) of this section); DPF system (paragraph (g)(8) of this section); boost pressure control system (paragraph (g)(4) of this section); and, NO_X adsorber system (paragraph (g)(7) of this section).

(i) The manufacturer shall not use the calculated ratio specified in paragraph (d)(2) of this section or any other indication of monitor frequency as a monitoring condition for a monitor (e.g., using a low ratio to enable more frequent monitoring through diagnostic executive priority or modification of other monitoring conditions, or using a high ratio to enable less frequent monitoring).

(ii) [Reserved.]

(2) *In-use performance ratio definition.* For monitors required to meet the requirements of paragraph (d) of this section, the performance ratio must be calculated in accordance with the specifications of this paragraph (d)(2).

(i) The numerator of the performance ratio is defined as the number of times a vehicle has been operated such that all monitoring conditions have been encountered that are necessary for the specific monitor to detect a malfunction.

(ii) The denominator is defined as the number of times a vehicle has been operated in accordance with the provisions of paragraph (d)(4) of this section.

(iii) The performance ratio is defined as the numerator divided by the denominator.

(3) *Specifications for incrementing the numerator.*

(i) Except as provided for in paragraph (d)(3)(v) of this paragraph (d)(3), the numerator, when incremented, must be incremented by an integer of one. The numerator shall not be incremented more than once per drive cycle.

(ii) The numerator for a specific monitor must be incremented within 10 seconds if and only if the following criteria are satisfied on a single drive cycle:

(A) Every monitoring condition has been satisfied that is necessary for the specific monitor to detect a malfunction and store a pending DTC, including applicable enable criteria, presence or absence of related DTCs, sufficient length of monitoring time, and diagnostic executive priority assignments (e.g., diagnostic ''A'' must execute prior to diagnostic ''B''). For the purpose of incrementing the numerator, satisfying all the monitoring conditions necessary for a monitor to determine that the monitor is not malfunctioning shall not, by itself, be sufficient to meet this criteria.

(B) For monitors that require multiple stages or events in a single drive cycle to detect a malfunction, every monitoring condition necessary for all events to complete must be satisfied.

(C) For monitors that require intrusive operation of components to detect a malfunction, a manufacturer must request approval of the strategy used to determine that, had a malfunction been present, the monitor would have detected the malfunction. Administrator approval of the request will be based on the equivalence of the strategy to actual intrusive operation and the ability of the strategy to determine accurately if every monitoring condition was satisfied that was necessary for the intrusive event to occur.

(D) For the secondary air system monitor, the criteria in paragraphs (d)(3)(ii)(A) through (d)(3)(ii)(C) of this section are satisfied during normal operation of the secondary air system. Monitoring during intrusive operation of the secondary air system later in the same drive cycle for the sole purpose of monitoring shall not, by itself, be sufficient to meet these criteria.

(iii) For monitors that can generate results in a ''gray zone'' or ''non-detection zone'' (i.e., monitor results that indicate neither a properly operating system nor a malfunctioning system) or in a ''non-decision zone'' (e.g., monitors that increment and decrement counters until a pass or fail threshold is reached), the numerator, in general, shall not be incremented when the monitor indicates a result in the ''non-detection zone'' or prior to the monitor reaching a complete decision. When necessary, the Administrator will consider data and/or engineering analyses submitted by the manufacturer demonstrating the expected frequency of results in the ''non-detection zone'' and the ability of the monitor to determine accurately, had an actual malfunction been present, whether or not the monitor would have detected a malfunction instead of a result in the ''non-detection zone.''

(iv) For monitors that run or complete their evaluation with the engine off, the numerator must be incremented either within 10 seconds of the monitor completing its evaluation in the engine off state, or during the first 10 seconds of engine start on the subsequent drive cycle.

(v) Manufacturers that use alternative statistical MIL activation protocols as allowed in paragraph (b)(2)(iii) of this section for any of the monitors requiring a numerator, are required to increment the numerator(s) appropriately. The manufacturer may be required to provide supporting data and/or engineering analyses demonstrating both the equivalence of their incrementing approach to the incrementing specified in this paragraph (d)(3) for monitors using the standard MIL activation protocol.

(4) *Specifications for incrementing the denominator.*

(i) The denominator, when incremented, must be incremented by an integer of one. The denominator shall not be incremented more than once per drive cycle.

(ii) The denominator for each monitor must be incremented within 10 seconds if and only if the following criteria are satisfied on a single drive cycle:

(A) Cumulative time since the start of the drive cycle is greater than or equal to 600 seconds while at an elevation of less than 8,000 feet (2,400 meters) above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit (−7 C);

(B) Cumulative gasoline engine operation at or above 25 miles per hour or diesel engine operation at or above 15% calculated load, either of which occurs for greater than or equal to 300 seconds while at an elevation of less than 8,000 feet (2,400 meters) above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit (−7 C); and

(C) Continuous vehicle operation at idle (e.g., accelerator pedal released by driver and vehicle speed less than or equal to one mile per hour) for greater than or equal to 30 seconds while at an elevation of less than 8,000 feet (2,400 meters) above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit (−7 C).

(iii) In addition to the requirements of paragraph (d)(4)(ii) of this section, the evaporative system monitor denominator(s) may be incremented if and only if:

(A) Cumulative time since the start of the drive cycle is greater than or equal to 600 seconds while at an ambient temperature of greater than or equal to 40 degrees Fahrenheit (4 C) but less than or equal to 95 degrees Fahrenheit (35 C); and,

(B) Engine cold start occurs with the engine coolant temperature greater than or equal to 40 degrees Fahrenheit (4 C) but less than or equal to 95 degrees Fahrenheit (35 C) and less than or equal to 12 degrees Fahrenheit (7 C) higher than the ambient temperature.

(iv) In addition to the requirements of paragraph (d)(4)(ii) of this section, the denominator(s) for the following monitors may be incremented if and only if the component or strategy is commanded ''on'' for a time greater than or equal to 10 seconds. For purposes of determining this commanded ''on'' time, the OBD system shall not include time during intrusive operation of any of the components or strategies that occurs later in the same drive cycle for the sole purpose of monitoring.

(A) Secondary air system (paragraph (h)(5) of this section).

(B) Cold start emission reduction strategy (paragraph (h)(4) of this section).

(C) Components or systems that operate only at engine start-up (e.g., glow plugs, intake air heaters) and are subject to monitoring under ''other emission control systems'' (paragraph (i)(4) of this section) or comprehensive component output components (paragraph (i)(3)(iii) of this section).

(v) In addition to the requirements of paragraph (d)(4)(ii) of this section, the denominator(s) for the following monitors of output components (except those operated only at engine start-up and subject to the requirements of paragraph (d)(4)(iv) of this section, may be incremented if and only if the component is commanded to function (e.g., commanded ''on'', ''opened'', ''closed'', ''locked'') on two or more occasions during the drive cycle or for a time greater than or equal to 10 seconds, whichever occurs first:

(A) Variable valve timing and/or control system (paragraph (g)(10) or (h)(9) of this section).

(B) ''Other emission control systems'' (paragraph (i)(4) of this section).

(C) Comprehensive component output component (paragraph (i)(3) of this section) (e.g., turbocharger waste-gates, variable length manifold runners).

(vi) For monitors of the following components, the manufacturer may use alternative or additional criteria for incrementing the denominator to that set forth in paragraph (d)(4)(ii) of this section. To do so, the alternative criteria must be based on equivalence to the criteria of paragraph (d)(4)(ii) of this section in measuring the frequency of monitor operation relative to the amount of engine operation:

(A) Engine cooling system input components (paragraph (i)(1) of this section).

(B) ''Other emission control systems'' (paragraph (i)(4) of this section).

(C) Comprehensive component input components that require extended monitoring evaluation (paragraph (i)(3) of this section) (e.g., stuck fuel level sensor rationality).

(vii) For monitors of the following components or other emission controls that experience infrequent regeneration events, the manufacturer may use alternative or additional criteria for incrementing the denominator to that set forth in paragraph (d)(4)(ii) of this section. To do so, the alternative criteria must be based on equivalence to the criteria of paragraph (d)(4)(ii) of this section in measuring the frequency of monitor operation relative to the amount of engine operation:

(A) Oxidation catalyst (paragraph (g)(5) of this section).

(B) DPF (paragraph (g)(8) of this section).

(viii) For hybrids that employ alternative engine start hardware or strategies (e.g., integrated starter and generators), or alternative fuel vehicles (e.g. dedicated, bi-fuel, or dual-fuel applications), the manufacturer may use alternative criteria for incrementing the denominator to that set forth in paragraph (d)(4)(ii) of this section. In general, the Administrator will not approve alternative criteria for those hybrids that employ engine shut off only at or near idle and/or vehicle stop conditions. To use alternative criteria, the alternative criteria must be based on the equivalence to the criteria of paragraph (d)(4)(ii) of this section in measuring the amount of vehicle operation relative to the measure of conventional vehicle operation.

(5) *Disablement of numerators and denominators.*

(i) Within 10 seconds of detecting a malfunction (i.e. a pending or a MIL-on DTC has been stored) that disables a monitor for which the monitoring conditions in paragraph (d) of this section must be met, the OBD system must stop incrementing the numerator and denominator for any monitor that may be disabled as a consequence of the detected malfunction. Within 10 seconds of the time at which the malfunction is no longer being detected (e.g., the pending DTC is erased through OBD system self-clearing or through a scan tool command), incrementing of all applicable numerators and denominators must resume.

(ii) Within 10 seconds of the start of a power take-off unit (e.g., dump bed, snow plow blade, or aerial bucket, etc.) that disables a monitor for which the monitoring conditions in paragraph (d) of this section must be met, the OBD system must stop incrementing the numerator and denominator for any monitor that may be disabled as a consequence of power take-off operation. Within 10 seconds of the time at which the power take-off operation ends, incrementing of all applicable numerators and denominators must resume.

(iii) Within 10 seconds of detecting a malfunction (i.e., a pending or a MIL-on DTC has been stored) of any component used to determine if the criteria of paragraphs (d)(4)(ii) and (d)(4)(iii) of this section are satisfied, the OBD system must stop incrementing all applicable numerators and denominators. Within 10 seconds of the time at which the malfunction is no longer being detected (e.g., the pending DTC is erased through OBD system self-clearing or through a scan tool command), incrementing of all applicable numerators and denominators must resume.

(e) *Standardized tracking and reporting of in-use monitor performance.*

(1) *General.* For monitors required to track and report in-use monitor performance according to paragraph (d) of this section, the performance data must be tracked and reported in accordance with the specifications in paragraphs (d)(2), (e), and (k)(5) of this section. The OBD system must separately report an in-use monitor performance numerator and denominator for each of the following components:

(i) For diesel engines, NMHC catalyst bank 1, NMHC catalyst bank 2, NO_X catalyst bank 1, NO_X catalyst bank 2, exhaust gas sensor bank 1, exhaust gas sensor bank 2, EGR/VVT system, DPF, boost pressure control system, and NO_X adsorber. The OBD system must also report a general denominator and an ignition cycle counter in the standardized format specified in paragraphs (e)(5), (e)(6), and (k)(5) of this section.

(ii) For gasoline engines, catalyst bank 1, catalyst bank 2, exhaust gas sensor bank 1, exhaust gas sensor bank 2, evaporative leak detection system, EGR/VVT system, and secondary air system. The OBD system must also report a general denominator and an ignition cycle counter in the standardized format specified in paragraphs (e)(5), (e)(6), and (k)(5) of this section.

(iii) For specific components or systems that have multiple monitors that are required to be reported under paragraphs (g) and (h) of this section (e.g., exhaust gas sensor bank 1 may have multiple monitors for sensor response or other sensor characteristics), the OBD system must separately track numerators and denominators for each of the specific monitors and report only the corresponding numerator and denominator for the specific monitor that has the lowest numerical ratio. If two or more specific monitors have identical ratios, the corresponding numerator and denominator for the specific monitor that has the highest denominator must be reported for the specific component.

(2) *Numerator.*

(i) The OBD system must report a separate numerator for each of the applicable components listed in paragraph (e)(1) of this section.

(ii) The numerator(s) must be reported in accordance with the specifications in paragraph (k)(5)(ii) of this section.

(3) *Denominator.*

(i) The OBD system must report a separate denominator for each of the applicable components listed in paragraph (e)(1) of this section.

(ii) The denominator(s) must be reported in accordance with the specifications in paragraph (k)(5)(ii) of this section.

(4) *Monitor performance ratio.* For purposes of determining which corresponding numerator and denominator to report as required in paragraph (e)(1)(iii) of this section, the ratio must be calculated in accordance with the specifications in paragraph (k)(5)(iii) of this section.

(5) *Ignition cycle counter.*

(i) The ignition cycle counter is defined as a counter that indicates the number of ignition cycles a vehicle has experienced according to the specifications of paragraph (e)(5)(ii)(B) of this section. The ignition cycle counter must be reported in accordance with the specifications in paragraph (k)(5)(ii) of this section.

(ii) The ignition cycle counter must be incremented as follows:

(A) The ignition cycle counter, when incremented, must be incremented by an integer of one. The ignition cycle counter shall not be incremented more than once per ignition cycle.

(B) The ignition cycle counter must be incremented within 10 seconds if and only if the engine exceeds an engine speed of 50 to 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for engines paired with an automatic transmission) for at least two seconds plus or minus one second.

(iii) Within 10 seconds of detecting a malfunction (i.e., a pending or a MIL-on DTC has been stored) of any component used to determine if the criteria in paragraph (e)(5)(ii)(B) of this section are satisfied (i.e., engine speed or time of operation), the OBD system must stop incrementing the ignition cycle counter. Incrementing of the ignition cycle counter shall not be stopped for any other condition. Within 10 seconds of the time at which the malfunction is no longer being detected (e.g., the pending DTC is erased through OBD system self-clearing or through a scan tool command), incrementing of the ignition cycle counter must resume.

(6) *General denominator.*

(i) The general denominator is defined as a measure of the number of times an engine has been operated according to the specifications of paragraph (e)(6)(ii)(B) of this section. The general denominator must be reported in accordance with the specifications in paragraph (k)(5)(ii) of this section.

(ii) The general denominator must be incremented as follows:

(A) The general denominator, when incremented, must be incremented by an integer of one. The general denominator shall not be incremented more than once per drive cycle.

(B) The general denominator must be incremented within 10 seconds if and only if the criteria identified in paragraph (d)(4)(ii) of this section are satisfied on a single drive cycle.

(C) Within 10 seconds of detecting a malfunction (i.e., a pending or a MIL-on DTC has been stored) of any component used to determine if the criteria in paragraph (d)(4)(ii) of this section are satisfied (i.e., vehicle speed/load, ambient temperature, elevation, idle operation, or time of operation), the OBD system must stop incrementing the general denominator. Incrementing of the general denominator shall not be stopped for any other condition (e.g., the disablement criteria in paragraphs (d)(5)(i) and (d)(5)(ii) of this section shall not disable the general denominator). Within 10 seconds of the time at which the malfunction is no longer being detected (e.g., the pending DTC is erased through OBD system self-clearing or through a scan tool command), incrementing of the general denominator must resume.

(f) *Malfunction criteria determination.*

(1) In determining the malfunction criteria for the diesel engine monitors required under paragraphs (g) and (i) of

this section that are required to indicate a malfunction before emissions exceed an emission threshold based on any applicable standard, the manufacturer must:

(i) Use the emission test cycle and standard (i.e., the transient FTP or the supplemental emissions test (SET)) determined by the manufacturer to be more stringent (i.e., to result in higher emissions with the same level of monitored component malfunction). The manufacturer must use data and/or engineering analysis to determine the test cycle and standard that is more stringent.

(ii) Identify in the certification documentation required under paragraph (m) of this section, the test cycle and standard determined by the manufacturer to be the most stringent for each applicable monitor.

(iii) If the Administrator reasonably believes that a manufacturer has determined incorrectly the test cycle and standard that is most stringent, the manufacturer must be able to provide emission data and/or engineering analysis supporting their choice of test cycle and standard.

(2) On engines equipped with emission controls that experience infrequent regeneration events, a manufacturer must adjust the emission test results that are used to determine the malfunction criteria for monitors that are required to indicate a malfunction before emissions exceed a certain emission threshold. For each such monitor, the manufacturer must adjust the emission result as done in accordance with the provisions of section 86.004–28(i) with the component for which the malfunction criteria are being established having been deteriorated to the malfunction threshold. The adjusted emission value must be used for purposes of determining whether or not the applicable emission threshold is exceeded.

(i) For purposes of this paragraph (f)(2) of this section, regeneration means an event, by design, during which emissions levels change while the emission control performance is being restored.

(ii) For purposes of this paragraph (f)(2) of this section, infrequent means having an expected frequency of less than once per transient FTP cycle.

(3) For gasoline engines, rather than meeting the malfunction criteria specified under paragraphs (h) and (i) of this section, the manufacturer may request approval to use an OBD system certified to the requirements of § 86.010–17. To do so, the manufacturer must demonstrate use of good engineering judgment in determining equivalent malfunction detection criteria to those required in this section.

(g) *OBD monitoring requirements for diesel-fueled/compression-ignition engines.* The following table shows the thresholds at which point certain components or systems, as specified in this paragraph (g), are considered malfunctioning.

TABLE 1.—OBD EMISSIONS THRESHOLDS FOR DIESEL-FUELED/COMPRESSION-IGNITION ENGINES MEANT FOR PLACEMENT IN APPLICATIONS GREATER THAN 14,000 POUNDS GVWR (G/BHP-HR)

Component	§ 86.010–18 reference	NMHC	CO	NO_X	PM
NMHC catalyst system	(g)(5)	2.5x			
NO_X aftertreatment system	(g)(6), (g)(7)			+0.3	
Diesel particulate filter (DPF) system	(g)(8)	2.5x			0.05/+0.04
Air-fuel ratio sensors upstream of aftertreatment devices	(g)(9)	2.5x	2.5x	+0.3	0.03/+0.02
Air-fuel ratio sensors downstream of aftertreatment devices	(g)(9)	2.5x		+0.3	0.05/+0.04
NO_X sensors	(g)(9)			+0.3	0.05/+0.04
"Other monitors" with emissions thresholds	(g)(1), (g)(3), (g)(4), (g)(10).	2.5x	2.5x	+0.3	0.03/+0.02

Notes: FEL=Family Emissions Limit; 2.5x std means a multiple of 2.5 times the applicable emissions standard; +0.3 means the standard or FEL plus 0.3; 0.05/+0.04 means an absolute level of 0.05 or an additive level of the standard or FEL plus 0.04, whilchever level is higher; these emissions thresholds apply to the monitoring requirements of paragraph (g) of this section 86.010–18.

(1) *Fuel system monitoring.*

(i) *General.* The OBD system must monitor the fuel delivery system to verify that it is functioning properly. The individual electronic components (e.g., actuators, valves, sensors, pumps) that are used in the fuel system and are not specifically addressed in this paragraph (g)(1) must be monitored in accordance with the requirements of paragraph (i)(3) of this section.

(ii) *Fuel system malfunction criteria.*

(A) *Fuel system pressure control.* The OBD system must monitor the fuel system's ability to control to the desired fuel pressure. This monitoring must be done continuously unless new hardware has to be added, in which case the monitoring must be done at least once per drive cycle. The OBD system must detect a malfunction of the fuel system's pressure control system when the pressure control system is unable to maintain an engine's emissions at or below the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the fuel system pressure control could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that the commanded fuel system pressure cannot be delivered.

(B) *Fuel system injection quantity.* The OBD system must detect a malfunction of the fuel injection system when the system is unable to deliver the commanded quantity of fuel necessary to maintain an engine's emissions at or below the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the fuel injection quantity could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that the commanded fuel quantity cannot be delivered.

(C) *Fuel system injection timing.* The OBD system must detect a malfunction of the fuel injection system when the system is unable to deliver fuel at the proper crank angle/timing (e.g., injection timing too advanced or too retarded) necessary to maintain an engine's emissions at or below the emissions thresholds for "other monitors" as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the fuel injection timing could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that the commanded fuel injection timing cannot be achieved.

(D) *Fuel system feedback control.* See paragraph (i)(6) of this section.

(iii) *Fuel system monitoring conditions.*

(A) The OBD system must monitor continuously for malfunctions identified in paragraphs (g)(1)(ii)(A) and (g)(1)(ii)(D) of this section.

(B) The manufacturer must define the monitoring conditions for malfunctions identified in paragraphs (g)(1)(ii)(B) and (g)(1)(ii)(C) in accordance with paragraphs (c) and (d) of this section.

(iv) *Fuel system MIL activation and DTC storage.* The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(2) *Engine misfire monitoring.*

(i) *General.* The OBD system must monitor the engine for misfire causing excess emissions.

(ii) *Engine misfire malfunction criteria.* The OBD system must be capable of detecting misfire occurring in one or more cylinders. To the extent possible without adding hardware for this specific purpose, the OBD system must also identify the specific misfiring cylinder. If more than one cylinder is misfiring continuously, a separate DTC must be stored indicating that multiple cylinders are misfiring. When identifying multiple cylinder misfire, the OBD system is not required to identify individually through separate DTCs each of the continuously misfiring cylinders.

(iii) *Engine misfire monitoring conditions.*

(A) The OBD system must monitor for engine misfire during engine idle conditions at least once per drive cycle in which the monitoring conditions for misfire are met. The manufacturer must be able to demonstrate via engineering analysis and/or data that the self-defined monitoring conditions: Are technically necessary to ensure robust detection of malfunctions (e.g., avoid false passes and false detection of malfunctions); require no more than 1000 cumulative engine revolutions; and, do not require any single continuous idle operation of more than 15 seconds to make a determination that a malfunction is present (e.g., a decision can be made with data gathered during several idle operations of 15 seconds or less); or, satisfy the requirements of paragraph (c) of this section with alternative engine operating conditions.

(B) Manufacturers may employ alternative monitoring conditions (e.g., off-idle) provided the manufacturer is able to demonstrate that the alternative monitoring ensure equivalent robust detection of malfunctions and equivalent timeliness in detection of malfunctions.

(iv) *Engine misfire MIL activation and DTC storage.* The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(3) *EGR system monitoring.*

(i) *General.* The OBD system must monitor the EGR system on engines so equipped for low flow rate, high flow rate, and slow response malfunctions. For engines equipped with EGR coolers (e.g., heat exchangers), the OBD system must monitor the cooler for insufficient cooling malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the EGR system must be monitored in accordance with the comprehensive component requirements in paragraph (i)(3) of this section.

(ii) *EGR system malfunction criteria.*

(A) *EGR low flow.* The OBD system must detect a malfunction of the EGR system prior to a decrease from the manufacturer's specified EGR flow rate that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the EGR system that causes a decrease in flow could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that it cannot increase EGR flow to achieve the commanded flow rate.

(B) *EGR high flow.* The OBD system must detect a malfunction of the EGR system, including a leaking EGR valve (i.e., exhaust gas flowing through the valve when the valve is commanded closed) prior to an increase from the manufacturer's specified EGR flow rate that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the EGR system that causes an increase in flow could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that it cannot reduce EGR flow to achieve the commanded flow rate.

(C) *EGR slow response.* The OBD system must detect a malfunction of the EGR system prior to any failure or deterioration in the capability of the EGR system to achieve the commanded flow rate within a manufacturer-specified time that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 1 of this paragraph (g). The OBD system must monitor both the capability of the EGR system to respond to a commanded increase in flow and the capability of the EGR system to respond to a commanded decrease in flow.

(D) *EGR system feedback control.* See paragraph (i)(6) of this section.

(E) *EGR cooler performance.* The OBD system must detect a malfunction of the EGR cooler prior to a reduction from the manufacturer's specified cooling performance that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the EGR cooler could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has no detectable amount of EGR cooling.

(iii) *EGR system monitoring conditions.*

(A) The OBD system must monitor continuously for malfunctions identified in paragraphs (g)(3)(ii)(A), (g)(3)(ii)(B), and (g)(3)(ii)(D) of this section.

(B) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (g)(3)(ii)(C) in accordance with paragraphs (c) and (d) of this section, with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in paragraph (c)(2) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(3)(ii)(C) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(C) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (g)(3)(ii)(E) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(3)(ii)(E) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(D) The manufacturer may request Administrator approval to disable temporarily the EGR system monitor(s) under specific conditions (e.g., when freezing may affect performance of the system) provided the manufacturer is able to demonstrate via data or engineering analysis that a reliable monitor cannot be run when these conditions exist.

(iv) *EGR system MIL activation and DTC storage.* The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(4) *Turbo boost control system monitoring.*

(i) *General.* The OBD system must monitor the boost pressure control system (e.g., turbocharger) on engines so equipped for under and over boost malfunctions. For engines equipped with variable geometry turbochargers (VGT), the OBD system must monitor the VGT system for slow response malfunctions. For engines equipped with charge air cooler systems, the OBD system must monitor the charge air cooler system for cooling system performance malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the boost pressure control system must be monitored in accordance with the comprehensive component requirements in paragraph (i)(3) of this section.

(ii) *Turbo boost control system malfunction criteria.*

(A) *Turbo underboost.* The OBD system must detect a malfunction of the boost pressure control system prior to a decrease from the manufacturer's commanded boost pressure that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the boost pressure control system that causes a decrease in boost could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that it cannot increase boost to achieve the commanded boost pressure.

(B) *Turbo overboost.* The OBD system must detect a malfunction of the boost pressure control system prior to an increase from the manufacturer's commanded boost pressure that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the boost pressure control system that causes an increase in boost could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that it cannot decrease boost to achieve the commanded boost pressure.

(C) *VGT slow response.* The OBD system must detect a malfunction prior to any failure or deterioration in the capability of the VGT system to achieve the commanded turbocharger geometry within a manufacturer-specified time that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the VGT system response could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction of the VGT system when proper functional response of the system to computer commands does not occur.

(D) *Turbo boost feedback control.* See paragraph (i)(6) of this section.

(E) *Charge air undercooling.* The OBD system must detect a malfunction of the charge air cooling system prior to a decrease from the manufacturer's specified cooling rate that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 1 of this paragraph (g). For engines in which no failure or deterioration of the charge air cooling system that causes a decrease in cooling performance could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has no detectable amount of charge air cooling.

(iii) *Turbo boost monitoring conditions.*

(A) The OBD system must monitor continuously for malfunctions identified in paragraphs (g)(4)(ii)(A), (g)(4)(ii)(B), and (g)(4)(ii)(D) of this section.

(B) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (g)(4)(ii)(C) of this section in accordance with paragraphs (c) and (d) of this section, with the exception that monitoring must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in paragraph (c)(2) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(4)(ii)(C) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(C) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (g)(4)(ii)(E) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(4)(ii)(E) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(iv) *Turbo boost system MIL activation and DTC storage.* The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(5) *NMHC converting catalyst monitoring.*

(i) *General.* The OBD system must monitor the NMHC converting catalyst(s) for proper NMHC conversion capability. For engines equipped with catalyzed diesel particulate filter(s) (DPF) that convert NMHC emissions, the catalyst function of the DPF must be monitored in accordance with the DPF requirements of paragraph (g)(8) of this section. For purposes of this paragraph (g)(5), each catalyst that converts NMHC must be monitored either individually or in combination with others.

(ii) *NMHC converting catalyst malfunction criteria.*

(A) *NMHC converting catalyst conversion efficiency.* The OBD system must detect a catalyst malfunction when the catalyst conversion capability decreases to the point that NMHC emissions exceed the emissions thresholds for the NMHC catalyst system as shown in Table 1 of this paragraph (g). If no failure or deterioration of the catalyst NMHC conversion capability could result in an engine's NMHC emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the catalyst has no detectable amount of NMHC conversion capability.

(B) *NMHC converting catalyst aftertreatment assistance functions.* For catalysts used to generate an exotherm to assist DPF regeneration, the OBD system must detect a malfunction when the catalyst is unable to generate a sufficient exotherm to achieve DPF regeneration. For catalysts used to generate a feedgas constituency to assist selective catalytic reduction (SCR) systems (e.g., to increase NO_2 concentration upstream of an SCR system), the OBD system must detect a malfunction when the catalyst is unable to generate the necessary feedgas constituents for proper SCR system operation. For catalysts located downstream of a DPF and used to convert NMHC emissions during DPF regeneration, the OBD system must detect a malfunction when the catalyst has no detectable amount of NMHC conversion capability.

(iii) *NMHC converting catalyst monitoring conditions.* The manufacturer must define the monitoring conditions for malfunctions identified in paragraphs (g)(5)(ii)(A) and (g)(5)(ii)(B) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraphs (g)(5)(ii)(A) and (g)(5)(ii)(B) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(iv) *NMHC converting catalyst MIL activation and DTC storage.* The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section. The monitoring method for the NMHC converting catalyst(s) must be capable of detecting all instances, except diagnostic self-clearing, when a catalyst DTC has been erased but the catalyst has not been replaced (e.g., catalyst over-temperature histogram approaches are not acceptable).

(6) *Selective catalytic reduction (SCR) and lean NO_X catalyst monitoring.*

(i) *General.* The OBD system must monitor the SCR and/or the lean NO_X converting catalyst(s) for proper conversion capability. For engines equipped with SCR systems or other catalyst systems that use an active/intrusive reductant injection (e.g., active lean NO_X catalysts that use diesel fuel post-injection or in-exhaust injection), the OBD system must monitor the active/intrusive reductant injection system for proper performance. The individual electronic components (e.g., actuators, valves, sensors, heaters, pumps) in the active/intrusive reductant injection system must be monitored in accordance with the comprehensive component requirements in paragraph (i)(3) of this section. For purposes of this paragraph (g)(6), each catalyst that converts NO_X must be monitored either individually or in combination with others.

(ii) *SCR and lean NO_X catalyst malfunction criteria.*

(A) *SCR and lean NO_X catalyst conversion efficiency.* The OBD system must detect a catalyst malfunction when the catalyst conversion capability decreases to the point that would cause an engine's emissions to exceed the emissions thresholds for NO_X aftertreatment systems as shown in Table 1 of this paragraph (g). If no failure or deterioration of the catalyst NO_X conversion capability could result in an engine's emissions exceeding any of the applicable emissions thresholds, the OBD system must detect a malfunction when the catalyst has no detectable amount of NO_X conversion capability.

(B) *SCR and lean NO_X catalyst active/intrusive reductant delivery performance.* The OBD system must detect a malfunction prior to any failure or deterioration of the system to properly regulate reductant delivery (e.g., urea injection, separate injector fuel injection, post injection of fuel, air assisted injection/mixing) that would cause an engine's emissions to exceed any of the applicable emissions thresholds for NO_X aftertreatment systems as shown in Table 1 of this paragraph (g). If no failure or deterioration of the reductant delivery system could result in an engine's emissions exceeding any of the applicable thresholds, the OBD system must detect a malfunction when the system has reached its control limits such that it is no longer able to deliver the desired quantity of reductant.

(C) *SCR and lean NO_X catalyst active/intrusive reductant quantity.* If the SCR or lean NO_X catalyst system uses a reductant other than the fuel used for the engine, or uses a reservoir/tank for the reductant that is separate from the fuel tank used for the engine, the OBD system must detect a malfunction when there is no longer sufficient reductant available (e.g., the reductant tank is empty).

(D) *SCR and lean NO_X catalyst active/intrusive reductant quality.* If the SCR or lean NO_X catalyst system uses a reservoir/tank for the reductant that is separate from the fuel tank used for the engine, the OBD system must detect a malfunction when an improper reductant is used in the reductant reservoir/tank (e.g., the reductant tank is filled with something other than the reductant).

(E) *SCR and lean NO_X catalyst active/intrusive reductant feedback control.* See paragraph (i)(6) of this section.

(iii) *SCR and lean NO_X catalyst monitoring conditions.*

(A) The manufacturers must define the monitoring conditions for malfunctions identified in paragraphs (g)(6)(ii)(A) and (g)(6)(ii)(D) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (g)(6)(ii)(A) of this section must be tracked separately but reported as a single set of values as specified in paragraph (e)(1)(iii) of this section.

(B) The OBD system must monitor continuously for malfunctions identified in paragraphs (g)(6)(ii)(B), (g)(6)(ii)(C), and (g)(6)(ii)(E) of this section.

(iv) *SCR and lean NO_X catalyst MIL activation and DTC storage.*

(A) For malfunctions identified in paragraph (g)(6)(ii)(A) of this section, the MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(B) For malfunctions identified in paragraphs (g)(6)(ii)(B), (g)(6)(ii)(C), and (g)(6)(ii)(D) of this section, the manufacturer may delay activating the MIL if the vehicle is equipped with an alternative indicator for notifying the vehicle operator of the malfunction. The alternative indicator must be of sufficient illumination and be located such that it is readily visible to the vehicle operator under all lighting conditions. If the vehicle is not equipped with such an alternative indicator and the OBD MIL activates, the MIL may be immediately deactivated and the corresponding DTC(s) erased once the OBD system has verified that the reductant tank has been refilled properly and the MIL has not been activated for any other malfunction. The Administrator may approve other strategies that provide equivalent assurance that a vehicle operator would be promptly notified and that corrective action would be taken.

(C) The monitoring method for the SCR and lean NO_X catalyst(s) must be capable of detecting all instances, except diagnostic self-clearing, when a catalyst DTC(s) has been erased but the catalyst has not been replaced (e.g., catalyst over-temperature histogram approaches are not acceptable).

(7) *NO_X adsorber system monitoring.*

(i) *General.* The OBD system must monitor the NO_X adsorber on engines so-equipped for proper performance. For engines equipped with active/intrusive injection (e.g., in-exhaust fuel and/or air injection) to achieve desorption of the NO_X adsorber, the OBD system must monitor the active/intrusive injection system for proper performance. The individual electronic components (e.g., injectors, valves, sensors) that are used in the active/intrusive injection system must be monitored in accordance with the comprehensive component requirements in paragraph (i)(3) of this section.

(ii) *NO_X adsorber system malfunction criteria.*

(A) *NO_X adsorber system capability.* The OBD system must detect a NO_X adsorber malfunction when its capability (i.e., its combined adsorption and conversion capability) decreases to