ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 86

[OAR–2005–0047; FRL–8256–9]

RIN 2060–AL92

Control of Air Pollution From New Motor Vehicles and New Motor Vehicle Engines; Regulations Requiring Onboard Diagnostic Systems on 2010 and Later Heavy-Duty Engines Used in Highway Applications Over 14,000 Pounds; Revisions to Onboard Diagnostic Requirements for Diesel Highway Heavy-Duty Vehicles Under 14,000 Pounds

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice of proposed rulemaking.

SUMMARY: In 2001, EPA finalized a new, major program for highway heavy-duty engines. That program, the Clean Diesel Trucks and Buses program, will result in the introduction of advanced emissions control systems such as catalyzed diesel particulate filters (DPF) and catalysts capable of reducing harmful nitrogen oxide (NO_X) emissions. This proposal would require that these advanced emissions control systems be monitored for malfunctions via an onboard diagnostic system (OBD), similar to those systems that have been required on passenger cars since the mid-1990s. This proposal would require manufacturers to install OBD systems that monitor the functioning of emission control components and alert the vehicle operator to any detected need for emission related repair. This proposal would also require that manufacturers make available to the service and repair industry information necessary to perform repair and maintenance service on OBD systems and other emission related engine components. Lastly, this proposal would revise certain existing OBD requirements for diesel engines used in heavy-duty vehicles under 14,000 pounds.

DATES: If we do not receive a request for a public hearing, written comments are due March 26, 2007. Requests for a public hearing must be received by February 8, 2007. If we do receive a request for a public hearing, we will publish a notice in the **Federal Register** and on the Web at *http://www.epa.gov/obd/regtech/heavy.htm* containing details regarding the location, date, and time of the public hearing. In that case, the public comment period would close 30 days after the public hearing. Under the Paperwork Reduction Act, comments on the information collection provisions must be received by OMB on or before February 23, 2007.

ADDRESSES: Submit your comments, identified by Docket ID No. EPA–HQ–OAR–2005–0047, by one of the following methods:

- *http://www.regulations.gov:* Follow the on-line instructions for submitting comments.
- *Mail:* Onboard Diagnostic (OBD) Systems on 2010 and Later Heavy-Duty Highway Vehicles and Engines, Environmental Protection Agency, Mailcode: 6102T, 1200 Pennsylvania Ave., NW., Washington, DC, 20460, Attention Docket ID No. EPA–HQ–OAR–2005–0047. In addition, please mail a copy of your comments on the information collection provisions to the Office of Information and Regulatory Affairs, Office of Management and Budget (OMB), Attn: Desk Officer for EPA, 725 17th St. NW., Washington, DC 20503.

Instructions: Direct your comments to Docket ID No. EPA–HQ–OAR–2005–0047. EPA's policy is that all comments received will be included in the public docket without change and may be made available online at *http://www.regulations.gov,* including any personal information provided, unless the comment includes information claimed to be Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Do not submit information that you consider to be CBI or otherwise protected through *http://www.regulations.gov* or e-mail. The *http://www.regulations.gov* Web site is an ''anonymous access'' system, which means EPA will not know your identity or contact information unless you provide it in the body of your comment. If you send an e-mail comment directly to EPA without going through *http://www.regulations.gov* your e-mail address will be automatically captured and included as part of the comment that is placed in the public docket and made available on the Internet. If you submit an electronic comment, EPA recommends that you include your name and other contact information in the body of your comment and with any disk or CD–ROM you submit. If EPA cannot read your comment due to technical difficulties and cannot contact you for clarification, EPA may not be able to consider your comment. Electronic files should avoid the use of special characters, any form of encryption, and be free of any defects or viruses.

Docket: All documents in the docket are listed in the *http://www.regulations.gov* index. Although listed in the index, some information is not publicly available, e.g., CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, will be publicly available only in hard copy. Publicly available docket materials are available either electronically in *http://www.regulations.gov* or in hard copy at the Air Docket, EPA/DC, EPA West, Room B102, 1301 Constitution Ave., NW., Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566–1744, and the telephone number for the Air Docket is (202) 566–1742.

Note: The EPA Docket Center suffered damage due to flooding during the last week of June 2006. The Docket Center is continuing to operate. However, during the cleanup, there will be temporary changes to Docket Center telephone numbers, addresses, and hours of operation for people who wish to make hand deliveries or visit the Public Reading Room to view documents. Consult EPA's **Federal Register** notice at 71 FR 38147 (July 5, 2006) or the EPA Web site at *http://www.epa.gov/epahome/dockets.htm* for current information on docket operations, locations and telephone numbers. The Docket Center's mailing address for U.S. mail and the procedure for submitting comments to *www.regulations.gov* are not affected by the flooding and will remain the same.

FOR FURTHER INFORMATION CONTACT: U.S. EPA, National Vehicle and Fuel Emissions Laboratory, Assessment and Standards Division, 2000 Traverwood Drive, Ann Arbor, MI 48105; telephone (734) 214–4405, fax (734) 214–4816, email *sherwood.todd@epa.gov.*

SUPPLEMENTARY INFORMATION:

Regulated Entities

This action will affect you if you produce or import new heavy-duty engines which are intended for use in highway vehicles such as trucks and buses, or produce or import such highway vehicles, or convert heavy-duty vehicles or heavy-duty engines used in highway vehicles to use alternative fuels.

The following table gives some examples of entities that may have to follow the regulations. But because these are only examples, you should carefully examine the regulations in 40 CFR part 86. If you have questions, call the person listed in the **FOR FURTHER INFORMATION CONTACT** section of this preamble:

Category	NAICS Codes[a]	SIC Codes[b]	Examples of potentially regulated entities
Industry	336111	3711	Motor Vehicle Manufacturers; Engine and Truck Manufacturers.
	336112		
	336120		
Industry	811112	7533	Commercial Importers of Vehicles and Vehicle Components.
	811198	7549	
	541514	8742	
Industry	336111	3592	Alternative fuel vehicle converters.
	336312	3714	
	422720	5172	
	454312	5984	
	811198	7549	
	541514	8742	
	541690	8931	

[a]North American Industry Classification Systems (NAICS).
[b]Standard Industrial Classification (SIC) system code.

What Should I Consider as I Prepare My Comments for EPA?

Submitting CBI. Do not submit this information to EPA through *www.regulations.gov* or e-mail. Clearly mark the part or all of the information that you claim to be CBI. For CBI information in a disk or CD ROM that you mail to EPA, mark the outside of the disk or CD ROM as CBI and then identify electronically within the disk or CD ROM the specific information that is claimed as CBI). In addition to one complete version of the comment that includes information claimed as CBI, a copy of the comment that does not contain the information claimed as CBI must be submitted for inclusion in the public docket. Information so marked will not be disclosed except in accordance with procedures set forth in 40 CFR part 2.

Tips for Preparing Your Comments. When submitting comments, remember to:

- Identify the rulemaking by docket number and other identifying information (subject heading, **Federal Register** date and page number).
- Follow directions—The agency may ask you to respond to specific questions or organize comments by referencing a Code of Federal Regulations (CFR) part or section number.
- Explain why you agree or disagree; suggest alternatives and substitute language for your requested changes.
- Describe any assumptions and provide any technical information and/or data that you used.
- If you estimate potential costs or burdens, explain how you arrived at your estimate in sufficient detail to allow for it to be reproduced.
- Provide specific examples to illustrate your concerns, and suggest alternatives.
- Explain your views as clearly as possible, avoiding the use of profanity or personal threats.
- Make sure to submit your comments by the comment period deadline identified.

Outline of this Preamble

I. Overview

A. Background

Section 202(m) of the CAA, 42 U.S.C. 7521(m), directs EPA to promulgate regulations requiring 1994 and later model year light-duty vehicles (LDVs) and light-duty trucks (LDTs) to contain an OBD system that monitors emission-related components for malfunctions or deterioration ''which could cause or result in failure of the vehicles to comply with emission standards established'' for such vehicles. Section 202(m) also states that, ''The Administrator may, in the Administrator's discretion, promulgate regulations requiring manufacturers to install such onboard diagnostic systems on heavy-duty vehicles and engines.''

On February 19, 1993, we published a final rule requiring manufacturers of light-duty applications to install such OBD systems on their vehicles beginning with the 1994 model year (58 FR 9468). The OBD systems must monitor emission control components for any malfunction or deterioration that could cause exceedance of certain emission thresholds. The regulation also required that the driver be notified of any need for repair via a dashboard light, or malfunction indicator light (MIL), when the diagnostic system detected a problem. We also allowed optional compliance with California's second phase OBD requirements, referred to as OBDII (13 CCR 1968.1), for purposes of satisfying the EPA OBD requirements. Since publishing the 1993 OBD final rule, EPA has made several revisions to the OBD requirements, most of which served to align the EPA OBD requirements with revisions to the California OBDII requirements (13 CCR 1968.2).

On August 9, 1995, EPA published a final rulemaking that set forth service information regulations for light-duty vehicles and light-duty trucks (60 FR 40474). These regulations, in part, required each Original Equipment Manufacturer (OEM) to do the following: (1) List all of its emission-related service and repair information on a Web site called FedWorld (including the cost of each item and where it could be purchased); (2) either provide enhanced information to equipment and tool companies or make its OEM-specific diagnostic tool available for purchase by aftermarket technicians, and (3) make reprogramming capability available to independent service and repair professionals if its franchised dealerships had such capability. These requirements are intended 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. These service information availability requirements have been revised since that first final rule in response to changing technology among other reasons. (68 FR 38428)

In October of 2000, we published a final rule requiring OBD systems on heavy-duty vehicles and engines up to 14,000 pounds GVWR (65 FR 59896). In that rule, we expressed our intention of developing OBD requirements in a future rule for vehicles and engines used in vehicles over 14,000 pounds. We expressed this same intention in our 2007HD highway final rule (66 FR 5002) which established new heavy-duty highway emissions standards for 2007 and later model year engines. In June of 2003, we published a final rule extending service information availability requirements to heavy-duty vehicles and engines weighing up to 14,000 pounds GVWR. We declined extending these requirements to engines above 14,000 pounds GVWR at least until such engines are subject to OBD requirements.

On January 18, 2001, EPA established a comprehensive national control program—the Clean Diesel Truck and Bus program—that regulates the heavy-duty vehicle and its fuel as a single system. (66 FR 5002) As part of this program, new emission standards will begin to take effect in model year 2007 and will apply to heavy-duty highway engines and vehicles. These standards are based on the use of high-efficiency catalytic exhaust emission control devices or comparably effective advanced technologies. Because these devices are damaged by sulfur, the regulation also requires the level of sulfur in highway diesel fuel be reduced by 97 percent.[1]

Today's action proposes new OBD requirements for highway engines used in vehicles greater than 14,000 pounds. Today's action also proposes new availability requirements for emission-related service information that will make this information more widely available to the industry servicing vehicles over 14,000 pounds.

In addition to these proposed requirements and changes, we are seeking comment on possible future regulations that would require OBD systems on heavy-duty diesel engines used in nonroad equipment. Diesel engines used in nonroad equipment are, like highway engines, a major source of NO_X and particulate matter (PM) emissions, and the diesel engines used in nonroad equipment are essentially the same as those used in heavy-duty highway trucks. Further, new regulations applicable to nonroad diesel engines will result in the introduction of advanced emissions control systems like those expected for highway diesel engines. (69 FR 38958) Therefore, having OBD systems and OBD regulations for nonroad engines seems to be a natural progression from the proposed requirements for heavy-duty highway engines. We discuss this issue in greater detail in section I of this preamble with the goal of soliciting public comment regarding how we should proceed with respect to nonroad OBD.

B. What Is EPA Proposing?

1. OBD Requirements for Engines Used in Highway Vehicles Over 14,000 Pounds GVWR

We believe that OBD requirements should be extended to include over 14,000 pound heavy-duty vehicles and engines for many reasons. In the past, heavy-duty diesel engines have relied primarily on in-cylinder modifications to meet emission standards. For example, emission standards have been met through changes in fuel timing, piston design, combustion chamber design, charge air cooling, use of four valves per cylinder rather than two valves, and piston ring pack design and location improvements. In contrast, the 2004 and 2007 emission standards represent a different sort of technological challenge that are being met with the addition of exhaust gas recirculation (EGR) systems and the addition of exhaust aftertreatment devices such as diesel particulate filters (DPF), sometimes called PM traps, and NO_X catalysts. Such ''add on'' devices can experience deterioration and malfunction that, unlike the engine design elements listed earlier, may go unnoticed by the driver. Because deterioration and malfunction of these devices can go unnoticed by the driver, and because their primary purpose is emissions control, and because the level of emission control is on the order of 50 to 99 percent, some form of diagnosis and malfunction detection is crucial. We believe that such detection can be effectively achieved by employing a well designed OBD system.

The same is true for gasoline heavy-duty vehicles and engines. While emission control is managed with both engine design elements and aftertreatment devices, the catalytic converter is the primary emission control feature accounting for over 95 percent of the emission control. We believe that monitoring the emission control system for proper operation is critical to ensure that new vehicles and engines certified to the very low emission standards set in recent years continue to meet those standards throughout their full useful life.

Further, the industry trend is clearly toward increasing use of computer and electronic controls for both engine and powertrain management, and for emission control. In fact, the heavy-duty industry has already gone a long way, absent any government regulation, to standardize computer communication protocols.[2] Computer and electronic control systems, as opposed to mechanical systems, provide improvements in many areas including, but not limited to, improved precision and control, reduced weight, and lower cost. However, electronic and computer controls also create increased difficulty in diagnosing and repairing the malfunctions that inevitably occur in any engine or powertrain system. Today's proposed OBD requirements would build on the efforts already undertaken by the industry to ensure that key emissions related components will be monitored in future heavy-duty vehicles and engines and that the diagnosis and repair of those components will be as efficient and cost effective as possible.

Lastly, heavy-duty engines and, in particular, diesel engines tend to have very long useful lives. With age comes deterioration and a tendency toward increasing emissions. With the OBD systems proposed today, we expect that these engines will continue to be properly maintained and therefore will continue to emit at low emissions levels even after accumulating hundreds of thousands and even a million miles.

For the reasons laid out above, most manufacturers of vehicles, trucks, and engines have incorporated some type of OBD system into their products that are capable of identifying when certain types of malfunctions occur, and in what systems. In the heavy-duty industry, those OBD systems traditionally have been geared toward

[1] Note that the 2007HD highway rule contained new emissions standards for gasoline engines as well as diesel engines.

[2] See ''On-Board Diagnostics, A Heavy-Duty Perspective,'' SAE 951947; ''Recommended Practice for a Serial Control and Communications Vehicle Network,'' SAE J1939 which may be obtained from Society of Automotive Engineers International, 400 Commonwealth Dr., Warrendale, PA, 15096–0001; and ''Road Vehicles-Diagnostics on Controller Area Network (CAN)—Part 4: Requirements for emission-related systems,'' ISO 15765–4:2001 which may be obtained from the International Organization for Standardization, Case Postale 56, CH–1211 Geneva 20, Switzerland.

detecting malfunctions causing drivability and/or fuel economy related problems. Without specific requirements for manufacturers to include OBD mechanisms to detect emission-related problems, those types of malfunctions that could result in high emissions without a corresponding adverse drivability or fuel economy impact could go unnoticed by both the driver and the repair technician. The resulting increase in emissions and detrimental impact on air quality could be avoided by incorporating an OBD system capable of detecting emission control system malfunctions.

2. Requirements That Service Information Be Made Available

We are proposing that makers of engines that go into vehicles over 14,000 pounds make available to any person engaged in repair or service all information necessary to make use of the OBD systems and for making emission-related repairs, including any emissions-related information that is provided by the OEM to franchised dealers. This information includes, but is not limited to, manuals, technical service bulletins (TSBs), a general description of the operation of each OBD monitor, etc. We discuss the proposed requirements further in section IV of this preamble.

The proposed requirements are similar to those required currently for all 1996 and newer light-duty vehicles and light-duty trucks and 2005 and newer heavy-duty applications up to 14,000 pounds. While EPA understands that there may be some differences between aftermarket service for the under 14,000 pound and over 14,000 pound applications, we believe that any such differences would not substantially affect the implementation of such requirements and that, therefore, it is reasonable to use EPA's existing service information regulations as a basis for proposing service information requirements for the over 14,000 pound arena. See section IV for a complete discussion of the service information provisions being proposed for the availability of over 14,000 pound service information.

Note that information for making emission-related repairs does not include information used to design and manufacture parts, but it may include OEM changes to internal calibrations and other indirect information, as discussed in section IV.

3. OBD Requirements for Diesel Heavy-Duty Vehicles and Engines Used in Vehicles Under 14,000 Pounds

We are also proposing some changes to the existing diesel OBD requirements for heavy-duty applications under 14,000 pounds (i.e., 8,500 to 14,000 pounds). Some of these changes are being proposed for the 2007 and later model years (i.e., for immediate implementation) because we believe that some of the requirements that we currently have in place for 8,500 to 14,000 pound applications cannot be met by diesels without granting widespread deficiencies to industry. Other changes are being proposed for the 2010 and later model years since they represent an increase in the stringency of our current OBD requirements and, therefore, some leadtime is necessary for manufacturers to comply. All of the changes being proposed for 8,500 to 14,000 pound diesel applications would result in OBD emissions thresholds identical, for all practical purposes, to the OBD thresholds being proposed for over 14,000 pound applications.

C. Why Is EPA Making This Proposal?

1. Highway Engines and Vehicles Contribute to Serious Air Pollution Problems

The pollution emitted by heavy-duty highway engines contributes greatly to our nation's continuing air quality problems. Our 2007HD highway rule was designed to address these serious air quality problems. These problems include premature mortality, aggravation of respiratory and cardiovascular disease, aggravation of existing asthma, acute respiratory symptoms, chronic bronchitis, and decreased lung function. Numerous studies also link diesel exhaust to increased incidence of lung cancer. We believe that diesel exhaust is likely to be carcinogenic to humans by inhalation and that this cancer hazard exists for occupational and environmental levels of exposure.

Our 2007HD highway rule will regulate the heavy-duty vehicle and its fuel as a single system. As part of this program, new emission standards will begin to take effect in model year 2007 and phase-in through model year 2010, and will apply to heavy-duty highway engines and vehicles. These standards are based on the use of high-efficiency catalytic exhaust emission control devices or comparably effective advanced technologies and a cap on the allowable sulfur content in both diesel fuel and gasoline.

In the 2007HD highway final rule, we estimated that, by 2007, heavy-duty trucks and buses would account for about 28 percent of nitrogen oxides emissions and 20 percent of particulate matter emissions from mobile sources. In some urban areas, the contribution is even greater. The 2007HD highway program will reduce particulate matter and oxides of nitrogen emissions from heavy-duty engines by 90 percent and 95 percent below current standard levels, respectively. In order to meet these more stringent standards for diesel engines, the program calls for a 97 percent reduction in the sulfur content of diesel fuel. As a result, diesel vehicles will achieve gasoline-like exhaust emission levels. We have also established more stringent standards for heavy-duty gasoline vehicles, based in part on the use of the low sulfur gasoline that will be available when the standards go into effect.

2. Emissions Control of Highway Engines and Vehicles Depends on Properly Operating Emissions Control Systems

The emissions reductions and resulting health and welfare benefits of the 2007HD highway program will be dramatic when fully implemented. By 2030, the program will reduce annual emissions of nitrogen oxides, nonmethane hydrocarbons, and particulate matter by a projected 2.6 million, 115,000 and 109,000 tons, respectively. However, to realize those large emission reductions and health benefits, the emission control systems on heavy-duty highway engines and vehicles must continue to provide the 90 to 95 percent emission control effectiveness throughout their operating life. Today's proposed OBD requirements will help to ensure that emission control systems continue to operate properly by detecting when those systems malfunction, by then notifying the driver that a problem exists that requires service and, lastly, by informing the service technician what the problem is so that it can be properly repaired.

3. Basis for Action Under the Clean Air Act

Section 202(m) of the CAA, 42 U.S.C. 7521(m), directs EPA to promulgate regulations requiring 1994 and later model year light-duty vehicles (LDVs) and light-duty trucks (LDTs) to contain an OBD system that monitors emission-related components for malfunctions or deterioration "which could cause or result in failure of the vehicles to comply with emission standards established" for such vehicles. Section

202(m) also states that, ''The Administrator may, in the Administrator's discretion, promulgate regulations requiring manufacturers to install such onboard diagnostic systems on heavy-duty vehicles and engines.''

Section 202(m)(5) of the CAA states that the Administrator shall require manufacturers to, ''provide promptly to any person engaged in the repairing or servicing of motor vehicles or motor vehicle engines * * * with any and all information needed to make use of the emission control diagnostics system prescribed under this subsection and such other information including instructions for making emission related diagnosis and repairs.''

D. How Has EPA Chosen the Level of the Proposed Emissions Thresholds?

The OBD emissions thresholds that we are proposing are summarized in Tables II.B–1, II.C–1, II.H–1 and II.H–2. These tables show the actual threshold levels and how they relate to current emissions standards. Here, we wish to summarize how we chose those proposed thresholds. First, it is important to note that OBD is more than emissions thresholds. In fact, most OBD monitors are not actually tied to an emissions threshold. Instead, they monitor the performance of a given component or system and evaluate that performance based on electrical information (e.g., voltage within proper range) or temperature information (e.g., temperature within range), etc. Such monitors often detect malfunctions well before emissions are seriously compromised. Nonetheless, emissions thresholds are a critical element to OBD requirements since some components and systems, most notably any aftertreatment devices, cannot be monitored in simple electrical or temperature related terms. Instead, their operating characteristics can be measured and correlated to an emissions impact. This way, when those operating characteristics are detected, an unacceptable emissions increase can be inferred and a malfunction can be noted to the driver.

Part of the challenge in establishing OBD requirements is determining the point—the OBD threshold—at which an unacceptable emissions increase has occurred that is detectable by the best available OBD technology. Two factors have gone into our determination of the emissions thresholds we are proposing: technological feasibility; and the costs and emissions reductions associated with repairs initiated as a result of malfunctions found by OBD systems. The first of these factors is discussed in more detail in section III where we present our case for the technological feasibility of the thresholds. In summary, we believe that the thresholds we are proposing are, while challenging, technologically feasible in the 2010 and later timeframe. We have carefully considered monitoring system capability, sensor capability, emissions measurement capability, test-to-test variability and, perhaps most importantly, the manufacturers' engineering and test cell resources and have arrived at thresholds we believe can be met on one engine family per manufacturer in the 2010 model year and on all engine families by the 2013 model year.

We believe that the proposed thresholds strike the proper balance between environmental protection, OBD and various sensor capabilities, and avoidance of repairs whose costs could be high compared to their emission control results. One must keep in mind that increasingly stringent OBD thresholds (i.e., OBD detection at lower emissions levels) may lead to more durable emission controls due to a manufacturer's desire to avoid the negative impression given their product upon an OBD detection. Such an outcome would result in lower fleetwide emissions while increasing costs to manufacturers. However, increasingly stringent OBD thresholds may also lead to more OBD detections and more OBD induced repairs and, perhaps, many OBD induced repairs for malfunctions having little impact on emissions. Such an outcome would result in lower fleetwide emissions while increasing costs to both manufacturers and truck owners.

E. World Wide Harmonized OBD (WWH–OBD)

Within the United Nations (UN), the World Forum for Harmonization of Vehicle Regulations (WP.29) administers the 1958 Geneva Agreement (1958 Agreement) to facilitate the adoption of uniform conditions of approval and reciprocal recognition of approval for motor vehicle equipment and parts. As a result, WP.29 has responsibility for vehicle regulations within Europe and, indirectly, many countries outside of Europe that have voluntarily adopted the WP.29 regulations. The United States was never a party to the 1958 Agreement, but EPA has monitored the WP.29 regulations developed under the 1958 Agreement and we have benefited from a reciprocal consultative relationship with our European counterparts. More recently, WP.29 took on the responsibility of administering the 1998 Global Agreement that established a process to permit all regions of the world to jointly develop global technical regulations without required mutual recognition of approvals or designated compliance and enforcement. The United States is a signatory of the 1998 Global Agreement (1998 Agreement), and EPA has responsibility for representing the U.S. with respect to environmental issues within WP.29 as they pertain to the 1998 Agreement.

During the one-hundred-and-twenty-sixth session of WP.29 of March 2002, the Executive Committee (AC.3) of the 1998 Global Agreement (1998 Agreement) adopted a Programme of Work, which includes the development of a Global Technical Regulation (GTR) concerning onboard diagnostic systems for heavy-duty vehicles and engines. An informal working group—the WWH–OBD working group—was established to develop the GTR. The working group was instructed that the OBD system should detect failures from the engine itself, as well as from the exhaust aftertreatment systems fitted downstream of the engine, and from the package of information exchanged between the engine electronic control unit(s) and the rest of vehicle and/or powertrain. The working group was also instructed to base the OBD requirements on the technologies expected to be industrially available at the time the GTR would be enforced, and to take into account both the expected state of electronics in the years 2005–2008 and the expected newest engine and aftertreatment technologies.

In November 2003, AC.3 further directed the working group to structure the GTR in such a manner as to enable its future extension to other functions of the vehicle. In so doing, AC.3 did not revise the scope of the task given to the working group (i.e., the scope remained emissions-related heavy-duty OBD). As a result, the GTR is structured such that OBD monitoring and communications could be extended to other systems such as vehicle safety systems. This has been achieved by dividing the GTR into a set of generic OBD requirements to be followed by specific OBD requirements concerning any future desired OBD systems. The generic OBD requirements contain definitions and other OBD regulatory elements that are meant to be applicable throughout the GTR and all of its modules, annexes, and appendices. This generic section is followed by the first specific OBD section—emission-related OBD—which contains definitions and OBD regulatory elements specific to emissions-related OBD.

EPA has been active in the WWH–OBD working group for more than three years. Because that group has been developing a regulation at the same time that we have been developing the requirements in this proposal, our proposed OBD requirements are consistent, for the most part, with the current efforts of the WWH–OBD group.

The WWH–OBD working group submitted a draft GTR as a formal document in March of 2006. During the months immediately following, the WWH–OBD working group has made final revisions to the GTR and will submit it to WP.29 for consideration. If approved by WP.29 and adopted as a formal global technical regulation, we would intend to propose any revisions to our OBD regulations that might be necessary to make them consistent with WWH–OBD.[3]

The latest version of the draft WWH–OBD GTR has been placed in the docket for this rule.[4] While it is not yet a final document, we are nonetheless interested in comments regarding the current version. More specifically, we are interested in comments regarding any possible inconsistencies between the requirements of the draft GTR and the requirements being proposed today. We believe that if such inconsistencies exist, they are minor. WWH–OBD provides a framework for nations to establish a heavy-duty OBD program. It has the potential to result in similar OBD systems, but the WWH–OBD GTR must fit into the context of any country's existing heavy-duty emissions regulations. For example, at this time, the draft GTR does not specify emissions threshold levels, implementation dates, or phase-in schedules. As such, our proposal today is much more detailed than the draft WWH–OBD GTR, but we believe there exist no major inconsistencies between the two regulations.

F. Onboard Diagnostics for Diesel Engines Used in Nonroad Land-Based Equipment

We are also considering regulations—although we are not making any proposals today—that would require OBD systems on heavy-duty diesel engines used in nonroad land-based equipment. The pollution emitted by diesel nonroad engines contributes greatly to our nation's continuing air quality problems. Our recent Nonroad Tier 4 rulemaking was designed to address these serious air quality problems from land-based diesel engines. (69 FR 38958) Like with diesel highway emissions, these problems include premature mortality, aggravation of respiratory and cardiovascular disease, aggravation of existing asthma, acute respiratory symptoms, chronic bronchitis, and decreased lung function. And, as noted above, we believe that diesel exhaust is likely to be carcinogenic to humans by inhalation and that this cancer hazard exists for occupational and environmental levels of exposure.

In our preamble to the Nonroad Tier 4 final rule, we estimated that, absent the nonroad Tier 4 standards, by 2020, land based nonroad diesel engines would account for as much as 70 percent of the diesel mobile source PM inventory. As part of our nonroad Tier 4 program, new emission standards will begin to take effect in calendar year 2011 that are based on the use of high-efficiency catalytic exhaust emission control devices or comparably effective advanced technologies. As with our 2007HD highway program, a cap is also included on the allowable sulfur content in nonroad diesel fuel.

The diesel engines used in nonroad land-based equipment are, in certain horsepower ranges, often essentially the same as those used in heavy-duty highway trucks. In other horsepower ranges—e.g., very large nonroad machines with engines having more than 1,500 horsepower—the engine is quite different. Such differences can include the addition of cylinders and turbo chargers among other things. Notably, the new nonroad Tier 4 regulations will result in the introduction of advanced emissions control systems on nonroad land-based equipment; those advanced emissions control systems will be the same type of systems as those expected for highway diesel engines.

Therefore, having OBD systems and OBD regulations for nonroad diesel engines seems to be a natural progression from the proposed requirements for heavy-duty highway engines. Nonetheless, we believe that there are differences between nonroad equipment and highway applications, and differences between the nonroad market and the highway market such that proposing the same OBD requirements for nonroad as for highway may not be appropriate. Therefore, we are providing advance notice to the public with the goal of soliciting public comment regarding how we should proceed with respect to nonroad OBD. This section presents issues we have identified and solicits comment. We also welcome comment with respect to other issues we have not addressed here, such as service information availability.

1. What Is the Baseline Nonroad OBD System?

We know that highway diesel engines already use a sophisticated level of OBD system. For nonroad diesel engines in the 200 to 600 horsepower range—i.e., the typical range of highway engines—are the current OBD system identical to their highway counterparts? How would the proposed highway OBD requirements change this, if at all? Do diesel engines outside the range typical of highway engines use OBD?

2. What Is the Appropriate Level of OBD Monitoring for Nonroad Diesel Engines?

The proposed OBD requirements for highway engines are very comprehensive and would result in virtually every element of the emissions control system being monitored. Is this appropriate for nonroad diesel engines? And to what degree should such monitoring be required? The emissions thresholds proposed for highway engines will push OBD and sensor technology beyond where it is today because of their stringency. Is a similar level of stringency appropriate for nonroad engines? Should emissions thresholds analogous to those presented in Table II.B–1 of this preamble even be a part of any potential nonroad OBD requirements or should nonroad OBD rely more heavily on comprehensive component monitoring as discussed in section II.D.4 of this preamble? This latter question is particularly compelling given the incredibly broad range of operating characteristics for nonroad equipment. Similar to the issue of emissions thresholds, certain aspects of the proposed highway OBD requirements carry with them serious concerns given the range of use for heavy-duty highway trucks (line-haul trucks versus garbage trucks versus urban delivery trucks, etc.). As discussed in various places in section II of this preamble, this broad range of uses makes it difficult for manufacturers to design a single approach that would, for example, ensure frequent monitoring events on all possible applications. This difficulty could be even more pronounced in the nonroad industry given the greater number of possible applications.

[3] Note that, while the WWH–OBD GTR is consistent with many of the specific requirements we are proposing, it is not currently as comprehensive as our proposal (e.g., it does not contain the same level of detail with respect to certification requirements and enforcement provisions). For that reason, at this time, we do not believe that the GTR would fully replace what we are proposing today.

[4] "Revised Proposal for New Draft Global Technical Regulation (gtr): Technical Requirements for On-Board Diagnostic Systems (OBD) for Road Vehicles;" ECE/TRANS/WP.29/GRPE/2006/8/Rev.1; March 27, 2006, Docket ID# EPA–HQ–OAR–2005–0047–0004.

We request comment regarding what any potential nonroad OBD monitoring requirements should look like. More specifically, we request comment regarding the inclusion of emissions thresholds versus relying solely on comprehensive component monitoring. From commenters in favor of emissions thresholds, we request details regarding the appropriate level of emissions thresholds including data and strong engineering analyses for/against the suggested level. We request comment regarding the comprehensiveness of monitoring (i.e., the entire emissions control system, aftertreatement devices only, feedback control systems only, etc.).

3. What Should the OBD Standardization Features Be?

Should nonroad OBD include a requirement for a dedicated, OBD-only malfunction indicator light? Should nonroad OBD require specific communication protocols for communication of onboard information to offboard devices and scan tools? What should those protocols be? What are the needs of the nonroad service industry with respect to standardization of onboard to offboard communications?

4. What Are the Prospects and/or Desires for International Harmonization of Nonroad OBD?

Nonroad equipment is perhaps the most international of all mobile source equipment. Land based nonroad equipment, while not as much so as marine equipment, tends to be designed, produced, marketed, and sold to a world market to a greater extent than is highway equipment. Given that, is there a sense within the nonroad industry that international harmonization is important? Imperative? Is the proper avenue for putting into place nonroad OBD regulations the WWH–OBD process discussed above? If so, is industry prepared to play a role in developing a nonroad OBD element to the WWH–OBD document? Are other government representatives prepared to do so?

II. What Are the Proposed OBD Requirements and When Would They Be Implemented?

The following subsections describe our proposed OBD monitoring requirements and the timelines for their implementation. The requirements are indicative of our goal for the program which is a set of OBD monitors that provide robust diagnosis of the emission control system. Our intention is to provide industry sufficient time and experience with satisfying the demands of the proposed OBD program. While their engines already incorporate OBD systems, those systems are generally less comprehensive and do not monitor the emission control system in the ways we are proposing. Additionally, the proposed OBD requirements represent a new set of technological requirements and a new set of certification requirements for the industry in addition to the 2007HD highway program and its challenging emission standards for PM and NO_X and other pollutants. As a result, we believe the monitoring requirements and timelines outlined in this section appropriately weigh the need for OBD monitors on the emission control system and the need to gain experience with not only those monitors but also the newly or recently added emission control hardware.

We request comment on all aspects of the requirements laid out in this section and throughout this preamble. As discussed in Section IX, we are also interested in comments concerning state run HDOBD-based inspection and maintenance (I/M) programs, the level of interest in such programs, and comments concerning the suitability of today's proposed OBD requirements toward facilitating potential HDOBD I/M programs in the future.

A. General OBD System Requirements

1. The OBD System

We are proposing that the OBD system be designed to operate for the actual life of the engine in which it is installed. Further, the OBD system cannot be programmed or otherwise designed to deactivate based on age and/or mileage of the vehicle during the actual life of the engine. This requirement is not intended to 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.

We are also proposing that computer coded engine operating parameters not be changeable without the use of specialized tools and procedures (e.g. soldered or potted computer components or sealed (or soldered) computer enclosures). Upon Administrator approval, certain product lines may be exempted from this requirement if those product lines can be shown to not need such protections. In making the approval decision, the Administrator will consider such things as the current availability of performance chips, performance capability of the engine, and sales volume.

2. Malfunction Indicator Light (MIL) and Diagnostic Trouble Codes (DTC)

Upon detecting a malfunction within the emission control system,[5] the OBD system must make some indication to the driver so that the driver can take action to get the problem repaired. The proposal would require that a dashboard malfunction indicator light (MIL) be illuminated to inform the driver that a problem exists that needs attention. Upon illumination of the MIL, the proposal would require that a diagnostic trouble code (DTC) be stored in the engine's computer that identifies the detected malfunction. This DTC would then be read by a service technician to assist in making the necessary repair.

Because the MIL is meant to inform the driver of a detected malfunction, we are proposing that the MIL be located on the driver's side instrument panel and be of sufficient illumination and location to be readily visible under all lighting conditions. We are proposing that the MIL be amber (yellow) in color when illuminated because yellow is synonymous with the notion of a ''cautionary warning''; the use of red for the MIL would be strictly prohibited because red signifies ''danger'' which is not the proper message for malfunctions detected according to today's proposal. Further, we are proposing that, when illuminated, the MIL display the International Standards Organization (ISO) engine symbol because this symbol has become accepted after 10 years of light-duty OBD as a communicator of engine and emissions system related problems. We are also proposing that there be only one MIL used to indicate all malfunctions detected by the OBD system on a single vehicle. We believe this is important to avoid confusion over multiple lights and, potentially, multiple interpretations of those lights. Nonetheless, we seek comment on this limitation to one dedicated MIL to communicate emissions-related malfunctions. We also seek comment on the requirement that the MIL be amber in color since some trucks may use liquid crystal display (LCD) panels to display dashboard information and some such panels are monochromic and unable to display color.

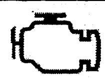
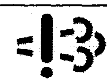
We are also interested in comments regarding the malfunction indicator light and the symbol displayed to

[5] What constitutes a ''malfunction'' for over 14,000 pound applications under today's proposal is covered in section II.B for diesel engines, section II.C for gasoline engines, and section II.D for all engines.

communicate that there is an engine and/or emission-related malfunction. As noted, we are proposing use of the ISO engine symbol as shown in Table II.A–1. The U.S. Department of Transportation has proposed use of an alternative ISO symbol to denote, specifically, an emission-related malfunction. (68 FR 55217) That symbol is also shown in Table II.A–1. While we are not proposing that this alternative symbol be used, comments are solicited regarding whether this alternative symbol provides a clearer message to the driver.

Generally, a manufacturer would be allowed sufficient time to be certain that a malfunction truly exists before illuminating the MIL. No one benefits if the MIL illuminates spuriously when a real malfunction does not exist. Thus, for most OBD monitoring strategies, manufacturers would not be required to illuminate the MIL until a malfunction clearly exists which will be considered to be the case when the same problem has occurred on two sequential driving cycles.[6]

Table II.A-1. ISO Warning Light Symbols

ISO Designation	Displayed Symbol	Comments
F01		Proposed for >14K OBD
F22		Proposed by U.S. DOT; Comments requested as possible MIL display for >14K OBD

To keep this clear in the onboard computer, we are proposing that the OBD system make certain distinctions between the problems it has detected, and that the system maintain a strict logic for diagnostic trouble code (DTC) storage/erasure and for MIL illumination/extinguishment. Whenever the enable criteria for a given monitor are met, we would expect that monitor to run. For continuous monitors, this would be during essentially all engine operation.[7] For non-continuous monitors, it would be during only a subset of engine operation.[8] In general, we are proposing that monitors make a diagnostic decision just once per drive cycle that contains operation satisfying the enable criteria for the given monitor.

When a problem is first detected, we are proposing that a ''pending'' DTC be stored. If, during the subsequent drive cycle that contains operation satisfying the enable criteria for the given monitor, a problem in the components/system is not again detected, the OBD system would declare that a malfunction does not exist and would, therefore, erase the pending DTC. However, if, during the subsequent drive cycle that contains operation satisfying the enable criteria for the given monitor, a problem in the component/system is again detected, a malfunction has been confirmed and, hence, a ''confirmed'' or ''MIL-on'' DTC would be stored.[9] Section II.F presents the requirements for standardization of OBD information and communications. Upon storage of a MIL-on DTC and, depending on the communication protocol used—ISO 15765–4 or SAE J1939—the pending DTC would either remain stored or be erased, respectively. Today's proposal neither stipulates which communication protocol nor which pending DTC logic be used. We are proposing to allow the use of either of the existing protocols as is discussed in more detail in section II.F. Upon storage of the MIL-on DTC, the MIL must be illuminated.[10] Also at this time, a ''permanent'' DTC would be stored (see section II.F.4 for more details regarding permanent DTCs and our rationale for proposing them).[11]

We are also proposing that, after three subsequent drive cycles that contain operation satisfying the enable criteria for the given monitor without any recurrence of the previously detected malfunction, the MIL should be extinguished (unless there are other MIL-on DTCs stored for which the MIL must also be illuminated), the permanent DTC should be erased, but a ''previous-MIL-on'' DTC should remain stored.[12] We are proposing that the previous MIL-on DTC remain stored for 40 engine warmup cycles after which time, provided the identified malfunction has not been detected again and the MIL is presently not illuminated for that malfunction, the previous-MIL-on DTC can be erased.[13] However, if an illuminated MIL is not extinguished, or if a MIL-on DTC is not erased, by the OBD system itself but is instead erased via scan tool or battery disconnect (which would erase all non-permanent, volatile memory), the permanent DTC must remain stored. This way, permanent DTCs can only be erased by the OBD system itself and cannot be erased through human interaction with the system.

We are proposing that the manufacturer be allowed, upon

[6] Generally, a ''driving cycle'' or ''drive cycle'' consists of engine startup and engine shutoff or consists of four hours of continuous engine operation.

[7] A ''continuous'' monitor—if used in the context of monitoring conditions for circuit continuity, lack of circuit continuity, circuit faults, and out-of-range values—means sampling at a rate no less than two samples per second. If a computer input component is sampled less frequently for engine control purposes, the signal of the component may instead be evaluated each time sampling occurs.

[8] A ''non-continuous'' monitor being a monitor that runs only when a limited set of operating conditions occurs.

[9] Different industry standards organizations—the Society of Automotive Engineers (SAE) and the International Standards Organization (ISO)—use different terminology to refer to a ''MIL-on'' DTC. For clarity, we use the term ''MIL-on'' DTC throughout this preamble to convey the concept and not any requirement that standard making bodies use the term in their standards.

[10] Throughout this proposal, we refer to MIL illumination to mean a steady, continuous illumination during engine operation unless stated otherwise. This contrasts with the MIL illumination logic used by many engine manufacturers today by which the MIL would illuminate upon detection of a malfunction but would remain illuminated only while the malfunction was actually occurring. Under this latter logic, an intermittent malfunction or one that occurs under only limited operating conditions may result in a MIL that illuminates, extinguishes, illuminates, etc., as operating conditions change.

[11] A permanent DTC must be stored in a manner such that electrical disconnections do not result in their erasure (i.e., they must be stored in non-volatile random access memory (NVRAM)).

[12] This general ''three trip'' condition for extinguishing the MIL is true for all but two diesel systems/monitors—the misfire monitor and the SCR system—and three gasoline systems/monitors—the fuel system, the misfire monitor, and the evaporative system—which have further conditions on extinguishing the MIL This is discussed in more detail in sections II.B and II.C.

[13] For simplicity, the discussion here refers to ''previous-MIL-on'' DTCs only. The ISO 15765 standard and the SAE J1939 standard use different terms to refer to the concept of a previous-MIL-on DTC. Our intent is to present the concept of our proposal in this preamble and not to specify the terminology used by these standard making bodies.

Administrator approval, to use alternative statistical MIL illumination and DTC storage protocols to those described above (i.e., alternatives to the ''first trip—pending DTC, second strip—MIL-on DTC logic). The Administrator would consider whether the manufacturer provided data and/or engineering evaluation adequately demonstrates that the alternative protocols can evaluate system performance and detect malfunctions in a manner that is equally effective and timely. Alternative strategies requiring, on average, more than six driving cycles for MIL illumination would probably not be accepted.

Upon storage of either a pending DTC and/or a MIL-on DTC, we are proposing that the computer store a set of ''freeze frame'' data. This freeze frame data would provide a snap shot of engine operating conditions present at the time the malfunction occurred and was detected. This information serves the repair technician in diagnosing the problem and conducting the proper repair. The freeze frame data should be stored upon storage of a pending DTC. If the pending DTC matures to a MIL-on DTC, the manufacturer can choose to update the freeze frame data or retain the freeze frame stored in conjunction with the pending DTC. Likewise, any freeze frame stored in conjunction with any pending or MIL-on DTC should be erased upon erasure of the DTC. Further information concerning the freeze frame requirement and the data required in the freeze frame is presented in section II.F.4, below.

We are also proposing that the OBD system illuminate the MIL and store a MIL-on DTC to inform the vehicle operator whenever the engine enters a mode of operation that can affect the performance of the OBD system. If such a mode of operation is recoverable (i.e., operation automatically returns to normal at the beginning of the following ignition cycle [14]), then in lieu of illuminating the MIL when the mode of operation is entered, the OBD system may wait to illuminate the MIL and store the MIL-on DTC if the mode of operation is again entered before the end of the next ignition cycle. We are proposing this because many operating strategies are designed such that they continue automatically through to the next key-off. Regardless, upon the next key-on, the engine control would start off in ''normal'' operating mode and would return to the ''abnormal'' operating mode only if the condition causing the abnormal mode was again encountered. In such cases, we are proposing to allow that the MIL be illuminated during the second consecutive drive cycle during which such an ''abnormal'' mode is engaged.[15]

Whether or not the ''abnormal'' mode of operation is recoverable, in this context, has nothing to do with whether the detected malfunction goes away or stays. Instead, it depends solely on whether or not the engine, by design, will stay in abnormal operating mode on the next key-on. We are proposing this MIL logic because often the diagnostic (i.e., monitor) that caused the engine to enter abnormal mode cannot run again once the engine is in the abnormal mode. So, if the MIL logic associated with abnormal mode activation was always a two-trip diagnostic, abnormal mode activation would set a pending DTC on the first trip and, since the system would then be stuck in that abnormal operating mode and would never be able to run the diagnostic again, the pending DTC could never mature to a MIL-on DTC nor illuminate the MIL. Hence, the MIL must illuminate upon the first entry into such an abnormal operating mode. If such a mode is recoverable, the engine will start at the next key-on in ''normal'' mode allowing the monitor to run again and, assuming another detection of the condition, the system would set a MIL-on DTC and illuminate the MIL.

The OBD system would not need to store a DTC nor illuminate the MIL upon abnormal mode operation if other telltale conditions would result in immediate action by the driver. Such telltale conditions would be, for example, an overt indication like a red engine shut-down warning light. The OBD system also need not store a DTC nor illuminate the MIL upon abnormal mode operation if the mode is indeed an auxiliary emission control device (AECD) approved by the Administrator.

There may be malfunctions of the MIL itself that would prevent it from illuminating. A repair technician—or possibly an I/M inspector—would still be able to determine the status of the MIL (i.e., commanded ''on'' or ''off'') by reading electronic information available through a scan tool, but there would be no indication to the driver of an emissions-related malfunction should one occur. Unidentified malfunctions may cause excess emissions to be emitted from the vehicle and may even cause subsequent deterioration or failure of other components or systems without the driver's knowledge. In order to prevent this, the manufacturer must ensure that the MIL is functioning properly. For this reason, we are proposing two requirements to check the functionality of the MIL itself. First, the MIL would be required to illuminate for a minimum of five seconds when the vehicle is in the key-on, engine-off position. This allows an interested party to check the MIL's functionality simply by turning the key to the key-on position. While the MIL would be physically illuminated during this functional check, the data stream value for the MIL command status would be required to indicate ''off'' during this check unless, of course, the MIL was currently being commanded ''on'' for a detected malfunction. This functional check of the MIL would not be 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).

The second functional check requirement we are proposing requires the OBD system to perform a circuit continuity check of the electrical circuit that is used to illuminate the MIL to verify that the circuit is not shorted or open (e.g., a burned out bulb). While there would not be an ability to illuminate the MIL when such a malfunction is detected, the electronically readable MIL command status in the onboard computer would be changed from commanded ''off'' to ''on''. This would allow the truck owner or fleet maintenance staff to quickly determine whether an extinguished MIL means ''no malfunctions'' or ''broken MIL.'' It would also serve, should it become of interest in the future, complete automation of the I/M process by eliminating the need for inspectors to input manually the results of their visual inspections. Feedback from passenger car I/M programs indicates that the current visual bulb check performed by inspectors is subject to error and results in numerous vehicles being falsely failed or passed. By requiring monitoring of the circuit itself, the entire pass/fail criteria of an I/M program could be determined by the electronic information available through a scan tool, thus better facilitating quick

[14] ''Ignition Cycle'' means a drive cycle that begins with engine start and includes an engine speed that exceeds 50 to 150 rotations per minute (rpm) below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission) for at least two seconds plus or minus one second.

[15] Note that we use the term ''abnormal'' to refer to an operating mode that the engine is designed to enter upon determining that ''normal'' operation cannot be maintained. Therefore, the term ''abnormal'' is somewhat of a misnomer since the engine is doing what it has been designed to do. Nonetheless, the abnormal operating mode is clearly not the operating mode the manufacturer has intended for optimal operation. Such operating modes are sometimes referred to as ''default'' operating modes or ''limp-home'' operating modes.

and effective inspections and minimizing the chance for manually-entered errors.

At the manufacturer's option, the MIL may be used to indicate readiness status in a standardized format (see Section II.F) in the key-on, engine-off position. Readiness status is a term used in light-duty OBD that refers to a vehicle's readiness for I/M inspection. For a subset of monitors—those that are non-continuous monitors for which an emissions threshold exists (see sections II.B and II.C for more on emissions thresholds)—a readiness status indicator must be stored in memory to indicate whether or not that particular monitor has run enough times to make a diagnostic decision. Until the monitor has run sufficient times, the readiness status would indicate ''not ready''. Upon running sufficient times, the readiness status would indicate ''ready.'' This serves to protect against drivers disconnecting their battery just prior to the I/M inspection so as to erase any MIL-on DTCs. Such an action would simultaneously set all readiness status indicators to ''not ready'' resulting in a notice to return to the inspection site at a future date. Readiness indicators also help repair technicians because, after completing a repair, they can operate the vehicle until the readiness status indicates ''ready'' and, provided no DTCs are stored, know that the repair has been successful. We are proposing that HDOBD systems follow this same readiness status logic as used for years in light-duty OBD both to assist repair technicians and to facilitate potential future HDOBD I/M programs.

We are also proposing that the manufacturer, upon Administrator approval, be allowed to use the MIL to indicate which, if any, DTCs are currently stored (e.g., to ''blink'' the stored codes). The Administrator would approve the request if the manufacturer can demonstrate that the method used to indicate the DTCs will not be unintentionally activated during any inspection test or during routine driver operation.

3. Monitoring Conditions

a. Background

Given that the intent of the proposed OBD requirements is to monitor the emission control system for proper operation, it is logical that the OBD monitors be designed such that they monitor the emission control system during typical driving conditions. While many OBD monitors would be designed such that they are continuously making decisions about the operational status of the engine, many—and arguably the most critical—monitors are not so designed. For example, an OBD monitor whose function is to monitor the active fuel injection system of a NO_X adsorber or a DPF cannot be continuously monitoring that function since that function occurs on an infrequent basis. This OBD monitor presumably would be expected to ''run,'' or evaluate the active injection system, during an actual fuel injection event.

For this reason, manufacturers are allowed to determine the most appropriate times to run their non-continuous OBD monitors. This way, they are able to make an OBD evaluation either at the operating condition when an emission control system is active and its operational status can best be evaluated, and/or at the operating condition when the most accurate evaluation can be made (e.g., highly transient conditions or extreme conditions can make evaluation difficult). Importantly, manufacturers are prohibited from using a monitoring strategy that is so restrictive such that it rarely or never runs. To help protect against monitors that rarely run, we are proposing an ''in-use monitor performance ratio'' requirement which is detailed in section II.E.

The set of operating conditions that must be met so that an OBD monitor can run are called the ''enable criteria'' for that given monitor. These enable criteria are often different for different monitors and may well be different for different types of engines. A large diesel engine intended for use in a Class 8 truck would be expected to see long periods of relatively steady-state operation while a smaller engine intended for use in an urban delivery truck would be expected to see a lot of transient operation. Manufacturers will need to balance between a rather loose set of enable criteria for their engines and vehicles given the very broad range of operation HD highway engines see and a tight set of enable criteria given the desire for greater monitor accuracy.

b. General Monitoring Conditions

i. Monitoring Conditions for All Engines

As guidance to manufacturers, we are proposing the following criteria to assist manufacturers in developing their OBD enable criteria. These criteria would be used by the Agency during our OBD certification approval process to ensure that monitors run on a frequent basis during real world driving conditions. These criteria would be:

- The monitors should run during conditions that are technically necessary to ensure robust detection of malfunctions (e.g., to avoid false passes and false indications of malfunctions);
- The monitor enable criteria should ensure monitoring will occur during normal vehicle operation; and,
- Monitoring should occur during at least one test used by EPA for emissions verification '' either the HD Federal Test Procedure (FTP) transient cycle, or the Supplementary Emissions Test (SET).[16]

As discussed in more detail in sections II.B through II.D, we are proposing that manufacturers define the monitoring conditions, subject to Administrator approval, for detecting the malfunctions required by this proposal. The Administrator would determine if the monitoring conditions proposed by the manufacturer for each monitor abide by the above criteria.

In general, except as noted in sections II.B through II.D, the proposed regulation would require each monitor to run at least once per driving cycle in which the applicable monitoring conditions are met. The proposal would also require certain monitors to run continuously throughout the driving cycle. These include a few threshold monitors (e.g., fuel system monitor) and most circuit continuity monitors. While a basic definition of a driving cycle (e.g., from ignition key-on and engine startup to engine shutoff) has been sufficient for passenger cars, the driving habits of many types of vehicles in the heavy-duty industry dictate an alternate definition. Specifically, many heavy-duty operators will start the engine and leave it running for an entire day or, in some cases, even longer. As such, we are proposing that any period of continuous engine-on operation of four hours be considered a complete driving cycle. A new driving cycle would begin following such a four hour period, regardless of whether or not the engine had been shut down. Thus, the ''clock'' for monitors that are required to run once per driving cycle would be reset to run again (in the same key-on engine start or trip) once the engine has been operated beyond four hours continuously. This would avoid an unnecessary delay in detection of malfunctions simply because the heavy-duty vehicle operator has elected to leave the vehicle running continuously for an entire day or days at a time.

Manufacturers may request Administrator approval to define monitoring conditions that are not encountered during the FTP cycle. In evaluating the manufacturer's request, the Administrator will consider the degree to which the requirement to run

[16] See 40 CFR part 86, subpart N for details of EPA's test procedures.

during the FTP cycle restricts in-use monitoring, 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 which demonstrate that the component/system does not normally function, or monitoring is otherwise not feasible, during the FTP cycle, and, where applicable, the ability of the manufacturer to demonstrate that the monitoring conditions will satisfy the minimum acceptable in-use monitor performance ratio requirement as defined below.

ii. In-Use Performance Tracking Monitoring Conditions

In addition to the general monitoring conditions above, we are proposing that manufacturers be required to implement software algorithms in the OBD system to individually track and report in-use performance of the following monitors in the standardized format specified in section II.E:

- Diesel NMHC converting catalyst(s)
- Diesel NO_X converting catalyst(s)
- Gasoline catalyst(s)
- Exhaust gas sensor(s)
- Gasoline evaporative system
- Exhaust gas recirculation (EGR) system
- Variable valve timing (VVT) system
- Gasoline secondary air system
- Diesel particulate filter system
- Diesel boost pressure control system
- Diesel NO_X adsorber(s)

The OBD system is not required to track and report in-use performance for monitors other than those specifically identified above.

iii. In-Use Performance Ratio Requirement

We are also proposing that, for all 2013 and subsequent model year engines, manufacturers be required to define monitoring conditions that, in addition to meeting the general monitoring conditions, ensure that certain monitors yield an in-use performance ratio (which monitors and the details that define the performance ratio are defined in section II.E) that meets or exceeds the minimum acceptable in-use monitor performance ratio for in-use vehicles. We are proposing a minimum acceptable in-use monitor performance ratio of 0.100 for all monitors specifically required to track in-use performance. This means that the monitors listed in section II.A.3.ii above must run and make valid diagnostic decisions during 10 percent of the vehicle's trips. We intend to work with industry during the initial years of implementation to gather data on in-use performance ratios and may revise this ratio lower as appropriate depending on what we learn.

Note that manufacturers may not use the calculated ratio (or any element thereof), or any other indication of monitor frequency, as a monitoring condition for a monitor. For example, the manufacturer would not be allowed to use a low ratio to enable more frequent monitoring through diagnostic executive priority or modification of other monitoring conditions, or to use a high ratio to enable less frequent monitoring.

4. Determining the Proper OBD Malfunction Criteria

For determining the malfunction criteria for diesel engine monitors associated with an emissions threshold (see sections II.B and II.C for more on emissions thresholds), we are proposing that manufacturers be required to determine the appropriate emissions test cycle such that the most stringent monitor would result. In general, we believe that manufacturers can make this determination based on engineering judgement, but there may be situations where testing would be required to make the determination. We do not necessarily anticipate challenging a manufacturer's determination of which test cycle to use. Nonetheless, the manufacturer should be prepared, perhaps with test data, to justify their determination.

We are also proposing that, for engines equipped with emission controls that experience infrequent regeneration events (e.g., a DPF and/or a NO_X adsorber), a manufacturer must adjust the emission test results for monitors that are required to indicate a malfunction before emissions exceed a certain emission threshold.[17] For each such monitor, the manufacturer would have to 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. As proposed, the adjusted emission value must be used for purposes of determining whether or not the applicable emission threshold is exceeded.

While we believe that this adjustment process for monitors of systems that experience infrequent regeneration events makes sense and would result in robust monitors, we also believe that it could prove to be overly burdensome for manufacturers. For example, a NO_X adsorber threshold being evaluated by running an FTP using a ''threshold'' part (i.e., a NO_X adsorber deteriorated such that tailpipe emissions are at the applicable thresholds) may be considered acceptable provided the NO_X adsorber does not regenerate during the test, but it may be considered unacceptable if the NO_X adsorber does happen to regenerate during the test. This could happen because emissions would be expected to increase slightly during the regeneration event thereby causing emissions to be slightly above the applicable threshold. This would require the manufacturer to recalibrate the NO_X adsorber monitor to detect at a lower level of deterioration to ensure that a regeneration event would not cause an exceedance of the threshold during an emissions test. After such a recalibration, the emissions occurring during the regeneration event would be lower than before because the new ''threshold'' NO_X adsorber would have a slightly higher conversion efficiency. We are concerned that manufacturers may find themselves in a difficult iterative process calibrating such monitors that, in the end, will not be correspondingly more effective.

For this reason, we request comment regarding the burden associated with the need to consider regeneration events in determining compliance with emissions thresholds. We also request comment on how to address any environmental concern versus the burden. Would it perhaps be best to simply use the emissions adjustments that are determined in accordance with section 86.004–28(i)? Is it necessary to even consider regeneration emissions when determining emission threshold compliance or is it perhaps best to ignore regeneration events in determining threshold calibrations?

B. Monitoring Requirements and Timelines for Diesel-Fueled/ Compression-Ignition Engines

Table II.B–1 summarizes the proposed diesel fueled compression ignition emissions thresholds at which point a component or system has failed to the point of requiring an illuminated MIL and a stored DTC. More detail regarding the specific monitoring requirements, implementation schedules, and liabilities can be found in the sections that follow.

[17] See proposed § 86.010–18(f).

TABLE II.B–1.—PROPOSED EMISSIONS THRESHOLDS FOR DIESEL FUELED CI ENGINES OVER 14,000 POUNDS

Component/monitor	MY	NMHC	CO	NO_X	PM
NMHC catalyst system	2010–2012	2.5x	....	....	....
	2013+	2x	....	....	....
NO_X catalyst system	2010+	....	....	+0.3	....
DPF system	2010–2012	2.5x	....	....	0.05/+0.04
	2013+	2x	....	....	0.05/+0.04
Air-fuel ratio sensors upstream	2010–2012	2.5x	2.5x	+0.3	0.03/+0.02
	2013+	2x	2x	+0.3	0.03/+0.02
Air-fuel ratio sensors downstream	2010–2012	2.5x	....	+0.3	0.05/+0.04
	2013+	2x	....	+0.3	0.05/+0.04
NO_X sensors	2010+	....	....	+0.3	0.05/+0.04
"Other monitors" with emissions thresholds (see section II.B)	2010–2012	2.5x	2.5x	+0.3	0.03/+0.02
	2013+	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.

There are exceptions to the emissions thresholds shown in Table II.B–1 whereby a manufacturer can demonstrate that emissions do not exceed the threshold even when the component or system is non-functional at which point a functional check would be allowed.

Note that, in general, the monitoring strategies designed to meet the requirements discussed below should not involve the alteration of the engine control system or the emissions control system such that tailpipe emissions would increase. We do not want emissions to increase, even for short durations, for the sole purpose of monitoring the systems intended to control emissions. The Administrator would consider such monitoring strategies on a case-by-case basis taking into consideration the emissions impact and duration of the monitoring event. However, much effort has been expended in recent years to minimize engine operation that results in increased emissions and we encourage manufacturers to develop monitoring strategies that do not require alteration of the basic control system.

1. Fuel System Monitoring

a. Background

The fuel system of a diesel engine is an essential component of the engine's emissions control system. Proper delivery of fuel—quantity, pressure, and timing—can play a crucial role in maintaining low engine-out emissions. The performance of the fuel system is also critical for aftertreatment device control strategies. As such, thorough monitoring of the fuel system is an essential element in an OBD system. The fuel system is primarily comprised of a fuel pump, fuel pressure control device, and fuel injectors. Additionally, the fuel system generally has sophisticated control strategies that utilize one or more feedback sensors to ensure the proper amount of fuel is being delivered to the cylinders. While gasoline engines have undergone relatively minor hardware changes (but substantial fine-tuning in the control strategy and feedback inputs), diesel engines have more recently undergone substantial changes to the fuel system hardware and now incorporate more refined control strategies and feedback inputs.

For diesel engines, a substantial change has occurred in recent years as manufacturers have transitioned to new high-pressure fuel systems. One of the most widely used is a high-pressure common-rail fuel injection system, which is generally comprised of a high-pressure fuel pump, a fuel rail pressure sensor, a common fuel rail that feeds all injectors, individual fuel injectors that directly control fuel injection quantity and timing for each cylinder, and a closed-loop feedback system that uses the fuel rail pressure sensor to achieve the commanded fuel rail pressure. Unlike older style fuel systems where fuel pressure was mechanically linked to engine speed (and thus, varied from low to high as engine speed increased), common-rail systems are capable of controlling fuel pressure independent of engine speed. This increase in fuel pressure control allows greater flexibility in optimizing the performance and emission characteristics of the engine. The ability of the system to generate high pressure independent of engine speed also improves fuel delivery at low engine speeds.

Precise control of the fuel injection timing is crucial for optimal engine and emission performance. As injection timing is advanced (i.e., fuel injection occurs earlier), hydrocarbon (HC) emissions and fuel consumption are decreased but oxides of nitrogen (NO_X) emissions are increased. As injection timing is retarded (i.e., fuel injection occurs later), NO_X emissions can be reduced but HC emissions, particulate matter (PM) emissions, and fuel consumption increase. Most modern diesel fuel systems even provide engine manufacturers with the ability to separate a single fuel injection event into discrete events such as pilot (or pre) injection, main injection, and post injection.

Given the important role that modern diesel fuel systems play in emissions control, malfunctions or deterioration that would affect the fuel pressure control, injection timing, pilot/main/post injection timing or quantity, or ability to accurately perform rate-shaping could lead to substantial increases in emissions (primarily NO_X or PM), often times with an associated change in fuel consumption.

b. Fuel System Monitoring Requirements

We are proposing that the OBD system monitor the fuel delivery system to verify that it is functioning properly. The fuel system monitor would be required to monitor for malfunctions in the injection pressure control, injection quantity, injection timing, and feedback control (if equipped). The individual electronic components (e.g., actuators, valves, sensors, pumps) that are used in the fuel system and not specifically addressed in this section shall be monitored in accordance with the comprehensive component requirements in section II.D.4.

i. Fuel System Pressure Control

We are proposing that the OBD system continuously monitor the fuel system's ability to control to the desired fuel pressure. The OBD system would have to 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 II.B–1. 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 would be required to detect a malfunction when the system has reached its control limits such that the commanded fuel system pressure cannot be delivered.

ii. Fuel System Injection Quantity

We are proposing that the OBD system 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 II.B–1. 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 would be required to detect a malfunction when the system has reached its control limits such that the commanded fuel quantity cannot be delivered.

iii. Fuel System Injection Timing

We are proposing that the OBD system 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 II.B–1. 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 would be required to detect a malfunction when the system has reached its control limits such that the commanded fuel injection timing cannot be achieved.

iv. Fuel System Feedback Control

If the engine is equipped with feedback control of the fuel system (e.g., feedback control of pressure or pilot injection quantity), we are proposing that the OBD system detect a malfunction when and if:

- The system fails to begin feedback control within a manufacturer specified time interval;
- A failure or deterioration causes open loop or default operation; or
- Feedback control has used up all of the adjustment allowed by the manufacturer.

A manufacturer may temporarily disable monitoring for malfunctions where the feedback control has used up all of the adjustment allowed by the manufacturer during conditions that the monitor cannot distinguish robustly between a malfunctioning system and a properly operating system. To do so, the manufacturer would be required to submit data and/or engineering analyses demonstrating that the control system, when operating as designed on an engine with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up. In lieu of detecting, with a fuel system specific monitor, when the system fails to begin feedback control within a manufacturer specified time interval and/or when a failure or deterioration causes open loop or default operation, the OBD system may monitor the individual parameters or components that are used as inputs for fuel system feedback control provided that the monitors detect all malfunctions related to feedback control.

c. Fuel System Monitoring Conditions

The OBD system would be required to monitor continuously for malfunctions of the fuel pressure control and feedback control. Manufacturers would be required to define the monitoring conditions for malfunctions of the injection quantity and injection timing such that the minimum performance ratio requirements discussed in section II.E would be met.

d. Fuel System MIL Illumination and DTC Storage

We are proposing the general MIL illumination and DTC storage requirements as discussed in section II.A.2.

2. Engine Misfire Monitoring

a. Background

Misfire, the lack of combustion in the cylinder, causes increased engine-out hydrocarbon emissions. On gasoline engines, misfire results from the absence of spark, poor fuel metering, and poor compression. Further, misfire can be intermittent on gasoline engines (e.g., the misfire only occurs under certain engine speeds or loads). Consequently, our existing under 14,000 pound OBD regulation requires continuous monitoring for misfire malfunctions on gasoline engines.

In contrast, manufacturers have historically maintained that a diesel engine with traditional diesel technology misfires only due to poor compression (e.g., worn valves or piston rings, improper injector or glow plug seating). They have also maintained that, when poor compression results in a misfiring cylinder, the cylinder will misfire under all operating conditions rather than only some operating conditions. For that reason, our existing under 14,000 pound OBD regulation has not required continuous monitoring for misfire malfunctions on diesel engines.

However, with the increased use of EGR and its use to varying degrees at different speeds and load, and with emerging technologies such as homogeneous charge compression ignition (HCCI), we believe that the conventional wisdom regarding diesel engines and misfires no longer holds true. These newer technologies may indeed result in misfires that are intermittent, spread out among various cylinders, and that only happen at certain speeds and loads.

b. Misfire Monitoring Requirements

We are proposing that the OBD system monitor the engine for misfire causing excess emissions. 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 continuously misfiring, a separate DTC must be stored indicating that multiple cylinders are misfiring. When identifying multiple cylinder misfire, the OBD system is not required to also identify each of the continuously misfiring cylinders individually through separate DTCs.

For 2013 and subsequent model year engines, we are proposing a more stringent requirement that the OBD system detect a misfire malfunction causing emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table II.B–1. This requirement to detect engine misfire prior to exceeding an emissions threshold would apply only to those engines equipped with sensors capable of detecting combustion or combustion quality (e.g., cylinder pressure sensors used in homogeneous charge compression ignition (HCCI) control systems). Engines without such sensors would have to detect only when one or more cylinders are continually misfiring.

To determine what level of misfire would cause emissions to exceed the applicable emissions thresholds, we are proposing that manufacturers determine the percentage of misfire evaluated in 1000 revolution increments that would cause emissions from an emission durability demonstration engine to exceed the emissions thresholds if the percentage of misfire were present from the beginning of the test. To establish this percentage of misfire, the manufacturer would utilize misfire events occurring at equally spaced, complete engine cycle intervals, across randomly selected cylinders throughout each 1000-revolution increment. If this percentage of misfire is determined to be lower than one percent, the manufacturer may set the malfunction criteria at one percent. Any malfunction should be detected if the percentage of misfire established via this testing is exceeded regardless of the pattern of misfire events (e.g., random, equally spaced, continuous).

The manufacturer may employ other revolution increments besides the 1000 revolution increment being proposed. To do so, the manufacturer would need to demonstrate that the strategy would be equally effective and timely in detecting misfire.

c. Engine Misfire Monitoring Conditions

For engines without combustion sensors, we are proposing that the OBD system monitor for misfire during engine idle conditions at least once per drive cycle in which the monitoring conditions for misfire are met. The manufacturer would be required to define monitoring conditions, supported by manufacturer-submitted data and/or engineering analyses, that demonstrate that the 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).

For 2013 and subsequent model year engines with combustion sensors, we are proposing that the OBD system continuously monitor for misfire under all positive torque engine speeds and load conditions. If a monitoring system cannot detect all misfire patterns under all positive torque engine speeds and load conditions, the manufacturer may request that the Administrator approve the monitoring system nonetheless. In evaluating the manufacturer's request, the Administrator would consider the following factors: the magnitude of the region(s) in which misfire detection is limited; the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events); the frequency with which said region(s) are expected to be encountered in-use; the type of misfire patterns for which misfire detection is troublesome; and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under required conditions (i.e., compliance can be achieved on other engines). The evaluation would be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders; single cylinder continuous misfire; and, paired cylinder (cylinders firing at the same crank angle) continuous misfire.

d. Engine Misfire MIL Illumination and DTC Storage

For engines without combustion sensors, we are proposing the general MIL illumination and DTC storage requirements as discussed in section II.A.2.

For 2013 and subsequent model year engines with combustion sensors, we are proposing that, after four detections of the percentage of misfire that would cause emissions to exceed the applicable emissions thresholds during a single driving cycle, a pending DTC would be stored. If a pending DTC is stored, the OBD system would be required to illuminate the MIL and store a MIL—on DTC if the percentage of misfire is again exceeded four times during either: the driving cycle immediately following the storage of the pending DTC, regardless of the conditions encountered during the driving cycle; or, the next driving cycle in which similar conditions are encountered to the engine conditions that occurred when the pending DTC was stored.[18] For erasure of the pending DTC, we are proposing if, by the end of the next driving cycle in which similar conditions have been encountered to the engine conditions that occurred when the pending DTC was stored without an exceedance of the specified percentage of misfire, the pending DTC may be erased. The pending DTC may also be erased if similar conditions are not encountered during the next 80 driving cycles immediately following initial detection of the malfunction.

[18] ''Similar conditions,'' as used in conjunction with misfire and fuel system monitoring, 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) as existing during the applicable previous problem detection. The Administrator may approve other definitions of similar conditions based on comparable timeliness and reliability in detecting similar engine operation.

We are proposing some specific items with respect to freeze frame storage associated with engine misfire. The OBD system shall store and erase freeze frame conditions either in conjunction with storing and erasing a pending DTC or in conjunction with storing a MIL—on DTC and erasing a MIL—on DTC. In addition to those proposed requirements discussed in section II.A.2, we are proposing that, if freeze frame conditions are stored for a malfunction other than a misfire malfunction when a DTC is stored, the previously stored freeze frame information shall be replaced with freeze frame information regarding the misfire malfunction (i.e., the misfire's freeze frame information should take precedence over freeze frames for other malfunctions). Further, we are proposing that, upon detection of misfire, the OBD system store the following engine conditions: engine speed, load, and warm up status of the first misfire event that resulted in the storage of the pending DTC.

Lastly, we are proposing that the MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without an exceedance of the specified percentage of misfire.

3. Exhaust Gas Recirculation (EGR) System Monitoring

a. Background

Exhaust gas recirculation (EGR) systems are currently being used by many heavy-duty engine manufacturers to meet the 2.5 g/bhp-hr NO_X+NMHC standard for 2004 and later model year engines. (65 FR 59896) EGR reduces NO_X emissions in several ways. First, the recirculated exhaust gases dilute the intake air—i.e., oxygen in the fresh air is displaced with relatively non-reactive exhaust gases—which, in turn, results in less oxygen to form NO_X. Second, EGR absorbs heat from the combustion process which reduces combustion chamber temperatures which, in turn, reduces NO_X formation. The amount of heat absorbed from the combustion process is a function of EGR flow rate and recirculated gas temperature, both of which are controlled to minimize NO_X emissions. An EGR cooler can be added to the EGR system to lower the recirculated gas temperature which further enhances NO_X control. We fully expect that 2007 and later model year engines will continue to make use of cooled EGR systems.

While in theory the EGR system simply routes some exhaust gas back to the intake, production systems can be complex and involve many components to ensure accurate control of EGR flow to maintain acceptable PM and NO_X emissions while minimizing effects on fuel economy. To control EGR flow rates, EGR systems normally use the following components: an EGR valve, valve position sensor, boost pressure sensor, intake temperature sensor, intake (fresh) airflow sensor, and tubing or piping to connect the various components of the system. EGR temperature sensors and exhaust backpressure sensors can also be used. Additionally, some systems use a variable geometry turbocharger to provide the backpressure necessary to drive the EGR flow. Therefore, EGR is not a stand alone emission control device. Rather, it is carefully integrated with the air handling system (turbocharging and intake cooling) to control NO_X while not adversely affecting PM emissions and fuel economy.

b. EGR System Monitoring Requirements

We are proposing that the OBD system monitor the EGR system on engines so equipped for low EGR flow rate, high EGR flow rate, and slow EGR flow response malfunctions. For engines so equipped, we are proposing that the EGR feedback control be monitored. Also, for engines equipped with EGR coolers (e.g., heat exchangers), the OBD system would have to monitor the cooler for malfunctions associated with insufficient EGR cooling. The individual electronic components (e.g., actuators, valves, sensors) that are used in the EGR system would be monitored in accordance with the comprehensive component requirements presented in section II.D.4.

i. EGR Low Flow Malfunctions

We are proposing that the OBD system detect a malfunction 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 II.B–1. 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 would have to detect a malfunction when the system has reached its control limits such that it cannot increase EGR flow to achieve the commanded flow rate.

ii. EGR High Flow Malfunctions

We are proposing that the OBD system 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 II.B–1. 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 would have to detect a malfunction when the system has reached its control limits such that it cannot reduce EGR flow to achieve the commanded flow rate.

iii. EGR Slow Response Malfunctions

We are proposing that the OBD system 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 II.B–1. The OBD system would have to 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.

iv. EGR Feedback Control

We are proposing that the OBD system on any engine equipped with feedback control of the EGR system (e.g., feedback control of flow, valve position, pressure differential across the valve via intake throttle or exhaust backpressure), detect a malfunction when and if:

- The system fails to begin feedback control within a manufacturer specified time interval;
- A failure or deterioration causes open loop or default operation; or
- Feedback control has used up all of the adjustment allowed by the manufacturer.

v. EGR Cooler Performance

We are proposing that the OBD system 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 II.B–1. 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 would have to detect a malfunction when the system has no detectable amount of EGR cooling.

c. EGR System Monitoring Conditions

We are proposing that the OBD system monitor continuously for low EGR flow, high EGR flow, and feedback control malfunctions. Manufacturers would be required to define the monitoring conditions for EGR slow response malfunctions such that the minimum performance ratio requirements discussed in section II.E would be met with the exception that monitoring must occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required for most monitors. For purposes of tracking and reporting as required in section II.E, all monitors used to detect EGR slow response malfunctions must be tracked separately but reported as a single set of values as specified in section II.E.[19]

Manufacturersmay temporarily disable the EGR system check under specific conditions (e.g., when freezing may affect performance of the system). To do so, the manufacturer would be required to submit data and/or engineering analyses that demonstrate that a reliable check cannot be made when these specific conditions exist.

d. EGR System MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2.

4. Turbo Boost Control System Monitoring

a. Background

Turbochargers are used on internal combustion engines to enhance performance by increasing the density of the intake air. Some of the benefits of turbocharging include increased horsepower, improved fuel economy, and decreased exhaust smoke. Most modern diesel engines take advantage of these benefits and are equipped with turbocharging systems. Moreover, smaller turbocharged diesel engines can be used in place of larger non-turbocharged engines to achieve the desired engine performance characteristics.

[19] For specific components or systems that have multiple monitors that are required to be reported (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 shall be reported for the specific component.

Exhaust gases passing through the turbine cause it to spin which, in turn, causes an adjacent centrifugal pump on the same rotating shaft to spin. The spinning pump serves to compress the intake air thereby increasing its density. Typically, a boost pressure sensor is located in the intake manifold to provide a feedback signal of the current intake manifold pressure. As turbo speed (boost) increases, the pressure in the intake manifold also increases.

Proper boost control is essential to optimize emission levels. Even short periods of over-or under-boost can result in undesired air-fuel ratio excursions and corresponding emission increases. Additionally, the boost control system directly affects exhaust and intake manifold pressures. Another critical emission control system, EGR, is very dependent on these two pressures and generally uses the differential between them to force exhaust gas into the intake manifold. If the boost control system is not operating correctly, the exhaust or intake pressures may not be as expected and the EGR system may not function as designed. In high-pressure EGR systems, higher exhaust pressures will generate more EGR flow and, conversely, lower pressures will reduce EGR flow. A malfunction that causes excessive exhaust pressures (e.g., wastegate stuck closed at high engine speed) can produce higher EGR flowrates at high load conditions and have a negative impact on emissions.

Manufacturers commonly use charge air coolers to maximize the benefits of turbocharging and to control NO_X emissions. As the turbocharger compresses the intake air, the temperature of that intake air increases. This increasing air temperature causes the air to expand, which conflicts with one of the goals of turbocharging which is to increase charge air density. Charge air coolers are used to exchange heat between the compressed air and ambient air (or coolant) and cool the compressed air. Accordingly, a decrease in charge air cooler performance can affect emissions by causing higher intake air temperatures that can lead to higher combustion temperatures and higher NO_X emissions.

One drawback of turbocharging is known as turbo lag. Turbo lag occurs when the driver attempts to accelerate quickly from a low engine speed. Since the turbocharger is a mechanical device, a delay exists from the driver demand for more boost until the exhaust flow can physically speed up the turbocharger enough to deliver that boost. In addition to a negative effect on driveability and performance, improper fueling (e.g., over-fueling) during this lag can cause emission increases (typically PM).

To decrease the effects of turbo lag, manufacturers design turbos that spool up quickly at low engine speeds and low exhaust flowrates. However, designing a turbo that will accelerate quickly from a low engine speed but will not result in an over-speed/over-boost condition at higher engine speeds is challenging. That is, as the engine speed and exhaust flowrates near their maximum, the turbo speed increases to levels that cause excessive boost pressures and heat that could lead to engine or turbo damage. To prevent excessive turbine speeds and boost pressures at higher engine speeds, a wastegate is often used to bypass part of the exhaust stream around the turbocharger. The wastegate valve is typically closed at lower engine speeds so that all exhaust is directed through the turbocharger, thus providing quick response from the turbocharger when the driver accelerates quickly from low engine speeds. The wastegate is then opened at higher engine speeds to prevent engine or turbo damage from an over-speed condition.

An alternative to a wastegate is the variable geometry turborcharger (VGT). To prevent over-boost conditions and to decrease turbo lag, VGTs are designed such that the geometry of the turbocharger changes with engine speed. While various physical mechanisms are used to achieve the variable geometry, the overall result is essentially the same. At low engine speeds, the exhaust gas into the turbo is restricted in a manner that maximizes the use of the available energy to spin the turbo. This allows the turbo to spool up quickly and provide good acceleration response. At higher engine speeds, the turbo geometry changes such that exhaust gas flow into the turbo is not as restricted. In this configuration, more exhaust can flow through the turbocharger without causing an over-speed condition. The advantage that VGTs offer compared to a waste-gated turbocharger is that all exhaust flow is directed through the turbocharger under all operating conditions. This can be viewed as maximizing the use of the available exhaust energy.

b. Turbo Boost Control System Monitoring Requirements

We are proposing that the OBD system monitor the boost pressure control system on engines so equipped for under and over boost malfunctions. For engines equipped with variable geometry turbochargers (VGT), the OBD system would have to monitor the VGT system for slow response malfunctions. For engines equipped with charge air cooler systems, the OBD system would have to 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 shall be monitored in accordance with the comprehensive component requirements in section II.D.4.

i. Turbo Underboost Malfunctions

We are proposing that the OBD system 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 II.B–1. 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.

ii. Turbo Overboost Malfunctions

We are proposing that the OBD system 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 II.B–1. 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.

iii. VGT Slow Response Malfunctions

We are proposing that the OBD system 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 II.B–1. 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.

iv. Turbo Boost Feedback Control Malfunctions

We are proposing that, for engines equipped with feedback control of the boost pressure system—e.g., control of VGT position, turbine speed, manifold pressure—the OBD system shall detect a malfunction when and if:

- The system fails to begin feedback control within a manufacturer specified time interval;
- A failure or deterioration causes open loop or default operation; or
- Feedback control has used up all of the adjustment allowed by the manufacturer.

v. Charge Air Undercooling Malfunctions

We are proposing that the OBD system 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 II.B–1. 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.

c. Turbo Boost Control System Monitoring Conditions

We are proposing that the OBD system monitor continuously for underboost and overboost malfunctions and for boost feedback control malfunctions. Manufacturers would be required to define the monitoring conditions for VGT slow response malfunctions such that the minimum performance ratio requirements discussed in section II.E would be met with the exception that monitoring must occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required for most monitors. For purposes of tracking and reporting as required in section II.E, all monitors used to detect VGT slow response malfunctions malfunctions must be tracked separately but reported as a single set of values as discussed in section II.E.[20]

d. Turbo Boost MIL Illumination and DTC Storage

We are proposing the general MIL illumination and DTC storage requirements as discussed in section II.A.2.

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

a. Background

Diesel oxidation catalysts (DOCs) have been used on some nonroad diesel engines since the 1960s and on some diesel trucks and buses in the U.S. since the early 1990s. DOCs are generally used for converting HC and carbon monoxide (CO) emissions to water and CO_2 via an oxidation process. Current DOCs can also be used to convert PM emissions. DOCs may also be used in conjunction with other aftertreatment emission controls—such as NO_X adsorber systems, selective catalytic reduction (SCR) systems, and PM filters—to improve their performance and/or clean up certain reducing agents that might slip through the system (e.g., the urea used in urea SCR systems).

b. NMHC Converting Catalyst Monitoring Requirements

We are proposing that the OBD system monitor the NMHC converting catalyst(s) for proper NMHC conversion capability. We are also proposing that each catalyst that converts NMHC be monitored either individually or in combination with others. For engines equipped with catalyzed diesel particulate filters (CDPFs) that convert NMHC emissions, the catalyst function of the CDPF must be monitored in accordance with the CDPF monitoring requirements in section II.B.8.

i. NMHC Converting Catalyst Conversion Efficiency

We are proposing that the OBD system detect an NMHC catalyst malfunction when the catalyst conversion capability decreases to the point that NMHC emissions exceed the emissions thresholds for ''NMHC catalysts'' as shown in Table II.B–1. 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 would have to detect a malfunction when the catalyst has no detectable amount of NMHC conversion capability.

ii. Other Aftertreatment Assistance Functions

For catalysts used to generate an exotherm to assist CDPF regeneration, we are proposing that the OBD system detect a malfunction when the catalyst is unable to generate a sufficient exotherm to achieve that regeneration. For catalysts used to generate a feedgas constituency to assist SCR systems (e.g., to increase NO_2 concentration upstream of an SCR system), the OBD system would have to 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 CDPF and used to convert NMHC emissions during a CDPF regeneration event, the OBD system would be required to detect a malfunction when the catalyst has no detectable amount of NMHC conversion capability.

c. NMHC Converting Catalyst Monitoring Conditions

Manufacturers would be required to define the monitoring conditions for NMHC converting catalyst malfunctions such that the minimum performance ratio requirements discussed in section II.E would be met. For purposes of tracking and reporting as discussed in section II.E, all monitors used to detect NMHC converting catalyst malfunctions must be tracked separately but reported as a single set of values as discussed in section II.E.[21]

d. NMHC Converting Catalyst MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage discussed in section II.A.2. Note that the monitoring method for the catalyst(s) must be capable of detecting all instances, except diagnostic self-clearing, when a catalyst DTC has been cleared but the catalyst has not been replaced (e.g., catalyst over temperature histogram approaches are not acceptable).[22]

[20] For specific components or systems that have multiple monitors that are required to be reported (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 shall be reported for the specific component.

[21] For specific components or systems that have multiple monitors that are required to be reported (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 shall be reported for the specific component.

[22] For gasoline catalyst monitoring, manufacturers generally use what is called an exponentially

Continued

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

a. Background

Selective Catalytic Reduction (SCR) catalysts that use ammonia as a NO_X reductant have been used for stationary source NO_X control for a number of years. Frequently, urea is used as the source of ammonia for SCR catalysts, and such systems are commonly referred to as Urea SCR systems. In recent years, considerable effort has been invested in developing urea SCR systems that could be applied to heavy-duty diesel vehicles with low sulfur diesel fuel. We now expect that urea SCR systems will be introduced in Europe to comply with the EURO IV heavy-duty diesel emission standards. Such systems have been introduced in the past year by some heavy-duty diesel engine manufacturers both in Europe and in Japan.

SCR catalyst systems require an accurate urea control system to inject precise amounts of reductant. An injection rate that is too low may result in lower NO_X conversions while an injection that is too high may release unwanted ammonia emissions—referred to as ammonia slip—to the atmosphere. In general, ammonia to NO_X ratios of around 1:1 are used to provide the highest NO_X conversion rates with minimal ammonia slip. Therefore, injecting just the right amount of ammonia appropriate for the amount of NO_X in the exhaust is very important. This can be challenging in a highway application because on-road diesel engines operate over a variety of speeds and loads. This makes the use of closed-loop feedback systems for reductant metering very attractive. This can be achieved, for example, with a dedicated NO_X sensor in the exhaust so that the NO_X concentration can be accurately known. With an accurate fast response NO_X sensor, closed-loop control of the ammonia injection can be used to achieve and maintain the desired ammonia/NO_X ratios in the SCR catalyst for the high NO_X conversion efficiencies necessary to achieve the 2010 emission standards under various engine operating conditions.

Some have estimated that achieving the 2010 NO_X emission standards with SCR systems will require NO_X sensors that can measure NO_X levels accurately in the 20 to 40 ppm range with little cross sensitivity to ammonia. Some in industry have even stated a desire for accuracy in the two to three ppm range. Suppliers have been developing NO_X sensors capable of measuring NO_X in the 0 to 100 ppm range with +/−5 ppm accuracy which we believe will be available by 2010.[23] Regarding cross-sensitivity to ammonia, work has been done that indicates ammonia and NO_X measurements can be independently measured by conditioning the output signal.[24] This signal conditioning method resulted in a linear output for both ammonia and NO_X from the NO_X sensor downstream of the catalyst.

For SCR systems, closed-loop control of the reductant injection may require the use of two NO_X sensors. The first NO_X sensor would be located upstream of the catalyst and the reductant injection point would be used for measuring the engine-out NO_X emissions and determining the amount of reductant injection needed to reduce emissions. The second NO_X sensor located downstream of the catalyst would be used for measuring the amount of ammonia and NO_X emissions exiting the catalyst and providing feedback to the reductant injection control system. If the downstream NO_X sensor detects too much NO_X emissions exiting the catalyst, the control system can inject higher quantities of reductant. Conversely, if the downstream NO_X sensor detects too much ammonia slip exiting the catalyst, the control system can decrease the amount of reductant injection.

In addition to exhaust NO_X levels, another important parameter for achieving high NO_X conversion rates with minimum ammonia slip is catalyst temperature. SCR catalysts have a defined temperature range where they are most effective. For example, platinum catalysts are effective between 175 and 250 degrees Celsius, vanadium catalysts are effective between 300 and 450 degrees Celsius, and zeolite catalysts are most effective between 350 and 600 degrees Celsius. To determine exhaust catalyst temperature for reductant control purposes, manufacturers are likely to use temperature sensors placed in the exhaust system. We project that only one temperature sensor positioned just downstream of the SCR system will be utilized for reductant injection control purposes.

Production SCR catalyst systems may also contain auxiliary catalysts to improve the overall emissions control capability of the system. An oxidation catalyst is often positioned downstream of the SCR catalyst to help control ammonia slip on systems without closed-loop control of ammonia injection. The use of a ‘‘guard’’ catalyst could allow higher ammonia injection levels, thereby increasing the NO_X conversion efficiency without releasing un-reacted ammonia into the exhaust. The guard catalyst can also reduce HC and CO emission levels and diesel odors. However, increased N2O emissions may occur and NO_X emission levels may actually increase if too much ammonia is oxidized in the catalyst. Some SCR systems may also include an oxidation catalyst upstream of the SCR catalyst and urea injection point to generate NO2 for lowering the effective operating temperature and/or volume of the SCR catalyst. Studies have indicated that increasing the NO2 content in the exhaust stream can reduce the SCR temperature requirements by about 100 degrees Celsius.[25] This ‘‘pre-oxidation’’ catalyst also has the added benefit of reducing HC emissions.

b. SCR and Lean NO_X Catalyst Monitoring Requirements

We are proposing that the OBD system monitor SCR catalysts and lean NO_X catalysts for proper conversion capability. We are also proposing that each catalyst that converts NO_X be monitored either individually or in combination with others. For engines equipped with SCR systems or other catalyst systems that utilize an active/intrusive reductant injection (e.g., active lean NO_X catalysts utilizing diesel fuel

weighted moving average (EWMA) approach to making decisions about the catalyst's pass/fail status. This approach monitors the catalyst and ‘‘saves’’ that information. The next time it monitors the catalyst, it saves that information along with the previous information, placing a higher weighting on the most recent information. This is done every time the OBD system monitors the catalyst and the EWMA saves six or seven monitoring events before making a decision. Importantly, once there exists six or seven pieces of information, every monitoring event can result in a decision because the EWMA is always using the previous six or seven events. Unfortunately, if a service technician clears the data with a scan tool, it is going to take six or seven monitoring events before the catalyst monitor can make a decision on the pass/fail status of the catalyst. So, we want to be sure that, in addition to the EWMA aspect of the catalyst monitor, there exists a way of determining quickly that someone has cleared the data but perhaps did not actually repair the catalyst. This is required to help prevent against DTC clearing without fixing a failed catalyst as a means of passing an inspection & maintenance test.

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

[24] 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.

[25] Walker, A. P., Chandler, G. R., Cooper, B. J., et al., ‘‘An Integrated SCR and Continuously Regenerating Trap System to Meet Future NO_X and PM Legislation,’’ SAE Paper 2000–01–0188 which may be obtained from Society of Automotive Engineers International, 400 Commonwealth Dr., Warrendale, PA, 15096–0001.

injection), the OBD system would be required to 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 section II.D.4.

i. Catalyst Conversion Efficiency Malfunctions

We are proposing that the OBD system detect a catalyst malfunction when the catalyst conversion capability decreases to the point that would cause an engine's NO_X emissions to exceed any of the applicable emissions thresholds for ''NO_X Catalyst Systems'' as shown in Table II.B–1. If no failure or deterioration of the catalyst NO_X conversion capability could result in an engine's NO_X emissions exceeding any of the applicable emissions thresholds, the OBD system would have to detect a malfunction when the catalyst has no detectable amount of NO_X conversion capability.

ii. Active/Intrusive Reductant Injection System Malfunctions

Specific to SCR and other active/intrusive reductant injection system performance, we are proposing that the OBD system detect a malfunction prior to any failure or deterioration of the system to regulate reductant delivery properly (e.g., urea injection, separate injector fuel injection, post injection of fuel, air assisted injection/mixing) that would cause an engine's NO_X emissions to exceed any of the applicable emissions thresholds for ''NO_X Catalyst Systems'' as shown in Table II.B–1. As above, if no failure or deterioration of the reductant delivery system could result in an engine's NO_X emissions exceeding the applicable emissions thresholds, the OBD system would have to 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.

If the 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). If the 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 proper reductant).

iii. SCR and Lean NO_X Catalyst Feedback Control System Malfunctions

If the engine is equipped with feedback control of the reductant injection, we are proposing that the OBD system detect a malfunction when and if:

- The system fails to begin feedback control within a manufacturer specified time interval;
- A failure or deterioration causes open loop or default operation; or
- Feedback control has used up all of the adjustment allowed by the manufacturer.

c. SCR and Lean NO_X Catalyst Monitoring Conditions

Manufacturers would be required to define the monitoring conditions for catalyst conversion efficiency malfunctions such that the minimum performance ratio requirements discussed in section II.E would be met. For purposes of tracking and reporting as required in section II.E, all monitors used to detect catalyst conversion efficiency malfunctions must be tracked separately but reported as a single set of values as specified in section II.E.[26] We are also proposing that the OBD system monitor continuously for active/intrusive reductant injection system malfunctions. Manufacturers would be required to monitor continuously the active/intrusive reductant delivery system.

d. SCR and Lean NO_X Catalyst MIL Illumination and DTC Storage

We are proposing the general MIL illumination and DTC storage requirements presented in section II.A.2 with the exception of active/intrusive reductant injection related malfunctions. If the OBD system is capable of discerning that a system malfunction is being caused by an empty reductant tank, the manufacturer may delay illumination of the MIL if the vehicle is equipped with an alternative indicator for notifying the vehicle operator of the malfunction. The manufacturer would be required to demonstrate that: The alternative indicator is of sufficient illumination and location to be readily visible to the operator under all lighting conditions; and the alternative indicator provides equivalent assurance that a vehicle operator will be promptly notified; and, that corrective action would be undertaken. If the vehicle is not equipped with an alternative indicator and the MIL illuminates, the MIL may be immediately extinguished and the corresponding DTC erased once the OBD system has verified that the reductant tank has been properly refilled and the MIL has not been illuminated for any other type of malfunction. The Administrator may approve other strategies that provide equivalent assurance that a vehicle operator will be promptly notified and that corrective action will be undertaken.

The monitoring method for the catalyst(s) would have to be capable of detecting all instances, except diagnostic self-clearing, when a catalyst DTC has been cleared but the catalyst has not been replaced (e.g., catalyst over temperature histogram approaches are not acceptable).

7. NO_X Adsorber System Monitoring

a. Background

NO_X adsorbers, or lean NO_X traps (LNT), work to control NO_X emissions by storing NO_X on the surface of the catalyst during the lean engine operation typical of diesel engines and then by undergoing subsequent brief rich regeneration events where the NO_X is released and reduced across a precious metal catalyst.

NO_X adsorber systems generally consist of a conventional three-way catalyst function (e.g., platinum) with NO_X storage components (i.e., adsorbents) incorporated into the washcoat. Three-way catalysts convert NO_X emissions as well as HC and CO emissions (hence the name three-way) by promoting oxidation of HC and CO to H_2O and CO_2 using the oxidation potential of the NO_X pollutant and, in the process, reducing the NO_X emissions to nitrogen, N_2. Said another way, three-way catalysts work with exhaust conditions where the net oxidizing and reducing chemistry of the exhaust is approximately equal, allowing the catalyst to promote complete oxidation/reduction reactions to the desired exhaust components of CO_2, H_2O, and N_2. The oxidizing potential in the exhaust comes from NO_X emissions and any feedgas oxygen (O_2) not consumed during combustion. The reducing potential in the exhaust

[26] For specific components or systems that have multiple monitors that are required to be reported (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 shall be reported for the specific component.

comes from HC and CO emissions, which represent products of incomplete combustion. Operation of the engine to ensure that the oxidizing and reducing potential of the combustion and exhaust conditions is precisely balanced is referred to as stoichiometric engine operation.

Because diesel engines run lean of stoichiometric operation, the NO_X emissions are stored, or absorbed—via chemical reaction with alkaline earth metals such as barium nitrate in the washcoat—and then released during rich operation for conversion to N_2. This NO_X release during rich operation is referred to as a regeneration event. The rich operating conditions required for NO_X regeneration, which generally last for several seconds, are typically achieved using a combination of intake air throttling (to reduce the amount of intake air), exhaust gas recirculation, and post-combustion fuel injection.

NO_X adsorber systems have demonstrated NO_X reduction efficiencies from 50 percent to in excess of 90 percent. This efficiency has been found to be highly dependent on the fuel sulfur content because NO_X adsorbers are extremely sensitive to sulfur. The NO_X adsorption material has an even greater affinity for sulfur compounds than NO_X. Thus, sulfur compounds can saturate the adsorber and limit the number of active sites for NO_X adsorption, thereby lowering the NO_X reduction efficiency. Accordingly, low sulfur fuel is required to achieve the greatest NO_X reduction efficiencies. Although new adsorber washcoat materials are being developed with a higher resistance to sulfur poisoning and ultra-low sulfur fuel will be the norm by 2010, NO_X adsorber systems will still need to purge the stored sulfur from the storage bed by a process referred to as desulfation. Because the desulfation process takes longer (e.g., several minutes) and requires more fuel and heat than the NO_X regeneration step, permanent thermal degradation of the NO_X adsorber and fuel economy penalties may result from desulfation events happening with excessive frequency. However, if desulfation is not done frequently enough, NO_X storage capacity would be compromised and fuel economy penalties would be incurred from excessive attempts at NO_X regeneration.

In order to achieve and maintain high NO_X conversion efficiencies while limiting negative impacts on fuel economy and driveability, vehicles with NO_X adsorber systems will require precise air/fuel control in the engine and in the exhaust stream. Diesel manufacturers are expected to utilize NO_X sensors and temperature sensors to provide the most precise closed-loop control for the NO_X adsorber system. If NO_X sensors are not used to control the NO_X adsorber system, manufacturers could use wide-range air-fuel (A/F) sensors located upstream and downstream of the adsorber as a substitute. However, A/F sensors cannot provide an instantaneous indication of tailpipe NO_X levels, which would allow the control system to precisely determine when the adsorber system is filled to capacity and regeneration should be initiated. If A/F sensors are used in lieu of NO_X sensors, an estimation of engine-out NO_X emissions and their subsequent storage in the NO_X adsorber can be achieved indirectly through modeling.

b. NO_X Adsorber System Monitoring Requirements

We are proposing that the OBD system 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 NO_X regeneration, the OBD system would have to 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 would have to be monitored in accordance with the comprehensive component requirements in section II.D.4.

i. NO_X Adsorber Capability Malfunctions

We are proposing that the OBD system detect a NO_X adsorber malfunction when its capability—i.e., its combined adsorption and conversion capability—decreases to the point that would cause an engine's NO_X emissions to exceed the applicable emissions thresholds for ''NO_X Catalyst Systems'' as shown in Table II.B–1. If no failure or deterioration of the NO_X adsorber capability could result in an engine's NO_X emissions exceeding the applicable emissions thresholds, the OBD system would have to detect a malfunction when the system has no detectable amount of NO_X adsorber capability.

ii. Active/Intrusive Reductant Injection System Malfunctions

For NO_X adsorber systems that use active/intrusive injection (e.g., in-cylinder post fuel injection, in-exhaust air-assisted fuel injection) to achieve desorption of the NO_X adsorber, the OBD system would have to detect a malfunction if any failure or deterioration of the injection system's ability to properly regulate injection causes the system to be unable to achieve desorption of the NO_X adsorber.

iii. NO_X Adsorber Feedback Control System Malfunctions

If the engine is equipped with feedback control of the reductant injection (e.g., feedback control of injection quantity, time), we are proposing that the OBD system detect a malfunction when and if:

- The system fails to begin feedback control within a manufacturer specified time interval;
- A failure or deterioration causes open loop or default operation; or
- Feedback control has used up all of the adjustment allowed by the manufacturer.

c. NO_X Adsorber System Monitoring Conditions

We are proposing that manufacturers define the monitoring conditions for NO_X adsorber capability malfunctions such that the minimum performance ratio requirements discussed in section II.E would be met. For purposes of tracking and reporting as required in section II.E, all monitors used to detect NO_X adsorber capability malfunctions must be tracked separately but reported as a single set of values as specified in section II.E.[27] We are also proposing that the OBD system monitor continuously for active/intrusive reductant injection and feedback control system malfunctions.

d. NO_X Adsorber System MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage discussed in section II.A.2.

8. Diesel Particulate Filter (DPF) System Monitoring

a. Background

Diesel particulate filters control diesel PM by capturing the soot (solid carbon) portion of PM in a filter media, typically a ceramic wall flow substrate, and then by oxidizing (burning) it in the oxygen-rich atmosphere of diesel exhaust.[28] In aggregate over a driving cycle, the PM must be burned at a rate equal to or

[27] For specific components or systems that have multiple monitors that are required to be reported (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 shall be reported for the specific component.

greater than its accumulation rate, or the DPF will clog. Given low sulfur diesel fuel (diesel fuel with a sulfur content of 15 ppm or lower), highly active catalytic metals (e.g., platinum) can be used to promote soot oxidation. This method of PM filter regeneration, called passive regeneration, is the primary means of soot oxidation that we project industry will use in 2007/2010.

The DPF technology has proven itself in tens of thousands of retrofit applications where low sulfur diesel fuel is already available. More than a million light-duty passenger cars in Europe now have diesel particulate filters. DPFs are considered the most effective control technology for the reduction of particulate emissions and can typically achieve PM reductions in excess of 90 percent.

In order to maintain the performance of the DPF and the engine, the trapped PM must be periodically removed before too much particulate is accumulated and exhaust backpressure reaches unacceptable levels. The process of periodically removing accumulated PM from the DPF is known as ''regeneration'' and is very important for maintaining low PM emission levels. DPF regeneration can be passive (i.e., occur continuously during regular operation of the filter), active (i.e., occur on a controlled, periodic basis after a predetermined quantity of particulates have been accumulated), or a combination of the two. With passive regeneration, the oxidizing catalyst material on the DPF substrate serves to lower the temperature for oxidizing PM. This allows the DPF to continuously oxidize trapped PM material during normal driving. In contrast, active systems utilize an external heat source—such as an electric heater or fuel burner—to facilitate DPF regeneration. We are projecting that virtually all DPF systems will have some sort of active regeneration mechanism as a backup mechanism should operating conditions not be conducive for passive regeneration.

One of the key considerations for a DPF regeneration control system is the amount of soot quantity that is stored in the DPF (often called soot loading). If too much soot is stored when regeneration is activated, the soot can burn uncontrollably and DPF substrate could be damaged via melting or cracking. Conversely, activating regeneration when there is too little trapped soot will not ensure good combustion propagation which would effectively waste the energy (fuel) used to initiate the regeneration. Another important consideration in the control system design is the fuel economy penalty involved with DPF regeneration. Prolonged operation with high backpressures in the exhaust and regenerations occurring too frequently are both detrimental to fuel economy and DPF durability. Therefore, DPF system designers will need to carefully balance the regeneration frequency with various conflicting factors. To optimize the trap regeneration for these design factors, the DPF regeneration control system is projected to incorporate both pressure sensors and temperature sensors to model soot loading and other phenomena.[29] Through the information provided by these sensors, designers can optimize the DPF for high effectiveness and maximum durability while minimizing fuel economy and performance penalties.

b. DPF System Monitoring Requirements

We are proposing that the OBD system monitor the DPF on engines so-equipped for proper performance.[30] For engines equipped with active regeneration systems that utilize an active/intrusive injection (e.g., in-exhaust fuel injection, in-exhaust fuel/air burner), the OBD system would have to 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 section II.D.4.

i. PM Filtering Performance

We are proposing that the OBD system detect a malfunction prior to a decrease in the filtering capability of the DPF (e.g., cracking, melting, etc.) that would cause an engine's PM emissions to exceed the applicable emissions thresholds for ''DPF Systems'' as shown in Table II.B–1. If no failure or deterioration of the PM filtering performance could result in an engine's PM emissions exceeding the applicable emissions thresholds, the OBD system would have to detect a malfunction when no detectable amount of PM filtering occurs.

ii. DPF Regeneration Frequency Malfunctions—Too Frequent

We are proposing that the OBD system detect a malfunction when the DPF regeneration frequency increases from—i.e., occurs more often than—the manufacturer's specified regeneration frequency to a level such that it would cause an engine's NMHC emissions to exceed the applicable emissions threshold for ''DPF Systems'' as shown in Table II.B–1. If no such regeneration frequency exists that could cause NMHC emissions to exceed the applicable emission threshold, the OBD system would have to detect a malfunction when the PM filter regeneration frequency exceeds the manufacturer's specified design limits for allowable regeneration frequency.

iii. DPF Incomplete Regeneration Malfunctions

We are proposing that the OBD system detect a regeneration malfunction when the DPF does not properly regenerate under manufacturer-defined conditions where regeneration is designed to occur.

iv. DPF NMHC Conversion Efficiency Malfunctions

We are proposing that, for any DPF that serves to convert NMHC emissions, the OBD system must monitor the NMHC converting function of the DPF and detect a malfunction when the NMHC conversion capability decreases to the point that NMHC emissions exceed the NMHC threshold for ''DPF Systems'' as shown in Table II.B–1. If no failure or deterioration of the NMHC conversion capability could result in NMHC emissions exceeding the applicable NMHC threshold, the OBD system would have to detect a malfunction when the system has no detectable amount of NMHC conversion capability.

v. DPF Missing Substrate Malfunctions

We are proposing that the OBD system detect a malfunction if either the DPF substrate is completely destroyed, removed, or missing, or if the DPF assembly has been replaced with a muffler or straight pipe.

vi. DPF Active/Intrusive Injection System Malfunctions

We are proposing that, for systems that utilize active/intrusive injection (e.g., in-cylinder post fuel injection, in-exhaust air-assisted fuel injection) to achieve DPF regeneration, the OBD system detect a malfunction if any

[28] See ''Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements;'' EPA420–R–00–026; December 2000 at Chapter III for a more complete description of DPFs.

[29] Salvat, O., Marez, P., and Belot, G., ''Passenger Car Serial Application of a Particulate Filter System on a Common Rail Direct Injection Diesel Engine,'' SAE Paper 2000–01–0473 which may be obtained from Society of Automotive Engineers International, 400 Commonwealth Dr., Warrendale, PA, 15096–0001.

[30] Note that these requirements would also apply to a catalyzed diesel particulate filter (CDPF). We use the more common term DPF throughout this discussion.

failure or deterioration of the injection system's ability to properly regulate injection causes the system to be unable to achieve DPF regeneration.

vii. DPF Regeneration Feedback Control System Malfunctions

We are proposing that, if the engine is equipped with feedback control of the DPF regeneration (e.g., feedback control of oxidation catalyst inlet temperature, PM filter inlet or outlet temperature, in-cylinder or in-exhaust fuel injection), the OBD system must detect a malfunction when and if:

- The system fails to begin feedback control within a manufacturer specified time interval;
- A failure or deterioration causes open loop or default operation; or
- Feedback control has used up all of the adjustment allowed by the manufacturer.

c. DPF System Monitoring Conditions

We are proposing that manufacturers define the monitoring conditions for all DPF related malfunctions such that the minimum performance ratio requirements discussed in section II.E would be met with the exception that monitoring must occur every time the monitoring conditions are met during the driving cycle rather than once per driving cycle as required for most monitors. For purposes of tracking and reporting as required in section II.E, all monitors used to detect all DPF related malfunctions would have to be tracked separately but reported as a single set of values as specified in section II.E.[31]

d. DPF System MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2.

9. Exhaust Gas Sensor Monitoring

a. Background

Exhaust gas sensors (e.g., oxygen sensors, wide-range air-fuel (A/F) sensors, NO_X sensors) are important to the emission control system of vehicles. These sensors are used for enhancing the performance of several emission control technologies (e.g., catalysts, EGR systems). We expect that both oxygen sensors and wide range A/F sensors may be used by heavy-duty manufacturers to optimize their emission control technologies. We would expect that, in addition to their emissions control functions, these sensors will also be used to satisfy many of the proposed HDOBD monitoring requirements, such as fuel system monitoring, catalyst monitoring, and EGR system monitoring. NO_X sensors may also be used for optimization of several diesel emission control technologies, such as NO_X adsorbers and selective catalytic reduction (SCR) systems. Since an exhaust gas sensor can be a critical component of a vehicle's fuel and emission control system, the proper performance of this component needs to be assured to maintain low emissions. The reliance on these sensors for emissions control and OBD monitoring makes it important that any malfunction that adversely affects the performance of any of these sensors be detected by the OBD system.

b. Exhaust Gas Sensor Monitoring Requirements

We are proposing that the OBD system monitor all exhaust gas sensors (e.g., oxygen, air-fuel ratio, NO_X) used either for emission control system feedback (e.g., EGR control/feedback, SCR control/feedback, NO_X adsorber control/feedback), or as a monitoring device, for proper output signal, activity, response rate, and any other parameter that can affect emissions. For engines equipped with heated exhaust gas sensors, the OBD system would have to monitor the heater for proper performance.

i. Air/Fuel Ratio Sensor Malfunctions

For all air/fuel ratio sensors, we are proposing the following:

- Circuit malfunctions: The OBD system must detect malfunctions of the sensor caused by either a lack of circuit continuity or out-of-range values.
- Feedback malfunctions: The OBD system must detect a malfunction of the sensor when a sensor failure or deterioration causes an emissions control system—e.g., the EGR, SCR, or NO_X adsorber systems—to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).
- Monitoring capability: To the extent feasible, the OBD system must detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst, EGR, SCR, or NO_X adsorber monitoring).

Specifically for sensors located upstream of an aftertreatment device, we are proposing the following:

- Sensor performance malfunctions: The OBD system must detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed the applicable emissions thresholds for ''Other Monitors'' as shown in Table II.B–1.

Specifically for sensors located downstream of an aftertreatment device, we are proposing the following:

- Sensor performance malfunctions: The OBD system must detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed the applicable emissions thresholds for ''Air-fuel ratio sensors downstream of aftertreatment devices'' as shown in Table II.B–1.

ii. NO_X Sensor Malfunctions

For NO_X sensors, we are proposing the following:

- Sensor performance malfunctions: The OBD system must detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed the applicable emissions thresholds for ''NO_X sensors'' as shown in Table II.B–1.
- Circuit malfunctions: The OBD system must detect malfunctions of the sensor caused by either a lack of circuit continuity or out-of-range values.
- Feedback malfunctions: The OBD system shall detect a malfunction of the sensor when a sensor failure or deterioration causes an emission control—e.g., the EGR, SCR, or NO_X adsorber systems—to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).
- Monitoring capability: To the extent feasible, the OBD system must detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst, EGR, SCR, or NO_X adsorber monitoring).

[31] For specific components or systems that have multiple monitors that are required to be reported (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 shall be reported for the specific component.

iii. Other Exhaust Gas Sensor Malfunctions

For other exhaust gas sensors, we are proposing that the manufacturer submit a monitoring plan to the Administrator for approval. The Administrator would approve the request upon determining that the manufacturer has submitted data and an engineering evaluation that demonstrate that the monitoring plan is as reliable and effective as the monitoring plan required for air/fuel ratio sensors and NO_X sensors.

iv. Exhaust Gas Sensor Heater Malfunctions

We are proposing that the OBD system detect a malfunction of the heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required to be met by the component vendor for heater circuit performance at high mileage). The manufacturer may use other malfunction criteria for heater performance malfunctions. To do so, the manufacturer would be required to submit data and/or engineering analyses that demonstrate that the monitoring reliability and timeliness would be equivalent to the criteria stated here. Further, the OBD system would be required to detect malfunctions of the heater circuit including open or short circuits that conflict with the commanded state of the heater (e.g., shorted to 12 Volts when commanded to 0 Volts (ground)).

c. Exhaust Gas Sensor Monitoring Conditions

For exhaust gas sensor performance malfunctions, we are proposing that manufacturers define the monitoring conditions such that the minimum performance ratio requirements discussed in section II.E would be met. For purposes of tracking and reporting as required in section II.E, all monitors used to detect sensor performance malfunctions would have to be tracked separately but reported as a single set of values as specified in section II.E.[32]

For exhaust gas sensor monitoring capability malfunctions, manufacturers would have to define the monitoring conditions such that the minimum performance ratio requirements discussed in section II.E would be met with the exception that monitoring must occur every time the monitoring conditions are met during the driving cycle rather than once per driving cycle as required for most monitors.

For exhaust gas sensor circuit malfunctions and feedback malfunctions, monitoring must be conducted continuously.

The manufacturer may disable continuous exhaust gas sensor monitoring when an exhaust gas sensor malfunction cannot be distinguished from other effects (e.g., disable ''out-of-range low'' monitoring during fuel cut conditions). To do so, the manufacturer would be required to submit test data and/or engineering analyses that demonstrate that a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding a false detection.

For exhaust gas sensor heater malfunctions, manufacturers must define monitoring conditions such that the minimum performance ratio requirements discussed in section II.E would be met. Monitoring for sensor heater circuit malfunctions must be conducted continuously.

d. Exhaust Gas Sensor MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2.

C. Monitoring Requirements and Timelines for Gasoline/Spark-Ignition Engines

Table II.C–1 summarizes the proposed gasoline fueled spark ignition 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.C–2 summarizes the proposed implementation schedule for these thresholds—i.e., the proposed certification requirements and in-use liabilities. More detail regarding the specific monitoring requirements, implementation schedules, and liabilities can be found in the sections that follow.

TABLE II.C–1.—PROPOSED EMISSIONS THRESHOLDS FOR GASOLINE FUELED SI ENGINES OVER 14,000 POUNDS

Component/Monitor	MY	NMHC	CO	NO_X
Catalytic converter system	2010+	1.75x		1.75x
''Other monitors'' with emissions thresholds (see section II.C)	2010+	1.5x	1.5x	1.5x
Evaporative emissions control system	2010+	0.150 inch leak.		

Notes: MY=Model Year; 1.75x means a multiple of 1.75 times the applicable emissions standard; not all proposed monitors have emissions thresholds but instead rely on functionality and rationality checks as described in section II.D.4. The evaporative emissions control system threshold is not, technically, an emissions threshold but rather a leak size that must be detected; nonetheless, for ease we refer to this as the threshold.

There are exceptions to the emissions thresholds shown in Table II.C–1 whereby a manufacturer can demonstrate that emissions do not exceed the threshold even when the component or system is non-functional at which point a functional check would be allowed.

The monitoring requirements described below for gasoline engines mirror those that are already in place for gasoline engines used in vehicles under 14,000 pounds. The HD gasoline industry—General Motors and Ford, as of today[33]—have told us that their preference is to use essentially the same OBD system on their engines used in both under and over 14,000 pound vehicles.[34] In general, we agree with the

[32] For specific components or systems that have multiple monitors that are required to be reported (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 shall be reported for the specific component.

[33] This is true according to our certification database for both he 2004 and 2005 model years. Other manufacturers certify engines that use the Otto cycle, but those engines do not burn gasoline and instead burn various alternative fuels.

[34] ''EMA Comments on Proposed HDOBD Requirements for HDGE,'' bullet items 3 and 4; April 28, 2005, Docket ID# EPA–HQ–OAR–2005–0047–0003.

HD gasoline industry on this issue for three reasons:

• The engines used in vehicles above and below 14,000 pounds are the same which makes it easy for industry to use the same OBD monitors.

• The existing OBD requirements for engines used in vehicles below 14,000 pounds have proven effective; and,

• The industry members have more than 10 years experience complying with the OBD requirements for engines used in vehicles below 14,000 pounds.

As a result, we are proposing requirements that should allow for OBD system consistency in vehicles under and over 14,000 pounds rather than proposing requirements that mirror the proposed HD diesel requirements discussed in section II.B. Nonetheless, the requirements proposed below are for engine-based OBD monitors only rather than monitors for the entire powertrain (which would include the transmission). We are doing this for the same reasons as done for the proposed diesel OBD requirements in that certification of gasoline applications over 14,000 pounds, like their diesel counterparts, is done on an engine basis and not a vehicle basis.

1. Fuel System Monitoring

a. Background

As with diesel engines, the fuel system of a gasoline engine is an essential component of the engine's emissions control system. Proper delivery of fuel is essential to maintain stoichiometric operation and minimize engine out emissions. Proper stoichiometric control is also critical to maximize catalyst conversion efficiency and reach low tailpipe emission levels. As such, thorough monitoring of the fuel system is an essential element in an OBD system.

For gasoline engines, the fuel system generally includes a fuel pump, fuel pressure regulator, fuel rail, individual injectors for each cylinder, and a closed-loop feedback control system using oxygen sensor(s) or air-fuel ratio (A/F) sensor(s). The feedback sensors are located in the exhaust system and are used to regulate the fuel injection quantity to achieve a stoichiometric mixture in the exhaust. If the sensor indicates a rich (or lean) mixture, the system reduces (or increases) the amount of fuel being injected by applying a short term correction to the fuel injection quantity calculated for the current engine operating condition. To account for aging or deterioration in the system such as reduced injector flow, more permanent long term corrections are also learned and applied to the fuel injection quantity for more precise fueling.

For gasoline engines, fuel system monitoring has been implemented on light-duty vehicles since the 1996 model year and on heavy-duty vehicles less than 14,000 pounds and the engines used in those vehicles since the 2004/2005 model year. For heavy-duty gasoline engines used in vehicles over 14,000 pounds (many of which are the same engine as is used in vehicles less than 14,000 pounds), the system components and control strategies are identical to those used in the light-duty and under 14,000 pound categories. As such, the monitoring requirements established for engines used in vehicles less than 14,000 pounds can be directly applied to engines used in vehicles over 14,000 pounds.

b. Fuel System Monitoring Requirements

We are proposing that the fuel system be continuously monitored for its ability to maintain engine emissions below the applicable emissions thresholds. Manufacturers would also be required to verify that the fuel system is in closed-loop operation—e.g., that it is using the oxygen sensor for feedback control. The individual components of the fuel system would also be covered by separate monitoring requirements for oxygen sensors, misfire (for the fuel injectors), and comprehensive components (in systems such as those with electronically-controlled variable speed fuel pumps or electronically-controlled fuel pressure regulators).

i. Fuel System Performance

We are proposing that the OBD system be required to detect a malfunction of the fuel delivery system (including feedback control based on a secondary oxygen sensor) when the fuel delivery system is unable to maintain the engine's emissions at or below the applicable emissions thresholds for ''Other monitors'' as shown in Table II.C–1.

ii. Fuel System Feedback Control

If the engine is equipped with adaptive feedback control, we are proposing that the OBD system be required to detect a malfunction when the adaptive feedback control has used up all of the adjustment allowed by the manufacturer. However, if the engine is equipped with feedback control that is based on a secondary oxygen (or equivalent) sensor, the OBD system would not be required to detect a malfunction of the fuel system solely when the feedback control based on that secondary oxygen sensor has used up all of the adjustment allowed by the manufacturer. For such systems, the OBD system would be required to meet the fuel system performance requirements presented above.

Additionally, we are proposing that the OBD system be required to detect a malfunction whenever the fuel control system fails to enter closed loop operation within a time interval after engine startup. The manufacturer would be required to submit data and/or engineering analyses that support their chosen time interval.

Lastly, manufacturers would be allowed to adjust the malfunction criteria and/or monitoring conditions to compensate for changes in altitude, temporary introduction of large amounts of purge vapor, or for other similar identifiable operating conditions when they occur.

c. Fuel System Monitoring Conditions

We are proposing that the OBD system monitor continuously for malfunctions of the fuel system.

d. Fuel System MIL Illumination and DTC Storage

We are proposing that a pending DTC be stored immediately upon detecting a malfunction according to the fuel system monitoring requirements presented in section II.C.1.b (i.e., rather than waiting until the end of the drive cycle to store the pending DTC). Once a pending DTC is stored, the OBD system would be required to illuminate the MIL immediately and store a MIL-on DTC if a malfunction is again detected during either of the following two events: (1) The drive cycle immediately following the drive cycle during which the pending DTC was stored, regardless of the conditions encountered during the drive cycle; or, (2) on the next drive cycle during which similar conditions are encountered to those that occurred when the pending DTC was stored.[35]

We are also proposing that the pending DTC may be erased at the end of the next drive cycle in which similar conditions have been encountered without detecting a malfunction according to the fuel system monitoring requirements. The pending DTC may also be erased if similar conditions are not encountered during the 80 drive cycles immediately after the initial

[35] ''Similar conditions,'' as used in conjunction with misfire and fuel system monitoring, 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) as existing during the applicable previous problem detection. The Administrator may approve other definitions of similar conditions based on comparable timeliness and reliability in detecting similar engine operation.

detection of a malfunction for which the pending DTC was set.

We are proposing some specific requirements with respect to storage of freeze frame information associated with fuel system malfunctions. First, the OBD system must store and erase freeze frame information either in conjunction with storing and erasing a pending DTC or in conjunction with storing and erasing a MIL-on DTC. Second, if freeze frame information is already stored for a malfunction other than an engine misfire or fuel system malfunction at the time that a fuel system DTC is stored, the preexisting freeze frame information must be replaced with freeze frame information regarding the fuel system malfunction.

The OBD system would also be required to store the engine speed, load, and warm up status present when the first fuel system malfunction is detected that resulted in the storage of the pending DTC. The MIL may be extinguished after three sequential drive cycles in which similar conditions have been encountered without detecting a malfunction of the fuel system.

2. Engine Misfire Monitoring

a. Background

Detecting engine misfire on a gasoline spark ignition engine is important for two reasons: Its impact on the emissions performance of the engine and its impact on the durability of the catalytic converter. Engine misfire has two primary causes: Lack of spark and poor fuel metering (delivery). When misfire occurs, unburned fuel and air are pumped out of the engine and into the exhaust system and into the catalyst. This can increase dramatically the operating temperature of the catalyst where temperatures can soar to above 900 degrees Celsius. This problem is usually most severe under high load/high speed engine operating conditions and can cause irreversible damage to the catalyst. Though the durability of catalysts has been improving, most are unable to sustain continuous operation at such high temperatures. Engine misfire also contributes to poor emissions performance, especially when the misfire occurs during engine warm-up and the catalyst itself has not yet reached its operating temperature.

b. Engine Misfire Monitoring Requirements

We are proposing that the OBD system detect both engine misfire capable of causing catalyst damage and engine misfire capable of causing poor emissions performance. Additionally, the OBD system would be required to identify the specific cylinder in which misfire is occurring and/or if there exists a condition in which more than one cylinder is misfiring; when identifying a multiple cylinder misfire condition, the OBD system would not be required to identify individually each of the misfiring cylinders. We are proposing an exception to this whereby if more than 90 percent of the detected misfires are occurring in a single cylinder, the manufacturer may elect to consider it a single cylinder misfire condition rather than a multiple cylinder misfire condition. However, we are proposing that, if two or more cylinders individually have more than 10 percent of the total number of detected misfires, the manufacturer must consider it a multiple cylinder misfire condition.

i. Engine Misfire Capable of Causing Catalyst Damage

We are proposing that the manufacturer be required to detect the percentage of misfire—evaluated in 200 revolution increments—for each engine speed and load condition that would result in a temperature capable of damaging the catalyst. For every engine speed and load condition at which this percentage is determined to be less than five percent, the manufacturer may set the malfunction criteria at five percent. The manufacturer may use a longer interval than a 200 revolution increment but only for determining, on a given drive cycle, the first misfire exceedance; upon detecting the first such exceedance, the 200 revolution increment must be used. The manufacturer may use a longer initial interval by submitting data and/or engineering analyses that demonstrate that catalyst damage would not occur due to unacceptably high catalyst temperatures before the interval has elapsed.

Further, we are proposing that, for the purpose of establishing the temperature at which catalyst damage would occur, manufacturers not be allowed to define the catalyst damaging temperature at a temperature more severe than what the catalyst system could be operated at for 10 consecutive hours and still meet the applicable standards.

ii. Engine Misfire Causing Poor Emissions Performance

We are proposing that the manufacturer be required to detect the percentage of misfire—evaluated in 1000 revolution increments—that would cause emissions to exceed the emissions thresholds for ''Other monitors'' as shown in Table II.C–1 if that percentage of misfire were present from the beginning of the test procedure. To establish this percentage of misfire, the manufacturer would be required to use misfire events occurring at equally spaced, complete engine cycle intervals, across randomly selected cylinders throughout each 1000 revolution increment. If this percentage of misfire is determined to be lower than one percent, the manufacturer may set the malfunction criteria at one percent. The manufacturer may use a different interval than a 1000 revolution increment. To do so, the manufacturer would be required to submit data and/or engineering analyses demonstrating that the strategy would be equally effective and timely at detecting misfire. A malfunction must be detected if the percentage of misfire is exceeded regardless of the pattern of misfire events (e.g., random, equally spaced, continuous).

c. Engine Misfire Monitoring Conditions

We are proposing that the OBD system monitor continuously to detect engine misfire under all of the following conditions:

- From no later than the end of the second crankshaft revolution after engine start;
- During the rise time and settling time as the engine reaches the desired idle speed immediately following engine start-up (i.e., ''flare-up'' and ''flare-down''); and,
- Under all positive torque conditions except within the engine operating region bound by lines connecting the following three points: An engine speed of 3000 rpm with the engine load at the positive torque line (i.e., engine load with the transmission in neutral), an engine speed at the redline rpm with the engine load at the positive torque line, and an engine speed at the redline rpm with an engine load at which intake manifold vacuum is four inches of mercury lower than that at the positive torque line (this would be an engine load somewhat greater than the engine load at the positive torque line).[36]

If a monitoring system cannot detect all misfire patterns under the required engine speed and load conditions, the manufacturer may request approval of the system nonetheless. In evaluating the manufacturer's request, the Administrator would consider:

- The magnitude of the region(s) in which misfire detection is limited;
- The degree to which misfire detection is limited in those region(s)

[36] ''Redline engine speed'' is actually defined by the manufacturer as either the recommended maximum engine speed as normally displayed on instrument panel tachometers or the engine speed at which fuel shutoff occurs.

(i.e., the probability of detection of misfire events);

- The frequency with which said region(s) are expected to be encountered in-use;
- The type of misfire patterns for which misfire detection is troublesome; and,
- Demonstration that the monitoring technology being used is not inherently incapable of detecting misfire under the required conditions (i.e., compliance can be achieved by other manufacturers on their engines).

The Administrator's evaluation would be based on the following misfire patterns:

- Equally spaced misfire occurring on randomly selected cylinders;
- Single cylinder continuous misfire; and,
- Paired cylinder (cylinders firing at the same crank angle) continuous misfire.

Further, a manufacturer may use a monitoring system that has reduced misfire detection capability during the portion of the first 1000 revolutions after engine start during which a cold start emission reduction strategy is active that reduces engine torque (e.g., spark retard strategies). To do so, the manufacturer would be required to submit data and/or engineering analyses demonstrating that the probability of detection is greater than or equal to 75 percent during the worst case condition (i.e., lowest generated torque) for a vehicle operated continuously at idle (park/neutral idle) on a cold start between 50 and 86 degrees Fahrenheit and that the technology cannot reliably detect a higher percentage of the misfire events during these conditions.

A manufacturer may disable misfire monitoring or use an alternative malfunction criterion when misfire cannot be distinguished from other effects. To do so, the manufacturer would be required to submit data and/or engineering analyses demonstrating that the disablement interval or period of use of an alternative malfunction criterion is limited only to that necessary for avoiding a false detection (errors of commission). Such disablements would be allowed for conditions involving:

- Rough road;
- Fuel cut;
- Gear changes for manual transmission vehicles;
- Traction control or other vehicle stability control activation such as anti-lock braking or other engine torque modifications to enhance vehicle stability;
- Off-board control or intrusive activation of vehicle components or diagnostics during service or assembly plant testing;
- Portions of intrusive evaporative system or EGR diagnostics that can significantly affect engine stability (i.e., while the purge valve is open during the vacuum pull-down of a evaporative system leak check but not while the purge valve is closed and the evaporative system is sealed or while an EGR diagnostic causes the EGR valve to be intrusively cycled on and off during positive torque conditions); or,
- Engine speed, load, or torque transients due to throttle movements more rapid than occurs over the FTP cycle for the worst case engine within each engine family.

Additionally, the manufacturer may disable misfire monitoring when the fuel level is 15 percent or less of the nominal capacity of the fuel tank, when PTO units are active, or while engine coolant temperature is below 20 degrees Fahrenheit. For the latter case, the manufacturer may continue the misfire monitoring disablement until engine coolant temperature exceeds 70 degrees Fahrenheit provided the manufacturer can demonstrate that it is necessary.

In general, the Administrator would not approve misfire monitoring disablement for conditions involving normal air conditioning compressor cycling from on-to-off or off-to-on, automatic transmission gear shifts (except for shifts occurring during wide open throttle operation), transitions from idle to off-idle, normal engine speed or load changes that occur during the engine speed rise time and settling time (i.e., ''flare-up'' and ''flare-down'') immediately after engine starting without any vehicle operator-induced actions (e.g., throttle stabs), or excess acceleration (except for acceleration rates that exceed the maximum acceleration rate obtainable at wide open throttle while the vehicle is in gear due to abnormal conditions such as slipping of a clutch).

Further, the manufacturer may request approval of other misfire monitoring disablements or use of alternative malfunction criteria for any other condition. The Administrator would consider such requests on a case by case basis and will consider whether or not the manufacturer has demonstrated that the request is based on an unusual or unforeseen circumstance and that it is applying the best available computer and monitoring technology.

For engines with more than eight cylinders that cannot meet the continuous monitoring and detection requirements listed above, a manufacturer may use alternative misfire monitoring conditions. Any manufacturer wishing to use alternative misfire monitoring conditions must submit data and/or an engineering evaluation that demonstrate that misfire detection throughout the required operating region cannot be achieved when using proven monitoring technology (i.e., a technology that provides for compliance with these requirements on other engines) and provided misfire is detected to the fullest extent permitted by the technology. However, the misfire detection system would still be required to monitor during all positive torque operating conditions encountered during an FTP transient cycle.

d. Engine Misfire MIL Illumination and DTC Storage

Manufacturers may store a general misfire DTC instead of a cylinder specific DTC under certain operating conditions. Do so shall depend on the manufacturer submitting data and/or an engineering evaluation that demonstrate that the specific misfiring cylinder cannot be reliably identified when the certain operating conditions occur.

i. Engine Misfire Capable of Causing Catalyst Damage

We are proposing that a pending DTC shall be stored immediately if, during a single drive cycle, the percentage of misfire determined by the manufacturer as being capable of causing catalyst damage is exceeded three times when operating in the positive torque region encountered during an FTP transient cycle or is exceeded on a single occasion when operating at any other engine speed and load condition in the positive torque region defined above. Immediately after a pending DTC is stored, the MIL shall blink once per second at all times while misfire is occurring during the drive cycle (i.e., the MIL may be extinguished during those times when misfire is not occurring during the drive cycle). If, at the time such a catalyst damaging engine misfire is occurring, the MIL is already illuminated for a malfunction other than engine misfire, the MIL shall blink similarly while the engine misfire is occurring and, if the misfire ceases, the MIL shall stop blinking but shall remain illuminated as commanded by the other malfunction.

If a pending DTC is stored as described above, the OBD system shall immediately store a MIL-on DTC if the percentage of misfire determined by the manufacturer as being capable of causing catalyst damage is again exceeded one or more times during either: (a) the drive cycle immediately following the storage of the pending DTC, regardless of the conditions encountered during the drive cycle; or, (b) on the next drive cycle in which similar conditions are encountered to those that existed when the pending DTC was stored.

If, during a previous drive cycle, a pending DTC has been stored associated with detection of an engine misfire capable of causing poor emissions performance, the OBD system shall immediately store a MIL-on DTC if the percentage of misfire determined by the manufacturer as capable of causing catalyst damage is exceeded, regardless of the conditions encountered.

Upon storage of a MIL-on DTC associated with engine misfire capable of causing catalyst damage, the MIL shall blink as described above while the engine misfire is occurring and then shall remain continuously illuminated if the engine misfire ceases. This MIL illumination logic shall continue until the requirements for extinguishing the MIL are met, as described below.

If the engine misfire is not again detected by the end of the next drive cycle in which similar conditions are encountered to those that existed when the pending DTC was stored then the pending DTC shall be erased. The pending DTC may also be erased if similar conditions are not encountered during the 80 drive cycles subsequent to the initial malfunction detection.

We are also proposing that engines with fuel shutoff and default fuel control—that are used to prevent catalyst damage should engine misfire capable of causing catalyst damage be detected—shall have some exemptions from these MIL illumination requirements. Most notably, the MIL is not required to blink while the catalyst damaging misfire is occurring. Instead, the MIL may simply illuminate in a steady fashion while the misfire is occurring provided that the fuel shutoff and default fuel control are activated as soon as the misfire is detected. Fuel shutoff and default fuel control may be deactivated only to permit fueling outside of the misfire range. Manufacturers may also periodically, but not more than once every 30 seconds, deactivate fuel shutoff and default fuel control to determine if the catalyst damaging misfire is still occurring. Normal fueling and fuel control may be resumed if the catalyst damaging misfire is no longer being detected.

Manufacturers may also use a MIL illumination strategy that continuously illuminates the MIL in lieu of blinking the MIL during extreme misfire conditions capable of causing catalyst damage (i.e., misfire capable of causing catalyst damage that is occurring at all engine speeds and loads). Manufacturers would be allowed to use such a strategy only when catalyst damaging misfire levels cannot be avoided during reasonable driving conditions and the manufacturer can demonstrate that the strategy will encourage operation of the vehicle in conditions that will minimize catalyst damage (e.g., at low engine speeds and loads).

ii. Engine Misfire Causing Poor Emissions Performance

We are proposing that, for a misfire detected within the first 1000 revolutions after engine start during which misfire detection is active, a pending DTC shall be stored after the first exceedance of the percentage of misfire determined by the manufacturer as capable of causing poor emissions performance. If a pending DTC is stored, the OBD system shall illuminate the MIL and store a MIL-on DTC within 10 seconds if an exceedance of the percentage of misfire is again detected in the first 1000 revolutions during any subsequent drive cycle, regardless of the conditions encountered during the driving cycle. The pending DTC shall be erased at the end of the next drive cycle in which similar conditions are encountered to those that existed when the pending DTC was stored provided the specified percentage of misfire is not again detected. The pending DTC may also be erased if similar conditions are not encountered during the 80 drive cycles subsequent to the initial malfunction detection.

For a misfire detected after the first 1000 revolutions following engine start, a pending DTC shall be stored no later than after the fourth exceedance—during a single drive cycle—of the percentage of misfire determined by the manufacturer as being capable of causing poor emissions performance. If a pending DTC is stored, the OBD system shall illuminate the MIL and store a MIL-on DTC within 10 seconds if an exceedance of the percentage of misfire is again detected four times during: (a) the drive cycle immediately following the storage of the pending DTC, regardless of the conditions encountered during the drive cycle; or, (b) on the next drive cycle in which similar conditions are encountered to those that existed when the pending DTC was stored. The pending DTC shall be erased at the end of the next drive cycle in which similar conditions are encountered to those that existed when the pending DTC was stored provided the specified percentage of misfire is not again detected. The pending DTC may also be erased if similar conditions are not encountered during the 80 drive cycles subsequent to the initial malfunction detection.

We are proposing some specific items with respect to freeze frame storage associated with engine misfire. The OBD system shall store and erase freeze frame conditions either in conjunction with storing and erasing a pending DTC or in conjunction with storing a MIL-on DTC and erasing a MIL-on DTC. In addition to those proposed requirements discussed in section II.A.2, we are proposing that, if freeze frame conditions are stored for a malfunction other than a misfire malfunction when a DTC is stored, the previously stored freeze frame information shall be replaced with freeze frame information regarding the misfire malfunction (i.e., the misfire's freeze frame information should take precedence over freeze frames for other malfunctions). Further, we are proposing that, upon detection of misfire, the OBD system store the following engine conditions: engine speed, load, and warm up status of the first misfire event that resulted in the storage of the pending DTC.

Lastly, we are proposing that the MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without an exceedance of the specified percentage of misfire.

3. Exhaust Gas Recirculation (EGR) Monitoring

a. Background

EGR works to reduce NO_X emissions the same way in gasoline engines as described earlier for diesel engines. First, the recirculated exhaust gases dilute the intake air—i.e., oxygen in the fresh air is displaced with relatively non-reactive exhaust gases—which, in turn, results in less oxygen to form NO_X. Second, EGR absorbs heat from the combustion process which reduces combustion chamber temperatures which, in turn, reduces NO_X formation. The amount of heat absorbed from the combustion process is a function of EGR flow rate and recirculated gas temperature, both of which are controlled to minimize NO_X emissions. EGR systems can involve many components to ensure accurate control of EGR flow, including valves, valve position sensors, and actuators.

b. EGR System Monitoring Requirements

We are proposing that the OBD system monitor the EGR system on engines so equipped for low and high flow rate 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 section II.D.4.

i. EGR Low Flow Malfunctions

We are proposing that the OBD system detect a malfunction 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 II.C–1. 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 would have to detect a malfunction when the system has reached its control limits such that it cannot increase EGR flow to achieve the commanded flow rate.

ii. EGR High Flow Malfunctions

We are proposing that the OBD system 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 II.C–1. 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 would have to 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 System Monitoring Conditions

We are proposing that manufacturers define the monitoring conditions for EGR system malfunctions such that the minimum performance ratio requirements discussed in section II.E would be met. For purposes of tracking and reporting as required in section II.E, all monitors used to detect EGR low flow and high flow malfunctions must be tracked separately but reported as a single set of values as specified in section II.E.[37]

Manufacturers may temporarily disable the EGR system monitor under conditions when monitoring may not be reliable (e.g., when freezing may affect performance of the system). Such temporary disablement would be allowed provided the manufacturer has submitted data and/or an engineering evaluation that demonstrate that the EGR monitor cannot be done reliably when these specific conditions exist.

d. EGR System MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2.

4. Cold Start Emission Reduction Strategy Monitoring

a. Background

The largest portion of exhaust emissions from gasoline engines is generated during the brief period following startup before the engine and catalyst have warmed up to their normal operating temperatures. To meet increasingly stringent emissions standards, manufacturers are developing hardware and associated control strategies to reduce these ''cold start'' emissions. Most efforts center on reducing catalyst warm-up time.

A cold catalyst is heated mainly by two mechanisms: heat transferred from the exhaust gases to the catalyst; and, heat generated in the catalyst as a result of the exothermic catalytic reactions. Most manufacturers use substantial spark retard and/or increased idle speed following a cold engine start, both of which maximize the heat available in the exhaust gases which, in turn, increases the heat transfer to the catalyst. Vehicle drivability and engine idle quality concerns tend to limit the amount of spark retard and/or increased idle speed that a manufacturer can use to accelerate catalyst warm up. These strategies or, more correctly, the systems used to employ these strategies—the ignition system for spark retard and the idle control system for control of engine speed—are normally monitored only after engine warm-up. Therefore, any malfunctions that might occur during the cold start event may not be detected by the OBD system. This could have significant emissions consequences due to the unknown loss of emissions control during the time following engine startup.

This concern is exacerbated by the high cost of precious metals—the platinum group metals (PGM) platinum, palladium, and rhodium—which motivates industry to minimize their use in catalysts. To compensate for the resultant reduction in overall catalyst performance, manufacturers will likely use increasingly more aggressive cold start emission reduction strategies in an attempt to further reduce cold start emissions. These strategies must be successful—and be properly monitored—to meet the more stringent 2008 emissions standards and to maintain low emissions in-use.

b. Cold Start Emission Reduction Strategy Monitoring Requirements

We are proposing that, if an engine incorporates an engine control strategy specifically to reduce cold start emissions, the OBD system must monitor the key components (e.g., idle air control valve), other than the secondary air system, while the control strategy is active to ensure that the control strategy is operating properly. Secondary air systems would have to be monitored separately as discussed in section II.C.5.

The OBD system would be required to detect a malfunction prior to any failure or deterioration of the individual components associated with the cold start emissions reduction control strategy that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table II.C–1. For components where no failure or deterioration of the component used by the cold start emission reduction strategy could result in an engine's emissions exceeding the applicable emissions thresholds, the individual components would have to be monitored for proper functional response as described in section II.D.4 while the control strategy is active.

Manufacturers would be required to establish the appropriate malfunction criteria based on data from one or more representative engine(s). Further, manufacturers would be required to provide an engineering evaluation for establishing the malfunction criteria for the remainder of the manufacturer's product line. An annual evaluation of these criteria by the Administrator may not be necessary provided the manufacturer can demonstrate that any technological changes from one year to the next do not affect the previously approved malfunction criteria.

c. Cold Start Emission Reduction Strategy Monitoring Conditions

We are proposing that manufacturers define the monitoring conditions for

[37] For specific components or systems that have multiple monitors that are required to be reported (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 shall be reported for the specific component.

malfunctions of the cold start emissions reduction strategy such that the minimum performance ratio requirements discussed in section II.E would be met.

d. Cold Start Emission Reduction Strategy MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2.

5. Secondary Air System Monitoring

a. Background

Secondary air systems—expected to be used on gasoline engines only—are used to reduce cold start emissions of hydrocarbons and carbon monoxide. Many of today's engines operate near stoichiometry after a cold engine start. However, the future more stringent emission standards may require the addition of a secondary air system in combination with a richer than stoichiometric cold start mixture. Such an approach could quickly warm up the catalyst for improved cold start emissions performance.

Secondary air systems typically consist of an electric air pump, various hoses, and check valves to deliver outside air to the exhaust system upstream of the catalytic converter(s). This system usually operates only after a cold engine start and usually for only a brief period of time. When the electric air pump is operating, fresh air is delivered into the exhaust where it mixes with and ignites any unburned fuel. This serves to warm up the catalyst far more rapidly than would otherwise occur. Any problems that might occur in the field—corroded check valves, damaged tubing and hoses, malfunctioning air switching valves—could cause cold start emissions performance to suffer. Therefore, monitoring is needed given the importance of a properly functioning secondary air system to emissions performance.

b. Secondary Air System Monitoring Requirements

We are proposing that the OBD system on engines equipped with any form of secondary air delivery system be required to monitor the proper functioning of the secondary air delivery system, including all air switching valve(s). The individual electronic components (e.g., actuators, valves, sensors) in the secondary air system would have to be monitored in accordance with the comprehensive component requirements discussed in section II.D.4.

i. Secondary Air System Low Flow Malfunctions

We are proposing that the OBD system detect a secondary air system malfunction prior to a decrease from the manufacturer's specified air flow during normal operation that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table II.C–1.[38] For engines in which no deterioration or failure of the secondary air system would result in an engine's emissions exceeding any of the applicable emissions thresholds, the OBD system would have to detect a malfunction when no detectable amount of air flow is delivered during normal operation of the secondary air system.

ii. Secondary Air System High Flow Malfunctions

We are proposing that the OBD system detect a secondary air system malfunction prior to an increase from the manufacturer's specified air flow during normal operation that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table II.C–1.[39] For engines in which no deterioration or failure of the secondary air system would result in an engine's emissions exceeding any of the applicable emissions thresholds, the OBD system would have to detect a malfunction when no detectable amount of air flow is delivered during normal operation of the secondary air system.

c. Secondary Air System Monitoring Conditions

We are proposing that manufacturers define the monitoring conditions for malfunctions of the secondary air system such that the minimum performance ratio requirements discussed in section II.E would be met. For purposes of tracking and reporting as required in section II.E, all monitors used to detect malfunctions of the secondary air system during its normal operation must be tracked separately but reported as a single set of values as specified in section II.E

d. Secondary Air System MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2.

6. Catalytic Converter Monitoring

a. Background

Three-way catalysts are one of the most important emission-control components on gasoline engines. They consist of ceramic or metal substrates coated with the one or more of the platinum group metals (PGM) platinum, palladium, and rhodium. These PGMs are dispersed within an alumina washcoat containing ceria, and the substrates are mounted in a stainless steel container in the vehicle exhaust system. Three-way catalysts are capable of oxidizing HC emissions, oxidizing CO emissions, and reducing NO_X emissions, hence the term three-way.

While continuous improvements to catalysts have increased their durability, their performance still deteriorates, especially when subjected to very high temperatures. Such high temperatures can be caused by, among other factors, engine misfire which results in unburned fuel and air entering and igniting in the catalyst. Exposure to such high temperatures will result in reduced catalyst conversion efficiency. Catalyst efficiency can also deteriorate via poisoning if exposed to lead, phosphorus, or high sulfur levels. Catalysts can also fail by mechanical means such as excessive vibration. Given its importance to emissions control and the many factors that can reduce its effectiveness, the catalyst is one of the most important components to be monitored.

b. Catalytic Converter Monitoring Requirements

We are proposing that the OBD system monitor the catalyst system for proper conversion capability. Specifically, the OBD system would be required to detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that any of the following occurs:

- NMHC and/or NO_X emissions exceed the emissions thresholds for the ''catalytic converter system'' as shown in Table II.C–1.

For purposes of determining the catalyst system malfunction criteria the manufacturer would be required to use a catalyst system deteriorated to the malfunction criteria using methods established by the manufacturer to

[38] For purposes of secondary air system malfunctions, ''air flow'' is defined as the air flow delivered by the secondary air system to the exhaust system. For engines using secondary air systems with multiple air flow paths/distribution points, the air flow to each bank (i.e., a group of cylinders that share a common exhaust manifold, catalyst, and control sensor) must be monitored in accordance with these malfunction criteria. Also, ''normal operation'' is defined as the condition where the secondary air system is activated during catalyst and/or engine warm-up following engine start. ''Normal operation'' does not include the condition where the secondary air system is intrusively turned on solely for the purpose of monitoring.

[39] *Ibid.*

represent real world catalyst deterioration under normal and malfunctioning operating conditions. The malfunction criteria must be established by using a catalyst system with all monitored and unmonitored catalysts simultaneously deteriorated to the malfunction criteria.[40] For engines using fuel shutoff to prevent over-fueling during misfire conditions (see section II.C.2), the malfunction criteria could be established using a catalyst system with all monitored catalysts simultaneously deteriorated to the malfunction criteria and all unmonitored catalysts deteriorated to the end of the engine's useful life.

c. Catalytic Converter Monitoring Conditions

We are proposing that manufacturers define the monitoring conditions for malfunctions of the catalytic converter system such that the minimum performance ratio requirements discussed in section II.E would be met. For purposes of tracking and reporting as required in section II.E, all monitors used to detect malfunctions of the catalytic converter system during its normal operation must be tracked separately but reported as a single set of values as specified in section II.E.

d. Catalytic Converter MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2. Note that the monitoring method for the catalyst(s) would have to be capable of detecting all instances, except diagnostic self-clearing, when a catalyst DTC has been cleared but the catalyst has not been replaced (e.g., catalyst over temperature histogram approaches are not acceptable).

7. Evaporative Emission Control System Monitoring

a. Background

The evaporative emission control system controls HC emissions that would otherwise evaporate from the vehicle's fuel tank and fuel lines. Should any leak develop in the evaporative emission control system—e.g., a disconnected hose—the HC emissions can be quite high and well over the evaporative emissions standards. Additionally, evaporative purge system defects—e.g., deteriorated vacuum lines, damaged canisters, non-functioning purge control valves—may occur which could also result in very high evaporative emissions.

b. Evaporative System Monitoring Requirements

We are proposing that the OBD system verify purge flow from the evaporative system and detect any vapor leaks from the complete evaporative system, excluding the tubing and connections between the purge valve and the intake manifold. Individual components of the evaporative system (e.g. valves, sensors) must be monitored in accordance with the comprehensive components requirements discussed in section II.D.4.

The OBD system would be required to detect an evaporative system malfunction when any of the following conditions exist:

- No purge flow from the evaporative system to the engine can be detected by the OBD system (i.e., the ''purge flow'' requirement); or
- For the 2010 and later model years, the complete evaporative system contains a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.150 inch diameter orifice (i.e., the ''system leak'' requirement).[41]

If the most reliable monitoring method available cannot reliably detect a system leak as specified above, a manufacturer may design their system to detect a larger leak. The manufacturer would be required to provide data and/or engineering analyses that demonstrate the inability of the monitor to reliably detect the required leak and their justification for detecting at their proposed orifice size. Further, if the manufacturer can demonstrate that leaks of the required size cannot cause evaporative or running loss emissions to exceed 1.5 times the applicable evaporative emissions standards, the Administrator would revise upward the required leak size to the size demonstrated by the manufacturer that would result in emissions exceeding 1.5 times the standards.

c. Evaporative System Monitoring Conditions

We are proposing that manufacturers define the monitoring conditions for both purge flow and system leak malfunctions such that the minimum performance ratio requirements discussed in section II.E would be met. For purposes of tracking and reporting as required in section II.E, all monitors used to detect system leak malfunctions must be tracked separately but reported as a single set of values as specified in section II.E.

Manufacturers may disable or abort an evaporative emission control system monitor when the fuel tank level is over 85 percent of nominal tank capacity or during a refueling event. Manufacturers may design their evaporative emission control system monitor such that it executes only during drive cycles determined by the manufacturer to be cold starts if such a condition is needed to ensure reliable monitoring. The manufacturer would have to provide data and/or an engineering evaluation demonstrating that a reliable check can only be made on drive cycles when the cold start criteria are satisfied. However, the manufacturer may not determine a cold start solely on the basis that ambient temperature is higher than engine coolant temperature at engine start. Lastly, manufacturers would be allowed to disable temporarily the evaporative purge system to perform an evaporative system leak check.

d. Evaporative System MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2, with an exception for leaks associated with the fuel filler cap. If the OBD system is capable of discerning that a system leak is being caused by a missing or improperly secured fuel filler cap, the manufacturer is not required to illuminate the MIL or store a DTC provided the vehicle is equipped with an alternative indicator for notifying the vehicle operator of the fuel filler cap ''malfunction.'' The alternative indicator would have to be of sufficient illumination and location to be readily visible to the vehicle operator under all lighting conditions. However, if the vehicle is not equipped with an alternative indicator and, instead, the MIL is illuminated to inform the operator of the ''malfunction,'' the MIL may be extinguished and the corresponding DTC(s) erased once the OBD system has verified that the fuel filler cap has been securely fastened and the MIL has not been commanded ON for any other type of malfunction. The Administrator may approve other strategies provided the manufacturer was able to demonstrate that the vehicle operator would be promptly notified of the missing or improperly secured fuel filler cap and that the notification would reasonably result in corrective action being undertaken.

[40] The unmonitored portion of the catalyst system would be that portion downstream of the sensor(s) used for catalyst monitoring.

[41] In their HDOBD regulation, 13 CCR 1971.1, CARB defines ''orifice'' as an O'Keefe Controls Co. precision metal ''Type B'' orifice with NPT connections with a diameter of the specified dimension (e.g., part number B–31–SS for a stainless steel 0.031 inch diameter orifice).

8. Exhaust Gas Sensor Monitoring

a. Background

Exhaust gas sensors (e.g., oxygen sensors, air-fuel ratio (A/F) sensors) are a critical element of the emissions control system on gasoline engines. In addition to maintaining a stoichiometric air-fuel mixture and, thus, helping to achieve the lowest possible emissions, these sensors are also used for enhancing the performance of several emission control technologies—e.g., catalysts, EGR systems). Many modern vehicles control the fuel supply with an oxygen sensor feedback system to maintain stoichiometry. Oxygen sensors are located typically in the exhaust system upstream and downstream of the catalytic converters. The front, or upstream, oxygen sensor is used generally for fuel control. The rear, or downstream, oxygen sensor is used generally for adjusting the front oxygen sensor signal as it drifts slightly with age related deterioration—often referred to as fuel trimming—and for onboard monitoring the catalyst system. Many vehicles use A/F sensors in lieu of the more conventional oxygen sensors since A/F sensors provide a precise reading of the actual air-fuel ratio.

We expect that heavy-duty gasoline manufacturers will use both of these types of sensors to optimize their emissions control strategies and to satisfy many of the proposed heavy-duty OBD monitoring requirements—fuel system monitoring, catalyst monitoring, EGR system monitoring. Since exhaust gas sensors can be a critical component of an engine's fuel and emissions control system, their proper performance needs to be assured to maintain low emissions. Thus, any malfunction that adversely affects the performance of any of these exhaust gas sensors should be detected by the OBD system.

b. Exhaust Gas Sensor Monitoring Requirements

We are proposing that the OBD system monitor the output signal, response rate, and any other parameter that could affect emissions of all primary (i.e., fuel control) exhaust gas sensors for malfunction. Both the lean to rich and rich to lean response rates must be monitored. In addition, we are proposing that the OBD system monitor all secondary exhaust gas sensors (i.e., those used for fuel trimming or as a monitoring device for another system) for proper output signal, activity, and response rate. For engines equipped with heated exhaust gas sensors, the OBD system would be required to monitor the sensor heater for proper performance.

i. Primary Exhaust Gas Sensors

We are proposing that the OBD system detect a malfunction prior to any failure or deterioration of the exhaust gas sensor output voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) (including drift or bias corrected for by secondary sensors) that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table II.C–1. The OBD system would also be required to detect the following exhaust gas sensor malfunctions:

- Those caused by either a lack of circuit continuity or out-of-range values.
- Those where a sensor failure or deterioration causes the fuel system to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).
- Those where the sensor output voltage, resistance, impedance, current, amplitude, activity, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst monitoring).

ii. Secondary Exhaust Gas Sensors

We are proposing that the OBD system detect a malfunction prior to any failure or deterioration of the exhaust gas sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table II.C–1. The OBD system would also be required to detect the following exhaust gas sensor malfunctions:

- Those caused by either a lack of circuit continuity or out-of-range values.
- Those where a sensor failure or deterioration causes the fuel system to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).
- Those where the sensor output voltage, resistance, impedance, current, amplitude, activity, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst monitoring).

iii. Exhaust Gas Sensor Heaters

We are proposing that the OBD system detect a malfunction of the sensor heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required by the component vendor for heater circuit performance at high mileage). The manufacturer may use other malfunction criteria for heater performance malfunctions. To do so, the manufacturer would be required to submit data and/or engineering analyses that demonstrate that the monitoring reliability and timeliness would be equivalent to the criteria stated here.

In addition, the OBD system would be required to detect malfunctions of the heater circuit including open or short circuits that conflict with the commanded state of the heater (e.g., shorted to 12 Volts when commanded to 0 Volts (ground)).

c. Exhaust Gas Sensor Monitoring Conditions

i. Primary Exhaust Gas Sensors

We are proposing that manufacturers define the monitoring conditions for primary exhaust gas sensor malfunctions causing exceedance of the applicable thresholds and/or inability to perform as an OBD monitoring device such that the minimum performance ratio requirements discussed in section II.E would be met. For purposes of tracking and reporting as required in section II.E, all such monitors must be tracked separately but reported as a single set of values as specified in section II.E.

Monitoring for primary exhaust gas sensor malfunctions related to circuit continuity, out-of-range, and open-loop operation must be done continuously with the exception that manufacturers may disable continuous exhaust gas sensor monitoring when an exhaust gas sensor malfunction cannot be distinguished from other effects. As an example, a manufacturer may disable monitoring for out-of-range on the low side during conditions where fuel has been cut (i.e., shut off temporarily). To do so, the manufacturer would have to submit data and/or engineering analyses that demonstrate that a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding a false detection.

ii. Secondary Exhaust Gas Sensors

We are proposing that manufacturers define the monitoring conditions for secondary exhaust gas sensor malfunctions causing exceedance of the applicable emissions thresholds, lack of circuit continuity, and/or inability to perform as an OBD monitoring device such that the minimum performance ratio requirements discussed in section II.E would be met.

Monitoring for secondary exhaust gas sensor malfunctions related to out-of-range and open loop operation must be done continuously with the exception that manufacturers may disable continuous exhaust gas sensor monitoring when an exhaust gas sensor malfunction cannot be distinguished from other effects. As an example, a manufacturer may disable monitoring for out-of-range on the low side during conditions where fuel has been cut (i.e., shut off temporarily). To do so, the manufacturer would have to submit data and/or engineering analyses that demonstrate that a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding a false detection.

iii. Sensor Heaters

We are proposing that manufacturers define monitoring conditions for sensor heater performance malfunctions such that the minimum performance ratio requirements discussed in section II.E would be met. Monitoring for sensor heater circuit malfunctions must be done continuously.

d. Exhaust Gas Sensor MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2.

D. Monitoring Requirements and Timelines for Other Diesel and Gasoline Systems

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

a. Background

Variable valve timing (VVT) and/or control systems are used primarily to optimize engine performance and have many advantages over conventional valve control. Instead of opening and closing the valves by fixed amounts and at fixed times, VVT controls can vary the timing of valve opening/closing and vary the effective size of the valve opening itself (in some systems) depending on the driving conditions (e.g., high engine speed and load). This feature permits a better compromise between performance, driveability, and emissions than conventional systems. With more stringent NO_X emission standards being phased in, more vehicles are anticipated to use VVT. By doing so, some exhaust gas can be retained in the combustion chamber thereby reducing peak combustion temperatures and, hence, NO_X emissions (known as ''internal EGR'').

b. VVT and/or Control System Monitoring Requirements

We are proposing that the OBD system monitor the VVT system on engines so equipped for target error and slow response malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the VVT system must be monitored in accordance with the comprehensive components requirements in section II.D.4.

i. VVT Target Error Malfunctions

We are proposing that the OBD system detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a crank angle and/or lift tolerance that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table II.B–1 for diesel engines or Table II.C–1 for gasoline engines. For engines in which no failure or deterioration of the VVT system could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system would have to detect a malfunction of the VVT system when proper functional response of the system to computer commands does not occur.

ii. VVT Slow Response Malfunctions

We are proposing that the OBD system detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a manufacturer-specified time that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table II.B–1 for diesel engines or Table II.C–1 for gasoline engines. For engines in which no failure or deterioration of the VVT system could result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system would have to detect a malfunction of the VVT system when proper functional response of the system to computer commands does not occur.

c. VVT and/or Control System Monitoring Conditions

We are proposing that manufacturers define the monitoring conditions for VVT target error or slow response malfunctions such that the minimum performance ratio requirements discussed in section II.E would be met with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle rather than once per driving cycle as required for most monitors. For purposes of tracking and reporting as required in section II.E, all monitors used to detect all VVT related malfunctions would have to be tracked separately but reported as a single set of values as specified in section II.E.[42]

d. VVT and/or Control System MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2.

2. Engine Cooling System Monitoring

a. Background

We are concerned about two elements of the engine cooling system. These elements are the thermostat and the engine coolant temperature sensor. Manufacturers typically use a thermostat to control the flow of coolant through the radiator and around the engine. During a cold engine start, the thermostat is closed typically which prevents the flow of coolant and serves to promote more rapid warm-up of the engine. As the coolant approaches a specific temperature, the thermostat begins to open allowing circulation of coolant through the radiator and around the engine. The thermostat then acts to regulate the coolant to the specified temperature. If the temperature rises above the regulated temperature, the thermostat opens further to allow more coolant to circulate, thus reducing the temperature. If the temperature drops below the regulated temperature, the thermostat partially closes to reduce the amount of coolant circulating, thereby increasing the temperature. If a thermostat malfunctions in such a manner that it does not adequately restrict coolant flow during vehicle warm-up, an increase in emissions could occur due to prolonged operation of the vehicle at temperatures below the stabilized, warmed-up value. This is particularly true at lower ambient temperatures—50 degrees Fahrenheit and below—but not so low that they are rare in the U.S. Equally important is that the engine coolant temperature is often used as an enable criterion for many OBD monitors. If the engine's coolant temperature does not reach the

[42] For specific components or systems that have multiple monitors that are required to be reported (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 shall be reported for the specific component.

manufacturer-specified warmed-up value, such monitors would be effectively disabled, perhaps indefinitely, and would, therefore, never detect malfunctions.

Closely linked with the thermostat is the engine coolant temperature (ECT) sensor. Manufacturers typically use an ECT sensor as an input for many of the emission-related engine control systems. For gasoline engines, the ECT sensor is often one of the most important factors in determining when to begin closed-loop fuel control. If the engine coolant does not warm-up sufficiently, closed-loop fuel control is usually not engaged and the vehicle remains in open-loop fuel control. Since open-loop fuel control does not provide the precision of closed-loop control, the result is increased emissions levels. For diesel engines, the ECT sensor is often used to engage closed-loop control of the EGR system. Similar to closed-loop fuel control on gasoline engines, if the coolant temperature does not warm up, closed-loop control of the EGR system would not engage which would result in increased emissions levels. In addition, for both gasoline and diesel engines, the ECT sensor may be used to enable many of the monitors that are being proposed. Such monitors would be effectively disabled and incapable of detecting malfunctions should the ECT sensor itself malfunction.

b. Engine Cooling System Monitoring Requirements

We are proposing that the OBD system monitor the thermostat on engines so equipped for proper operation. We are also proposing that the OBD system monitor the ECT sensor for circuit continuity, out-of-range values, and rationality faults. For engines that use an approach other than the cooling system and ECT sensor—e.g., oil temperature, cylinder head temperature—for an indication of engine operating temperature for emission control purposes (e.g., to modify spark or fuel injection timing or quantity), the manufacturer may forego cooling system monitoring in favor of monitoring the components or systems used in their approach. To do so, the manufacturer would be required to submit data and/or engineering analyses that demonstrate that their monitoring plan is as reliable and effective as the monitoring required for the engine cooling system.

i. Thermostat Monitoring Requirements

We are proposing that the OBD system detect a thermostat malfunction if, within the manufacturer specified time interval following engine start, any of the following conditions occur:

- The coolant temperature does not reach the highest temperature required by the OBD system to enable other diagnostics;
- The coolant temperature does not reach a warmed-up temperature within 20 degrees Fahrenheit of the manufacturer's nominal thermostat regulating temperature. The manufacturer may use a lower temperature for this criterion provided the manufacturer can demonstrate that the fuel, spark timing, and/or other coolant temperature-based modification to the engine control strategies would not cause an emissions increase greater than or equal to 50 percent of any of the applicable emissions standards.

The time interval specified by the manufacturer would have to be supported by the manufacturer via data and/or engineering analyses demonstrating that it provides robust monitoring and minimizes the likelihood of other OBD monitors being disabled. The manufacturer may use alternative malfunction criteria that are a function of temperature at engine start on engines that do not reach the temperatures specified in the malfunction criteria when the thermostat is functioning properly. To do so, the manufacturer would be required to submit data and/or engineering analyses that demonstrate that a properly operating system does not reach the specified temperatures and that the possibility is minimized for cooling system malfunctions to go undetected and disable other OBD monitors. In some cases, a manufacturer may forgo thermostat monitoring if the manufacturer can demonstrate that a malfunctioning thermostat cannot cause a measurable increase in emissions during any reasonable driving condition nor cause any disablement of other OBD monitors.

ii. Engine Coolant Temperature Sensor Monitoring Requirements

We are proposing that the OBD system detect an ECT sensor malfunction when a lack of circuit continuity or an out-of-range value occurs. We are also proposing that the OBD system detect if, within the manufacturer specified time interval following engine start, the ECT sensor does not achieve the highest stabilized minimum temperature that is needed to initiate closed-loop/feedback control of all affected emission control systems (e.g., fuel system, EGR system). The manufacturer specified time interval would have to be a function of the engine coolant temperature and/or intake air temperature at startup. The manufacturer time interval would also have to be supported by the manufacturer via data and/or engineering analyses demonstrating that it provides robust monitoring and minimizes the likelihood of other OBD monitors being disabled. Manufacturers may forego the requirement to detect the ''time to closed loop/feedback enable temperature'' malfunction if the manufacturer does not use engine coolant temperature or the ECT sensor to enable closed-loop/feedback control of any emission control systems.

We are also proposing that, to the extent feasible when using all available information, the OBD system must detect a malfunction if the ECT sensor inappropriately indicates a temperature below the highest minimum enable temperature required by the OBD system to enable other monitors. For example, an OBD system that requires an engine coolant temperature greater than 140 degrees Fahrenheit prior to enabling an OBD monitor must detect malfunctions that cause the ECT sensor to indicate inappropriately a temperature below 140 degrees Fahrenheit. Manufacturers may forego such monitoring within temperature regions in which the thermostat monitor or the ECT sensor ''time to reach closed-loop/feedback enable temperature'' monitor would detect this ''stuck in a range below the highest minimum enable temperature'' ECT sensor malfunction.

Lastly, we are proposing that, to the extent feasible when using all available information, the OBD system must detect a malfunction if the ECT sensor inappropriately indicates a temperature above the lowest maximum enable temperature required by the OBD system to enable other monitors. For example, an OBD system that requires an engine coolant temperature less than 90 degrees Fahrenheit at startup prior to enabling an OBD monitor must detect malfunctions that cause the ECT sensor to indicate inappropriately a temperature above 90 degrees Fahrenheit. Manufacturers may forego such monitoring within temperature regions in which the thermostat monitor, the ECT sensor ''time to reach closed-loop/feedback enable temperature'' monitor, or the ECT sensor ''stuck in a range below the highest minimum enable temperature'' monitor would detect this ECT sensor ''stuck in a range above the lowest maximum enable temperature'' ECT sensor malfunction. The manufacturer may also forego such monitoring if the MIL would be illuminated for entering a ''limp home'' or default mode of operation—e.g., for an over temperature protection strategy—as discussed in section II.A.2. Manufacturers may also forego this monitoring within temperature regions where the temperature gauge indicates a temperature in the engine overheating ''red zone'' should the vehicle have a temperature gauge on the instrument panel that displays the same temperature information as used by the OBD system (note that a temperature gauge would be required, not a temperature warning light).

c. Engine Cooling System Monitoring Conditions

i. Thermostat Monitoring Conditions

We are proposing that manufacturers define the monitoring conditions for thermostat malfunctions in accordance with the general monitoring conditions for all engines described in section II.A.3. Additionally, monitoring for thermostat malfunctions would have to be done once per drive cycle on every drive cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria in section II.D.2.b.i. Manufacturers would be allowed to disable thermostat monitoring at ambient engine start temperatures below 20 degrees Fahrenheit. Manufacturers may suspend or disable thermostat monitoring if the engine is subjected to conditions that could lead to false diagnosis (e.g., engine operation at idle for more than 50 percent of the warm-up time and/or hot restart conditions). To do so, the manufacturer must submit data and/or engineering analyses that demonstrate that the suspension or disablement is necessary. In general, the manufacturer would not be allowed to suspend or disable the thermostat monitor on engine starts where the engine coolant temperature at engine start is more than 35 degrees Fahrenheit lower than the thermostat malfunction threshold temperature.

ii. Engine Coolant Temperature Sensor Monitoring Conditions

We are proposing that monitoring for ECT sensor circuit continuity and out-of-range malfunctions be done continuously. Manufacturers would be allowed to disable continuous ECT sensor monitoring when an ECT sensor malfunction cannot be distinguished from other effects. To do so, the manufacturer would have to submit test data and/or engineering evaluation that demonstrate that a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

We are also proposing that manufacturers define the monitoring conditions for ''time to reach closed-loop/feedback enable temperature'' malfunctions in accordance with the general monitoring conditions for all engines described in section II.A.3. Additionally, monitoring for ''time to reach closed-loop/feedback enable temperature'' malfunctions would have to be conducted once per drive cycle on every drive cycle in which the ECT sensor at engine start indicates a temperature lower than the closed-loop enable temperature (i.e., all engine start temperatures greater than the ECT sensor out-of-range low temperature and less than the closed-loop enable temperature). Manufacturers would be allowed to suspend or delay the ''time to reach closed-loop/feedback enable temperature'' monitor if the engine is subjected to conditions that could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 to 75 percent of the warm-up time).

We are also proposing that manufacturers define the monitoring conditions for ECT sensor ''stuck in a range below the highest minimum enable temperature'' and ''stuck in a range above the lowest maximum enable temperature'' malfunctions in accordance with the general monitoring conditions for all engines described in section II.A.3 and in accordance with the minimum performance ratio requirements discussed in section II.E.

d. Engine Cooling System MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2.

3. Crankcase Ventilation System Monitoring

a. Background

Crankcase emissions are the pollutants emitted in the gases that are vented from an engine's crankcase. These gases are also referred to as ''blowby gases'' because they result from engine exhaust from the combustion chamber ''blowing by'' the piston rings into the crankcase. These gases are vented to prevent high pressures from occurring in the crankcase. Our emission standards have historically prohibited crankcase emissions from all highway engines except turbocharged heavy-duty diesel engines. The most common way to eliminate crankcase emissions has been to vent the blowby gases into the engine air intake system, so that the gases can be recombusted. We made the exception for turbocharged heavy-duty diesel engines in the past because of concerns about fouling that could occur by routing the diesel particulates (including engine oil) into the turbocharger and aftercooler. Newly developed closed crankcase filtration systems specifically designed for turbocharged heavy-duty diesel engines now allow the crankcase gases to be captured.

In general, the crankcase ventilation system consists of a fresh air inlet hose, a crankcase vapor outlet hose, and a crankcase ventilation valve to control the flow through the system. Fresh air is introduced to the crankcase via the inlet (typically a connection from the intake air cleaner assembly). On the opposite side of the crankcase, vapors are vented from the crankcase through the valve by way of the outlet hose and then to the intake manifold. On gasoline engines, the intake manifold provides the vacuum that is needed to accomplish the circulation while the engine is running.

For gasoline engines, the valve is used to regulate the amount of flow based on engine speed. During low engine load operation (e.g., idle), the valve is nearly closed allowing only a small portion of air to flow through the system. With open throttle conditions, the valve opens to allow more air into the system. At high engine load operation (i.e., hard accelerations), the valve begins to close again, limiting air flow to a small amount. For most systems, a mechanical valve is all that is necessary to adequately regulate crankcase ventilation system air flow. The crankcase ventilation system on diesel engines, while slightly different than that for gasoline engines, has essentially the same purpose and function.

We do not believe that failures involving cracked or deteriorated hoses have a significant impact on crankcase emissions because vapors are drawn into the engine by intake manifold vacuum which suggests that fresh air would be drawn into the cracked hose rather than dirty exhaust being blown out of the cracked hose. The more likely cause of crankcase ventilation system malfunctions and excess emissions is improper service or tampering of the system. Such failures include misrouted or disconnected hoses and missing valves. Of these failures, hose disconnections on the vapor vent side of the system and/or missing valves can cause harmful crankcase emissions to be vented directly to the atmosphere.

b. Crankcase Ventilation System Monitoring Requirements

We are proposing that the OBD system monitor the crankcase ventilation system on engines so equipped for system integrity. Engines not equipped with crankcase ventilation systems would be exempt from monitoring the crankcase ventilation system.

Specifically for diesel engines, the manufacturer would be required to submit a plan for the monitoring strategy, malfunction criteria, and monitoring conditions prior to OBD certification. The plan would have to demonstrate the effectiveness of the strategy to monitor the performance of the crankcase ventilation system to the extent feasible with respect to the malfunction criteria below and the monitoring conditions required by the monitor.

We are proposing that the OBD system detect a malfunction of the crankcase ventilation system when a disconnection of the system occurs between either the crankcase and the crankcase ventilation valve, or between the crankcase ventilation valve and the intake manifold. Manufacturers may forego detecting a disconnection between the crankcase and the crankcase ventilation valve provided the manufacturer can demonstrate that the crankcase ventilation system is designed such that the crankcase ventilation valve is fastened directly to the crankcase in a manner that makes it significantly more difficult to remove the valve from the crankcase than to disconnect the line between the valve and the intake manifold (aging effects must be taken into consideration). Manufacturers may also forego detecting a disconnection between the crankcase and the crankcase ventilation valve for system designs that use tubing between the valve and the crankcase provided the manufacturer can demonstrate that the connections between the valve and the crankcase are: (1) Resistant to deterioration or accidental disconnection; (2) significantly more difficult to disconnect than the line between the valve and the intake manifold; and, (3) not subject to disconnection per the manufacturer's repair procedures for non-crankcase ventilation system repair work. Lastly, manufacturers may forego detecting a disconnection between the crankcase ventilation valve and the intake manifold upon determining that the disconnection: (1) Causes the vehicle to stall immediately during idle operation; or, (2) is unlikely to occur due to a crankcase ventilation system design that is integral to the induction system (e.g., machined passages rather than tubing or hoses).

c. Crankcase Ventilation System Monitoring Conditions

We are proposing that manufacturers define the monitoring conditions for crankcase ventilation system malfunctions in accordance with the general monitoring conditions for all engines described in section II.A.3, and the minimum performance ratio requirements discussed in section II.E.

d. Crankcase Ventilation System MIL Illumination and DTC Storage

We are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2. The stored DTC need not specifically identify the crankcase ventilation system (e.g., a DTC for idle speed control or fuel system monitoring can be stored) if the manufacturer can demonstrate that additional monitoring hardware would be necessary to make this identification, and provided the manufacturer's diagnostic and repair procedures for the detected malfunction include directions to check the integrity of the crankcase ventilation system.

4. Comprehensive Component Monitors

a. Background

Comprehensive components is a term meant to capture essentially every other emissions related component not discussed above. Specifically, it covers all other electronic engine components or systems not mentioned above that either can affect vehicle emissions or are used as part of the OBD diagnostic strategy for another monitored component or system. Comprehensive components are generally identified as input components—i.e., those that provide input directly or indirectly to the onboard computer—or as output components and/or systems—i.e., those that receive commands from the onboard computer. Typical examples of input components include temperature sensors and pressure sensors, while examples of output components and/or systems include the idle control system, glow plugs, and wait-to-start lamps.

While a malfunctioning comprehensive component may not have as much impact on emissions as a malfunctioning major emissions-related component, it still could result in a measurable increase in emissions. The proper performance of these components can be critical to both the proper functioning of major emissions-related components, and to the accurate monitoring of those components or systems. Malfunctions of comprehensive components that go undetected by the OBD system may disable or adversely affect the robustness of other OBD monitors without any awareness by the operator that a problem exists. Due to the vital role these components play, monitoring them properly is extremely important.

b. Comprehensive Component Monitoring Requirements

We are proposing that the OBD system monitor for malfunction any electronic engine components/systems not otherwise described in sections above that either provides input to (directly or indirectly) or receives commands from the onboard computer(s), and: (1) Can affect emissions during any reasonable in-use driving condition; or, (2) is used as part of the diagnostic strategy for any other monitored system or component.[43]

Input components required to be monitored may include the crank angle sensor, knock sensor, throttle position sensor, cam position sensor, intake air temperature sensor, boost pressure sensor, manifold pressure sensor, mass air flow sensor, exhaust temperature sensor, exhaust pressure sensor, fuel pressure sensor, and fuel composition sensor (e.g., flexible fuel vehicles). Output components/systems required to be monitored may include the idle speed control system, glow plug system, variable length intake manifold runner systems, supercharger or turbocharger electronic components, heated fuel preparation systems, the wait-to-start lamp on diesel applications, and the MIL. The manufacturer would be responsible for determining which input and output components/systems could affect emissions during any reasonable in-use driving condition. The manufacturer would be allowed to make this determination based on data or engineering judgment. However, if the Administrator reasonably believes that a manufacturer has incorrectly determined that a component/system cannot affect emissions, the manufacturer may be required to provide emissions data showing that the component/system, when malfunctioning and installed in a suitable test engine, does not have an emissions effect. Such emissions data may be requested for any reasonable driving condition.

[43] When referring to "comprehensive components" and their monitors, "electronic engine components/systems" is not meant to include components/systems that are driven by the engine yet are not related to the control of the fueling, air handling, or emissions of the engine (e.g., PTO components, air conditioning system components, and power steering components are not included).

i. Input Components

We are proposing that the OBD system detect malfunctions of input components caused by a lack of circuit continuity, out-of-range values, and, where feasible, improper rationality. To the extent feasible, the rationality diagnostics should verify that a sensor's input to the onboard computer is neither inappropriately high nor inappropriately low (i.e., ''two-sided'' diagnostics should be used). Also to the extent feasible, the OBD system should detect and store different DTCs that distinguish rationality malfunctions from lack of circuit continuity malfunctions and out-of-range values. For lack of circuit continuity malfunctions and out-of-range values, the OBD system should detect and store different DTCs for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit). The OBD system is not required to store separate DTCs for lack of circuit continuity malfunctions that cannot be distinguished from malfunctions associated with out-of-range values.

For input components that are used to activate alternative strategies that can affect emissions (e.g., AECDs, engine shutdown systems), the OBD system would be required to detect rationality malfunctions that cause the system to erroneously activate or deactivate the alternative strategy. To the extent feasible when using all available information, the rationality diagnostics should detect a malfunction if the input component inappropriately indicates a value that activates or deactivates the alternative strategy. For example, if an alternative strategy requires an intake air temperature greater than 120 degrees Fahrenheit prior to activating, the OBD system should detect malfunctions that cause the intake air temperature sensor to inappropriately indicate a temperature above 120 degrees Fahrenheit.

For engines that require precise alignment between the camshaft and the crankshaft, the OBD system would be required to monitor the crankshaft position sensor(s) and camshaft position sensor(s) to verify proper alignment between the camshaft and crankshaft. The OBD system would also have to monitor the sensors for circuit continuity and rationality malfunctions. Such monitoring for proper alignment between a camshaft and a crankshaft would only be required in cases where both are equipped with position sensors.

For engines equipped with VVT systems and a timing belt or chain, the OBD system must detect a malfunction if the alignment between the camshaft and crankshaft is off by one or more cam/crank sprocket cogs (e.g., the timing belt/chain has slipped by one or more teeth/cogs). If a manufacturer demonstrates that a single tooth/cog misalignment cannot cause a measurable increase in emissions during any reasonable driving condition, the OBD system would be required to detect a malfunction when the minimum number of teeth/cogs misalignment needed to cause a measurable emission increase has occurred.

ii. Output Components/Systems

We are proposing that the OBD system detect a malfunction of an output component/system when proper functional response of the component/system to computer commands does not occur. If a functional check is not feasible, the OBD system would be required to detect malfunctions caused by a lack of circuit continuity (e.g., short to ground or high voltage). For output component malfunctions associated with the lack of circuit continuity, the OBD system is not required to store different DTCs for each distinct malfunction (e.g., open circuit, shorted low). Further, manufacturers would not be required to activate an output component/system when it would not normally be active for the exclusive purpose of performing functional monitoring of output components/systems.

Additionally, the idle control system would have to be monitored for proper functional response to computer commands. For gasoline engines that use monitoring strategies based on deviation from target idle speed, a malfunction would have to be detected when either of the following conditions occur: (a) The idle speed control system cannot achieve the target idle speed within 200 revolutions per minute (rpm) above the target speed or 100 rpm below the target speed—the OBD system could use larger engine speed tolerances provided the manufacturer is able to demonstrate via data and/or engineering analyses that the tolerances can be exceeded without a malfunction being present; or, (b) the idle speed control system cannot achieve the target idle speed within the smallest engine speed tolerance range required by the OBD system to enable any other OBD monitors. For diesel engines, a malfunction would have to be detected when either of the following conditions occur: (a) The idle fuel control system cannot achieve the target idle speed or fuel injection quantity within +/−50 percent of the manufacturer-specified fuel quantity and engine speed tolerances; or, (b) the idle fuel control system cannot achieve the target idle speed or fueling quantity within the smallest engine speed or fueling quantity tolerance range required by the OBD system to enable any other OBD monitors.

Glow plugs and intake air heater systems would also have to be monitored for proper functional response to computer commands and for malfunctions associated with circuit continuity. The glow plug and intake air heater circuit(s) would have to be monitored for proper current and voltage drop. The manufacturer may use other monitoring strategies by submitting data and/or engineering analyses that demonstrate that the strategy provides equally reliable and timely detection of malfunctions. In general, the OBD system would have to detect a malfunction when a single glow plug no longer operates within the manufacturer's specified limits for normal operation. If a manufacturer demonstrates that a single glow plug malfunction cannot cause a measurable increase in emissions during any reasonable driving condition, the OBD system must detect a malfunction for the minimum number of glow plugs needed to cause an emissions increase. Further, to the extent feasible without adding additional hardware for this purpose, the stored DTC must identify the specific malfunctioning glow plug(s).

Lastly, the wait-to-start lamp circuit and the MIL circuit would have to be monitored for malfunctions that cause either lamp to fail to illuminate when commanded on (e.g., burned out bulb).

c. Comprehensive Component Monitoring Conditions

i. Input Components

We are proposing that input components be monitored continuously for circuit continuity and for providing values within the proper range. For rationality monitoring, where applicable, manufacturers would define the monitoring conditions for detecting malfunctions in accordance with the general monitoring conditions for all engines described in section II.A.3 and the minimum performance ratio requirements described in section II.E except that rationality monitoring would have to occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in section II.A.3.

A manufacturer may disable continuous monitoring for circuit continuity, and for providing values within the proper range, when a malfunction cannot be distinguished from other effects. To do so, the manufacturer would have to submit data and/or engineering analyses that demonstrate that a properly functioning input component cannot be distinguished from a malfunctioning input component and that the disablement interval is limited only to that necessary for avoiding false detection.

ii. Output Components/Systems

We are proposing that output components/systems be monitored continuously for circuit continuity. For functional monitoring, manufacturers would define the monitoring conditions for detecting malfunctions in accordance with the general monitoring conditions for all engines described in section II.A.3 and the minimum performance ratio requirements described in section II.E.

For the idle control system, we are proposing that manufacturers define the monitoring conditions for functional monitoring in accordance with the general monitoring conditions for all engines described in section II.A.3 and the minimum performance ratio requirements described in section II.E except that functional monitoring would have to occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in section II.A.3.

A manufacturer may disable continuous monitoring for circuit continuity when a malfunction cannot be distinguished from other effects. To do so, the manufacturer would have to submit data and/or engineering analyses that demonstrate that a properly functioning output component cannot be distinguished from a malfunctioning output component and that the disablement interval is limited only to that necessary for avoiding false detection.

d. Comprehensive Component MIL Illumination and DTC Storage

With a couple of exceptions, we are proposing the general requirements for MIL illumination and DTC storage as discussed in section II.A.2. The exceptions to this being that MIL illumination would not be required in conjunction with storing a MIL-on DTC for any comprehensive component if: (a) The component or system, when malfunctioning, could not cause engine emissions to increase by 15 percent or more of the FTP standard during any reasonable driving condition; and, (b) the component or system is not used as part of the diagnostic strategy for any other monitored system or component. MIL illumination is also not required if a malfunction has been detected in the MIL circuit that prevents the MIL from illuminating (e.g., burned out bulb or light emitting diode (LED)). However, the electronic MIL status must be reported as ''commanded on'' and a MIL-on DTC would have to be stored.

5. Other Emissions Control System Monitoring

a. Background

As noted above, the primary purpose of OBD is to detect malfunctions in the engine and/or emissions control system. Therefore, we are proposing that manufacturers be required to submit to the Administrator a monitoring plan for any new engine and/or emissions control technology not otherwise described above. Such technology might include hydrocarbon traps or homogeneous charge compression ignition (HCCI) systems. This would allow manufacturers and EPA to evaluate the new technology and determine an appropriate level of monitoring that would be both technologically feasible and consistent with the monitoring requirements for the other emissions control devices described above.

As proposed, the Administrator would provide guidance as to what type of components would fall under the ''other emissions control system'' requirements and which would fall under the comprehensive component requirements. Specifically, we are concerned that uncertainty may arise for those emission control components or systems that also meet the definition of electronic engine components. As such, the proposal would delineate the two by requiring components/systems that fit both definitions but are not corrected or compensated for by the adaptive fuel control system to be monitored as ''other emissions control devices'' rather than as comprehensive components. A typical device that would fall under this category instead of the comprehensive components category because of this delineation would be a swirl control valve system. Such delineation is necessary because such emissions control components generally require more thorough monitoring than comprehensive components to ensure low emissions levels throughout an engine's life. Further, emissions control components that are not compensated for by the fuel control system as they age or deteriorate can have a larger impact on tailpipe emissions than is typical of comprehensive components that are corrected for by the fuel control system as they deteriorate.

Note that the Administrator does not foresee any outcome where a promising new emissions control technology would be prohibited based solely on the lack of an OBD monitoring strategy for it. Instead, we want to instill in manufacturers the need to consider OBD monitoring when developing any new emissions control technology. Further, we want to instill in manufacturers the sense that an OBD monitoring strategy will, one day, be necessary so a plan for such should exist prior to introducing the technology on new products.

b. Other Emissions Control System Monitoring Requirements/Conditions

We are proposing that, for other emission control systems that are: (1) Not identified or addressed in sections II.B through II.D.4—e.g., hydrocarbon traps, HCCI control systems; or, (2) identified or addressed in section II.D.4 but not corrected or compensated for by an adaptive control system—e.g., swirl control valves, manufacturers would be required to submit a plan for Administrator approval of the monitoring strategy, the malfunction criteria, and the monitoring conditions prior to introduction on a production engine. Administrator approval of the plan would be based on the effectiveness of the monitoring strategy, the robustness of the malfunction criteria, and the frequency of meeting the necessary monitoring conditions.

We are also proposing that, for engines that use emissions control systems that alter intake air flow or cylinder charge characteristics by actuating valve(s), flap(s), etc., in the intake air delivery system (e.g., swirl control valve systems), the manufacturers, in addition to meeting the requirements above, may elect to have the OBD system monitor the shaft to which all valves in one intake bank are physically attached rather than monitoring the intake air flow, cylinder charge, or individual valve(s)/flap(s) for proper functional response. For non-metal shafts or segmented shafts, the monitor must verify all shaft segments for proper functional response (e.g., by verifying the segment or portion of the shaft furthest from the actuator functions properly). For systems that have more than one shaft to operate valves in multiple intake banks, manufacturers are not required to add more than one set of detection hardware (e.g., sensor, switch) per intake bank to meet this requirement.

6. Exceptions to Monitoring Requirements

a. Background

Under some conditions, the reliability of specific monitors may be diminished significantly. Therefore, we are proposing to allow manufacturers to disable the affected monitors when these conditions are encountered in-use. These include situations of extreme conditions (e.g., very low ambient temperatures, high altitudes) and of periods where default modes of operation are active (e.g., when a tire pressure problem is detected). In some of these cases, we may allow manufacturers to revise the emission malfunction threshold to ensure the most reliable monitoring performance.

b. Requirements for Exceptions to Monitoring

The Administrator may revise the emission threshold for any monitor, or revise the PM filtering performance malfunction criteria for DPFs to exclude detection of specific failure modes such as partially melted substrates, if the most reliable monitoring method developed requires a higher threshold or, in the case of PM filtering performance, the exclusion of specific failure modes, to prevent significant errors of commission in detecting a malfunction. The Administrator would notify the industry of any such revisions to ensure that all manufacturers would be able to implement OBD on an equal basis. In other words, we would not allow one manufacturer to revise a specific monitoring threshold upwards while insisting that another meet the proposed threshold.

Manufacturers may disable an OBD system monitor at ambient engine start temperatures below 20 degrees Fahrenheit (low ambient temperature conditions may be determined based on intake air or engine coolant temperature at engine start) or at elevations higher than 8000 feet above sea level. To do so, the manufacturer would have to submit data and/or engineering analyses that demonstrate that monitoring would be unreliable during the disable conditions. A manufacturer may request that an OBD system monitor be disabled at other ambient engine start temperatures by submitting data and/or engineering analyses demonstrating that misdiagnosis would occur at the given ambient temperatures due to their effect on the component itself (e.g., component freezing).

Manufacturers may disable an OBD system monitor when the fuel level is 15 percent or less of the nominal fuel tank capacity for those monitors that can be affected by low fuel level or running out of fuel (e.g., misfire detection). To do so, the manufacturer would have to submit data and/or engineering analyses that demonstrate that both monitoring at the given fuel levels would be unreliable, and the OBD system is still able to detect a malfunction if the component(s) used to determine fuel level indicates erroneously a fuel level that causes the disablement.

Manufacturers may disable OBD monitors that can be affected by vehicle battery or system voltage levels. For an OBD monitor affected by low vehicle battery or system voltages, manufacturers may disable monitoring when the battery or system voltage is below 11.0 Volts. Manufacturers may use a voltage threshold higher than 11.0 Volts to disable monitors but would have to submit data and/or engineering analyses that demonstrate that monitoring at those voltages would be unreliable and that either operation of a vehicle below the disablement criteria for extended periods of time is unlikely or the OBD system monitors the battery or system voltage and would detect a malfunction at the voltage used to disable other monitors.

For monitoring systems affected by high vehicle battery or system voltages, manufacturers may disable monitoring when the battery or system voltage exceeds a manufacturer-defined voltage. To do so, the manufacturer would have to submit data and/or engineering analyses that demonstrate that monitoring above the manufacturer-defined voltage would be unreliable and that either the electrical charging system/alternator warning light would be illuminated (or voltage gauge would be in the ‘‘red zone’’) or the OBD system monitors the battery or system voltage and would detect a malfunction at the voltage used to disable other monitors.

A manufacturer may also disable affected OBD monitors in vehicles designed to accommodate the installation of power take off (PTO) units provided disablement occurs only while the PTO unit is active and the OBD readiness status is cleared by the onboard computer (i.e., all monitors set to indicate ‘‘not complete’’) while the PTO unit is activated (see section II.F.4 below). If the disablement occurs, the readiness status may be restored, when the disablement ends, to its state prior to PTO activation.

E. A Standardized Method To Measure Real World Monitoring Performance

As was noted in section II.A.3, manufacturers determine the most appropriate times to run the non-continuous OBD monitors. This way, they are able to make their OBD evaluation either at the operating condition when an emissions control system is active and its operational status can best be evaluated, and/or at the operating condition when the most accurate evaluation can be made (e.g., highly transient conditions or extreme conditions can make evaluation difficult). Importantly, manufacturers are prohibited from using a monitoring strategy that is so restrictive such that it rarely or never runs. To help protect against monitors that rarely run, we are proposing an ‘‘in-use monitor performance ratio’’ requirement as described here.

The set of operating conditions that must be met so that an OBD monitor can run are called the ‘‘enable criteria’’ for that given monitor. These enable criteria are often different for different monitors and may well be different for different types of engines. A large diesel engine intended for use in a Class 8 truck would be expected to see long periods of relatively steady-state operation while a smaller engine intended for use in an urban delivery truck would be expected to see a lot of transient operation. Manufacturers will need to balance between a rather loose set of enable criteria for their engines and vehicles given the very broad range of operation HD highway engines see and a tight set of enable criteria given the desire for greater monitor accuracy. Manufacturers would be required to design these enable criteria so that the monitor:

- Is robust (i.e., accurate at making pass/fail decisions);
- Runs frequently in the real world; and,
- In general, also runs during the FTP heavy-duty transient cycle.

If designed incorrectly, these enable criteria may be either too broad and result in inaccurate monitors, or overly restrictive thereby preventing the monitor from executing frequently in the real world.

Since the primary purpose of an OBD system is to monitor for and detect emission-related malfunctions while the engine is operating in the real world, a standardized methodology for quantifying real world performance would be beneficial to both EPA and manufacturers. Generally, in determining whether a manufacturer’s monitoring conditions are sufficient, a manufacturer would discuss the proposed monitoring conditions with EPA staff. The finalized conditions would be included in the certification applications and submitted to EPA staff who would review the conditions and make determinations on a case-by-case basis based on the engineering judgment of the staff. In cases where we are concerned that the documented conditions may not be met during reasonable in-use driving conditions, we would most likely ask the manufacturer for data or other engineering analyses used by the manufacturer to determine that the conditions would occur in-use. In proposing a standardized methodology for quantifying real world performance, we believe this review process can be done more efficiently than would occur otherwise. Furthermore, it would serve to ensure that all manufacturers are held to the same standard for real world performance. Lastly, we want review procedures that will ensure that monitors operate properly and frequently in the field.

Therefore, we are proposing that all manufacturers be required to use a standardized method for determining real world monitoring performance and to hold manufacturers liable if monitoring occurs less frequently than a minimum acceptable level, expressed as minimum acceptable in-use performance ratio. We are also proposing that manufacturers be required to implement software in the onboard computer to track how often several of the major monitors (e.g., catalyst, EGR, CDPF, other diesel aftertreatment devices) execute during real world driving. The onboard computer would keep track of how many times each of these monitors has executed and how much the engine has been operated. By measuring both of these values, the ratio of monitor operation relative to engine operation can be calculated to determine monitoring frequency.

The proposed minimum acceptable frequency requirement would apply to many but not all of the OBD monitors. We are proposing that monitors be required to operate either continuously, once per drive cycle, or, in a few cases, multiple times per drive cycle (i.e., whenever the proper monitoring conditions are present). For components or systems that are more likely to experience intermittent failures or failures that can routinely happen in distinct portions of an engine's operating range (e.g., only at high engine speed and load, only when the engine is cold or hot), monitors would be required to operate continuously. Examples of continuous monitors include the fuel system monitor and most electrical/circuit continuity monitors. For components or systems that are less likely to experience intermittent failures or failures that only occur in specific vehicle operating regions or for components or systems where accurate monitoring can only be performed under limited operating conditions, monitors would be required to run once per drive cycle. Examples of once per drive cycle monitors typically include gasoline catalyst monitors, evaporative system leak detection monitors, and output comprehensive component functional monitors. For components or systems that are routinely used to perform functions that are crucial to maintaining low emissions but may still require monitoring under fairly limited conditions, monitors would be required to run each and every time the manufacturer-defined enable conditions are present. Examples of multiple times per drive cycle monitors typically include input comprehensive component rationality monitors and some exhaust aftertreatment monitors.

Monitors required to run continuously, by definition, would always be running, thereby making a minimum frequency requirement moot. The new frequency requirement would essentially apply only to those monitors that are designated as once per drive cycle or multiple times per drive cycle monitors. For all of these monitors, manufacturers would be required to define monitoring conditions that ensure adequate frequency in-use. Specifically, the monitors would need to run often enough so that the measured monitor frequency on in-use engines would exceed the minimum acceptable frequency. However, even though the minimum frequency requirement would apply to nearly all once per drive cycle and multiple times per drive cycle monitors, manufacturers would only be required to implement software to track and report the in-use frequency for a few of the major monitors. These few monitors generally represent the major emissions control components and the ones with the most limited enable criteria.

We believe that OBD monitors should run frequently to ensure early detection of emissions-related malfunctions and, consequently, to maintain low emissions. Allowing malfunctions to continue undetected and unrepaired for long periods of time allows emissions to increase unnecessarily. Frequent monitoring can also help to ensure detection of intermittent emissions-related malfunctions (i.e., those that are not continuously present but occur sporadically for days and even weeks at a time). The nature of mechanical and electrical systems is that intermittent malfunctions can and do occur. The less frequent the monitoring, the less likely these malfunctions will be detected and repaired. Additionally, for both intermittent and continuous malfunctions, earlier detection is equivalent to preventative maintenance in that the original malfunction can be detected and repaired prior to it causing subsequent damage to other components. This can help vehicle operators avoid more costly repairs that could have resulted had the first malfunction gone undetected.

Infrequent monitoring can also have an impact on the service and repair industry. Specifically, monitors that have unreasonable or overly restrictive enable conditions could hinder vehicle repair services. In general, upon completing an OBD-related repair to an engine, a technician will attempt to verify that the repair has indeed fixed the problem. Ideally, a technician will operate the vehicle in a manner that will exercise the appropriate OBD monitor and allow the OBD system to confirm that the malfunction is no longer present. This affords a technician the highest level of assurance that the repair was indeed successful. However, OBD monitors that operate infrequently are difficult to exercise and, therefore, technicians may not be able (or may not be likely) to perform such post-repair evaluations. Despite the service information availability requirements we are proposing—requirements that manufacturers make all of their service and repair information available to all technicians, including the information necessary to exercise OBD monitors—technicians would still find it difficult to exercise monitors that require infrequently encountered engine operating conditions (e.g., abnormally steady constant speed operation for an extended period of time). Additionally, to execute OBD monitors in an expeditious manner or to execute monitors that would require unusual or infrequently encountered conditions, technicians may be required to operate the vehicle in an unsafe manner (e.g., at freeway speeds on residential streets or during heavy traffic). If unsuccessful in executing these monitors, technicians may even take shortcuts in attempting to validate the repair while maintaining a reasonable cost for customers. These shortcuts would likely not be as thorough in verifying repairs and could increase the chance that improperly repaired engines would be returned to the vehicle owner or additional repairs would be performed just to ensure the problem is fixed. In the end, monitors that operate less frequently can result in unnecessary costs and inconvenience to both vehicle owners and technicians.

1. Description of Software Counters to Track Real World Performance

As stated above, manufacturers would be required to track monitor peformance by comparing the number of monitoring events (i.e., how often each monitor has run) to the number of driving events (i.e., how often has the vehicle been operated). The ratio of these two numbers would give an indication of how often the monitor is operating relative to vehicle operation. In equation form, this can be stated as:

$$\text{In-Use Performance (Ratio)} = \frac{\text{Number of Monitoring Events (Numerator)}}{\text{Number of Driving Events (Denominator)}}$$

To ensure that all manufacturers are tracking in-use performance in the same manner, we are proposing very detailed requirements for defining and incrementing both the numerator and denominator of this ratio. Manufacturers would be required to keep track of separate numerators and denominators for each of the major monitors, and to ensure that the data are saved every time the engine is shut off. The numerators and denominators would be reset to zero only in extreme circumstances when the non-volatile memory has been cleared (e.g., when the onboard computer has been reprogrammed in the field or when the onboard computer memory has been corrupted). The values would not be reset to zero during normal occurrences such as clearing of stored DTCs or performing routine service or maintenance.

Further, the numerator and denominator would be structured such that their maximum values would be 65,535 which is the maximum number that can be stored in a 2-byte location. This would ensure that manufacturers allocate sufficient and consistent memory space in the onboard computer. If either the numerator or denominator for a particular monitor reaches the maximum value, both values for that particular monitor would be divided by two before counting resumes. In general, the numerator and denominator would only be allowed to increment a maximum of once per drive cycle because most of the major monitors are designed to operate only once per drive cycle. Additionally, incrementing of both the numerator and denominator for a particular monitor would be disabled (i.e., paused but the stored values would not be erased or reset) only when a problem has been detected (i.e., a pending or MIL-on DTC has been stored) that prevents the monitor from executing. Once the problem is no longer detected and any stored DTCs associated with the problem have been erased, either through the allowable self-clearing process or upon command by a technician via a scan tool, incrementing of both the numerator and denominator would resume.

SAE has developed standards for storing and reporting the data to a generic scan tool. This would help ensure that all manufacturers report the data in an identical manner which should ease data collection in the field.

a. Number of Monitoring Events (''Numerator'')

For the numerator, manufacturers would be required to keep a separate numeric count of how often each of the particular monitors has operated. More specifically, manufacturers would have to implement a software counter that increments by one every time the particular monitor meets all of the enable/monitoring conditions for a long enough period of time such that a malfunctioning component would have been detected. For example, if a manufacturer requires a vehicle to be warmed-up and at idle for 20 seconds continuously to detect a malfunctioning catalyst, the catalyst monitor numerator could only be incremented if the vehicle actually operates simultaneously in all of those conditions. If the vehicle is operated in some but not all of the conditions (e.g., at idle but not warmed-up), the numerator would not be allowed to increment because the monitor would not have been able to detect a malfunctioning catalyst since all of the conditions were not satisfied simultaneously.

Another complication is the difference between a monitor reaching a ''pass'' or ''fail'' decision. At first glance, it would appear that a manufacturer should simply increment the numerator anytime the particular monitor reaches a decision, be it ''pass'' or ''fail''. However, monitoring strategies may have a different set of criteria that must be met to reach a ''pass'' decision versus a ''fail'' decision. As a simple example, a manufacturer may appropriately require only 10 seconds of operation at idle to reach a ''pass'' decision but require 30 seconds of operation at idle to reach a ''fail'' decision. Manufacturers would not be allowed to increment the numerator if the vehicle had idled for 10 seconds and reached a ''pass'' decision since insufficient time had passed to allow for a possible ''fail'' decision. This is necessary because the primary function of OBD systems is to detect malfunctions (i.e., to correctly reach ''fail'' decisions, not ''pass'' decisions) and, thus, the real world ability of the monitors to detect malfunctions is the parameter we want most to measure. Therefore, monitors with different criteria to reach a ''pass'' decision versus a ''fail'' decision would not be allowed to increment the numerator solely upon satisfying the ''pass'' criteria.

The correct implementation of the numerator counters by manufacturers is imperative to ensure a reliable measure for determining real world performance. ''Overcounting'' would falsely indicate the monitor is executing more often than it really is, while ''undercounting'' would make it appear as if the monitor is not running as often as it really is. Manufacturers would be required to describe their numerator incrementing strategy in their certification documentation and to verify the proper performance of their strategy during production vehicle evaluation testing.

b. Number of Driving Events (''Denominator'')

We are also proposing that manufacturers separately track how often the engine is operated. Basically, the denominator would be a counter that increments by one each time the engine is operated. We are proposing that the denominator counter be incremented by one only if several criteria are satisfied during a single drive cycle. This allows very short trips or trips during extreme conditions such as very cold temperatures or very high altitude to be filtered out and excluded from the count. This is appropriate because these are also conditions where most OBD monitors are neither expected nor required to operate.

Specifically, the denominator would be incremented if, on a single key start, the following criteria were satisfied while ambient temperature remained above 20 degrees Fahrenheit and altitude remained below 8,000 feet:

• Minimum engine run time of 10 minutes;

• Minimum of 5 minutes, cumulatively, of operation at vehicle speeds greater than 25 miles-per-hour for gasoline engines or calculated load greater than 15 percent for diesel engines; and

• At least one continuous idle for a minimum of 30 seconds encountered.

We intend to work with industry to collect data during the first few years of implementation and make any adjustments, if necessary, to the criteria used to increment the denominator to ensure that the in-use performance ratio provides a meaningful measure of in-use monitoring performance.

2. Proposed Performance Tracking Requirements

a. In-use Monitoring Performance Ratio Definition

For monitors required to meet the in-use performance tracking requirements,[44] we are proposing that the incrementing of numerators and denominators and the calculation of the in-use performance ratio be done in accordance with the following specifications.

The numerator(s) would be defined as a measure of the number of times a vehicle has been operated such that all monitoring conditions necessary for a specific monitor to detect a malfunction have been encountered. Except for systems using alternative statistical MIL illumination protocols, the numerator is to be incremented by an integer of one. The numerator(s) may not be incremented more than once per drive cycle. The numerator(s) for a specific monitor would be incremented within 10 seconds if and only if the following criteria are satisfied on a single drive cycle:

• Every monitoring condition necessary for the monitor of the specific component to detect a malfunction and store a pending DTC has been satisfied, including 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 component is passing may not, by itself, be sufficient to meet this criteria.

• 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 have completed must be satisfied.

• For monitors that require intrusive operation of components to detect a malfunction, a manufacturer would be required to request Administrator 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 would 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 as necessary for the intrusive event to occur.

• For the secondary air system monitor, the three criteria above 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 solely for the purpose of monitoring may not, by itself, be sufficient to meet these criteria.

The third bullet item above requires explanation. There may be monitors, and there have been monitors in light-duty, designed to use what could be termed a two stage or two step process. The first step is usually a passive and/or short evaluation that can be used to ''pass'' a properly working component where ''pass'' refers to evaluating the component and determining that it is not malfunctioning. The second step is usually an intrusive and/or longer evaluation that is necessary to ''fail'' a malfunctioning component or ''pass'' a component nearing the point of failure. An example of such an approach might be an evaporative leak detection monitor that uses an intrusive vacuum pull-down/bleed-up evaluation during highway cruise conditions. If the evaporative system is sealed tight, the monitor ''passes'' and is done with testing for the given drive cycle. If the monitor senses a leak close to the required detection limit, the monitor does not ''pass'' and an internal flag is stored that will trigger the second stage of the test during the next cold start when a more accurate evaluation can be conducted. On the next cold start, provided the internal flag is set, an intrusive vacuum pull-down/bleed up monitor might be conducted during engine idle a very short time after the cold start. This second evaluation stage, being at idle and cold, gives a more accurate indication of the evaporative system's integrity and provides for a more accurate decision regarding the presence and size of a leak.

In this example, the second stage of this monitor would run less frequently in real use than the first stage since it is activated only on those occasions where the first stage suggests that a leak may be present (which most cars will not have). The rate-based tracking requirements are meant to give a measure of how often a monitor could detect a malfunction. To know the right answer, we need to know how often the first stage is running and could ''fail'', thus triggering the second stage, and then how often the second stage is completing. If we track only the first stage, we would get a false indication of how often the monitor could really detect a leak. But, if we track only the second stage, most cars would never increment the counter since most cars do not have leaks and would not trigger stage two.

In considering this, we see two possible solutions: (1) Always activate the second stage evaluation in which case there would be an intrusive monitor being performed that does not really need to be performed; or, (2) implement a ''ghost'' monitor that pretends that the first stage evaluation triggers the second stage evaluation and then also looks for when the second stage evaluation could have completed had it been necessary. The third bullet item in the list above requires that, if a manufacturer intends to implement a two stage monitor and intends to implement such a ''ghost'' monitor as described here for rate based tracking, approval must be sought for doing so to make sure we agree that you are doing it correctly and properly.

For monitors that can generate results in a ''gray zone'' or ''non-detection zone'' (i.e., results that indicate neither a passing 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 manufacturer would be responsible for incrementing the numerator appropriately. In general, the numerator should not be incremented when the monitor indicates a result in the ''non-detection zone'' or prior to the monitor reaching a decision. When necessary, the Administrator would 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.''

[44] These monitors, as presented in section II.A.3, are, for diesel engines: the NMHC catalyst, the CDPF system, the NO_X adsorber system, the NO_X converting catalyst system, and the boost system; and, for gasoline engines: the catalyst, the evaporative system, and the secondary air system; and, for all engines, the exhaust gas sensors, the EGR system, and the VVT system.

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.

Manufacturers using alternative statistical MIL illumination protocols for any of the monitors that require a numerator would be 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 above for monitors using the standard MIL illumination protocol, and the overall equivalence of their incrementing approach in determining that the minimum acceptable in-use performance ratio has been satisfied.

Regarding the denominator(s), defined as a measure of the number of times a vehicle has been operated, we are proposing that it also be incremented by an integer of one. The denominator(s) may not be incremented more than once per drive cycle. The general denominator and the denominators for each monitor would be incremented within 10 seconds if and only if the following criteria are satisfied on a single drive cycle during which ambient temperature remained at or above 20 degrees Fahrenheit and altitude remained below 8,000 feet:

- Cumulative time since the start of the drive cycle is greater than or equal to 600 seconds (10 minutes);
- Cumulative gasoline engine operation at or above 25 miles per hour or diesel engine operation at or above 15 percent calculated load, either of which occurs for greater than or equal to 300 seconds (5 minutes); and
- Continuous engine 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.

In addition to the requirements above, the evaporative system monitor denominator(s) must be incremented if and only if:

- Cumulative time since the start of the drive cycle is greater than or equal to 600 seconds (10 minutes) while at an ambient temperature of greater than or equal to 40 degrees Fahrenheit but less than or equal to 95 degrees Fahrenheit; and
- Engine cold start occurs with engine coolant temperature at engine start greater than or equal to 40 degrees Fahrenheit but less than or equal to 95 degrees Fahrenheit and less than or equal to 12 degrees Fahrenheit higher than ambient temperature at engine start.

In addition to the requirements above, the denominator(s) for the following monitors must be incremented if and only if the component or strategy is commanded ''on'' for a time greater than or equal to 10 seconds:

- Gasoline secondary air system;
- Cold start emission reduction strategy;
- 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'' (section II.D.5) or comprehensive component output components (see section II.D.4).

For purposes of determining this commanded ''on'' time, the OBD system may not include time during intrusive operation of any of the components or strategies later in the same drive cycle solely for the purposes of monitoring.

In addition to the requirements above, the denominator(s) for the monitors of the following output components (except those operated only at engine start-up as outlined above) must be incremented if and only if the component is commanded to function (e.g., commanded ''on'', ''open'', ''closed'', ''locked'') two or more times during the drive cycle or for a time greater than or equal to 10 seconds, whichever occurs first:

- Variable valve timing and/or control system
- ''Other emission control systems''
- Comprehensive component (output component only, e.g., turbocharger waste-gates, variable length manifold runners)

For monitors of the following components, the manufacturer may use alternative or additional criteria to that set forth above for incrementing the denominator. To do so, the manufacturer would need to be able to demonstrate that the criteria would be equivalent to the criteria outlined above at measuring the frequency of monitor operation relative to the amount of engine operation:

- Engine cooling system input components (section II.D.2)
- ''Other emission control systems'' (section II.D.5)
- Comprehensive component input components that require extended monitoring evaluation (section II.D.4, e.g., stuck fuel level sensor rationality)

For monitors of the following components or other emission controls that experience infrequent regeneration events, the manufacturer may use alternative or additional criteria to that set forth above for incrementing the denominator. To do so, the manufacturer would need to demonstrate that the criteria would be equivalent to the criteria outlined above at measuring the frequency of monitor operation relative to the amount of engine operation:

- Oxidation catalysts
- Diesel particulate filters

For hybrid engine systems, engines that employ alternative engine start hardware or strategies (e.g., integrated starter and generators), or alternative fueled engines (e.g., dedicated, bi-fuel, or dual-fuel applications), the manufacturer may request Administrator approval to use alternative criteria to that set forth above for incrementing the denominator. In general, approval would not be given for alternative criteria that only employ engine shut off at or near idle/vehicle stationary conditions. Approval of the alternative criteria would be based on the equivalence of the alternative criteria at determining the amount of engine operation relative to the measure of conventional engine operation in accordance with the criteria above.

The numerators and denominators may need to be disabled at some times. To do this, within 10 seconds of a malfunction being detected (i.e., a pending, MIL-on, or active DTC being stored) that disables a monitor required to meet the performance tracking requirements,[45] the OBD system must disable further incrementing of the corresponding numerator and denominator for each monitor that is disabled. When the malfunction is no longer detected (e.g., the pending DTC is erased through self-clearing or through a scan tool command), incrementing of all corresponding numerators and denominators should resume within 10 seconds. Also, within 10 seconds of the start of a power takeoff unit (PTO) that disables a monitor required to meet the performance tracking requirements, the OBD system should disable further incrementing of the corresponding numerator and denominator for each monitor that is disabled. When the PTO operation ends, incrementing of all corresponding numerators and denominators should resume within 10 seconds. The OBD system must disable further incrementing of all numerators

[45] These monitors, as presented in section II.A.3, are, for diesel engines: the NMHC catalyst, the CDPF system, the NO_X adsorber system, the NO_X converting catalyst system, and the boost system; and, for gasoline engines: the catalyst, the evaporative system, and the secondary air system; and, for all engines, the exhaust gas sensors, the EGR system, and the VVT system.

and denominators within 10 seconds if a malfunction has been detected in any component used to determine if: vehicle speed/calculated load; ambient temperature; elevation; idle operation; engine cold start; or, time of operation has been satisfied, and the corresponding pending DTC has been stored. Incrementing of all numerators and denominators should resume within 10 seconds when the malfunction is no longer present (e.g., pending DTC erased through self-clearing or by a scan tool command).

The in-use performance monitoring ratio itself is defined as the numerator for the given monitor divided by the denominator for that monitor.

b. Standardized Tracking and Reporting of Monitor Performance

We are proposing that the OBD system separately report an in-use monitor performance numerator and denominator for each of the following components:

- 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 system, turbo boost control system, and the NO_X adsorber. The OBD system must also report a general denominator and an ignition cycle counter in the standardized format discussed below and in section II.F.5.
- For gasoline engines: catalyst bank 1, catalyst bank 2, oxygen sensor bank 1, oxygen 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 below and in section II.F.5.

The OBD system would be required to report a separate numerator for each of the components listed in the above bullet lists. For specific components or systems that have multiple monitors that are required to be reported under section II.B—e.g., exhaust gas sensor bank 1 may have multiple monitors for sensor response or other sensor characteristics—the OBD system should 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 should be reported for the specific component. The numerator(s) must be reported in accordance with the specifications in section II.F.5.

The OBD system would also be required to report a separate denominator for each of the components listed in the above bullet lists. The denominator(s) must be reported in accordance with the specifications in section II.F.5.

Similarly, for the in-use performance ratio, determining which corresponding numerator and denominator to report as required for specific components or systems that have multiple monitors that are required to be reported—e.g., exhaust gas sensor bank 1 may have multiple monitors for sensor response or other sensor characteristics'the ratio should be calculated in accordance with the specifications in section II.F.5.

The ignition cycle counter is defined as a counter that indicates the number of ignition cycles a vehicle has experienced. The ignition cycle counter must also be reported in accordance with the specifications in section II.F.5. The ignition cycle counter, when incremented, should be incremented by an integer of one. The ignition cycle counter may not be incremented more than once per ignition cycle. The ignition cycle counter should 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 vehicles equipped with an automatic transmission) for at least two seconds plus or minus one second. The OBD system should disable further incrementing of the ignition cycle counter within 10 seconds if a malfunction has been detected in any component used to determine if engine speed or time of operation has been satisfied and the corresponding pending DTC has been stored. The ignition cycle counter may not be disabled from incrementing for any other condition. Incrementing of the ignition cycle counter should resume within 10 seconds after the malfunction is no longer present (e.g., pending DTC erased through self-clearing or by a scan tool command).

F. Standardization Requirements

The heavy-duty OBD regulation would include requirements for manufacturers to standardize certain features of the OBD system. Effective standardization assists all repair technicians in diagnosing and repairing malfunctions by providing equal access to essential repair information, and requires structuring the information in a common format from manufacturer to manufacturer. Additionally, the standardization would help to facilitate the potential use of OBD checks in heavy-duty inspection and maintenance programs.

Among the features that would be standardized under the proposed heavy-duty OBD regulation include:

- The diagnostic connector, the computer communication protocol;
- The hardware and software specifications for tools used by service technicians;
- The information communicated by the onboard computer and the methods for accessing that information;
- The numeric designation of the DTCs stored when a malfunction is detected; and,
- The terminology used by manufacturers in their service manuals.

Our proposal would require that only a certain minimum set of emissions-related information be made available through the standardized format, protocol, and connector. We are not limiting engine manufacturers as to what protocol they use for engine control, communication between onboard computers, or communication to manufacturer-specific scan tools or test equipment. Further, we are not prohibiting engine manufacturers from equipping the vehicle with additional diagnostic connectors or protocols as required by other suppliers or purchasers. For example, fleets that use data logging or other equipment that requires the use of SAE J1587 communication and connectors could still be installed and supported by the engine and vehicle manufacturers. The OBD rules would only require that engine manufacturers also equip their vehicles with a specific connector and communication protocol that meet the standardized requirements to communicate a minimum set of emissions-related diagnostic, service and, potentially, inspection information.

Additionally, our proposal includes a phase-in of one engine family meeting the requirements of OBD in the model years 2010 through 2012. Because non-compliant engines would not require the proposed standardization features, truck and coach builders could be faced with several integration issues when building product in 2010 through 2012. Specifically, they could be faced with designing their vehicles to accommodate a standardized MIL, diagnostic connector, and communication protocol when using a compliant engine yet to not accommodate those features when using a non-compliant engine. This outcome could easily arise since only one engine-family per manufacturer would be compliant and, therefore, a given truck designed to accommodate several engines from several engine manufacturers would very likely need to accommodate a compliant engine from manufacturer A and a non-compliant engine from manufacturer B. It should be noted that engine choices are typically driven by the end user—the truck buyer—and not by the truck or coach builder. For that reason, the truck builder must accommodate all possible engines for the truck size and cannot necessarily demand from the engine manufacturer a compliant versus a non-compliant engine.

As a result, rather than force truck and coach builders to accommodate two different systems and risk incompatibilities, we are proposing to exempt the 2010 through 2012 model year engines from meeting certain standardization requirements of OBD. This should allow truck and coach builders to integrate engines in the same manner as done currently and then to switch over to integrating a single system in 2013 when all engines are required to meet all of the standardization requirements of OBD. The proposed implementation schedule for standardization features is shown in Table II.G–2.

1. Reference Documents

We are proposing that OBD systems comply with the following provisions laid out in the following Society of Automotive Engineers (SAE) and/or International Organization of Standards (ISO) documents that are or would be incorporated by reference (IBR) into federal regulation:

TABLE II.F—1. REFERENCE DOCUMENTS FOR OVER 14,000 POUND OBD

Document No.	Document title	Date	Comment
SAE J1962	"Diagnostic Connector—Equivalent to ISO/DIS 15031–3: December 14, 2001".	April 2002	Updated IBR.
SAE J1930	"Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms—Equivalent to ISO/TR 15031–2: April 30, 2002".	April 2002	Updated IBR.
SAE J1978	"OBD II Scan Tool—Equivalent to ISO/DIS 15031–4: December 14, 2001"	April 2002	Updated IBR.
SAE J1979	"E/E Diagnostic Test Modes—Equivalent to ISO/DIS 15031–5: April 30, 2002".	April 2002	Updated IBR.
SAE J2012	"Diagnostic Trouble Code Definitions—Equivalent to ISO/DIS 15031–6: April 30, 2002".	April 2002	Updated IBR.
SAE J1939	"Recommended Practice for a Serial Control and Communications Vehicle Network," and the associated subparts included in SAE HS–1939, "Truck and Bus Control and Communications Network Standards Manual".	2005 Edition, March 2005	Updated IBR.
SAE J2403	"Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature"	August 2004	New IBR.
SAE J2534	"Recommended Practice for Pass-Thru Vehicle Reprogramming"	February 2002	New IBR.
ISO 15765–4:2001.	"Road Vehicles—Diagnostics on Controller Area Network (CAN)—Part 4: Requirements for emission-related systems".	December 2001	New IBR.

Copies of these SAE materials may be obtained from Society of Automotive Engineers International, 400 Commonwealth Dr., Warrendale, PA, 15096–0001. Copies of these ISO materials may be obtained from the International Organization for Standardization, Case Postale 56, CH–1211 Geneva 20, Switzerland.

2. Diagnostic Connector Requirements

We are proposing that a standard data link connector conforming to either SAE J1962 or SAE J1939–13 specifications (except as noted below) would have to be included in each vehicle. The connector would have to be located in the driver's side foot-well region of the vehicle interior in the area bound by the driver's side of the vehicle and the driver's side edge of the center console (or the vehicle centerline if the vehicle does not have a center console) and at a location no higher than the bottom of the steering wheel when in the lowest adjustable position. The Administrator would not allow the connector to be located on or in the center console (i.e., neither on the horizontal faces near the floor-mounted gear selector, parking brake lever, or cup-holders, nor on the vertical faces near the car stereo, climate system, or navigation system controls). The location of the connector must be easily identifiable and accessed (e.g., to connect an off-board tool). For vehicles equipped with a driver's side door, the connector would have to be easily identified and accessed by someone standing (or ''crouched'') on the ground outside the driver's side of the vehicle with the driver's side door open.

If a manufacturer wants to cover the connector, the cover must be removable by hand without the use of any tools and be labeled ''OBD'' to aid technicians in identifying the location of the connector. Access to the diagnostic connector could not require opening or removing any storage accessory (e.g., ashtray, coinbox). The label would have to clearly identify that the connector is located behind the cover and is consistent with language and/or symbols commonly used in the automobile and/or heavy truck industry.

If the ISO 15765–4 protocol (see section II.F.3) is used for the required OBD standardized functions, the connector would have to meet the ''Type A'' specifications of SAE J1962. Any pins in the connector that provide electrical power must be properly fused to protect the integrity and usefulness of the connector for diagnostic purposes and may not exceed 20.0 Volts DC regardless of the nominal vehicle system or battery voltage (e.g., 12V, 24V, 42V).

If the SAE J1939 protocol (see section II.F.3)) is used for the required OBD standardized functions, the connector must meet the specifications of SAE J1939–13. Any pins in the connector that provide electrical power must be properly fused to protect the integrity and usefulness of the connector for diagnostic purposes.

Manufacturers would be allowed to equip engines/vehicles with additional diagnostic connectors for manufacturer-specific purposes (i.e., purposes other than the required OBD functions). However, if the additional connector conforms to the ''Type A'' specifications of SAE J1962 or the specifications of SAE J1939–13 and is located in the vehicle interior near the required connector as described above, the connector(s) must be clearly labeled to identify which connector is used to access the standardized OBD information proposed below.

3. Communications to a Scan Tool

a. Background

In light-duty OBD, manufacturers are allowed to use one of four protocols for communication between a generic scan tool and the vehicle's onboard computer. A generic scan tool automatically cycles through each of the allowable protocols until it hits upon the proper one with which to establish communication with the particular onboard computer. While this has generally worked successfully in the field, some communication problems have arisen.

In an effort to address these problems, CARB has made recent changes to their light-duty OBD II regulation that require all light-duty vehicle manufacturers to use only one communication protocol by the 2008 model year. In making these changes, CARB staff argued that their experience with standardization under the OBD II regulation showed that having a single set of standards used by all vehicles would be desirable. CARB staff argued that a single protocol offers a tremendous benefit to both scan tool designers and service technicians. Scan tool designers could focus on added feature content and could expend much less time and money validating basic functionality of their product on all the various permutations of protocol interpretations that are implemented. In turn, technicians would likely get a scan tool that works properly on all vehicles without the need for repeated software updates that incorporate ''work-arounds'' or other patches to fix bugs or adapt the tool to accommodate slight variances in how the multiple protocols interact with each other or are implemented by various manufacturers. Further, a single protocol should also be beneficial to fleet operators that use add-on equipment such as data loggers, and for vehicle manufacturers that integrate parts from various engine and component suppliers all of which must work together.

Based on our similar experiences at the federal level with communication protocols giving rise to service and inspection/maintenance program issues, we initially wanted to propose a single communication protocol for engines used in over 14,000 pound vehicles. However, the affected industry has been divided over which single protocol should be required and has strongly argued for more than one protocol to be allowed. Therefore, for vehicles with diesel engines, we are proposing that manufacturers be required to use either the standards set forth in SAE J1939, or those set forth in the 500 kbps baud rate version of ISO 15765. For vehicles with gasoline engines, we are proposing that manufacturers be required to use the 500 kbps baud rate version of ISO 15765. Manufacturers would be required to use only one standard to meet all the standardization requirements on a single vehicle; that is, a vehicle must use only one protocol for all OBD modules on the vehicle.

Several in the heavy-duty industry have argued for options that would allow the use of more than these two protocols on heavy-duty engines. Some have even argued for combinations of these protocols—e.g., diagnostic connector and messages of ISO 15765 on an SAE J1939 physical layer network. However, as described above, experience from multiple protocols and multiple variants within the protocols has unnecessarily caused a significant number of problems with engine and vehicle related computer communications.

b. Requirements for Communications to a Scan Tool

We are proposing that all OBD control modules—e.g., engine, auxiliary emission control module—on a single vehicle be required to use the same protocol for communication of required emissions-related messages from onboard to off-board network communications to a scan tool meeting SAE J1978 specifications or designed to communicate with a SAE J1939 network. Engine manufacturers would not be allowed to alter normal operation of the engine emissions control system due to the presence of off-board test equipment accessing the OBD information proposed below. The OBD system would be required to use one of the following standardized protocols:

- ISO 15765–4 and all required emission-related messages using this protocol would have to use a 500 kbps baud rate.
- SAE J1939 which may only be used on vehicles with diesel engines.

4. Required Emissions Related Functions

Most of the proposed emissions related functions are elements that exist in our light-duty OBD requirements. We are proposing several required functions, these are:

- Readiness status
- Distance and number of warm-up cycles since DTC clear
- Permanent DTC storage
- Real time indication of monitor status
- Communicating readiness status to the vehicle operator
- Diagnostic trouble codes (DTC)
- Data stream
- Freeze frame
- Test results
- Software calibration identification
- Software calibration verification number
- Vehicle identification number (VIN)

i. Readiness Status

The main intent of readiness status is to ensure that a vehicle is ready for an OBD-based inspection—by indicating that monitors have run and operational status of the emissions-control system has been fully evaluated—and to prevent fraudulent testing in inspection programs. In general, for OBD-based inspections, technicians ''fail'' a vehicle with an illuminated MIL since this would indicate the presence of an emissions control system malfunction. Without the readiness status indicators, technicians would not have a clear indication from the OBD system that it had sufficiently evaluated the emissions control system prior to the inspection. Since the potential exists for OBD checks to be used as part of a heavy truck inspection program, we believe that having readiness status indicators as part of this proposal is important—waiting for a subsequent OBD–I/M rulemaking to require such indicators would unnecessarily delay implementation of such OBD–I/M programs.

Absent such OBD–I/M programs, we still believe that readiness indicators are an important OBD tool. Technicians would be expected to use the readiness status to verify OBD-related repairs. Specifically, technicians would clear the computer memory after repairing an OBD-detected fault in order to erase the DTC, extinguish the MIL, and reset the readiness status to ''incomplete.'' Then the vehicle could be operated in such a manner that the monitor of the repaired component would run (i.e., the readiness status of the monitor would be set to ''complete''). The absence of any DTCs or MIL illumination upon readiness status indicating ''complete'' would indicate a successful repair.

Therefore, we are proposing that manufacturers be required to indicate the readiness status of the OBD monitors. This would serve to indicate whether or not engine operation has been sufficient to allow certain OBD monitors to perform their system evaluations. The OBD system would be required to report a readiness status of either ''complete'' if the monitor has run a sufficient number of times to detect a malfunction since computer memory was last cleared, ''incomplete'' if the monitor has not yet run a sufficient number of times since the memory was last cleared, or ''not applicable'' if the monitor is not present or if the specific monitored component is not equipped on the vehicle. The readiness status of monitors that are required to run continuously would always indicate ''complete.'' The details of the proposal discussed below clarify that the readiness status would be set to ''incomplete'' whenever memory is cleared either by a battery disconnect or by a scan tool but not after a normal vehicle shutdown (i.e., key-off).

ii. Distance Traveled and Number of Warm-Up Cycles Since DTC Clear

As originally envisioned in our OBD–I/M rulemaking (61 FR 40940), we intended to require that all readiness status indicators be set to ''complete'' prior to accepting a vehicle for I/M inspection. However, it became clear that some vehicles were being rejected from inspection for reasons beyond the driver's control. For example, a vehicle driven in extreme ambient conditions would prohibit monitors from running and setting readiness status indicators to ''complete.'' Also, a vehicle repaired just prior to arriving at the inspection station may not have been operated sufficiently to set the readiness status of the monitor for the recently repaired component to ''complete.'' The driver of such a vehicle would, in essence, be punished unintentionally for having taken the time and expense to repair the vehicle just prior to the inspection. As a result, we issued guidance (cite) to state inspectors recommending that vehicles be accepted for I/M inspection provided two or fewer readiness status indicators are ''incomplete.'' Note that most light-duty gasoline vehicles—the bulk of the vehicle fleet facing OBD–I/M checks—have only four monitors for which the readiness status indicator is meaningful (all of their other monitors being continuous monitors). However, there exists evidence that this policy is perhaps accepting vehicles for I/M inspection that should not be accepted due to unscrupulous clearing of DTCs and readiness status by people that understand how to do so and then operate their vehicles just enough to set the required minimum number of readiness indicators to ''complete.''

As a result, we are proposing some additional features that should better differentiate between vehicles that have been repaired recently or have ''incomplete'' readiness indicators through circumstances outside the driver's control, and those vehicles operated by drivers that are attempting to fraudulently get through an OBD-based inspection. We are proposing that the OBD system make available data that would report the distance traveled or engine run time for those engines that do not use vehicle speed information, and the number of warm-up cycles since the fault memory was last cleared.[46] By combining these data with the readiness data, technicians or inspectors would better be able to determine if ''incomplete'' readiness status indicators or an extinguished MIL are due to unscrupulous memory clearing or circumstances beyond the driver's control. For example, a vehicle with several ''incomplete'' readiness indicators but with a high distance traveled/engine run time and a high number of warm-up cycles since the last clearing of fault memory would be unlikely to have undergone a recent fault memory clearing for the purpose of extinguishing the MIL prior to inspection. On the other hand, a vehicle with only one or two ''incomplete'' readiness indicators and a very low distance traveled/engine run time and a low number of warm-up cycles since fault memory clearing should probably be rejected or failed at an inspection. This would better allow an inspection program to be set up to reject only those vehicles with recently cleared memories while minimizing the chances of rejecting vehicles that driven such that monitors rarely run whether by unique driver behaviors or extreme ambient conditions.

iii. Permanent Diagnostic Trouble Code Storage

Consistent with the proposal for distance traveled/engine run time and number of warm-up cycles, we are proposing a requirement to make it much more difficult for a vehicle owner or technician to clear the fault memory and erase all traces of a previously detected malfunction. Current OBD systems on under 14,000 pound vehicles allow a technician or vehicle owner to erase all DTCs and extinguish the MIL by issuing a command from a generic scan tool or, in many cases, simply by disconnecting the vehicle battery. This would set to ''incomplete'' the readiness status indicators for all monitors and would remove all record of the malfunction that had been detected.

We are proposing that manufacturers be required to store in non-volatile memory random access memory (NVRAM) a minimum of four MIL-on DTCs that are, at present, commanding the MIL-on. These ''permanent'' DTCs would have to be stored in NVRAM at the end of every key cycle. By requiring these permanent DTCs to be stored in NVRAM, one would not be able to erase them simply by disconnecting the battery. Further, manufacturers would not be allowed to design their OBD systems such that these permanent DTCs could be erased by any generic or manufacturer-specific scan tool command. Instead, the permanent DTCs could be erased only via an OBD system self-clearing—i.e., upon evaluating the component or system for which the permanent DTC has been stored and detecting on sufficient drive cycles that the malfunction is no longer present, the OBD system would erase the fault memory as discussed in section II.A.2. Once this has occurred, the permanent DTC stored in NVRAM would be erased also.

The permanent DTCs should help if states choose to implement OBD-based I/M programs for heavy trucks. A truck with readiness status indicators for EGR and boost control set to ''incomplete'' and with permanent DTCs stored for both EGR and boost control would quite probably be a truck that should be rejected from inspection. The OBD system on such a truck has almost certainly had its fault memory cleared—via scan tool command or battery disconnect—which would set the readiness indicators to ''incomplete'' and erase all MIL-on DTCs but would still have permanent DTCs stored (only the OBD system itself can erase permanent DTCs). Likewise, a truck with the same readiness indicators set to ''incomplete'' and no permanent DTCs for those monitors should almost certainly be accepted for inspection since the lack of readiness is almost certainly due to circumstances outside the driver's control.

We believe that the permanent DTCs also provide advantages to technicians attempting to repair a malfunction and prepare it for subsequent inspection or proof of correction. The permanent DTC would identify the specific monitor that would need to be exercised after repair and prior to inspection to be sure that the malfunction has been repaired. By combining this information with the vehicle manufacturer's service information, technicians could identify the exact conditions necessary to exercise the particular monitor. As such, technicians could more effectively verify that the specific monitor (that monitor having illuminated the MIL for which the repair has been done) has run and confirmed that the malfunction no longer exists and the repair has been made correctly. This should also reduce vehicle owner ''come-backs'' for incomplete or ineffective repairs.

[46] The fault memory being any DTCs, readiness status indicators, freeze frame information, etc.

iv. Real Time Indication of Monitor Status

We are also proposing provisions to make it easier for technicians to prepare a vehicle for an inspection following a repair. These provisions would require that the OBD system provide real time data that indicate whether the necessary conditions are present currently to set all of the readiness indicators to ''complete.'' These data would indicate whether a particular monitor may still have an opportunity to run on the current drive cycle or whether a condition has been encountered that has disabled the monitor for the rest of the drive cycle regardless of the driving conditions that might be encountered. While these data would not provide technicians with the exact conditions necessary to exercise the monitors (only service information would provide such information), the date in combination with the service information should assist technicians in verifying repairs and/or preparing a vehicle for inspection. Technicians would be able to use this information to identify when specific monitors have indeed completed or to identify situations where they have overlooked one or more of the enable criteria and need to check the service information and try again.

v. Communicating Readiness Status to the Vehicle Operator

As mentioned above, substantial feedback has been received from OBD-based I/M programs throughout the U.S. Much of this feedback pertains to the effect on vehicle owners caused by being rejected from I/M inspection due to ''incomplete'' readiness status indicators. To address this, some light-duty vehicle manufacturers requested that they be allowed to communicate the vehicle's readiness status to the vehicle owner directly without need of a scan tool. This would provide assurance to the vehicle owner that their vehicle is ready for inspection prior to taking the vehicle to the I/M station. We are proposing that heavy-duty engine manufacturers be allowed to do the same thing (this is a proposed option, not a proposed requirement). If a manufacturer chooses to implement this option, though, they would be required to do so in a standardized manner. On engines equipped with this option, the owner would be able to initiate a self-check of the readiness status, thereby greatly reducing the possibility of being rejected at a roadside inspection.

vi. Diagnostic Trouble Codes (DTC)

Malfunctions are reported by the OBD system and displayed on a scan tool for service technicians in the form of diagnostic trouble codes (DTCs). We are proposing that manufacturers be required to report all emissions-related DTCs using a standardized format and to make them accessible to all service technicians, including the independent service industry. The reference document standards selected by the manufacturer would define many generic DTCs to be used by all manufacturers. In the rare circumstances that a manufacturer cannot find within the reference documents a suitable DTC, a unique ''manufacturer-specific'' DTC could be used. However, such manufacturer-specific DTCs are not as easily interpreted by the independent service industry. Excessive use of manufacturer-specific DTCs may increase the time and cost for vehicle repairs. Thus, we are proposing to restrict the use of manufacturer-specific DTCs. If a generic DTC suitable for a given malfunction cannot be found, the manufacturer would be expected to pursue approval and addition of appropriate generic DTCs into the reference documents; the intent being to standardize as much information as possible.

Additionally, we are proposing that the OBD system store DTCs that are as specific as possible to identify the nature of the malfunction. The intent being to provide service technicians with as detailed information as possible to diagnose and repair vehicles in an efficient manner. In other words, manufacturers should use separate DTCs for every monitor where the monitor and repair procedure, or likely cause of the failure, is different. Generally, a manufacturer would design an OBD monitor that detects different root causes (e.g., sensor shorted to ground or battery) for a malfunctioning component or system. We would expect manufacturers to store a specific DTC such as ''sensor circuit high input'' or ''sensor circuit low input'' rather than a general code such as ''sensor circuit malfunction.'' Further, we expect manufacturers to store different DTCs that distinguish circuit malfunctions from rationality and functional malfunctions since the root cause for each is different and, thus, the repair procedures may be different.

We are also proposing specific provisions for storage of pending and MIL-on DTCs. These proposed provisions were discussed in section II.A.2.

We are also proposing requirements that would help to distinguish between DTCs stored for malfunctions that are currently present and for malfunctions that are no longer present. These requirements would apply only to those engines using ISO 15765–4 as the communication protocol. As described in section II.A.2, the OBD system would generally extinguish the MIL if the malfunction responsible for the MIL illumination has not been detected (i.e., the monitor runs and determines that the malfunction no longer exists) on three subsequent sequential drive cycles. However, a manufacturer would not be allowed to erase the associated MIL-on DTC until 40 engine warm-up cycles have occurred without again detecting the malfunction. So even though the malfunction is no longer present and a MIL-on is not being commanded, the DTC would still remain (termed a ''history'' code in the ISO standard). Consequently, if another unrelated malfunction occurs and results in a MIL-on, a new DTC would be stored along with the history DTC. When trying to diagnose the OBD problem, technicians accessing DTC information may have trouble distinguishing which DTC is responsible for illuminating the MIL (i.e., which malfunction is present currently), and thus could have trouble determining what exactly must be repaired. Therefore, we are proposing this requirement for ISO engines to help distinguish between DTCs stored for malfunctions that are present and those that were present. Note that, for engines using SAE J1939 as the communication protocol, such a distinction is already provided for.

Permanent DTCs would also need to be separately identified from the other types of DTCs. Additionally, as described above, manufacturers would be required to develop additional software routines to store and erase permanent DTCs in NVRAM and to prevent erasure from any battery disconnect or scan tool command.

vii. Data Stream/Freeze Frame/Test Results

An important aspect of OBD is the ability of technicians to access critical information from the onboard computer to diagnose and repair emissions-related malfunctions. We believe that having access through the diagnostic connector to real-time electronic information regarding certain emissions critical components and systems would provide valuable assistance for repairing vehicles properly. The availability of real-time information would also provide assistance to technicians responding to drivability complaints since the vehicle could be operated within the necessary operating conditions and the technician could see how various sensors and systems were acting. Similarly, fuel economy complaints, loss of performance complaints, intermittent problems, and others issues could also be addressed.

We are proposing a number of data parameters that the OBD system would be required to report to a generic scan tool. These parameters, which would include information such as engine speed and exhaust gas sensor readings, would allow technicians to understand how the vehicle engine control system is functioning, either as the vehicle operates in a service bay or during actual driving. They would also help technicians diagnose and repair emission-related malfunctions by allowing them to watch instantaneous changes in the values while operating the vehicle.

Some of the data parameters we are proposing are intended to assist us in performing in-use testing of heavy-duty engines for compliance with emissions standards. One of the parameters that manufacturers would be required to report is the real-time status of the NO_X and PM ''not-to-exceed'' (NTE) control areas. The NTE standards define a wide range of engine operating points where a manufacturer must design the engine to be below a maximum emission level. In theory, whenever the engine is operated within the speed and load region defined as the NTE zone, emissions will be below the required standards. However, within the NTE zone, manufacturers are allowed, if justified on a case-by-case basis, to either modify the time frame in which the standard must be met, and in the second case to be exempted from the emission standards under specific conditions (e.g., an NTE deficiency). Manufacturers can request two types of modifications: first, a five percent limited testing region within which no more than five percent of in-use operation is expected to occur and, thus, no more than five percent of NTE emissions sampling within that region can be compared to the NTE standard for a given sampling event; and second, NTE deficiencies which are precisely defined exemption conditions where compliance cannot be met due to technical reasons or for engine protection. These regions and conditions can be defined by directly measured signals or, in some cases, by complicated modeled values calculated internally in the engine computer. When conducting emissions testing of these engines, knowing if the engine is inside the NTE zone—and subject to the NTE standards—or is outside of the NTE zone or, perhaps, in an NTE limited testing region or covered by an NTE deficiency is imperative. As our in-use testing program requirements are written currently, we must post process data to determine which data points were generated within a compliance zone and which were generated within an exempted zone. Such post processing, while possible, is inefficient, time consuming, and resource intensive. Having the NTE zone data broadcast in real-time over the engine's network would allow for a much more efficient use of our resources.

The specific parameters we are proposing for inclusion in the data stream are, for gasoline engines: calculated load value, engine coolant temperature, engine speed, vehicle speed, time elapsed since engine start, absolute load, fuel level (if used to enable or disable any other monitors), barometric pressure (directly measured or estimated), engine control module system voltage, commanded equivalence ratio, number of stored MIL-on DTCs, catalyst temperature (if directly measured or estimated for purposes of enabling the catalyst monitor(s)), monitor status (i.e., disabled for the rest of this drive cycle, complete this drive cycle, or not complete this drive cycle) since last engine shut-off for each monitor used for readiness status, distance traveled/engine run time with a commanded MIL-on, distance traveled/engine run time since fault memory last cleared, number of warm-up cycles since fault memory last cleared, OBD requirements to which the engine is certified (e.g., California OBD, EPA OBD, non-OBD) and MIL status (i.e., commanded-on or commanded-off). And, for diesel engines: calculated load (engine torque as a percentage of maximum torque available at the current engine speed),[47] driver's demand engine torque (as a percentage of maximum engine torque), actual engine torque (as a percentage of maximum engine torque), reference engine maximum torque, reference maximum engine torque as a function of engine speed (suspect parameter numbers (SPN) 539 through 543 defined in SAE J1939 within parameter group number (PGN) 65251 for engine configuration), engine coolant temperature, engine oil temperature (if used for emission control or any OBD monitors), engine speed, time elapsed since engine start, fuel level (if used to enable or disable any other diagnostics), vehicle speed (if used for emission control or any OBD monitors), barometric pressure (directly measured or estimated), engine control module system voltage, number of stored MIL-on DTCs, monitor status (i.e., disabled for the rest of this drive cycle, complete this drive cycle, or not complete this drive cycle) since last engine shut-off for each monitor used for readiness status, distance traveled/engine run time with a commanded MIL-on, distance traveled/engine run time since fault memory last cleared, number of warm-up cycles since DTC memory last cleared, OBD requirements to which the engine is certified (e.g., EPA OBD parent rating, EPA OBD child rating, non-OBD), and MIL status (i.e., commanded-on or commanded-off). Also for diesel engines, as discussed above, separate NO_X and PM NTE control area status (i.e., inside control area, outside control area, inside manufacturer-specific NTE carve-out area, or deficiency active area). Also, for all engines so equipped (and only those so equipped): absolute throttle position, relative throttle position, fuel control system status (e.g., open loop, closed loop), fuel trim, fuel pressure, ignition timing advance, fuel injection timing, intake air/manifold temperature, engine intercooler (aftercooler) temperature, manifold absolute pressure, air flow rate from mass air flow sensor, secondary air status (upstream, downstream, or atmosphere), ambient air temperature, commanded purge valve duty cycle/position, commanded EGR valve duty cycle/position, actual EGR valve duty cycle/position, EGR error between actual and commanded, PTO status (active or not active), redundant absolute throttle position (for electronic throttle or other systems that utilize two or more sensors), absolute pedal position, redundant absolute pedal position, commanded throttle motor position, fuel rate, boost pressure, commanded/target boost pressure, turbo inlet air temperature, fuel rail pressure, commanded fuel rail pressure, DPF inlet pressure, DPF inlet temperature, DPF outlet pressure, DPF outlet temperature, DPF delta pressure, exhaust pressure sensor output, exhaust gas temperature sensor output, injection control pressure, commanded injection control pressure, turbocharger/turbine speed,

[47] Note that, for purposes of the calculated load and torque parameters for diesel engines, manufacturers would be required to report the most accurate values that are calculated within the applicable electronic control unit (e.g., the engine control computer). ''Most accurate values,'' in this context, would be those of sufficient accuracy, resolution, and filtering that they could be used for the purpose of in-use emissions testing with the engine still in a vehicle (e.g., using portable emissions measurement equipment).

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.

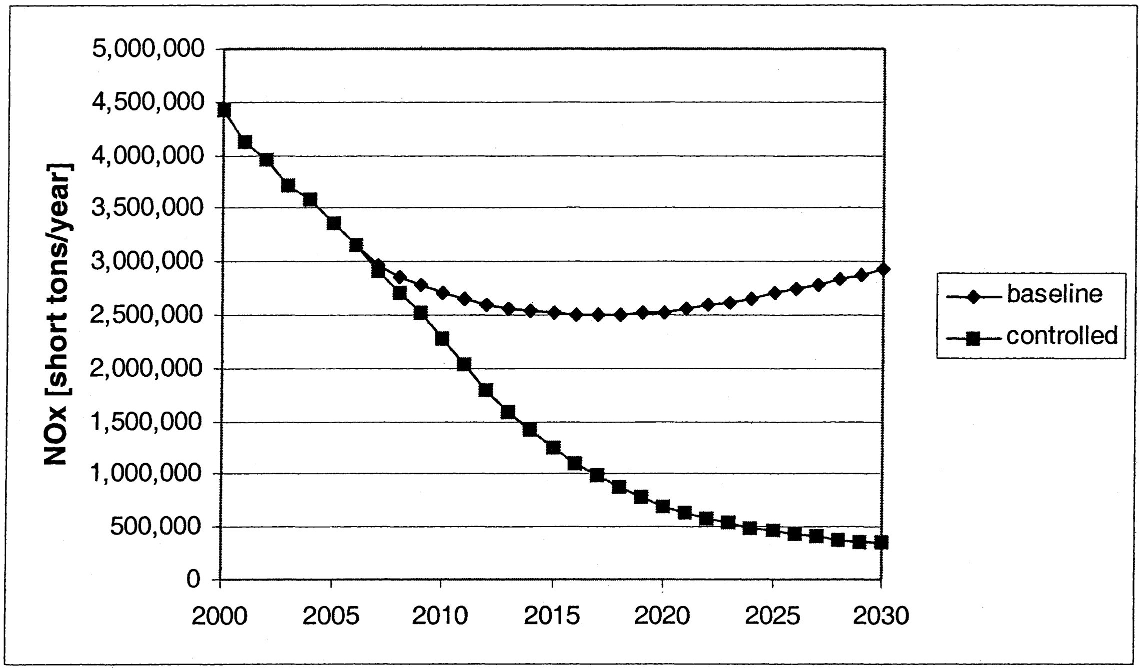


Figure V.A-1: Projected Nationwide Heavy-Duty Vehicle NOx Emissions; Control Case Represents the 2007/2010 Emissions Standards

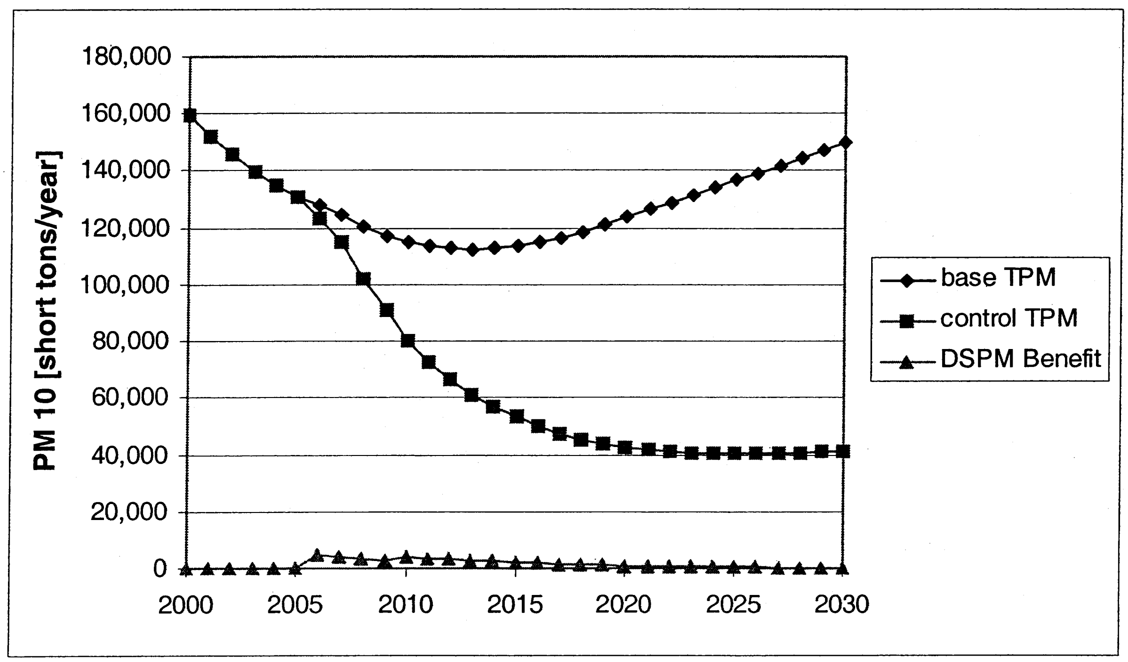


Figure V.A-2: Projected Nationwide Heavy-Duty Vehicle PM Emissions and Direct Sulfate PM Emission Reductions; Control Case Represents the 2007/2010 Emissions Standards

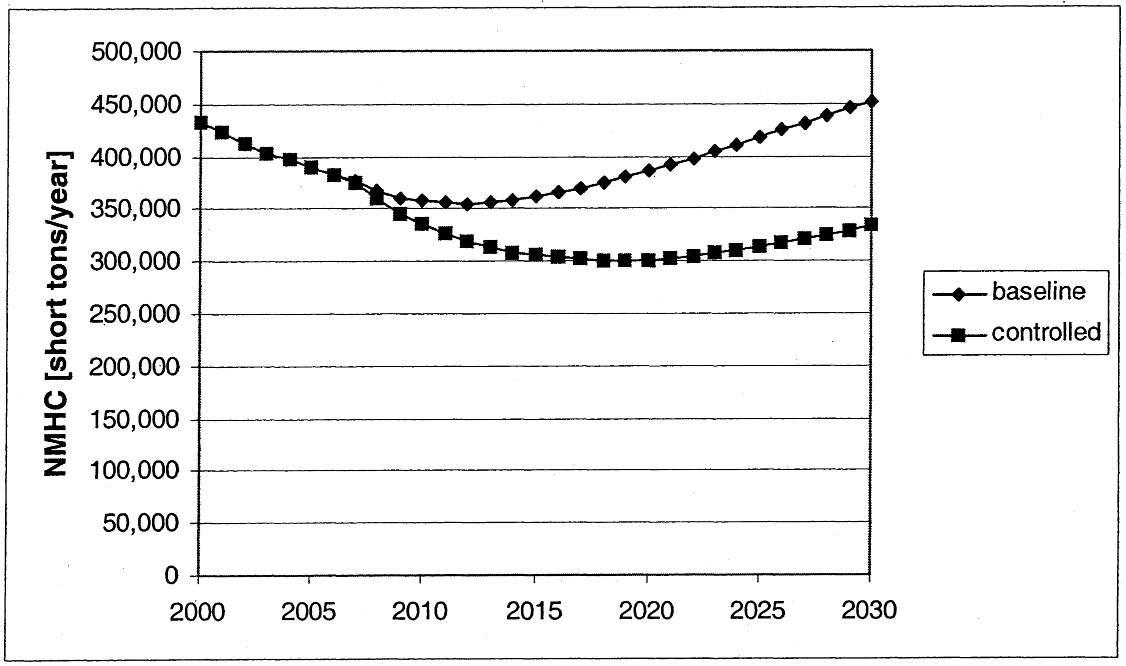


Figure V.A-3: Projected Nationwide Heavy-Duty Vehicle NMHC Emissions; Control Case Represents the 2007/2010 Emissions Standards

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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.

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(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

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(5) * * *

Document No. and name	40 CFR part 86 reference
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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 the point that would cause an engine's NO_X 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 NO_X adsorber capability could result in an engine's NO_X emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when the system has no detectable amount of NO_X adsorber capability.

(B) *NO_X adsorber system active/intrusive reductant delivery performance.* For NO_X adsorber systems that use active/intrusive injection (e.g., in-cylinder post fuel injection, in-exhaust air-assisted fuel injection) to achieve desorption of the NO_X adsorber, the OBD system must detect a malfunction if any failure or deterioration of the injection system's ability to properly regulate injection causes the system to be unable to achieve desorption of the NO_X adsorber.

(C) *NO_X adsorber system feedback control.* Malfunction criteria for the NO_X adsorber and the NO_X adsorber active/instrusive reductant delivery system are contained in paragraph (i)(6)of this section.

(iii) *NO_X adsorber system monitoring conditions.*

(A) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (g)(7)(ii)(A) 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)(7)(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)(7)(ii)(B) and (g)(7)(ii)(C) of this section.

(iv) *NO_X adsorber 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.

(8) *Diesel particulate filter (DPF) system monitoring.*

(i) *General.* The OBD system must monitor the DPF on engines so-equipped for proper performance. For engines equipped with active regeneration systems that use an active/intrusive injection (e.g., in-exhaust fuel injection, in-exhaust fuel/air burner), 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) *DPF system malfunction criteria.*

(A) *DPF filtering performance.* The OBD system must detect a malfunction prior to a decrease in the PM filtering capability of the DPF (e.g., cracking, melting, etc.) that would cause an engine's PM emissions to exceed the emissions thresholds for DPF systems as shown in Table 1 of this paragraph (g). If no failure or deterioration of the PM filtering performance could result in an engine's PM emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when no detectable amount of PM filtering occurs.

(B) *DPF regeneration frequency.* The OBD system must detect a malfunction when the DPF regeneration frequency increases from (i.e., occurs more often than) the manufacturer's specified regeneration frequency to a level such that it would cause an engine's NMHC emissions to exceed the emissions threshold for DPF systems as shown in Table 1 of this paragraph (g). If no such regeneration frequency exists that could cause NMHC emissions to exceed the applicable emission threshold, the OBD system must detect a malfunction when the DPF regeneration frequency exceeds the manufacturer's specified design limits for allowable regeneration frequency.

(C) *DPF incomplete regeneration.* The OBD system must detect a regeneration malfunction when the DPF does not properly regenerate under manufacturer-defined conditions where regeneration is designed to occur.

(D) *DPF NMHC conversion.* For any DPF that serves to convert NMHC emissions, the OBD system must detect a malfunction when the NMHC conversion capability decreases to the point that NMHC emissions exceed the emissions threshold for DPF systems as shown in Table 1 of this paragraph (g). If no failure or deterioration of the NMHC conversion capability could result in NMHC emissions exceeding the applicable threshold, the OBD system must detect a malfunction when the system has no detectable amount of NMHC conversion capability.

(E) *DPF missing substrate.* The OBD system must detect a malfunction if either the DPF substrate is completely destroyed, removed, or missing, or if the DPF assembly has been replaced with a muffler or straight pipe.

(F) *DPF system active/intrusive injection.* For DPF systems that use active/intrusive injection (e.g., in-cylinder post fuel injection, in-exhaust air-assisted fuel injection) to achieve regeneration of the DPF, the OBD system must detect a malfunction if any failure or deterioration of the injection system's ability to properly regulate injection causes the system to be unable to achieve regeneration of the DPF.

(G) *DPF regeneration feedback control.* See paragraph (i)(6) of this section.

(iii) *DPF monitoring conditions.* The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (g)(8)(ii) 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)(8)(ii) 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) *DPF 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.

(9) *Exhaust gas sensor and sensor heater monitoring.*

(i) *General.* The OBD system must monitor for proper output signal, activity, response rate, and any other parameter that can affect emissions, all exhaust gas sensors (e.g., oxygen, air-fuel ratio, NO_X) used for emission control system feedback (e.g., EGR control/feedback, SCR control/feedback, NO_X adsorber control/feedback) and/or as a monitoring device. For engines equipped with heated exhaust gas sensors, the OBD system must monitor the heater for proper performance.

(ii) *Malfunction criteria for air-fuel ratio sensors located upstream of aftertreatment devices.*

(A) *Sensor performance.* The OBD system must detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 1 of this paragraph (g).

(B) *Circuit integrity.* The OBD system must detect malfunctions of the sensor related to a lack of circuit continuity or signal out-of-range values.

(C) *Feedback function.* The OBD system must detect a malfunction of the sensor if the emission control system (e.g., EGR, SCR, or NO_X adsorber) is unable to use that sensor as a feedback input (e.g., causes limp-home or open-loop operation).

(D) *Monitoring function.* To the extent feasible, the OBD system must detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst, EGR, SCR, or NO_X adsorber monitoring).

(iii) *Malfunction criteria for air-fuel ratio sensors located downstream of aftertreatment devices.*

(A) *Sensor performance.* The OBD system must detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed the emissions thresholds for air-fuel ratio sensors downstream of aftertreatment devices as shown in Table 1 of this paragraph (g).

(B) *Circuit integrity.* The OBD system must detect malfunctions of the sensor related to a lack of circuit continuity or signal out-of-range values.

(C) *Feedback function.* The OBD system must detect a malfunction of the sensor if the emission control system (e.g., EGR, SCR, or NO_X adsorber) is unable to use that sensor as a feedback input (e.g., causes limp-home or open-loop operation).

(D) *Monitoring function.* To the extent feasible, the OBD system must detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst, EGR, SCR, or NO_X adsorber monitoring).

(iv) *Malfunction criteria for NO_X sensors.*

(A) *Sensor performance.* The OBD system must detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed the emissions thresholds for NO_X sensors as shown in Table 1 of this paragraph (g).

(B) *Circuit integrity.* The OBD system must detect malfunctions of the sensor related to a lack of circuit continuity or signal out-of-range values.

(C) *Feedback function.*The OBD system must detect a malfunction of the sensor if the emission control system (e.g., EGR, SCR, or NO_X adsorber) is unable to use that sensor as a feedback input (e.g., causes limp-home or open-loop operation).

(D) *Monitoring function.* To the extent feasible, the OBD system must detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst, EGR, SCR, or NO_X adsorber monitoring).

(v) *Malfunction criteria for other exhaust gas sensors.* For other exhaust gas sensors, the manufacturer must submit a monitoring plan to the Administrator for approval. The plan must include data and/or engineering evaluations that demonstrate that the monitoring plan is as reliable and effective as the monitoring required in paragraphs (g)(9)(ii) through (g)(9)(iv) of this section.

(vi) *Malfunction criteria for exhaust gas sensor heaters.*

(A) The OBD system must detect a malfunction of the heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required to be met by the component vendor for heater circuit performance at high mileage). The manufacturer may use other malfunction criteria for heater performance malfunctions. To do so, the manufacturer must be able to demonstrate via data and/or an engineering evaluation that the monitor is reliable and robust.

(B) The OBD system must detect malfunctions of the heater circuit including open or short circuits that conflict with the commanded state of the heater (e.g., shorted to 12 Volts when commanded to 0 Volts (ground)).

(vii) *Monitoring conditions for exhaust gas sensors.*

(A) The manufacturer must define the monitoring conditions for malfunctions identified in paragraphs (g)(9)(ii)(A), (g)(9)(iii)(A), and (g)(9)(iv)(A) of this section (i.e., sensor performance) 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)(9)(ii)(A), (g)(9)(iii)(A), and (g)(9)(iv)(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 manufacturer must define the monitoring conditions for malfunctions identified in paragraphs (g)(9)(ii)(D), (g)(9)(iii)(D), and (g)(9)(iv)(D) of this section (i.e., monitoring function) 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.

(C) Except as provided for in paragraph (g)(9)(vii)(D) of this paragraph (g)(9), the OBD system must monitor continuously for malfunctions identified in paragraphs (g)(9)(ii)(B), (g)(9)(ii)(C), (g)(9)(iii)(B), (g)(9)(iii)(C), (g)(9)(iv)(B), and (g)(9)(iv)(C) (i.e., circuit integrity and feedback function).

(D) A manufacturer may request approval to disable continuous exhaust gas sensor monitoring when an exhaust gas sensor malfunction cannot be distinguished from other effects (e.g., disable monitoring for out-of-range on the low side during fuel cut conditions). To do so, the manufacturer must demonstrate via data and/or engineering analyses that a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false malfunction detection.

(viii) *Monitoring conditions for exhaust gas sensor heaters.*

(A) The manufacturer must define monitoring conditions for malfunctions identified in paragraph (g)(9)(vi)(A) of this section (i.e., sensor heater performance) in accordance with paragraphs (c) and (d) of this section.

(B) The OBD system must monitor continuously for malfunctions identified in paragraph (g)(9)(vi)(B) of this section (i.e., circuit malfunctions).

(ix) *Exhaust gas sensor and sensor heater MIL activation and DTC storage.* The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(10) *Variable Valve Timing (VVT) system monitoring.*

(i) *General.* The OBD system must monitor the VVT system on engines so equipped for target error and slow response malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the VVT system must be monitored in accordance with the comprehensive components requirements in paragraph (i)(3) of this section.

(ii) *VVT system malfunction criteria.*

(A) *VVT system target error.* The OBD system must detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a crank angle and/or lift tolerance that would cause an engine's emissions to exceed the emission thresholds for ''other monitors'' as shown in Table 1 of this paragraph (g).

(B) *VVT slow response.* The OBD system must detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a manufacturer-specified time that would cause an engine's emissions to exceed the emission thresholds for ''other monitors'' as shown in Table 1 of this paragraph (g).

(C) For engines in which no failure or deterioration of the VVT system could result in an engine's emissions exceeding the applicable emissions thresholds of paragraphs (g)(10)(ii)(A) and (g)(10)(ii)(B) of this section, the OBD system must detect a malfunction of the VVT system when proper functional response of the system to computer commands does not occur.

(iii) *VVT system monitoring conditions.* Manufacturers must define the monitoring conditions for VVT system malfunctions identified in paragraph (g)(10)(ii) 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)(10)(ii) 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) *VVT MIL activation and DTC storage.* The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

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

TABLE 2.—OBD EMISSIONS THRESHOLDS FOR GASOLINE-FUELED/SPARK-IGNITION ENGINES MEANT FOR PLACEMENT IN APPLICATIONS GREATER THAN 14,000 POUNDS GVWR (G/BHP-HR)

Component	NO_X	NMHC	CO	§ 86.010–18 reference
Catalyst system	1.75x std	1.75x std		(h)(6).
Evaporative emissions control system		0.150 inch leak		(h)(7).
''Other monitors'' with emissions thresholds	1.5x std	1.5x std	1.5x std	(h)(1), (h)(2), (h)(3), (h)(4), (h)(5), (h)(8), (h)(9).

Notes: 1.75x std means a multiple of 1.75 times the applicable emissions standard; these emissions thresholds apply to the monitoring requirements of paragraph (h) of this section 86.010–18; The evaporative emissions control system threshold is not, technically, an emissions threshold but rather a leak size that must be detected; nonetheless, for ease we refer to this as the threshold.

(1) *Fuel system monitoring.*

(i) *General.* The OBD system must monitor the fuel delivery system to determine its ability to provide compliance with emission standards.

(ii) *Fuel system malfunction criteria.*

(A) The OBD system must detect a malfunction of the fuel delivery system (including feedback control based on a secondary oxygen sensor) when the fuel delivery system is unable to maintain an engine's emissions at or below the emissions thresholds for ''other monitors'' as shown in Table 2 of this paragraph (h).

(B) Except as provided for in paragraph (h)(1)(ii)(C) of this section, if the engine is equipped with adaptive feedback control, the OBD system must detect a malfunction when the adaptive feedback control has used up all of the adjustment allowed by the manufacturer.

(C) If the engine is equipped with feedback control that is based on a secondary oxygen (or equivalent) sensor, the OBD system is not required to detect a malfunction of the fuel system solely when the feedback control based on a secondary oxygen sensor has used up all of the adjustment allowed by the manufacturer. However, if a failure or deterioration results in engine emissions that exceed the emissions thresholds for ''other monitors'' as shown in Table 2 of this paragraph (h), the OBD system is required to detect a malfunction.

(D) The OBD system must detect a malfunction whenever the fuel control system fails to enter closed loop operation following engine start within a manufacturer specified time interval. The specified time interval must be supported by data and/or engineering analyses submitted by the manufacturer.

(E) The manufacturer may adjust the malfunction criteria and/or monitoring conditions to compensate for changes in altitude, for temporary introduction of large amounts of purge vapor, or for other similar identifiable operating conditions when such conditions occur.

(iii) *Fuel system monitoring conditions.* The fuel system must be monitored continuously for the presence of a malfunction.

(iv) *Fuel system MIL activation and DTC storage.*

(A) A pending DTC must be stored immediately upon the fuel system exceeding the malfunction criteria established in paragraph (h)(1)(ii) of this section.

(B) Except as provided for in paragraph (h)(1)(iv)(C) of this section, if a pending DTC is stored, the OBD system must activate the MIL immediately and store a MIL-on DTC if a malfunction is again detected during either the drive cycle immediately following storage of the pending DTC regardless of the conditions encountered during that drive cycle, or on the next drive cycle in which similar conditions are encountered to those that occurred when the pending DTC was stored. Similar conditions 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) as the engine conditions stored pursuant to paragraph (h)(1)(iv)(E) of this section. Other definitions of similar conditions may be used but must result in comparable timeliness and reliability in detecting similar engine operation.

(C) The pending DTC may be erased at the end of the next drive cycle in which similar conditions have been encountered without having again exceeded the specified fuel system malfunction criteria. The pending DTC may also be erased if similar conditions are not encountered during the 80 drive cycles immediately following detection of the potential malfunction for which the pending DTC was stored.

(D) Storage of freeze frame conditions. The OBD system must store and erase freeze frame conditions either in conjunction with storing and erasing a pending DTC or in conjunction with storing and erasing a MIL-on DTC. Freeze frame information associated with a fuel system malfunction shall be stored in preference to freeze frame information required elsewhere in paragraphs (h) or (i) of this section.

(E) Storage of fuel system conditions for determining similar conditions of operation. The OBD must store the engine speed, load, and warm-up status present at the time it first detects a potential malfunction meeting the criteria of paragraph (h)(1)(ii) of this section and stores a pending DTC.

(F) Deactivating the MIL. The MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without detecting a malfunction of the fuel system.

(2) *Engine misfire monitoring.*

(i) *General.*

(A) The OBD system must monitor the engine for misfire causing catalyst damage and misfire causing excess emissions.

(B) The OBD system must identify the specific cylinder that is misfiring. The manufacturer may store a general misfire DTC instead of a cylinder specific DTC under certain operating conditions. To do so, the manufacturer must submit data and/or engineering analyses that demonstrate that the misfiring cylinder cannot be identified reliably when the conditions occur.

(C) If more than one cylinder is misfiring, a separate DTC must be stored to indicate that multiple cylinders are misfiring unless otherwise allowed by this paragraph (h)(2). When identifying multiple cylinder misfire, the OBD system is not required to also identify using separate DTCs each of the misfiring cylinders individually. If more than 90 percent of the detected misfires occur in a single cylinder, an appropriate DTC may be stored that indicates the specific misfiring cylinder rather than storing the multiple cylinder misfire DTC. If two or more cylinders individually have more than 10 percent of the total number of detected misfires, a multiple cylinder DTC must be stored.

(ii) *Engine misfire malfunction criteria.*

(A) *Misfire causing catalyst damage.* The manufacturer must determine the percentage of misfire evaluated in 200 revolution increments for each engine speed and load condition that would result in a temperature that causes catalyst damage. If this percentage of misfire is exceeded, it shall be considered a malfunction that must be detected. For every engine speed and load condition for which this percentage of misfire is determined to be lower than five percent, the manufacturer may set the malfunction criteria at five percent. The manufacturer may use a longer interval than 200 revolutions but only for determining, on a given drive cycle, the first misfire exceedance as provided in paragraph (h)(2)(iv)(A) of this section. To do so, the manufacturer must demonstrate that the interval is not so long that catalyst damage would occur prior to the interval being elapsed.

(B) *Misfire causing emissions to exceed the applicable thresholds.* The manufacturer must determine the percentage of misfire evaluated in 1000 revolution increments that would cause emissions from an emissions durability demonstration engine to exceed the emissions thresholds for ''other monitors'' as shown in Table 2 of this paragraph (h) if that percentage of misfire were present from the beginning of the test. If this percentage of misfire is exceeded, regardless of the pattern of misfire events (e.g., random, equally spaced, continuous), it shall be considered a malfunction that must be detected. To establish this percentage of misfire, the manufacturer must use misfire events occurring at equally spaced, complete engine cycle intervals, across randomly selected cylinders throughout each 1000-revolution increment. If this percentage of misfire is determined to be lower than one percent, the manufacturer may set the malfunction criteria at one percent. The manufacturer may use a longer interval than 1000 revolutions. To do so, the manufacturer must demonstrate that the strategy would be equally effective and timely at detecting misfire.

(iii) *Engine misfire monitoring conditions.*

(A) The OBD system must monitor continuously for misfire under the following conditions: from no later than the end of the second crankshaft revolution after engine start; during the rise time and settling time for engine speed to reach the desired idle engine speed at engine start-up (i.e., ''flare-up'' and ''flare-down''); and, under all positive torque engine speeds and load conditions except within the engine operating region bound by the positive torque line (i.e., engine load with the transmission in neutral), and the points represented by an engine speed of 3000 rpm with the engine load at the positive torque line and the redline engine speed with the engine's manifold vacuum at four inches of mercury lower than that at the positive torque line. For this purpose, redline engine speed is defined as either the recommended maximum engine speed as displayed on the instrument panel tachometer, or the engine speed at which fuel shutoff occurs.

(B) If an OBD monitor cannot detect all misfire patterns under all required engine speed and load conditions as required by paragraph (h)(2)(iii)(A) of this section, the OBD system may still be acceptable. The Administrator will evaluate the following factors in making a determination: the magnitude of the region(s) in which misfire detection is limited; the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events); the frequency with which said region(s) are expected to be encountered in-use; the type of misfire patterns for which misfire detection is troublesome; and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under the required conditions (i.e., compliance can be achieved on other engines). The evaluation will be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders; single cylinder continuous misfire; and paired cylinder (cylinders firing at the same crank angle) continuous misfire.

(C) The manufacturer may use monitoring system that has reduced misfire detection capability during the portion of the first 1000 revolutions after engine start that a cold start emission reduction strategy is active that reduces engine torque (e.g., spark retard strategies). To do so, the manufacturer must demonstrate that the probability of detection is greater than or equal to 75 percent during the worst case condition (i.e., lowest generated torque) for a vehicle operated continuously at idle (park/neutral idle) on a cold start between 50 and 86 degrees Fahrenheit and that the technology cannot reliably detect a higher percentage of the misfire events during the conditions.

(D) The manufacturer may disable misfire monitoring or use an alternative malfunction criterion when misfire cannot be distinguished from other effects. To do so, the manufacturer must demonstrate that the disablement interval or the period of use of an alternative malfunction criterion is limited only to that necessary for avoiding false detection and for one or more of the following operating conditions: rough road; fuel cut; gear changes for manual transmission vehicles; traction control or other vehicle stability control activation such as anti-lock braking or other engine torque modifications to enhance vehicle stability; off-board control or intrusive activation of vehicle components or monitors during service or assembly plant testing; portions of intrusive evaporative system or EGR monitors that can significantly affect engine stability (i.e., while the purge valve is open during the vacuum pull-down of a evaporative system leak check but not while the purge valve is closed and the evaporative system is sealed or while an EGR monitor causes the EGR valve to be cycled intrusively on and off during positive torque conditions); or, engine speed, load, or torque transients due to throttle movements more rapid than those that occur over the FTP cycle for the worst case engine within each engine family. In general, the Administrator will not approve disablement for conditions involving normal air conditioning compressor cycling from on-to-off or off-to-on, automatic transmission gear shifts (except for shifts occurring during wide open throttle operation), transitions from idle to off-idle, normal engine speed or load changes that occur during the engine speed rise time and settling time (i.e., ''flare-up'' and ''flare-down'') immediately after engine starting without any vehicle operator-induced actions (e.g., throttle stabs), or excess acceleration (except for acceleration rates that exceed the maximum acceleration rate obtainable at wide open throttle while the vehicle is in gear due to abnormal conditions such as slipping of a clutch).

(iv) *MIL activation and DTC storage for engine misfire causing catalyst damage.*

(A) *Pending DTCs.* A pending DTC must be stored immediately if, during a single drive cycle, the specified misfire percentage described in paragraph (h)(2)(ii)(A) of this section is exceeded three times when operating in the positive torque region encountered during a FTP cycle or is exceeded on a single occasion when operating at any other engine speed and load condition in the positive torque region defined in paragraph (h)(2)(iii)(A) of this section. Immediately after a pending DTC is stored pursuant to this paragraph, the MIL must blink once per second at all times during the drive cycle that engine misfire is occurring. The MIL may be deactivated during those times that misfire is not occurring. If, at the time that a catalyst damaging misfire malfunction occurs, the MIL is already activated for a malfunction other than misfire, the MIL must still blink once per second at all times during the drive cycle that engine misfire is occurring. If misfire ceases, the MIL must stop blinking but remain activated as appropriate in accordance with the other malfunction.

(B) *MIL-on DTCs.* If a pending DTC is stored in accordance with paragraph (h)(2)(iv)(A) of this section, the OBD system must immediately store a MIL-on DTC if the percentage of misfire described in paragraph (h)(2)(ii)(A) of this section is again exceeded one or more times during either the drive cycle immediately following storage of the pending DTC, regardless of the conditions encountered during that drive cycle, or on the next drive cycle in which similar conditions are encountered to those that occurred when the pending DTC was stored. If, during a previous drive cycle, a pending DTC is stored in accordance with paragraph (h)(2)(iv)(A) of this section, a MIL-on DTC must be stored immediately upon exceeding the percentage misfire described in paragraph (h)(2)(ii)(A) of this section regardless of the conditions encountered. Upon storage of a MIL-on DTC, the MIL must blink once per second at all times during the drive cycle that engine misfire is occurring. If misfire ceases, the MIL must stop blinking but remain activated until the conditions are met for extinguishing the MIL.

(C) *Erasure of pending DTCs.* Pending DTCs stored in accordance with paragraph (h)(2)(iv)(A) of this section must be erased at the end of the next drive cycle in which similar conditions are encountered to those that occurred when the pending DTC was stored provided no exceedances have been detected of the misfire percentage described in paragraph (h)(2)(ii)(A) of this section. The pending DTC may also be erased if similar conditions are not encountered during the next 80 drive cycles immediately following storage of the pending DTC.

(D) *Exemptions for engines with fuel shutoff and default fuel control.* In engines that provide for fuel shutoff and default fuel control to prevent over fueling during catalyst damaging misfire conditions, the MIL need not blink as required by paragraphs (h)(2)(iv)(A) and (h)(2)(iv)(B) of this section. Instead, the MIL may be activated continuously upon misfire detection provided that the fuel shutoff and default fuel control are activated immediately upon misfire detection. Fuel shutoff and default fuel control may be deactivated only when the engine is outside of the misfire range except that the manufacturer may periodically, but not more than once every 30 seconds, deactivate fuel shutoff and default fuel control to determine if the catalyst damaging misfire is still occurring. Normal fueling and fuel control may be resumed if the catalyst damaging misfire is no longer occurring.

(E) The manufacturer may use a strategy that activates the MIL continuously rather than blinking the MIL during extreme catalyst damage misfire conditions (i.e., catalyst damage misfire occurring at all engine speeds and loads). Use of such a strategy must be limited to catalyst damage misfire levels that cannot be avoided during reasonable driving conditions. To use such a strategy, the manufacturer must be able to demonstrate that the strategy will encourage operation of the vehicle in conditions that will minimize catalyst damage (e.g., at low engine speeds and loads).

(v) *MIL activation and DTC storage for engine misfire causing emissions to exceed applicable emissions thresholds.*

(A) Immediately upon detection, during the first 1000 revolutions after engine start of the misfire percentage described in paragraph (h)(2)(ii)(B) of this section, a pending DTC must be stored. If such a pending DTC is stored already and another such exceedance of the misfire percentage is detected within the first 1000 revolutions after engine start on any subsequent drive cycle, the MIL must activate and a MIL-on DTC must be stored. The pending DTC may be erased if, at the end of the next drive cycle in which similar conditions are encountered to those that occurred when the pending DTC was stored, there has been no exceedance of the misfire percentage described in paragraph (h)(2)(ii)(B) of this section. The pending DTC may also be erased if similar conditions are not encountered during the next 80 drive cycles immediately following storage of the pending DTC.

(B) No later than the fourth detection during a single drive cycle, following the first 1000 revolutions after engine start of the misfire percentage described in paragraph (h)(2)(ii)(B) of this section, a pending DTC must be stored. If such a pending DTC is stored already, then the MIL must activate and a MIL-on DTC must be stored within 10 seconds of the fourth detection of the misfire percentage described in paragraph (h)(2)(ii)(B) of this section during either the drive cycle immediately following storage of the pending DTC, regardless of the conditions encountered during that drive cycle excepting those conditions within the first 1000 revolutions after engine start, or on the next drive cycle in which similar conditions are encountered to those that occurred when the pending DTC was stored excepting those conditions within the first 1000 revolutions after engine start. The pending DTC may be erased if, at the end of the next drive cycle in which similar conditions are encountered to those that occurred when the pending DTC was stored, there has been no exceedance of the misfire percentage described in paragraph (h)(2)(ii)(B) of this section. The pending DTC may also be erased if similar conditions are not encountered during the next 80 drive cycles immediately following storage of the pending DTC.

(vi) *Storage of freeze frame conditions for engine misfire.*

(A) The OBD system must store and erase freeze frame conditions (as defined in paragraph (k)(4)(iii) of this section) either in conjunction with storing and erasing a pending DTC or in conjunction with storing and erasing a MIL-on DTC.

(B) If, upon storage of a DTC as required by paragraphs (h)(2)(iv) and (h)(2)(v) of this section, there already exist stored freeze frame conditions for a malfunction other than a misfire or fuel system malfunction (see paragraph (h)(1) of this section) then the stored freeze frame information shall be replaced with freeze frame information associated with the misfire malfunction.

(vii) *Storage of engine conditions in association with engine misfire.* Upon detection of the misfire percentages described in paragraphs (h)(2)(ii)(A) and (h)(2)(ii)(B) of this section, the following engine conditions must be stored for use in determining similar conditions: engine speed, load, and warm up status of the first misfire event that resulted in pending DTC storage.

(viii) *MIL deactivation in association with engine misfire.* The MIL may be deactivated after three sequential drive cycles in which similar conditions have been encountered without an exceedance of the misfire percentages described in paragraphs (h)(2)(ii)(A) and (h)(2)(ii)(B) of this section.

(3) *Exhaust gas recirculation system monitoring.*

(i) *General.* The OBD system must monitor the EGR system on engines so equipped for low and high flow rate 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) 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 2 of this paragraph (h). 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 no detectable amount of EGR flow.

(B) The OBD system must detect a malfunction of the EGR system 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 2 of this paragraph (h). 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.

(iii) *EGR system monitoring conditions.*

(A) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (h)(3)(ii) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required by paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (h)(3)(ii) 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 manufacturer may disable temporarily the EGR monitor under conditions when monitoring may not be reliable (e.g., when freezing may affect performance of the system). To do so, the manufacturer must be able to demonstrate that the monitor is unreliable when such 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) *Cold start emission reduction strategy monitoring.*

(i) *General.* If an engine incorporates a specific engine control strategy to reduce cold start emissions, the OBD system must monitor the key components (e.g., idle air control valve), other than secondary air, while the control strategy is active to ensure proper operation of the control strategy.

(ii) *Cold start strategy malfunction criteria.*

(A) The OBD system must detect a malfunction prior to any failure or deterioration of the individual components associated with the cold start emission reduction control strategy that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 2 of this paragraph (h). The manufacturer must establish the malfunction criteria based on data from one or more representative engine(s) and provide an engineering evaluation for establishing the malfunction criteria for the remainder of the manufacturer's product line.

(B) Where no failure or deterioration of a component used for the cold start emission reduction strategy could result in an engine's emissions exceeding the applicable emissions thresholds, the individual component must be monitored for proper functional response while the control strategy is active in accordance with the malfunction criteria in paragraphs (i)(3)(ii) and (i)(3)(iii) of this section.

(iii) *Cold start strategy monitoring conditions.* The manufacturer must define monitoring conditions for malfunctions identified in paragraph (h)(4)(ii) of this section in accordance with paragraphs (c) and (d) of this section.

(iv) *Cold start strategy 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) *Secondary air system monitoring.*

(i) *General.* The OBD system on engines equipped with any form of secondary air delivery system must monitor the proper functioning of the secondary air delivery system including all air switching valves(s). The individual electronic components (e.g., actuators, valves, sensors) that are used in the secondary air system must be monitored in accordance with the comprehensive component requirements in paragraph (i)(3) of this section. For purposes of this paragraph (h)(5), ''air flow'' is defined as the air flow delivered by the secondary air system to the exhaust system. For engines using secondary air systems with multiple air flow paths/distribution points, the air flow to each bank (i.e., a group of cylinders that share a common exhaust manifold, catalyst, and control sensor) must be monitored in accordance with the malfunction criteria in paragraph (h)(5)(ii) of this section. Also for purposes of this paragraph (h)(5), ''normal operation'' is defined as the condition when the secondary air system is activated during catalyst and/or engine warm-up following engine start. ''Normal operation'' does not include the condition when the secondary air system is turned on intrusively for the sole purpose of monitoring.

(ii) *Secondary air system malfunction criteria.*

(A) Except as provided in paragraph (h)(5)(ii)(C) of this section, the OBD system must detect a secondary air system malfunction prior to a decrease from the manufacturer's specified air flow during normal operation that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 2 of this paragraph (h).

(B) Except as provided in paragraph (h)(5)(ii)(C) of this section, the OBD system must detect a secondary air system malfunction prior to an increase from the manufacturer's specified air flow during normal operation that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 2 of this paragraph (h).

(C) For engines in which no deterioration or failure of the secondary air system would result in an engine's emissions exceeding the applicable emissions thresholds, the OBD system must detect a malfunction when no detectable amount of air flow is delivered by the secondary air system during normal operation.

(iii) *Secondary air system monitoring conditions.* The manufacturer must define monitoring conditions for malfunctions identified in paragraph (h)(5)(ii) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required by paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (h)(5)(ii) 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) *Secondary air 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.

(6) *Catalyst system monitoring.*

(i) *General.* The OBD system must monitor the catalyst system for proper conversion capability.

(ii) *Catalyst system malfunction criteria.* The OBD system must detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that emissions exceed the emissions thresholds for the catalyst system as shown in Table 2 of this paragraph (h).

(iii) *Catalyst system monitoring conditions.* The manufacturer must define monitoring conditions for malfunctions identified in paragraph (h)(6)(ii) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required by paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (h)(6)(ii) 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) *Catalyst system MIL activation and DTC storage.*

(A) The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(B) The monitoring method for the catalyst system must be capable of detecting when a catalyst DTC has been erased (except OBD system self erasure), but the catalyst has not been replaced (e.g., catalyst overtemperature histogram approaches are not acceptable).

(7) *Evaporative system monitoring.*

(i) *General.* The OBD system must verify purge flow from the evaporative system and monitor the complete evaporative system, excluding the tubing and connections between the purge valve and the intake manifold, for vapor leaks to the atmosphere. Individual components of the evaporative system (e.g., valves, sensors) must be monitored in accordance with the comprehensive components requirements in paragraph (i)(3) of this section.

(ii) *Evaporative system malfunction criteria.*

(A) *Purge monitor.* The OBD system must detect an evaporative system malfunction when no purge flow from the evaporative system to the engine can be detected by the OBD system.

(B) *Leak monitor.* The OBD system must detect an evaporative system malfunction when the complete evaporative system contains a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.150 inch diameter hole.

(C) The manufacturer may demonstrate that detection of a larger hole is more appropriate than that specified in paragraph (h)(7)(ii)(B) of this section. To do so, the manufacturer must demonstrate through data and/or engineering analyses that holes smaller than the proposed detection size would not result in evaporative or running loss emissions that exceed 1.5 times the applicable evaporative emissions standards. Upon such a demonstration, the proposed detection size could be substituted for the requirement of paragraph (h)(7)(ii)(B) of this section.

(iii) *Evaporative system monitoring conditions.*

(A) The manufacturer must define monitoring conditions for malfunctions identified in paragraph (h)(7)(ii)(A) of this section in accordance with paragraphs (c) and (d) of this section.

(B) The manufacturer must define monitoring conditions for malfunctions identified in paragraph (h)(7)(ii)(B) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required by paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraph (h)(7)(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.

(C) The manufacturer may disable or abort an evaporative system monitor when the fuel tank level is over 85 percent of nominal tank capacity or during a refueling event.

(D) The manufacturer may request Administrator approval to run the evaporative system monitor during only those drive cycles characterized as cold starts provided such a condition is needed to ensure reliable monitoring. In making the request, the manufacturer must demonstrate through data and/or engineering analyses that a reliable monitor can only be run on drive cycles that begin with a specific set of cold start criteria. A set of cold start criteria based solely on ambient temperature exceeding engine coolant temperature will not be acceptable.

(E) The OBD system may disable temporarily the evaporative purge system to run an evaporative system leak monitor.

(iv) *Evaporative system MIL activation and DTC storage.*

(A) Except as provided for in paragraph (h)(7)(iv)(B) of this section, the MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(B) If the OBD system is capable of discerning that a system leak is being caused by a missing or improperly secured gas cap, the OBD system need not activate the MIL or store a DTC provided the vehicle is equipped with an alternative indicator for notifying the operator of the gas cap problem. The alternative indicator must be of sufficient illumination and location to be readily visible under all lighting conditions. If the vehicle is not equipped with such an alternative indicator, the MIL must activate and a DTC be stored as required in paragraph (h)(7)(iv)(A) of this section; however, these may be deactivated and erased, respectively, if the OBD system determines that the gas cap problem has been corrected 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 will be notified promptly of a missing or improperly secured gas cap and that corrective action will be undertaken.

(8) *Exhaust gas sensor monitoring.*

(i) *General.*

(A) The OBD system must monitor for malfunctions the output signal, response rate, and any other parameter that can affect emissions of all primary (i.e., fuel control) exhaust gas sensors (e.g., oxygen, wide-range air/fuel). Both the lean-to-rich and rich-to-lean response rates must be monitored.

(B) The OBD system must also monitor all secondary exhaust gas sensors (those used for secondary fuel trim control or as a monitoring device) for proper output signal, activity, and response rate.

(C) For engines equipped with heated exhaust gas sensor, the OBD system must monitor the heater for proper performance.

(ii) *Primary exhaust gas sensor malfunction criteria.*

(A) The OBD system must detect a malfunction prior to any failure or deterioration of the exhaust gas sensor output voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) (including drift or bias corrected for by secondary sensors) that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 2 of this paragraph (h).

(B) The OBD system must detect malfunctions of the exhaust gas sensor caused by either a lack of circuit continuity or out-of-range values.

(C) The OBD system must detect a malfunction of the exhaust gas sensor when a sensor failure or deterioration causes the fuel system to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).

(D) The OBD system must detect a malfunction of the exhaust gas sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst monitoring).

(iii) *Secondary exhaust gas sensor malfunction criteria.*

(A) The OBD system must detect a malfunction prior to any failure or deterioration of the exhaust gas sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause an engine's emissions to exceed the emissions thresholds for ''other monitors'' as shown in Table 2 of this paragraph (h).

(B) The OBD system must detect malfunctions of the exhaust gas sensor caused by a lack of circuit continuity.

(C) To the extent feasible, the OBD system must detect a malfunction of the exhaust gas sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD system monitoring device (e.g., for catalyst monitoring).

(D) The OBD system must detect malfunctions of the exhaust gas sensor caused by out-of-range values.

(E) The OBD system must detect a malfunction of the exhaust gas sensor when a sensor failure or deterioration causes the fuel system (e.g., fuel control) to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).

(iv) *Exhaust gas sensor heater malfunction criteria.*

(A) The OBD system must detect a malfunction of the heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required to be met by the component vendor for heater circuit performance at high mileage). Other malfunction criteria for heater performance malfunctions may be used upon demonstrating via data or engineering analyses that the monitoring reliability and timeliness is equivalent to the stated criteria in this paragraph (h)(8)(iv)(A).

(B) The OBD system must detect malfunctions of the heater circuit including open or short circuits that conflict with the commanded state of the heater (e.g., shorted to 12 Volts when commanded to 0 Volts (ground)).

(v) *Primary exhaust gas sensor monitoring conditions.*

(A) The manufacturer must define monitoring conditions for malfunctions identified in paragraphs (h)(8)(ii)(A) and (h)(8)(ii)(D) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required by paragraph (d)(1) of this section, all monitors used to detect malfunctions identified in paragraphs (h)(8)(ii)(A) and (h)(8)(ii)(D) 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) Except as provided for in paragraph (h)(8)(v)(C) of this section, monitoring for malfunctions identified in paragraphs (h)(8)(ii)(B) and (h)(8)(ii)(C) of this section must be conducted continuously.

(C) The manufacturer may disable continuous primary exhaust gas sensor monitoring when a primary exhaust gas sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). To do so, the manufacturer must demonstrate via data or engineering analyses that a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(vi) *Secondary exhaust gas sensor monitoring conditions.*

(A) The manufacturer must define monitoring conditions for malfunctions identified in paragraphs (h)(8)(iii)(A) through (h)(8)(iii)(C) of this section in accordance with paragraphs (c) and (d) of this section.

(B) Except as provided for in paragraph (h)(8)(vi)(C) of this section, monitoring for malfunctions identified in paragraphs (h)(8)(iii)(D) and (h)(8)(iii)(E) of this section must be conducted continuously.

(C) The manufacturer may disable continuous secondary exhaust gas sensor monitoring when a secondary exhaust gas sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). To do so, the manufacturer must demonstrate via data or engineering analyses that a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(vii) *Exhaust gas sensor heater monitoring conditions.*

(A) The manufacturer must define monitoring conditions for malfunctions identified in paragraph (h)(8)(iv)(A) of this section in accordance with paragraphs (c) and (d) of this section.

(B) Monitoring for malfunctions identified in paragraph (h)(8)(iv)(B) of this section must be conducted continuously.

(viii) *Exhaust gas sensor MIL activation and DTC storage.* The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(9) *Variable valve timing (VVT) system monitoring.*

(i) *General.* The OBD system must monitor the VVT system on engines so equipped for target error and slow response malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the VVT system must be monitored in accordance with the comprehensive components requirements in paragraph (i)(3) of this section.

(ii) *VVT system malfunction criteria.*

(A) *VVT system target error.* The OBD system must detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a crank angle and/or lift tolerance that would cause an engine's emissions to exceed the emission thresholds for ''other monitors'' as shown in Table 2 of this paragraph (h).

(B) *VVT slow response.* The OBD system must detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a manufacturer-specified time that would cause an engine's emissions to exceed the emission thresholds for ''other monitors'' as shown in Table 2 of this paragraph (h).

(C) For engines in which no failure or deterioration of the VVT system could result in an engine's emissions exceeding the applicable emissions thresholds of paragraphs (h)(9)(ii)(A) and (h)(9)(ii)(B) of this paragraph (h), the OBD system must detect a malfunction of the VVT system when proper functional response of the system to computer commands does not occur.

(iii) *VVT system monitoring conditions.* Manufacturers must define the monitoring conditions for VVT system malfunctions identified in paragraph (h)(9)(ii) 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 (h)(9)(ii) 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) *VVT MIL activation and DTC storage.* The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(i) *OBD monitoring requirements for all engines.*

(1) *Engine cooling system monitoring.*

(i) *General.*

(A) The OBD system must monitor the thermostat on engines so equipped for proper operation.

(B) The OBD system must monitor the engine coolant temperature (ECT) sensor for electrical circuit continuity, out-of-range values, and rationality malfunctions.

(C) For engines that use a system other than the cooling system and ECT sensor (e.g., oil temperature, cylinder head temperature) to determine engine operating temperature for emission control purposes (e.g., to modify spark or fuel injection timing or quantity), the manufacturer may forego cooling system monitoring and instead monitor the components or systems used in their approach. To do so, the manufacturer must to submit data and/or engineering analyses that demonstrate that their monitoring plan is as reliable and effective as the monitoring required in this paragraph (i)(1).

(ii) *Malfunction criteria for the thermostat.*

(A) The OBD system must detect a thermostat malfunction if, within the manufacturer specified time interval following engine start, any of the following conditions occur: the coolant temperature does not reach the highest temperature required by the OBD system to enable other diagnostics; and, the coolant temperature does not reach a warmed-up temperature within 20 degrees Fahrenheit of the manufacturer's nominal thermostat regulating temperature. For the second of these two conditions, the manufacturer may use a lower temperature for this criterion provided the manufacturer can demonstrate that the fuel, spark timing, and/or other coolant temperature-based modification to the engine control strategies would not cause an emissions increase greater than or equal to 50 percent of any of the applicable emissions standards.

(B) The manufacturer may use alternative malfunction criteria to those of paragraph (i)(1)(ii)(A) of this section and/or alternative monitoring conditions to those of paragraph (i)(1)(iv) of this section that are a function of temperature at engine start on engines that do not reach the temperatures specified in the malfunction criteria when the thermostat is functioning properly. To do so, the manufacturer is required to submit data and/or engineering analyses that demonstrate that a properly operating system does not reach the specified temperatures and that the possibility is minimized for cooling system malfunctions to go undetected thus disabling other OBD monitors.

(C) The manufacturer may request Administrator approval to forego monitoring of the thermostat if the manufacturer can demonstrate that a malfunctioning thermostat cannot cause a measurable increase in emissions during any reasonable driving condition nor cause any disablement of other OBD monitors.

(iii) *Malfunction criteria for the ECT sensor.*

(A) *Circuit integrity.* The OBD system must detect malfunctions of the ECT sensor related to a lack of circuit continuity or out-of-range values.

(B) *Time to reach closed-loop/feedback enable temperature.* The OBD system must detect if, within the manufacturer specified time interval following engine start, the ECT sensor does not achieve the highest stabilized minimum temperature that is needed to initiate closed-loop/feedback control of all affected emission control systems (e.g., fuel system, EGR system). The manufacturer specified time interval must be a function of the engine coolant temperature and/or intake air temperature at startup. The manufacturer time interval must be supported by data and/or engineering analyses demonstrating that it provides robust monitoring and minimizes the likelihood of other OBD monitors being disabled. The manufacturer may forego the requirements of this paragraph (i)(1)(iii)(B) provided the manufacturer does not use engine coolant temperature or the ECT sensor to enable closed-loop/feedback control of any emission control systems.

(C) *Stuck in range below the highest minimum enable temperature.* To the extent feasible when using all available information, the OBD system must detect a malfunction if the ECT sensor inappropriately indicates a temperature below the highest minimum enable temperature required by the OBD system to enable other monitors (e.g., an OBD system that requires ECT to be greater than 140 degrees Fahrenheit to enable a diagnostic must detect malfunctions that cause the ECT sensor to inappropriately indicate a temperature below 140 degrees Fahrenheit). The manufacturer may forego this requirement for temperature regions in which the monitors required under paragraphs (i)(1)(ii) or (i)(1)(iii)(B) of this section will detect ECT sensor malfunctions as defined in this paragraph (i)(1)(iii)(C).

(D) *Stuck in range above the lowest maximum enable temperature.* The OBD system must detect a malfunction if the ECT sensor inappropriately indicates a temperature above the lowest maximum enable temperature required by the OBD system to enable other monitors (e.g., an OBD system that requires an engine coolant temperature less than 90 degrees Fahrenheit at startup prior to enabling an OBD monitor must detect malfunctions that cause the ECT sensor to indicate inappropriately a temperature above 90 degrees Fahrenheit). The manufacturer may forego this requirement within temperature regions in which the monitors required under paragraphs (i)(1)(ii), (i)(1)(iii)(B), and (i)(1)(iii)(C) of this section will detect ECT sensor malfunctions as defined in this paragraph (i)(1)(iii)(D) or in which the MIL will be activated according to the provisions of paragraph (b)(2)(v) of this section. The manufacturer may also forego this monitoring within temperature regions where a temperature gauge on the instrument panel indicates a temperature in the ‘‘red zone’’ (engine overheating zone) and displays the same temperature information as used by the OBD system.

(iv) *Monitoring conditions for the thermostat.*

(A) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (i)(1)(ii)(A) of this section in accordance with paragraph (c) of this section. Additionally, except as provided for in paragraphs (i)(1)(iv)(B) and (i)(1)(iv)(C) of this section, monitoring for malfunctions identified in paragraph (i)(1)(ii)(A) of this section must be conducted once per drive cycle on every drive cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria in paragraph (i)(1)(ii)(A) of this section.

(B) The manufacturer may disable thermostat monitoring at ambient engine start temperatures below 20 degrees Fahrenheit.

(C) The manufacturer may request Administrator approval to suspend or disable thermostat monitoring if the engine is subjected to conditions that could lead to false diagnosis. To do so, the manufacturer must submit data and/or engineering analyses that demonstrate that the suspension or disablement is necessary. In general, the manufacturer will not be allowed to suspend or disable the thermostat monitor on engine starts where the engine coolant temperature at engine start is more than 35 degrees Fahrenheit lower than the thermostat malfunction threshold temperature determined under paragraph (i)(1)(ii)(A) of this paragraph (i)(1).

(v) *Monitoring conditions for the ECT sensor.*

(A) Except as provided for in paragraph (i)(1)(v)(E) of this section, the OBD system must monitor continuously for malfunctions identified in paragraph (i)(1)(iii)(A) of this section (i.e., circuit integrity and out-of-range).

(B) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (i)(1)(iii)(B) of this section in accordance with paragraph (c) of this section. Additionally, except as provided for in paragraph (i)(1)(v)(D) of this section, monitoring for malfunctions identified in paragraph (i)(1)(iii)(B) of this section must be conducted once per drive cycle on every drive cycle in which the ECT sensor indicates a temperature lower than the closed-loop enable temperature at engine start (i.e., all engine start temperatures greater than the ECT sensor out-of-range low temperature and less than the closed-loop enable temperature).

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

(D) The manufacturer may suspend or delay the monitor for the time to reach closed-loop enable temperature if the engine is subjected to conditions that could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 to 75 percent of the warm-up time).

(E) The manufacturer may request Administrator approval to disable continuous ECT sensor monitoring when an ECT sensor malfunction cannot be distinguished from other effects. To do so, the manufacturer must submit data and/or engineering analyses that demonstrate a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(vi) *Engine cooling 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) *Crankcase ventilation (CV) system monitoring.*

(i) *General.* The OBD system must monitor the CV system on engines so equipped for system integrity. Engines not required to be equipped with CV systems are exempt from monitoring the CV system. For diesel engines, the manufacturer must submit a plan for Administrator prior to OBD certification. That plan must include descriptions of the monitoring strategy, malfunction criteria, and monitoring conditions for CV system monitoring. The plan must demonstrate that the CV system monitor is of equivalent effectiveness, to the extent feasible, to the malfunction criteria and the monitoring conditions of this paragraph (i)(2).

(ii) *Crankcase ventilation system malfunction criteria.*

(A) For the purposes of this paragraph (i)(2), ‘‘CV system’’ is defined as any form of crankcase ventilation system, regardless of whether it utilizes positive pressure. ‘‘CV valve’’ is defined as any form of valve or orifice used to restrict or control crankcase vapor flow. Further, any additional external CV system tubing or hoses used to equalize crankcase pressure or to provide a ventilation path between various areas of the engine (e.g., crankcase and valve cover) are considered part of the CV system ‘‘between the crankcase and the CV valve’’ and subject to the malfunction criteria in paragraph (i)(2)(ii)(B) of this section.

(B) Except as provided for in paragraphs (i)(2)(ii)(C) through (i)(2)(ii)(E) of this section, the OBD system must detect a malfunction of the CV system when a disconnection of the system occurs between either the crankcase and the CV valve, or between the CV valve and the intake manifold.

(C) The manufacturer may forego monitoring for a disconnection between the crankcase and the CV valve provided the CV system is designed such that the CV valve is fastened directly to the crankcase such that it is significantly more difficult to remove the CV valve from the crankcase than to disconnect the line between the CV valve and the intake manifold (taking aging effects into consideration). To do so, the manufacturer must be able to provide data and/or an engineering evaluation demonstrating that the CV system is so designed.

(D) The manufacturer may forego monitoring for a disconnection between the crankcase and the CV valve provided the CV system is designed such that it uses tubing connections between the CV valve and the crankcase that are: resistant to deterioration or accidental disconnection; significantly more difficult to disconnect than is the line between the CV valve and the intake manifold; and, not subject to disconnection per the manufacturer’s repair procedures for any non-CV system repair. To do so, the manufacturer must be able to provide data and/or engineering evaluation demonstrating that the CV system is so designed.

(E) The manufacturer may forego monitoring for a disconnection between the CV valve and the intake manifold provided the CV system is designed such that any disconnection either causes the engine to stall immediately during idle operation, or is unlikely to occur due to a CV system design that is integral to the induction system (e.g., machined passages rather than tubing or hoses). To do so, the manufacturer must be able to provide data and/or an engineering evaluation demonstrating that the CV system is so designed.

(iii) *Crankcase ventilation system monitoring conditions.* The manufacturer must define the monitoring conditions for malfunctions identified in paragraph (i)(2) of this section in accordance with paragraphs (c) and (d) of this section.

(iv) *Crankcase ventilation 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. The stored DTC need not identify specifically the CV system (e.g., a DTC for idle speed control or fuel system monitoring can be stored) if the manufacturer can demonstrate that additional monitoring hardware is necessary to make such an identification and provided the manufacturer's diagnostic and repair procedures for the detected malfunction include directions to check the integrity of the CV system.

(3) *Comprehensive component monitoring.*

(i) *General.* Except as provided for in paragraph (i)(4) of this section, the OBD system must detect a malfunction of any electronic engine component or system not otherwise described in paragraphs (g), (h), (i)(1), and (i)(2) of this section that either provides input to (directly or indirectly, such components may include the crank angle sensor, knock sensor, throttle position sensor, cam position sensor, intake air temperature sensor, boost pressure sensor, manifold pressure sensor, mass air flow sensor, exhaust temperature sensor, exhaust pressure sensor, fuel pressure sensor, fuel composition sensor of a flexible fuel vehicle, etc.) or receives commands from (such components or systems may include the idle speed control system, glow plug system, variable length intake manifold runner systems, supercharger or turbocharger electronic components, heated fuel preparation systems, the wait-to-start lamp on diesel applications, the MIL, etc.) the onboard computer(s) and meets either of the criteria described in paragraphs (i)(3)(i)(A) and/or (i)(3)(i)(B) of this section. Note that, for the purposes of this paragraph (i)(3), ''electronic engine component or system'' does not include components that are driven by the engine and are not related to the control of the fueling, air handling, or emissions of the engine (e.g., power take-off (PTO) components, air conditioning system components, and power steering components).

(A) It can affect emissions during any reasonable in-use driving condition. The manufacturer must be able to provide emission data showing that the component or system, when malfunctioning and installed on a suitable test engine, does not have an emission effect.

(B) It is used as part of the monitoring strategy for any other monitored system or component.

(ii) *Comprehensive component malfunction criteria for input components.*

(A) The OBD system must detect malfunctions of input components caused by a lack of circuit continuity and out-of-range values. In addition, where feasible, rationality checks must also be done and shall verify that a sensor output is neither inappropriately high nor inappropriately low (i.e., ''two-sided'' monitoring).

(B) To the extent feasible, the OBD system must separately detect and store different DTCs that distinguish rationality malfunctions from lack of circuit continuity and out-of-range malfunctions. For lack of circuit continuity and out-of-range malfunctions, the OBD system must, to the extent feasible, separately detect and store different DTCs for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit). The OBD system is not required to store separate DTCs for lack of circuit continuity malfunctions that cannot be distinguished from other out-of-range circuit malfunctions.

(C) For input components that are used to activate alternative strategies that can affect emissions (e.g., AECDs, engine shutdown systems), the OBD system must conduct rationality checks to detect malfunctions that cause the system to activate erroneously or deactivate the alternative strategy. To the extent feasible when using all available information, the rationality check must detect a malfunction if the input component inappropriately indicates a value that activates or deactivates the alternative strategy. For example, for an alternative strategy that activates when the intake air temperature is greater than 120 degrees Fahrenheit, the OBD system must detect malfunctions that cause the intake air temperature sensor to indicate inappropriately a temperature above 120 degrees Fahrenheit.

(D) For engines that require precise alignment between the camshaft and the crankshaft, the OBD system must monitor the crankshaft position sensor(s) and camshaft position sensor(s) to verify proper alignment between the camshaft and crankshaft in addition to monitoring the sensors for circuit continuity and proper rationality. Proper alignment monitoring between a camshaft and a crankshaft is required only in cases where both are equipped with position sensors. For engines equipped with VVT systems and a timing belt or chain, the OBD system must detect a malfunction if the alignment between the camshaft and crankshaft is off by one or more cam/crank sprocket cogs (e.g., the timing belt/chain has slipped by one or more teeth/cogs). If a manufacturer demonstrates that a single tooth/cog misalignment cannot cause a measurable increase in emissions during any reasonable driving condition, the OBD system must detect a malfunction when the minimum number of teeth/cogs misalignment has occurred that does cause a measurable emission increase.

(iii) *Comprehensive component malfunction criteria for output components/systems.*

(A) The OBD system must detect a malfunction of an output component/system when proper functional response does not occur in response to computer commands. If such a functional check is not feasible, the OBD system must detect malfunctions of output components/systems caused by a lack of circuit continuity or circuit malfunction (e.g., short to ground or high voltage). For output component lack of circuit continuity malfunctions and circuit malfunctions, the OBD system is not required to store different DTCs for each distinct malfunction (e.g., open circuit, shorted low). Manufacturers are not required to activate an output component/system when it would not normally be active for the sole purpose of performing a functional check of it as required in this paragraph (i)(3).

(B) For gasoline engines, the idle control system must be monitored for proper functional response to computer commands. For gasoline engines using monitoring strategies based on deviation from target idle speed, a malfunction must be detected when either of the following conditions occurs: the idle speed control system cannot achieve the target idle speed within 200 revolutions per minute (rpm) above the target speed or 100 rpm below the target speed; or, the idle speed control system cannot achieve the target idle speed within the smallest engine speed tolerance range required by the OBD system to enable any other monitors. Regarding the former of these conditions, the manufacturer may use larger engine speed tolerances. To do so, the manufacturer must be able to provide data and/or engineering analyses that demonstrate that the tolerances can be exceeded without a malfunction being present.

(C) For diesel engines, the idle control system must be monitored for proper functional response to computer commands. For diesel engines, a malfunction must be detected when either of the following conditions occurs: the idle fuel control system cannot achieve the target idle speed or fuel injection quantity within ±50 percent of the manufacturer-specified fuel quantity and engine speed tolerances; or, the idle fuel control system cannot achieve the target idle speed or fueling quantity within the smallest engine speed or fueling quantity tolerance range required by the OBD system to enable any other monitors.

(D) Glow plugs/intake air heater systems must be monitored for proper functional response to computer commands and for circuit continuity malfunctions. The glow plug/intake air heater circuit(s) must be monitored for proper current and voltage drop. The manufacturer may use other monitoring strategies but must be able to provide data and/or engineering analyses that demonstrate reliable and timely detection of malfunctions. The OBD system must also detect a malfunction when a single glow plug no longer operates within the manufacturer's specified limits for normal operation. If a manufacturer can demonstrate that a single glow plug malfunction cannot cause a measurable increase in emissions during any reasonable driving condition, the OBD system must instead detect a malfunction when the number of glow plugs needed to cause an emission increase is malfunctioning. To the extent feasible, the stored DTC must identify the specific malfunctioning glow plug(s).

(E) The wait-to-start lamp circuit and the MIL circuit must be monitored for malfunctions that cause either lamp to fail to activate when commanded to do so (e.g., burned out bulb).

(iv) *Monitoring conditions for input components.*

(A) The OBD system must monitor input components continuously for out-of-range values and circuit continuity. The manufacturer may disable continuous monitoring for circuit continuity and out-of-range values when a malfunction cannot be distinguished from other effects. To do so, the manufacturer must be able to provide data and/or engineering analyses that demonstrate that a properly functioning input component cannot be distinguished from a malfunctioning input component and that the disablement interval is limited only to that necessary for avoiding false malfunction detection.

(B) For input component rationality checks (where applicable), the manufacturer must define the monitoring conditions for detecting malfunctions in accordance with paragraphs (c) and (d) of this section, with the exception that rationality checks 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.

(v) *Monitoring conditions for output components/systems.*

(A) The OBD system must monitor output components/systems continuously for circuit continuity and circuit malfunctions. The manufacturer may disable continuous monitoring for circuit continuity and circuit malfunctions when a malfunction cannot be distinguished from other effects. To do so, the manufacturer must be able to provide data and/or engineering analyses that demonstrate that a properly functioning output component/system cannot be distinguished from a malfunctioning one and that the disablement interval is limited only to that necessary for avoiding false malfunction detection.

(B) For output component/system functional checks, the manufacturer must define the monitoring conditions for detecting malfunctions in accordance with paragraphs (c) and (d) of this section. Specifically for the idle control system, the manufacturer must define the monitoring conditions for detecting malfunctions in accordance with paragraphs (c) and (d) of this section, with the exception that functional checks 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.

(vi) *Comprehensive component MIL activation and DTC storage.*

(A) Except as provided for in paragraphs (i)(3)(vi)(B) and (i)(3)(vi)(C) of this section, the MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(B) The MIL need not be activated in conjunction with storing a MIL-on DTC for any comprehensive component if: the component or system, when malfunctioning, could not cause engine emissions to increase by 15 percent or more of the applicable FTP standard during any reasonable driving condition; or, the component or system is not used as part of the monitoring strategy for any other system or component that is required to be monitored.

(C) The MIL need not be activated if a malfunction has been detected in the MIL circuit that prevents the MIL from activating (e.g., burned out bulb or light-emitting diode, LED). Nonetheless, the electronic MIL status (see paragraph (k)(4)(ii) of this section) must be reported as MIL commanded-on and a MIL-on DTC must be stored.

(4) *Other emission control system monitoring.*

(i) *General.* For other emission control systems that are either not addressed in paragraphs (g) through (i)(3) of this section (e.g., hydrocarbon traps, homogeneous charge compression ignition control systems), or addressed in paragraph (i)(3) of this section but not corrected or compensated for by an adaptive control system (e.g., swirl control valves), the manufacturer must submit a plan for Administrator approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production engine. The plan must demonstrate the effectiveness of the monitoring strategy, the malfunction criteria used, the monitoring conditions required by the monitor, and, if applicable, the determination that the requirements of paragraph (i)(4)(ii) of this section are satisfied.

(ii) For engines that use emission control systems that alter intake air flow or cylinder charge characteristics by actuating valve(s), flap(s), etc., in the intake air delivery system (e.g., swirl control valve systems), the manufacturer, in addition to meeting the requirements of paragraph (i)(4)(i) of this section, may elect to have the OBD system monitor the shaft to which all valves in one intake bank are physically attached rather than performing a functional check of the intake air flow, cylinder charge, or individual valve(s)/flap(s). For non-metal shafts or segmented shafts, the monitor must verify all shaft segments for proper functional response (e.g., by verifying that the segment or portion of the shaft farthest from the actuator functions properly). For systems that have more than one shaft to operate valves in multiple intake banks, the manufacturer is not required to add more than one set of detection hardware (e.g., sensor, switch) per intake bank to meet this requirement.

(5) *Exceptions to OBD monitoring requirements.*

(i) The Administrator may revise the PM filtering performance malfunction criteria for DPFs to exclude detection of specific failure modes such as partially melted substrates, if the most reliable monitoring method developed requires it.

(ii) The manufacturer may disable an OBD system monitor at ambient engine start temperatures below 20 degrees Fahrenheit (low ambient temperature conditions may be determined based on intake air or engine coolant temperature at engine start) or at elevations higher than 8,000 feet above sea level. To do so, the manufacturer must submit data and/or engineering analyses that demonstrate that monitoring is unreliable during the disable conditions. A manufacturer may request that an OBD system monitor be disabled at other ambient engine start temperatures by submitting data and/or engineering analyses demonstrating that misdiagnosis would occur at the given ambient temperatures due to their effect on the component itself (e.g., component freezing).

(iii) The manufacturer may disable an OBD system monitor when the fuel level is 15 percent or less of the nominal fuel tank capacity for those monitors that can be affected by low fuel level or running out of fuel (e.g., misfire detection). To do so, the manufacturer must submit data and/or engineering analyses that demonstrate that monitoring at the given fuel levels is unreliable, and that the OBD system is still able to detect a malfunction if the component(s) used to determine fuel level indicates erroneously a fuel level that causes the disablement.

(iv) The manufacturer may disable OBD monitors that can be affected by engine battery or system voltage levels.

(A) For an OBD monitor affected by low vehicle battery or system voltages, manufacturers may disable monitoring when the battery or system voltage is below 11.0 Volts. The manufacturer may use a voltage threshold higher than 11.0 Volts to disable monitors but must submit data and/or engineering analyses that demonstrate that monitoring at those voltages is unreliable and that either operation of a vehicle below the disablement criteria for extended periods of time is unlikely or the OBD system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

(B) For an OBD monitor affected by high engine battery or system voltages, the manufacturer may disable monitoring when the battery or system voltage exceeds a manufacturer-defined voltage. To do so, the manufacturer must submit data and/or engineering analyses that demonstrate that monitoring above the manufacturer-defined voltage is unreliable and that either the electrical charging system/alternator warning light will be activated (or voltage gauge would be in the ''red zone'') or the OBD system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

(v) The manufacturer may also disable affected OBD monitors in systems designed to accommodate the installation of power take off (PTO) units provided monitors are disabled only while the PTO unit is active and the OBD readiness status (see paragraph (k)(4)(i) of this section) is cleared by the onboard computer (i.e., all monitors set to indicate ''not complete'' or ''not ready'') while the PTO unit is activated. If monitors are so disabled and when the disablement ends, the readiness status may be restored to its state prior to PTO activation.

(6) *Feedback control system monitoring.* If the engine is equipped with feedback control of any of the systems covered in paragraphs (g), (h) and (i) of this section, then the OBD system must detect as malfunctions the conditions specified in this paragraph (i)(6) for each of the individual feedback controls.

(i) The OBD system must detect when the system fails to begin feedback control within a manufacturer specified time interval.

(ii) When any malfunction or deterioration causes open loop or limp-home operation.

(iii) When feedback control has used up all of the adjustment allowed by the manufacturer.

(iv) A manufacturer may temporarily disable monitoring for malfunctions specified in paragraph (i)(6)(iii) of this section during conditions that the specific monitor cannot distinguish robustly between a malfunctioning system and a properly operating system. To do so, the manufacturer is required to submit data and/or engineering analyses demonstrating that the individual feedback control system, when operating as designed on an engine with all emission controls working properly, routinely operates during these conditions while having used up all of the adjustment allowed by the manufacturer. In lieu of detecting, with a system specific monitor, the malfunctions specified in paragraphs (i)(6)(i) and (i)(6)(ii) of this section the OBD system may monitor the individual parameters or components that are used as inputs for individual feedback control systems provided that the monitors detect all malfunctions that meet the criteria of paragraphs (i)(6)(i) and (i)(6)(ii) of this section.

(a) *Production evaluation testing.*

(1) [Reserved.]

(2) *Verification of monitoring requirements.*

(i) Within either the first six months of the start of engine production or the first three months of the start of vehicle production, whichever is later, the manufacturer must conduct a complete evaluation of the OBD system of one or more production vehicles (test vehicles) and submit the results of the evaluation to the Administrator.

(ii) *Selection of test vehicles.*

(A) For each engine selected for monitoring system demonstration in paragraph (l) of this section, the manufacturer must evaluate one production vehicle equipped with an engine from the same engine family and rating as the demonstration engine. The vehicle selection must be approved by the Administrator.

(B) If the manufacturer is required to test more than one test vehicle, the manufacturer may test an engine in lieu of a vehicle for all but one of the required test vehicles.

(C) The requirement for submittal of data from one or more of the test vehicles may be waived if data have been submitted previously for all of the engine ratings and variants.

(iii) *Evaluation requirements.*

(A) The evaluation must demonstrate the ability of the OBD system on the selected test vehicle to detect a malfunction, activate the MIL, and, where applicable, store an appropriate DTC readable by a scan tool when a malfunction is present and the monitoring conditions have been satisfied for each individual monitor required by this section.

(B) The evaluation must verify that the malfunction of any component used to enable another OBD monitor but that does not itself result in MIL activation (e.g., fuel level sensor) will not inhibit the ability of other OBD monitors to detect malfunctions properly.

(C) The evaluation must verify that the software used to track the numerator and denominator for the purpose of determining in-use monitoring frequency increments as required by paragraph (d)(2) of this section.

(D) Malfunctions may be implanted mechanically or simulated electronically, but internal onboard computer hardware or software changes shall not be used to simulate malfunctions. For monitors that are required to indicate a malfunction before emissions exceed an emission threshold, manufacturers are not required to use malfunctioning components/systems set exactly at their malfunction criteria limits. Emission testing is not required to confirm that the malfunction is detected before the appropriate emission thresholds are exceeded.

(E) The manufacturer must submit a proposed test plan for approval prior to performing evaluation testing. The test plan must identify the method used to induce a malfunction for each monitor.

(F) If the demonstration of a specific monitor cannot be reasonably performed without causing physical damage to the test vehicle (e.g., onboard computer internal circuit malfunctions), the manufacturer may omit the specific demonstration.

(G) For evaluation of test vehicles selected in accordance with paragraph (j)(2)(ii) of this section, the manufacturer is not required to demonstrate monitors that were demonstrated prior to certification as required in paragraph (l) of this section.

(iv) The manufacturer must submit a report of the results of all testing conducted as required by paragraph (j)(2) of this section. The report must identify the method used to induce a malfunction in each monitor, the MIL activation status, and the DTC(s) stored.

(3) *Verification of in-use monitoring performance ratios.*

(i) The manufacturer must collect and report in-use monitoring performance data representative of production vehicles (i.e., engine rating and chassis application combination). The manufacturer must collect and report the data to the Administrator within 12 months after the first production vehicle was first introduced into commerce.

(ii) The manufacturer must separate production vehicles into the monitoring performance groups and submit data that represents each of these groups. The groups shall be based on the following criteria:

(A) Emission control system architecture. All engines that use the same or similar emissions control system architecture (e.g., EGR with DPF and SCR; EGR with DPF and NO_X adsorber; EGR with DPF-only) and associated monitoring system would be in the same emission architecture category.

(B) Vehicle application type. Within an emission architecture category, engines shall be separated into one of three vehicle application types: engines intended primarily for line-haul chassis applications, engines intended primarily for urban delivery chassis applications, and all other engines.

(iii) The manufacturer may use an alternative grouping method to collect representative data. To do so, the manufacturer must show that the alternative groups include production vehicles using similar emission controls, OBD strategies, monitoring condition calibrations, and vehicle application driving/usage patterns such that they are expected to have similar in-use monitoring performance. The manufacturer will still be required to submit one set of data for each of the alternative groups.

(iv) For each monitoring performance group, the data must include all of the in-use performance tracking data (i.e., all numerators, denominators, the general denominator, and the ignition cycle counter), the date the data were collected, the odometer reading, the VIN, and the calibration ID.

(v) The manufacturer must submit a plan to the Administrator that details the types of production vehicles in each monitoring performance group, the number of vehicles per group to be sampled, the sampling method, the timeline to collect the data, and the reporting format. The plan must provide for effective collection of data from, at least, 15 vehicles per monitoring performance group and provide for data that represent a broad range of temperature conditions. The plan shall not, by design, exclude or include specific vehicles in an attempt to collect data only from vehicles expected to have the highest in-use performance ratios.

(vi) The 12 month deadline for reporting may be extended to 18 months if the manufacturer can show that the delay is justified. In such a case, an interim report of progress to date must be submitted within the 12 month deadline.

(k) *Standardization requirements.*

(1) *Reference materials.* The OBD system must conform with the following Society of Automotive Engineers (SAE) standards and/or the following International Standards Organization (ISO) standards. The following documents are incorporated by reference, see § 86.1:

(i) SAE material. Copies of these materials may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096–0001.

(A) SAE J1930 ''Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms—Equivalent to ISO/TR 15031–2:April 30, 2002,'' April 2002.

(B) SAE J1939 ''Recommended Practice for a Serial Control and Communications Vehicle Network'' and the associated subparts included in SAE HS–1939, ''Truck and Bus Control and Communications Network Standards Manual,'' 2006 Edition.

(C) [Reserved.]

(D) SAE J1978 ''OBD II Scan Tool—Equivalent to ISO/DIS 15031–4: December 14, 2001,'' April 2002.

(E) SAE J1979 ''E/E Diagnostic Test Modes—Equivalent to ISO/DIS 15031–5:April 30, 2002,'' April 2002.

(F) SAE J2012 ''Diagnostic Trouble Code Definitions—Equivalent to ISO/DIS 15031–6:April 30, 2002,'' April 2002.

(G) SAE J2403 ''Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature,'' August 2004.

(H) SAE J2534 ''Recommended Practice for Pass-Thru Vehicle Reprogramming,'' February 2002.

(ii) ISO materials. Copies of these materials may be obtained from the International Organization for Standardization, Case Postale 56, CH–1211 Geneva 20, Switzerland.

(A) ISO 15765–4:2001 ''Road Vehicles-Diagnostics on Controller Area Network (CAN)—Part 4: Requirements for emission-related systems,'' December 2001.

(2) The manufacturer defined data link connector must be accessible to a trained service technician.

(3) [Reserved.]

(4) *Required emission related functions.* The following functions must be implemented and must be accessible by, at a minimum, a manufacturer scan tool:

(i) *Ready status.* The OBD system must indicate ''complete'' or ''not complete'' for each of the installed monitored components and systems identified in paragraphs (g), (h) with the exception of (h)(4), and (i)(3) of this section. All components or systems identified in paragraphs (h)(1), (h)(2), or (i)(3) of this section that are monitored continuously must always indicate ''complete.'' Components or systems that are not subject to being monitored continuously must immediately indicate ''complete'' upon the respective monitor(s) being executed fully and determining that the component or system is not malfunctioning. A component or system must also indicate ''complete'' if, after the requisite number of decisions necessary for determining MIL status has been executed fully, the monitor indicates a malfunction of the component or system. The status for each of the monitored components or systems must indicate ''not complete'' whenever diagnostic memory has been cleared or erased by a means other than that allowed in paragraph (b) of this section. Normal vehicle shut down (i.e., key-off/engine-off) shall not cause the status to indicate ''not complete.''

(A) The manufacturer may request that the ready status for a monitor be set to indicate ''complete'' without the monitor having completed if monitoring is disabled for a multiple number of drive cycles due to the continued presence of extreme operating conditions (e.g., cold ambient temperatures, high altitudes). Any such request must specify the conditions for monitoring system disablement and the number of drive cycles that would pass without monitor completion before ready status would be indicated as ''complete.''

(B) For the evaporative system monitor, the ready status must be set in accordance with this paragraph (k)(4)(i) when both the functional check of the purge valve and, if applicable, the leak detection monitor of the hole size specified in paragraph (h)(7)(ii)(B) of this section indicate that they are complete.

(C) If the manufacturer elects to indicate ready status through the MIL in the key-on/engine-off position as provided for in paragraph (b)(1)(iii) of this section, the ready status must be indicated in the following manner: If the ready status for all monitored components or systems is ''complete,'' the MIL shall remain continuously activated in the key-on/engine-off position for at least 10–20 seconds. If the ready status for one or more of the monitored components or systems is ''not complete,'' after at least 5 seconds of operation in the key-on/engine-off position with the MIL activated continuously, the MIL shall blink once per second for 5–10 seconds. The data stream value for MIL status as required in paragraph (k)(4)(ii) of this section must indicate ''commanded off'' during this sequence unless the MIL has also been ''commanded on'' for a detected malfunction.

(ii) *Data stream.* The following signals must be made available on demand through the data link connector. The actual signal value must always be used instead of a limp home value.

(A) *For gasoline engines.*

(1) Calculated load value, engine coolant temperature, engine speed, vehicle speed, and time elapsed since engine start.

(2) Absolute load, fuel level (if used to enable or disable any other monitors), barometric pressure (directly measured or estimated), engine control module system voltage, and commanded equivalence ratio.

(3) Number of stored MIL-on DTCs, catalyst temperature (if directly measured or estimated for purposes of enabling the catalyst monitor(s)), monitor status (i.e., disabled for the rest of this drive cycle, complete this drive cycle, or not complete this drive cycle) since last engine shut-off for each monitor used for ready status, distance traveled (or engine run time for engines not using vehicle speed information) while MIL activated, distance traveled (or engine run time for engines not using vehicle speed information) since DTC memory last erased, and number of warm-up cycles since DTC memory last erased, OBD requirements to which the engine is certified (e.g., California OBD, EPA OBD, European OBD, non-OBD) and MIL status (i.e., commanded-on or commanded-off).

(B) *For diesel engines.*

(1) Calculated load (engine torque as a percentage of maximum torque available at the current engine speed), driver's demand engine torque (as a percentage of maximum engine torque), actual engine torque (as a percentage of maximum engine torque), reference engine maximum torque, reference maximum engine torque as a function of engine speed (suspect parameter numbers (SPN) 539 through 543 defined by SAE J1939 within parameter group number (PGN) 65251 for engine configuration), engine coolant temperature, engine oil temperature (if used for emission control or any OBD monitors), engine speed, and time elapsed since engine start.

(2) Fuel level (if used to enable or disable any other monitors), vehicle speed (if used for emission control or any OBD monitors), barometric pressure (directly measured or estimated), and engine control module system voltage.

(3) Number of stored MIL-on DTCs, monitor status (i.e., disabled for the rest of this drive cycle, complete this drive cycle, or not complete this drive cycle) since last engine shut-off for each monitor used for ready status, distance traveled (or engine run time for engines not using vehicle speed information) while MIL activated, distance traveled (or engine run time for engines not using vehicle speed information) since DTC memory last erased, number of warm-up cycles since DTC memory last erased, OBD requirements to which the engine is certified (e.g., California OBD, EPA OBD, European OBD, non-OBD), and MIL status (i.e., commanded-on or commanded-off).

(4) NO_X NTE control area status (i.e., inside control area, outside control area, inside manufacturer-specific NO_X NTE carve-out area, or deficiency active area) and PM NTE control area status (i.e., inside control area, outside control area, inside manufacturer-specific PM NTE carve-out area, or deficiency active area).

(5) For purposes of the calculated load and torque parameters in paragraph (k)(4)(ii)(B)(1) of this section, manufacturers must report the most accurate values that are calculated within the applicable electronic control unit (e.g., the engine control module). Most accurate, in this context, must be of sufficient accuracy, resolution, and filtering to be used for the purposes of in-use emission testing with the engine still in a vehicle (e.g., using portable emission measurement equipment).

(C) *For all engines so equipped.*

(1) Absolute throttle position, relative throttle position, fuel control system status (e.g., open loop, closed loop), fuel trim, fuel pressure, ignition timing advance, fuel injection timing, intake air/manifold temperature, engine intercooler temperature, manifold absolute pressure, air flow rate from mass air flow sensor, secondary air status (upstream, downstream, or atmosphere), ambient air temperature, commanded purge valve duty cycle/position, commanded EGR valve duty cycle/position, actual EGR valve duty cycle/position, EGR error between actual and commanded, PTO status (active or not active), redundant absolute throttle position (for electronic throttle or other systems that utilize two or more sensors), absolute pedal position, redundant absolute pedal position, commanded throttle motor position, fuel rate, boost pressure, commanded/target boost pressure, turbo inlet air temperature, fuel rail pressure, commanded fuel rail pressure, DPF inlet pressure, DPF inlet temperature, DPF outlet pressure, DPF outlet temperature, DPF delta pressure, exhaust pressure sensor output, exhaust gas temperature sensor output, injection control pressure, commanded injection control pressure, turbocharger/turbine speed, 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, waste gate valve position, and glow plug lamp status.

(2) Oxygen sensor output, air/fuel ratio sensor output, NO_X sensor output, and evaporative system vapor pressure.

(iii) *Freeze frame.*

(A) ''Freeze frame'' information required to be stored pursuant to paragraphs (b)(2)(iv), (h)(1)(iv)(D), and (h)(2)(vi) of this section must be made available on demand through the data link connector.

(B) ''Freeze frame'' conditions must include the DTC that caused the data to be stored along with all of the signals required in paragraphs (k)(4)(ii)(A)(*1*) or (k)(4)(ii)(B)(*1*) of this section. Freeze frame conditions must also include all of the signals required on the engine in paragraphs (k)(4)(ii)(A)(*2*) and (k)(4)(ii)(B)(*2*) of this section, and paragraph (k)(4)(ii)(C)(*1*) of this section that are used for diagnostic or control purposes in the specific monitor or emission-critical powertrain control unit that stored the DTC.

(C) Only one frame of data is required to be recorded. The manufacturer may choose to store additional frames provided that at least the required frame can be read by, at a minimum, a manufacturer scan tool.

(iv) *Diagnostic trouble codes*.

(A) For all monitored components and systems, any stored pending, MIL-on, and previous-MIL-on DTCs must be made available through the diagnostic connector.

(B) The stored DTC must, to the extent possible, pinpoint the probable cause of the malfunction or potential malfunction. To the extent feasible, the manufacturer must use separate DTCs for every monitor where the monitor and repair procedure or probable cause of the malfunction is different. In general, rationality and functional checks must use different DTCs than the respective circuit integrity checks. Additionally, input component circuit integrity checks must use different DTCs for distinct malfunctions (e.g., out-of-range low, out-of-range high, open circuit).

(C) The manufacturer must use appropriate standard-defined DTCs whenever possible. With Administrator approval, the manufacturer may use manufacturer-defined DTCs in accordance with the applicable standard's specifications. To do so, the manufacturer must be able to show a lack of available standard-defined DTCs, uniqueness of the monitor or monitored component, expected future usage of the monitor or component, and estimated usefulness in providing additional diagnostic and repair information to service technicians. Manufacturer-defined DTCs must be used in a consistent manner (i.e., the same DTC shall not be used to represent two different failure modes) across a manufacturer's entire product line.

(D) A pending or MIL-on DTC (as required in paragraphs (g) through (i) of this section) must be stored and available to, at a minimum, a manufacturer scan tool within 10 seconds after a monitor has determined that a malfunction or potential malfunction has occurred. A permanent DTC must be stored and available to, at a minimum, a manufacturer scan tool no later than the end of an ignition cycle in which the corresponding MIL-on DTC that caused MIL activation has been stored.

(E) Pending DTCs for all components and systems (including those monitored continuously and non-continuously) must be made available through the diagnostic connector. A manufacturer using alternative statistical protocols for MIL activation as allowed in paragraph (b)(2)(iii) of this section must submit the details of their protocol for setting pending DTCs. The protocol must be, overall, equivalent to the requirements of this paragraph (k)(4)(iv)(E) and provide service technicians with a quick and accurate indication of a potential malfunction.

(F) Permanent DTC for all components and systems must be made available through the diagnostic connector in a format that distinguishes permanent DTCs from pending DTCs, MIL-on DTCs, and previous-MIL-on DTCs. A MIL-on DTC must be stored as a permanent DTC no later than the end of the ignition cycle and subsequently at all times that the MIL-on DTC is commanding the MIL on. Permanent DTCs must be stored in non-volatile random access memory (NVRAM) and shall not be erasable by any scan tool command or by disconnecting power to the on-board computer. Permanent DTCs must be erasable if the engine control module is reprogrammed and the ready status described in paragraph (k)(4)(i) of this section for all monitored components and systems are set to ''not complete.'' The OBD system must have the ability to store a minimum of four current MIL-on DTCs as permanent DTCs in NVRAM. If the number of MIL-on DTCs currently commanding activation of the MIL exceeds the maximum number of permanent DTCs that can be stored, the OBD system must store the earliest detected MIL-on DTC as permanent DTC. If additional MIL-on DTCs are stored when the maximum number of permanent DTCs is already stored in NVRAM, the OBD system shall not replace any existing permanent DTC with the additional MIL-on DTCs.

(v) *Test results.*

(A) Except as provided for in paragraph (k)(4)(v)(G) of this section, for all monitored components and systems identified in paragraphs (g) and (h) of this section, results of the most recent monitoring of the components and systems and the test limits established for monitoring the respective components and systems must be stored and available through the data link.

(B) The test results must be reported such that properly functioning components and systems (e.g., ''passing'' systems) do not store test values outside of the established test limits. Test limits must include both minimum and maximum acceptable values and must be defined so that a test result equal to either test limit is a ''passing'' value, not a ''failing'' value.

(C) [Reserved.]

(D) The test results must be stored until updated by a more recent valid test result or the DTC memory of the OBD system computer is cleared. Upon DTC memory being cleared, test results reported for monitors that have not yet completed with valid test results since the last time the fault memory was cleared must report values of zero for the test result and test limits.

(E) All test results and test limits must always be reported and the test results must be stored until updated by a more recent valid test result or the DTC memory of the OBD system computer is cleared.

(F) The OBD system must store and report unique test results for each separate monitor.

(G) The requirements of this paragraph (k)(4)(v) do not apply to continuous fuel system monitoring, cold start emission reduction strategy monitoring, and continuous circuit monitoring.

(vi) *Software calibration identification (CAL ID).* On all engines, a single software calibration identification number (CAL ID) for each monitor or emission critical control unit(s) must be made available through the data link connector. A unique CAL ID must be used for every emission-related calibration and/or software set having at least one bit of different data from any other emission-related calibration and/or software set. Control units coded with multiple emission or diagnostic calibrations and/or software sets must indicate a unique CAL ID for each variant in a manner that enables an off-board device to determine which variant is being used by the vehicle. Control units that use a strategy that will result in MIL activation if the incorrect variant is used (e.g., control units that contain variants for manual and automatic transmissions but will activate the MIL if the selected variant does not match the type of transmission mated to the engine) are not required to use unique CAL IDs.

(vii) *Software calibration verification number (CVN).*

(A) All engines must use an algorithm to calculate a single calibration verification number (CVN) that verifies the on-board computer software integrity for each monitor or emission critical control unit that is electronically reprogrammable. The CVN must be made available through the data link connector. The CVN must indicate whether the emission-related software and/or calibration data are valid and applicable for the given vehicle and CAL ID.

(B) The CVN algorithm used to calculate the CVN must be of sufficient complexity that the same CVN is difficult to achieve with modified calibration values.

(C) The CVN must be calculated at least once per drive cycle and stored until the CVN is subsequently updated. Except for immediately after a reprogramming event or a non-volatile memory clear or for the first 30 seconds of engine operation after a volatile memory clear or battery disconnect, the stored value must be made available through the data link connector to, at a minimum, a manufacturer scan tool. The stored CVN value shall not be erased when DTC memory is erased or during normal vehicle shut down (i.e., key-off/engine-off).

(D) [Reserved.]

(viii) *Vehicle identification number (VIN).*

(A) All vehicles must have the vehicle identification number (VIN) available through the data link connector to, at a minimum, a manufacturer scan tool. Only one electronic control unit per vehicle may report the VIN to a scan tool.

(B) If the VIN is reprogrammable, all emission-related diagnostic information identified in paragraph (k)(4)(ix)(A) of this section must be erased in conjunction with reprogramming of the VIN.

(ix) *Erasure of diagnostic information.*

(A) For purposes of this paragraph (k)(4)(ix), ''emission-related diagnostic information'' includes all of the following: ready status as required by paragraph (k)(4)(i) of this section; data stream information as required by paragraph (k)(4)(ii) of this section including the number of stored MIL-on DTCs, distance traveled while MIL activated, number of warm-up cycles since DTC memory last erased, and distance traveled since DTC memory last erased; freeze frame information as required by paragraph (k)(4)(iii) of this section; pending, MIL-on, and previous-MIL-on DTCs as required by paragraph (k)(4)(iv) of this section; and, test results as required by paragraph (k)(4)(v) of this section.

(B) For all engines, the emission-related diagnostic information must be erased if commanded by any scan tool and may be erased if the power to the on-board computer is disconnected. If any of the emission-related diagnostic information is commanded to be erased by any scan tool, all emission-related diagnostic information must be erased from all diagnostic or emission critical control units. The OBD system shall not allow a scan tool to erase a subset of the emission-related diagnostic information (e.g., the OBD system shall not allow a scan tool to erase only one of three stored DTCs or only information from one control unit without erasing information from the other control unit(s)).

(5) *In-use performance ratio tracking requirements.*

(i) For each monitor required in paragraphs (g) through (i) of this section to separately report an in-use performance ratio, manufacturers must implement software algorithms to report a numerator and denominator.

(ii) For the numerator, denominator, general denominator, and ignition cycle counters required by paragraph (e) of this section, the following numerical value specifications apply:

(A) Each number shall have a minimum value of zero and a maximum value of 65,535 with a resolution of one.

(B) Each number shall 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 unit (e.g., battery disconnect). Numbers shall not be reset to zero under any other circumstances including when a scan tool command to clear DTCs or reset KAM is received.

(C) To avoid overflow problems, if either the numerator or denominator for a specific component reaches the maximum value of 65,535 ±2, both numbers shall be divided by two before either is incremented again.

(D) To avoid overflow problems, if the ignition cycle counter reaches the maximum value of 65,535 ±2, the ignition cycle counter shall roll over and increment to zero on the next ignition cycle.

(E) To avoid overflow problems, if the general denominator reaches the maximum value of 65,535 ±2, the general denominator shall roll over and increment to zero on the next drive cycle that meets the general denominator definition.

(F) If a vehicle is not equipped with a component (e.g., oxygen sensor bank 2, secondary air system), the corresponding numerator and denominator for that specific component shall always be reported as zero.

(iii) For the ratio required by paragraph (e) of this section, the following numerical value specifications apply:

(A) The ratio shall have a minimum value of zero and a maximum value of 7.99527 with a resolution of 0.000122.

(B) The ratio for a specific component shall be considered to be zero whenever the corresponding numerator is equal to zero and the corresponding denominator is not zero.

(C) The ratio for a specific component shall 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.

(6) *Engine run time tracking requirements.*

(i) For all gasoline and diesel engines, the manufacturer must implement software algorithms to track and report individually the amount of time the engine has been operated in the following conditions:

(A) Total engine run time.

(B) Total idle run time (with ''idle'' defined as accelerator pedal released by the driver, vehicle speed less than or equal to one mile per hour, engine speed greater than or equal to 50 to 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission), and power take-off not active).

(C) Total run time with power take off active.

(ii) For each counter specified in paragraph (k)(6)(i) of this section, the following numerical value specifications apply:

(A) Each number shall be a four-byte value with a minimum value of zero, a resolution of one second per bit, and an accuracy of ± ten seconds per drive cycle.

(B) Each number shall be reset to zero only when a non-volatile memory reset occurs (e.g., reprogramming event). Numbers shall not be reset to zero under any other circumstances including when a scan tool (generic or enhanced) command to clear fault codes or reset KAM is received.

(C) To avoid overflow problems, if any of the individual counters reach the maximum value, all counters shall be divided by two before any are incremented again.

(D) The counters shall be made available to, at a minimum, a manufacturer scan tool and may be rescaled when transmitted from a resolution of one second per bit to no more than three minutes per bit.

(l) *Monitoring system demonstration requirements for certification.*

(1) *General.*

(i) The manufacturer must submit emissions test data from one or more durability demonstration test engines (test engines).

(ii) The Administrator may approve other demonstration protocols if the manufacturer can provide comparable assurance that the malfunction criteria are chosen based on meeting the malfunction criteria requirements and that the timeliness of malfunction detection is within the constraints of the applicable monitoring requirements.

(iii) For flexible fuel engines capable of operating on more than one fuel or fuel combinations, the manufacturer must submit a plan for providing emission test data. The plan must demonstrate that testing will represent properly the expected in-use fuel or fuel combinations.

(2) *Selection of test engines.*

(i) Prior to submitting any applications for certification for a model year, the manufacturer must notify the Administrator regarding the planned engine families and engine ratings within each family for that model year. The Administrator will select the engine family(ies) and the specific engine rating within the engine family(ies) that the manufacturer shall use as demonstration test engines. The selection of test vehicles for production evaluation testing as specified in paragraph (j)(2) of this section may take place during this selection process.

(ii) The manufacturer must provide emissions test data from the OBD parent rating as defined in paragraph (o)(1) of this section.

(iii) For the test engine, the manufacturer must use an engine aged for a minimum of 125 hours fitted with exhaust aftertreatment emission controls aged to be representative of useful life aging. The manufacturer is required to submit a description of the accelerated aging process and/or supporting data. The process and/or data must demonstrate assurance that deterioration of the exhaust aftertreatment emission controls is stabilized sufficiently such that it represents emission control performance at the end of the useful life.

(3) *Required testing.* Except as otherwise described in this paragraph (l)(3), the manufacturer must perform single malfunction testing based on the applicable test with the components/systems set at their malfunction criteria limits as determined by the manufacturer for meeting the emissions thresholds required in paragraphs (g), (h), and (i) of this section.

(i) *Required testing for diesel-fueled/compression ignition engines.*

(A) *Fuel system.* The manufacturer must perform a separate test for each malfunction limit established by the manufacturer for the fuel system parameters (e.g., fuel pressure, injection timing) specified in paragraphs (g)(1)(ii)(A) through (g)(1)(ii)(C) of this section. When performing a test for a specific parameter, the fuel system must be operating at the malfunction criteria limit for the applicable parameter only. All other parameters must be operating with normal characteristics. In conducting the fuel system demonstration tests, the manufacturer may use computer modifications to cause the fuel system to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(B) [Reserved.]

(C) *EGR system.* The manufacturer must perform a separate test for each malfunction limit established by the manufacturer for the EGR system parameters (e.g., low flow, high flow, slow response) specified in paragraphs (g)(3)(ii)(A) through (g)(3)(ii)(C) of this section and in (g)(3)(ii)(E) of this section. In conducting the EGR system slow response demonstration tests, the manufacturer may use computer modifications to cause the EGR system to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(D) *Turbo boost control system.* The manufacturer must perform a separate test for each malfunction limit established by the manufacturer for the turbo boost control system parameters (e.g., underboost, overboost, response) specified in paragraphs (g)(4)(ii)(A) through (g)(4)(ii)(C) of this section and in (g)(4)(ii)(E) of this section.

(E) *NMHC catalyst.* The manufacturer must perform a separate test for each monitored NMHC catalyst(s). The catalyst(s) being evaluated must be deteriorated to the applicable malfunction limit established by the manufacturer for the monitoring required by paragraph (g)(5)(ii)(A) of this section and using methods established by the manufacturer in accordance with paragraph (l)(7) of this section. For each monitored NMHC catalyst(s), the manufacturer must also demonstrate that the OBD system will detect a catalyst malfunction with the catalyst at its maximum level of deterioration (i.e., the substrate(s) completely removed from the catalyst container or ''empty'' can). Emissions data are not required for the empty can demonstration.

(F) *NO_X catalyst.* The manufacturer must perform a separate test for each monitored NO_X catalyst(s) (e.g., SCR catalyst). The catalyst(s) being evaluated must be deteriorated to the applicable malfunction criteria established by the manufacturer for the monitoring required by paragraphs (g)(6)(ii)(A) and (g)(6)(ii)(B) of this section and using methods established by the manufacturer in accordance with paragraph (l)(7) of this section. For each monitored NO_X catalyst(s), the manufacturer must also demonstrate that the OBD system will detect a catalyst malfunction with the catalyst at its maximum level of deterioration (i.e., the substrate(s) completely removed from the catalyst container or ''empty'' can). Emissions data are not required for the empty can demonstration.

(G) *NO_X adsorber.* The manufacturer must perform a test using a NO_X adsorber(s) deteriorated to the applicable malfunction limit established by the manufacturer for the monitoring required by paragraph (g)(7)(ii)(A) of this section. The manufacturer must also demonstrate that the OBD system will detect a NO_X adsorber malfunction with the NO_X adsorber at its maximum level of deterioration (i.e., the substrate(s) completely removed from the container or ''empty'' can). Emissions data are not required for the empty can demonstration.

(H) *Diesel particulate filter.* The manufacturer must perform a separate test using a DPF deteriorated to the applicable malfunction limits established by the manufacturer for the monitoring required by paragraphs (g)(8)(ii)(A), (g)(8)(ii)(B), and (g)(8)(ii)(D) of this section. The manufacturer must also demonstrate that the OBD system will detect a DPF malfunction with the DPF at its maximum level of deterioration (i.e., the filter(s) completely removed from the filter container or ''empty'' can). Emissions data are not required for the empty can demonstration.

(I) *Exhaust gas sensor.* The manufacturer must perform a separate test for each malfunction limit established by the manufacturer for the monitoring required in paragraphs (g)(9)(ii)(A), (g)(9)(iii)(A), and (g)(9)(iv)(A) of this section. When performing a test, all exhaust gas sensors used for the same purpose (e.g., for the same feedback control loop, for the same control feature on parallel exhaust banks) must be operating at the malfunction criteria limit for the applicable parameter only. All other exhaust gas sensor parameters must be operating with normal characteristics.

(J) *VVT system.* The manufacturer must perform a separate test for each malfunction limit established by the manufacturer for the monitoring required in paragraphs (g)(10)(ii)(A) and (g)(10)(ii)(B) of this section. In conducting the VVT system demonstration tests, the manufacturer may use computer modifications to cause the VVT system to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(K) For each of the testing requirements of this paragraph (l)(3)(i), if the manufacturer has established that only a functional check is required because no failure or deterioration of the specific tested system could result in an engine's emissions exceeding the applicable emissions thresholds, the manufacturer is not required to perform a demonstration test; however, the manufacturer is required to provide the data and/or engineering analysis used to determine that only a functional test of the system(s) is required.

(ii) *Required testing for gasoline-fueled/spark-ignition engines.*

(A) *Fuel system.* For engines with adaptive feedback based on the primary fuel control sensor(s), the manufacturer must perform a test with the adaptive feedback based on the primary fuel control sensor(s) at the rich limit(s) and a test at the lean limit(s) established by the manufacturer as required by paragraph (h)(1)(ii)(A) of this section to detect a malfunction before emissions exceed applicable emissions thresholds. For engines with feedback based on a secondary fuel control sensor(s) and subject to the malfunction criteria in paragraph (h)(1)(ii)(A) of this section, the manufacturer must perform a test with the feedback based on the secondary fuel control sensor(s) at the rich limit(s) and a test at the lean limit(s) established by the manufacturer as required by paragraph (h)(1)(ii)(A) of this section to detect a malfunction before emissions exceed the applicable emissions thresholds. For other fuel metering or control systems, the manufacturer must perform a test at the criteria limit(s). For purposes of fuel system testing as required by this paragraph (l)(3)(ii)(A), the malfunction(s) induced may result in a uniform distribution of fuel and air among the cylinders. Non uniform distribution of fuel and air used to induce a malfunction shall not cause misfire. In conducting the fuel system demonstration tests, the manufacturer may use computer modifications to cause the fuel system to operate at the malfunction limit. To do so, the manufacturer must be able to demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(B) *Misfire.* The manufacturer must perform a test at the malfunction criteria limit specified in paragraph (h)(2)(ii)(B) of this section.

(C) *EGR system.* The manufacturer must perform a test at each flow limit calibrated to the malfunction criteria specified in paragraphs (h)(3)(ii)(A) and (h)(3)(ii)(B) of this section.

(D) *Cold start emission reduction strategy.* The manufacturer must perform a test at the malfunction criteria for each component monitored according to paragraph (h)(4)(ii)(A) of this section.

(E) *Secondary air system.* The manufacturer must perform a test at each flow limit calibrated to the malfunction criteria specified in paragraphs (h)(5)(ii)(A) and (h)(5)(ii)(B) of this section.

(F) *Catalyst.* The manufacturer must perform a test using a catalyst system deteriorated to the malfunction criteria specified in paragraph (h)(6)(ii) of this section using methods established by the manufacturer in accordance with paragraph (l)(7)(ii) of this section. The manufacturer must also demonstrate that the OBD system will detect a catalyst system malfunction with the catalyst system at its maximum level of deterioration (i.e., the substrate(s) completely removed from the catalyst container or ''empty'' can). Emission data are not required for the empty can demonstration.

(G) *Exhaust gas sensor.* The manufacturer must perform a test with all primary exhaust gas sensors used for fuel control simultaneously possessing a response rate deteriorated to the malfunction criteria limit specified in paragraph (h)(8)(ii)(A) of this section. The manufacturer must also perform a test for any other primary or secondary exhaust gas sensor parameter under parargraphs (h)(8)(ii)(A) and (h)(8)(iii)(A) of this section that can cause engine emissions to exceed the applicable emissions thresholds (e.g., shift in air/fuel ratio at which oxygen sensor switches, decreased amplitude). When performing additional test(s), all primary and secondary (if applicable) exhaust gas sensors used for emission control must be operating at the malfunction criteria limit for the applicable parameter only. All other primary and secondary exhaust gas sensor parameters must be operating with normal characteristics.

(H) *VVT system.* The manufacturer must perform a test at each target error limit and slow response limit calibrated to the malfunction criteria specified in (h)(9)(ii)(A) and (h)(9)(ii)(B) of this section. In conducting the VVT system demonstration tests, the manufacturer may use computer modifications to cause the VVT system to operate at the malfunction limit. To do so, the manufacturer must be able to demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(I) For each of the testing requirements of this paragraph (l)(3)(ii), if the manufacturer has established that only a functional check is required because no failure or deterioration of the specific tested system could cause an engine's emissions to exceed the applicable emissions thresholds, the manufacturer is not required to perform a demonstration test; however the manufacturer is required to provide the data and/or engineering analyses used to determine that only a functional test of the system(s) is required.

(iii) *Required testing for all engines.*

(A) Other emission control systems. The manufacturer must conduct demonstration tests for all other emission control components (e.g., hydrocarbon traps, adsorbers) designed and calibrated to a malfunction limit based on an emissions threshold based on the requirements of paragraph (i)(4) of this section.

(B) For each of the testing requirements of paragraph (l)(3)(iii)(A) of this section, if the manufacturer has established that only a functional check is required because no failure or deterioration of the specific tested system could result in an engine's emissions exceeding the applicable emissions thresholds, the manufacturer is not required to perform a demonstration test; however, the manufacturer is required to provide the data and/or engineering analysis used to determine that only a functional test of the system(s) is required.

(iv) The manufacturer may electronically simulate deteriorated components but shall not make any engine control unit modifications when performing demonstration tests unless approved by the Administrator. All equipment necessary to duplicate the demonstration test must be made available to the Administrator upon request.

(4) *Testing protocol.*

(i) *Preconditioning.* The manufacturer must use an applicable cycle for preconditioning test engines prior to conducting each of the emission tests required by paragraph (l)(3) of this section. The manufacturer may perform a single additional preconditioning cycle, identical to the initial one, after a 20 minute hot soak but must demonstrate that such an additional cycle is necessary to stabilize the emissions control system. A practice of requiring a cold soak prior to conducting preconditioning cycles is not permitted.

(ii) *Test sequence.*

(A) The manufacturer must set individually each system or component on the test engine at the malfunction criteria limit prior to conducting the applicable preconditioning cycle(s). If a second preconditioning cycle is permitted in accordance with paragraph (l)(4)(i) of this section, the manufacturer may adjust the system or component to be tested before conducting the second preconditioning cycle. The manufacturer shall not replace, modify, or adjust the system or component after the last preconditioning cycle has been completed.

(B) After preconditioning, the test engine must be operated over the applicable 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 monitoring strategy being tested, a cold soak may be performed prior to conducting this test cycle.

(C) The test engine must then be operated over the applicable exhaust emissions test.

(iii) [Reserved.]

(iv) The manufacturer may request approval to use an alternative testing protocol for demonstration of MIL activation if the engine dynamometer emission test cycle does not allow all of a given monitor's enable conditions to be satisfied. The manufacturer may request the use of an alternative engine dynamometer test cycle or the use of chassis testing to demonstrate proper MIL activation. To do so, the manufacturer must demonstrate the technical necessity for using an alternative test cycle and the degree to which the alternative test cycle demonstrates that in-use operation with the malfunctioning component will result in proper MIL activation.

(5) *Evaluation protocol.* Full OBD engine ratings, as defined by paragraph (o)(1) of this section, shall be evaluated according to the following protocol:

(i) For all tests conducted as required by paragraph (l) of this section, the MIL must activate before the end of the first engine start portion of the applicable test.

(ii) If the MIL activates prior to emissions exceeding the applicable malfunction criteria limits specified in paragraphs (g) through (i) of this section, no further demonstration is required. With respect to the misfire monitor demonstration test, if the manufacturer has elected to use the minimum misfire malfunction criteria of one percent as allowed in paragraph (h)(2)(ii)(B) of this section, no further demonstration is required provided the MIL activates with engine misfire occurring at the malfunction criteria limit.

(iii) If the MIL does not activate when the system or component is set at its malfunction criteria limit(s), the criteria limit(s) or the OBD system is not acceptable.

(A) Except for testing of the catalyst or DPF system, if the MIL first activates after emissions exceed the applicable malfunction criteria specified in paragraphs (g) through (i) of this section, the test engine shall be retested with the tested system or component adjusted so that the MIL will activate before emissions exceed the applicable malfunction criteria specified in paragraphs (g) through (i) of this section. If the component cannot be so adjusted because an alternative fuel or emission control strategy is used when a malfunction is detected (e.g., open loop fuel control used after an oxygen sensor malfunction is detected), the test engine shall be retested with the component adjusted to the worst acceptable limit (i.e., the applicable OBD monitor indicates that the component is performing at or slightly better than the malfunction criteria limit). When tested with the component so adjusted, the MIL must not activate during the test and the engine emissions must be below the applicable malfunction criteria specified in paragraphs (g) through (i) of this section.

(B) In testing the catalyst or DPF system, if the MIL first activates after emissions exceed the applicable emissions threshold(s) specified in paragraphs (g) and (h) of this section, the tested engine shall be retested with a less deteriorated catalyst or DPF system (i.e., more of the applicable engine out pollutants are converted or trapped). For the OBD system to be approved, testing shall be continued until the MIL activates with emissions below the applicable thresholds of paragraphs (g) and (h) of this section, or the MIL activates with emissions within a range no more than 20 percent below the applicable emissions thresholds and 10 percent or less above those emissions thresholds.

(iv) If an OBD system is determined to be unacceptable by the criteria of this paragraph (l)(5) of this section, the manufacturer may recalibrate and retest the system on the same test engine. In such a case, the manufacturer must confirm, by retesting, that all systems and components that were tested prior to the recalibration and are affected by it still function properly with the recalibrated OBD system.

(6) *Confirmatory testing.*

(i) The Administrator may perform confirmatory testing to verify the emission test data submitted by the manufacturer as required by this paragraph (l) of this section comply with its requirements and the malfunction criteria set forth in paragraphs (g) through (i) of this section. Such confirmatory testing is limited to the test engine required by paragraph (l)(2) of this section.

(ii) To conduct this confirmatory testing, the Administrator may install appropriately deteriorated or malfunctioning components (or simulate them) in an otherwise properly functioning test engine of an engine rating represented by the demonstration test engine in order to test any of the components or systems required to be tested by paragraph (l) of this section. The manufacturer shall make available, if requested, an engine and all test equipment (e.g., malfunction simulators, deteriorated components) necessary to duplicate the manufacturer's testing. Such a request from the Administrator shall occur within six months of reviewing and approving the demonstration test engine data submitted by the manufacturer for the specific engine rating.

(7) *Catalyst aging.*

(i) *Diesel catalysts.* For purposes of determining the catalyst malfunction limits for the monitoring required by paragraphs (g)(5)(ii)(A), (g)(5)(ii)(B), and (g)(6)(ii)(A) of this section, 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 limits for the monitoring required by paragraphs (g)(5)(ii)(A), (g)(5)(ii)(B), and (g)(6)(ii)(A) of this section, where those catalysts are monitored in combination with other catalysts, the manufacturer must submit their catalyst system aging and monitoring plan to the Administrator as part of their certification documentation package. The plan must 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.

(ii) *Gasoline catalysts.* For the purposes of determining the catalyst system malfunction criteria in paragraph (h)(6)(ii) of this section, the manufacturer must use a catalyst system deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning operating conditions. The malfunction criteria must be established by using a catalyst system with all monitored and unmonitored (downstream of the sensor utilized for catalyst monitoring) catalysts simultaneously deteriorated to the malfunction criteria except for those engines that use fuel shutoff to prevent over-fueling during engine misfire conditions. For such engines, the malfunction criteria must be established by using a catalyst system with all monitored catalysts simultaneously deteriorated to the malfunction criteria while unmonitored catalysts shall be deteriorated to the end of the engine's useful life.

(m) *Certification documentation requirements.*

(1) When submitting an application for certification of an engine, the manufacturer must submit the following documentation. If any of the items listed here are standardized for all of the manufacturer's engines, the manufacturer may, for each model year, submit one set of documents covering the standardized items for all of its engines.

(i) For the required documentation that is not standardized across all engines, the manufacturer may be allowed to submit documentation for certification from one engine that is representative of other engines. All such engines shall be considered to be part of an OBD certification documentation group. To represent the OBD group, the chosen engine must be certified to the most stringent emissions standards and OBD monitoring requirements and cover all of the emissions control devices for the engines in the group and covered by the submitted documentation. Such OBD groups must be approved in advance of certification.

(ii) Upon approval, one or more of the documentation requirements of this paragraph (m) of this section may be waived or modified if the information required is redundant or unnecessarily burdensome to generate.

(iii) To the extent possible, the certification documentation must use SAE J1930 or J2403 terms, abbreviations, and acronyms.

(2) Unless otherwise specified, the following information must be submitted as part of the certification application and prior to receiving a certificate.

(i) A description of the functional operation of the OBD system including a complete written description for each monitoring strategy that outlines every step in the decision-making process of the monitor. Algorithms, diagrams, samples of data, and/or other graphical representations of the monitoring strategy shall be included where necessary to adequately describe the information.

(ii) A table including the following information for each monitored component or system (either computer-sensed or computer-controlled) of the emissions control system:

(A) Corresponding diagnostic trouble code.

(B) Monitoring method or procedure for malfunction detection.

(C) Primary malfunction detection parameter and its type of output signal.

(D) Malfunction criteria limits used to evaluate output signal of primary parameter.

(E) Other monitored secondary parameters and conditions (in engineering units) necessary for malfunction detection.

(F) Monitoring time length and frequency of monitoring events.

(G) Criteria for storing a diagnostic trouble code.

(H) Criteria for activating a malfunction indicator light.

(I) Criteria used for determining out-of-range values and input component rationality checks.

(iii) Whenever possible, the table required by paragraph (m)(2)(ii) of this section shall use the following engineering units:

(A) Degrees Celsius for all temperature criteria.

(B) KiloPascals (KPa) for all pressure criteria related to manifold or atmospheric pressure.

(C) Grams (g) for all intake air mass criteria.

(D) Pascals (Pa) for all pressure criteria related to evaporative system vapor pressure.

(E) Miles per hour (mph) for all vehicle speed criteria.

(F) Relative percent (%) for all relative throttle position criteria (as defined in SAE J1979/J1939).

(G) Voltage (V) for all absolute throttle position criteria (as defined in SAE J1979/J1939).

(H) Per crankshaft revolution (/rev) for all changes per ignition event based criteria (e.g., g/rev instead of g/stroke or g/firing).

(I) Per second (/sec) for all changes per time based criteria (e.g., g/sec).

(J) Percent of nominal tank volume (%) for all fuel tank level criteria.

(iv) A logic flowchart describing the step-by-step evaluation of the enable criteria and malfunction criteria for each monitored emission related component or system.

(v) Emissions test data, a description of the testing sequence (e.g., the number and types of preconditioning cycles), approximate time (in seconds) of MIL activation during the test, diagnostic trouble code(s) and freeze frame information stored at the time of detection, corresponding test results (e.g. SAE J1979 Mode/Service $06, SAE J1939 Diagnostic Message 8 (DM8)) stored during the test, and a description of the modified or deteriorated components used for malfunction simulation with respect to the demonstration tests specified in paragraph (l) of this section. The freeze frame data are not required for engines subject to paragraph (o)(2) of this section.

(vi) For gasoline engines, data supporting the misfire monitor, including:

(A) The established percentage of misfire that can be tolerated without damaging the catalyst over the full range of engine speed and load conditions.

(B) Data demonstrating the probability of detection of misfire events by the misfire monitoring system over the full engine speed and load operating range for the following misfire patterns: random cylinders misfiring at the malfunction criteria established in paragraph (h)(2)(ii)(B) of this section, one cylinder continuously misfiring, and paired cylinders continuously misfiring.

(C) Data identifying all disablement of misfire monitoring that occurs during the FTP. For every disablement that occurs during the cycles, the data shall identify: when the disablement occurred relative to the driver's trace, the number of engine revolutions during which each disablement was present, and which disable condition documented in the certification application caused the disablement.

(D) Manufacturers are not required to use the durability demonstration engine to collect the misfire data required by paragraph (m)(2)(vi) of this section.

(vii) Data supporting the limit for the time between engine starting and attaining the designated heating temperature for after-start heated catalyst systems.

(viii) Data supporting the criteria used to detect a malfunction of the fuel system, EGR system, boost pressure control system, catalyst, NO_X adsorber, DPF, cold start emission reduction strategy, secondary air, evaporative system, VVT system, exhaust gas sensors, and other emission controls that causes emissions to exceed the applicable malfunction criteria specified in paragraphs (g) through (i) of this section. For diesel engine monitors required by 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 (e.g., 2.5 times any of the applicable standards), the test cycle and standard determined by the manufacturer to be the most stringent for each applicable monitor in accordance with paragraph (f)(1) of this section.

(ix) A list 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. For input and output signals that are monitored as comprehensive components, the listing shall also identify the specific diagnostic trouble code for each malfunction criteria (e.g., out-of-range low, out-of-range high, open circuit, rationality low, rationality high).

(x) A written description of all parameters and conditions necessary to begin closed-loop/feedback control of emission control systems (e.g., fuel system, boost pressure, EGR flow, SCR reductant delivery, DPF regeneration, fuel system pressure).

(xi) A written identification of the communication protocol utilized by each engine for communication with a scan tool.

(xii) Reserved.

(xiii) A written description of the method used by the manufacturer to meet the requirements of paragraph (i)(2) of this section (crankcase ventilation system monitoring) including diagrams or pictures of valve and/or hose connections.

(xiv) Build specifications provided to engine purchasers or chassis manufacturers detailing all specifications or limitations imposed on the engine purchaser relevant to OBD requirements or emissions compliance (e.g., cooling system heat rejection rates). A description of the method or copies of agreements used to ensure engine purchasers or chassis manufacturers will comply with the OBD and emissions relevant build specifications (e.g., signed agreements, required audit/evaluation procedures).

(xv) Any other information determined by the Administrator to be necessary to demonstrate compliance with the requirements of this section.

(n) *Deficiencies.*

(1) 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 is 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 shall not be carried over from the previous model year except where unreasonable hardware or software modifications are 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.

(2) In the event the manufacturer seeks to carry-over a deficiency from a past model year to the current model year, the manufacturer must re-apply for approval to do so. In considering the request to carry-over a deficiency, the Administrator shall consider the manufacturer's progress towards correcting the deficiency. The Administrator may not allow manufacturers to carry over monitoring system deficiencies for more than two model years unless it can be demonstrated that substantial engine hardware modifications and additional lead time beyond two years are necessary to correct the deficiency.

(3) A deficiency shall not be granted retroactively (i.e., after the engine has been certified).

(o) *Implementation schedule.* Except as provided for in paragraphs (o)(4) and (o)(5) of this section, the requirements of this section must be met according to the following provisions:

(1) *Full OBD.* The manufacturer must implement an OBD system meeting the requirements of this section on one engine rating within one engine family of the manufacturer's product line. This ''full OBD'' rating will be known as the ''OBD parent'' rating. The OBD parent rating must be chosen as the rating having the highest weighted projected U.S. sales within the engine family having the highest weighted projected U.S. sales, with U.S. sales being weighted by the useful life of the engine rating.

(2) *Extrapolated OBD.* For all other engine ratings within the engine family from which the OBD parent rating has been selected, the manufacturer must implement an OBD system meeting the requirements of this section except that the OBD system is not required to detect a malfunction prior to exceeding the emission thresholds shown in Table 1 of paragraph (g) of this section and Table 2 of paragraph (h) of this section. These extrapolated OBD engines will be known as the ''OBD child'' ratings. On these OBD child ratings, rather than detecting a malfunction prior to exceeding the emission thresholds, the manufacturer must submit a plan for Administrator review and approval that details the engineering evaluation the manufacturer will use to establish the malfunction criteria for the OBD child ratings. The plan must demonstrate both the use of good engineering judgment in establishing the malfunction criteria, and robust detection of malfunctions, including consideration of differences of base engine, calibration, emission control components, and emission control strategies.

(3) Engine families other than those from which the parent and child ratings have been selected are not subject to the requirements of this section.

(4) Small volume manufacturers, as defined in § 86.094–14(b)(1) and (2), are exempt from the requirements of § 86.010–18.

(5) Engines certified as alternative fueled engines are exempt from the requirements of § 86.010–18.

(p) *In-use compliance standards.* For monitors required to indicate a malfunction before emissions exceed a certain emission threshold (e.g., 2.5 times any of the applicable standards):

(1) On the full OBD rating (i.e., the parent rating) as defined in paragraph (o)(1) of this section, separate in-use emissions thresholds shall apply. These thresholds are determined by doubling the applicable thresholds as shown in Table 1 of paragraph (g) and Table 2 of paragraph (h) of this section. The resultant thresholds apply only in-use and do not apply for certification or selective enforcement auditing.

(2) The extrapolated OBD ratings (i.e., the child ratings) as defined in paragraph (o)(2) of this section shall not be evaluated against emissions levels for purposes of OBD compliance in-use.

(3) Only the test cycle and standard determined and identified by the manufacturer at the time of certification in accordance with paragraph (f) of this section as the most stringent shall be

used for the purpose of determining OBD system noncompliance in-use.

(4) An OBD system shall not be considered noncompliant solely due to a failure or deterioration mode of a monitored component or system that could not have been reasonably foreseen to occur by the manufacturer.

8. Section 86.010–30 is added to Subpart A to read as follows:

§ 86.010–30 Certification.

Section 86.010–30 includes text that specifies requirements that differ from §§ 86.094–30, 86.095–30, 86.096–30, 86.098–30, 86.001–30, 86.004–30 or 86.007–30. Where a paragraph in § 86.094–30, § 86.095–30, § 86.096–30, § 86.098–30, § 86.001–30, § 86.004–30 or § 86.007–30 is identical and applicable to § 86.010–30, 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.'' or ''[Reserved]. For guidance see § 86.007–30.''

(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) For engine families required to have an OBD system and meant for applications less than or equal to 14,000 pounds GVWR, certification will not be granted if, for any test vehicle approved by the Administrator in consultation with the manufacturer, the malfunction indicator light does not activate under any of the following circumstances, unless the manufacturer can demonstrate that any identified OBD problems discovered during the Administrator's evaluation will be corrected on production vehicles.

(f)(1)(i) *Otto-cycle.* [Reserved]. For guidance see § 86.004–30.

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

(A) If monitored for emissions performance—a reduction catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NO_X emissions exceeding the applicable NO_X FEL+0.3 g/bhp-hr. Also if monitored for emissions performance—an oxidation catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NMHC emissions exceeding 2.5 times the applicable NMHC standard.

(B) If monitored for performance—a particulate trap is replaced with a deteriorated or defective trap, or an electronic simulation of such, resulting in either exhaust PM emissions exceeding the applicable 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. Also, if monitored for performance—a particulate trap is replaced with a catastrophically failed trap or a 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.*

(f)(3)(i)(A) [Reserved]. For guidance see § 86.007–30.

(f)(3)(i)(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, 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.*

(f)(3)(ii)(A) [Reserved]. For guidance see § 86.007–30.

(f)(3)(ii)(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+0.02 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.*

(f)(3)(iii)(A) [Reserved]. For guidance see § 86.007–30.

(f)(3)(iii)(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, the applicable NO_X FEL+0.3 g/bhp-hr.

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

(f)(5)(i) [Reserved]. For guidance see § 86.007–30.

(f)(5)(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+0.02 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.

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

9. Section 86.010–38 is added to subpart A to read as follows:

§ 86.010–38 Maintenance instructions.

This Section 86.010–38 includes text that specifies requirements that differ from those specified in § 86.007–38. Where a paragraph in § 86.096–38, or § 86.004–38, or § 86.007–38 is identical and applicable to § 86.010–38, this may be indicated by specifying the corresponding paragraph and the statement ''[Reserved]. For guidance see § 86.096–38,'' ''[Reserved]. For guidance see or § 86.004–38, '' or ''[Reserved]. For guidance see § 86.007–38.''

(a)–(f) [Reserved]. For guidance see § 86.004–38.

(g) [Reserved]. For guidance see § 86.096–38. For incorporation by reference see §§ 86.1 and 86.096–38.

(h) [Reserved]. For guidance see § 86.004–38.

(i) [Reserved]. For guidance see § 86.007–38.

(j) Emission control diagnostic service information for heavy-duty engines used in vehicles over 14,000 pounds gross vehicle weight (GVW)

(1) Manufacturers of heavy-duty engines used in applications weighing more than 14,000 pounds gross vehicle weight (GVW) that are subject to the applicable OBD requirements of this subpart A are subject to the provisions of this paragraph (j) beginning in the 2010 model year. The provisions of this paragraph (j) apply only to those heavy-duty engines subject to the applicable OBD requirements.

(2) Upon Administrator approval, manufacturers may alternatively comply with all service information and tool provisions found in § 86.096–38 that are applicable to 1996 and subsequent vehicles weighing less than 14,000 pounds gross vehicle weight (GVW).

(3) *General Requirements*

(i) Manufacturers shall furnish or cause to be furnished to any person engaged in the repairing or servicing of heavy-duty engines, or the Administrator upon request, any and all information needed to make use of the on-board diagnostic system and such other information, including instructions for making emission-related diagnosis and repairs, including but not limited to service manuals, technical service bulletins, recall service information, bi-directional control information, and training information, unless such information is protected by section 208(c) as a trade secret. No such information may be withheld under section 208(c) of the Act if that information is provided (directly or indirectly) by the manufacturer to franchised dealers or other persons engaged in the repair, diagnosing, or servicing of heavy-duty engines.

(ii) *Definitions.* The following definitions apply for this paragraph (j):

(A) Aftermarket service provider means any individual or business engaged in the diagnosis, service, and repair of a heavy-duty engine, who is not directly affiliated with a manufacturer or manufacturer franchised dealership.

(B) Bi-directional control means the capability of a diagnostic tool to send messages on the data bus that temporarily overrides the module's control over a sensor or actuator and gives control to the diagnostic tool operator. Bi-directional controls do not create permanent changes to engine or component calibrations.

(C) Data stream information means information (i.e., messages and parameters) originated within the engine by a module or intelligent sensors (i.e., a sensor that contains and is ontrolled by its own module) and transmitted between a network of modules and/or intelligent sensors connected in parallel with either one or more communication wires. The information is broadcast over the communication wires for use by the OBD system to gather information on emissions-related components or systems and from other engine modules that may impact emissions. For the purposes of this section, data stream information does not include engine calibration related information, or any data stream information from systems or modules that do not impact emissions.

(D) Emissions-related information means any information related to the diagnosis, service, and repair of emissions-related components. Emissions-related information includes, but is not limited to, information regarding any system, component or part of an engine that controls emissions and any system, component and/or part associated with the engine, including, but not limited to: the engine, the fuel system and ignition system; information for any system, component or part that is likely to impact emissions, and any other information specified by the Administrator to be relevant to the diagnosis and repair of an emissions-related problem; any other information specified by the Administrator to be relevant for the diagnosis and repair of an emissions-related failure found through an evaluation of vehicles in-use and after such finding has been communicated to the affected manufacturer(s).

(E) Emissions-related training information means any information related training or instruction for the purpose of the diagnosis, service, and repair of emissions-related components.

(F) Enhanced service and repair information means information which is specific for an original equipment manufacturer's brand of tools and equipment. This includes computer or anti-theft system initialization information necessary for the completion of any emissions-related repair on engines that employ integral security systems.

(G) Equipment and Tool Company means a registered equipment or software company either public or private that is engaged in, or plans to engage in, the manufacture of scan tool reprogramming equipment or software.

(H) Generic service and repair information means information which is not specific for an original equipment manufacturer's brand of tools and equipment.

(I) Indirect information means any information that is not specifically contained in the service literature, but is contained in items such as tools or equipment provided to franchised dealers (or others). This includes computer or anti-theft system initialization information necessary for the completion of any emissions-related repair on engines that employ integral security systems.

(J) Intermediary means any individual or entity, other than an original equipment manufacturer, which provides service or equipment to aftermarket service providers.

(K) Manufacturer franchised dealership means any service provider with which a manufacturer has a direct business relationship.

(L) Third party information provider means any individual or entity, other than an original equipment manufacturer, who consolidates manufacturer service information and makes this information available to aftermarket service providers.

(M) Third party training provider means any individual or entity, other than an original equipment manufacturer who develops and/or delivers instructional and educational material for training courses.

(4) *Information dissemination.* By July 1, 2010 each manufacturer shall provide or cause to be provided to the persons specified in paragraph (j)(3)(i) of this section and to any other interested parties a manufacturer-specific World Wide Web site containing the information specified in paragraph (j)(3)(i) of this section for 2010 and later model year engines which have been certified to the OBD requirements specified in § 86.010–18 and are offered for sale; this requirement does not apply to indirect information, including the information specified in paragraphs (j)(13) through (j)(17) of this section. Upon request and approval of the Administrator, manufacturers who can demonstrate significant hardship in complying with this provision within four months after the effective date may request an additional six months lead time to meet this requirement. Each manufacturer Web site shall:

(i) Provide access in full-text to all of the information specified in paragraph (j)(5) of this section.

(ii) Be updated at the same time as manufacturer franchised dealership World Wide Web sites.

(iii) Provide users with a description of the minimum computer hardware and software needed by the user to access that manufacturer's information (e.g., computer processor speed and operating system software). This description shall appear when users first log-on to the home page of the manufacturer's Web site.

(iv) Provide Short-Term (24 to 72 hours), Mid-Term (30 day period), and Long-Term (365 day period) Web site subscription options to any person specified in paragraph (j)(2)(i) of this section whereby the user will be able to access the site, search for the information, and purchase, view and print the information at a fair and reasonable cost as specified in paragraph (j)(7) of this section for each of the options. In addition, for each of the tiers, manufacturers are required to make their entire site accessible for the respective period of time and price. In other words, a manufacturer may not limit any or all of the tiers to just one make or one model.

(v) Allow the user to search the manufacturer Web site by various topics including but not limited to model, model year, key words or phrases, etc., while allowing ready identification of the latest calibration. Manufacturers who do not use model year to classify their engines in their service information may use an alternate delineation such as body series. Any manufacturer utilizing this flexibility shall create a cross-reference to the corresponding model year and provide this cross-reference on the manufacturer Web site home page.

(vi) Provide accessibility using common, readily available software and shall not require the use of software, hardware, viewers, or browsers that are not readily available to the general public. Manufacturers shall also provide hyperlinks to any plug-ins, viewers or browsers (e.g. Adobe Acrobat or Netscape) needed to access the manufacturer Web site.

(vii) Allow simple hyper-linking to the manufacturer Web site from Government Web sites and automotive-related Web sites.

(viii) Posses sufficient server capacity to allow ready access by all users and has sufficient capacity to assure that all users may obtain needed information without undue delay.

(ix) Correct or delete broken Web links on a weekly basis.

(x) Allow for Web site navigation that does not require a user to return to the manufacturer home page or a search engine in order to access a different portion of the site.

(xi) Allow users to print out any and all of the materials required to be made available on the manufacturers Web site, including the ability to print it at the user's location.

(5) *Small volume provisions for information dissemination.*

(i) Manufacturers with total annual sales of less than 5,000 engines shall have until July 1, 2011 to launch their individual Web sites as required by paragraph (j)(4) of this section.

(ii) Manufacturers with total annual sales of less than 1,000 engines may, in lieu of meeting the requirement of paragraph (j)(4) of this section, request the Administrator to approve an alternative method by which the required emissions-related information can be obtained by the persons specified in paragraph (j)(3)(i) of this section.

(6) *Required information.* All information relevant to the diagnosis and completion of emissions-related repairs shall be posted on manufacturer Web sites. This excludes indirect information specified in paragraphs (j)(7) and (j)(13) through (j)(17) of this section. To the extent that this information does not already exist in some form for their manufacturer franchised dealerships, manufacturers are required to develop and make available the information required by this section to both their manufacturer franchised dealerships and the aftermarket. The required information includes, but is not limited to:

(i) Manuals, including subsystem and component manuals developed by a manufacturer's third party supplier that are made available to manufacturer franchised dealerships, technical service bulletins (TSBs), recall service information, diagrams, charts, and training materials. Manuals and other such service information from third party suppliers are not required to be made available in full-text on manufacturer Web sites as described in paragraph (j)(3) of this section. Rather, manufacturers must make available on the manufacturer Web site as required by paragraph (j)(3) of this section an index of the relevant information and instructions on how to order such information. In the alternate, a manufacturer can create a link from its Web site to the Web site(s) of the third party supplier.

(ii) OBD system information which includes, but is not limited to, the following:

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

(B) A listing of all typical OBD diagnostic trouble codes associated with each monitor;

(C) A description of the typical enabling conditions (either generic or monitor-specific) for each monitor (if equipped) to execute during engine operation, including, but not limited to, minimum and maximum intake air and engine coolant temperature, speed range, and time after engine startup. In addition, manufacturers shall list all monitor-specific OBD drive cycle information for all major OBD monitors as equipped including, but not limited to, catalyst, catalyst heater, oxygen sensor, oxygen sensor heater, evaporative system, exhaust gas re-circulation (EGR), secondary air, and air conditioning system. Additionally, for diesel engines which also perform misfire, fuel system and comprehensive component monitoring under specific driving conditions (i.e., non-continuous monitoring; as opposed to spark ignition engines that monitor these systems under all conditions or continuous monitoring), the manufacturer shall make available monitor-specific drive cycles for these monitors. Any manufacturer who develops generic drive cycles, either in addition to, or instead of, monitor-specific drive cycles shall also make these available in full-text on manufacturer Web sites;

(D) A listing of each monitor sequence, execution frequency and typical duration;

(E) A listing of typical malfunction thresholds for each monitor;

(F) For OBD parameters for specific engines that deviate from the typical parameters, the OBD description shall indicate the deviation and provide a separate listing of the typical values for those engines;

(G) Identification and scaling information necessary to interpret and understand data available through Diagnostic Message 8 pursuant to SAE Recommended Practice J1939–73, Application Layer—Diagnostics, revised June 2001 or through Service/Mode $06 pursuant to SAE Recommended Practice J1979, E/E Diagnostic Test Modes—Equivalent to ISO/DIS 15031–5: April 30, 2002. These documents are Incorporated by Reference in § 86.1.

(H) Algorithms, look-up tables, or any values associated with look-up tables are not required to be made available.

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

(iv) Manufacturer-specific emissions-related diagnostic trouble codes (DTCs) and any related service bulletins, trouble shooting guides, and/or repair procedures associated with these manufacturer-specific DTCs; and

(v) Information regarding how to obtain the information needed to perform reinitialization of any computer or anti-theft system following an emissions-related repair.

(7) *Anti-theft System Initialization Information.* Computer or anti-theft system initialization information and/or related tools necessary for the proper installation of on-board computers or necessary for the completion of any emissions-related repair on engines that employ integral security systems or the repair or replacement of any other emission-related part shall be made available at a fair and reasonable cost to the persons specified in paragraph (j)(3)(i) of this section.

(i) Except as provided under paragraph (j)(7)(ii) of this section, manufacturers must make this information available to persons specified in paragraph (j)(3)(i) of this section, such that such persons will not need any special tools or manufacturer-specific scan tools to perform the initialization. Manufacturers may make such information available through, for example, generic aftermarket tools, a pass-through device, or inexpensive manufacturer specific cables.

(ii) A manufacturer may request Administrator approval for an alternative means to re-initialize engines for some or all model years through the 2013 model year by 90 days following the effective date of the final rule. The Administrator shall approve the request only after the following conditions have been met:

(A) The manufacturer must demonstrate that the availability of such information to aftermarket service providers would significantly increase the risk of theft.

(B) The manufacturer must make available a reasonable alternative means to install or repair computers, or to otherwise repair or replace an emission-related part.

(C) Any alternative means proposed by a manufacturer cannot require aftermarket technicians to use a manufacturer franchised dealership to obtain information or special tools to re-initialize the anti-theft system. All information must come directly from the manufacturer or a single manufacturer-specified designee.

(D) Any alternative means proposed by a manufacturer must be available to aftermarket technicians at a fair and reasonable price.

(E) Any alternative must be available to aftermarket technicians within twenty-four hours of the initial request.

(F) Any alternative must not require the purchase of a special tool or tools, including manufacturer-specific tools, to complete this repair. Alternatives may include lease of such tools, but only for appropriately minimal cost.

(G) In lieu of leasing their manufacturer-specific tool to meet this requirement, a manufacturer may also choose to release the necessary information to equipment and tool manufacturers for incorporation into aftermarket scan tools. Any manufacturer choosing this option must release the information to equipment and tool manufacturers within 60 days of Administrator approval.

(8) *Cost of required information.*

(i) All information required to be made available by this section, shall be made available at a fair and reasonable price. In determining whether a price is fair and reasonable, consideration may be given to relevant factors, including, but not limited to, the following:

(A) The net cost to the manufacturer franchised dealerships for similar information obtained from manufacturers, less any discounts, rebates, or other incentive programs;

(B) The cost to the manufacturer for preparing and distributing the information, excluding any research and development costs incurred in designing and implementing, upgrading or altering the onboard computer and its software or any other engine part or component. Amortized capital costs for the preparation and distribution of the information may be included;

(C) The price charged by other manufacturers for similar information;

(D) The price charged by manufacturers for similar information prior to the launch of manufacturer Web sites;

(E) The ability of the average aftermarket technician or shop to afford the information;

(F) The means by which the information is distributed;

(G) The extent to which the information is used, which includes the number of users, and frequency, duration, and volume of use; and

(H) Inflation.

(ii) Manufacturers must submit to EPA a request for approval of their pricing structure for their Web sites and amounts to be charged for the information required to be made available under paragraphs (j)(4) and (j)(6) of this section at least 180 days in advance of the launch of the web site. Subsequent to the approval of the manufacturer Web site pricing structure, manufacturers shall notify EPA upon the increase in price of any one or all of the subscription options of 20 percent or more above the previously approved price, taking inflation into account.

(A) The manufacturer shall submit a request to EPA that sets forth a detailed description of the pricing structure and amounts, and support for the position that the pricing structure and amounts are fair and reasonable by addressing, at a minimum, each of the factors specified in paragraph (j)(8)(i) of this section.

(B) EPA will act upon on the request within180 days following receipt of a complete request or following receipt of any additional information requested by EPA.

(C) EPA may decide not to approve, or to withdraw approval for a manufacturer's pricing structure and amounts based on a conclusion that this pricing structure and/or amounts are not, or are no longer, fair and reasonable, by sending written notice to the manufacturer explaining the basis for this decision.

(D) In the case of a decision by EPA not to approve or to withdraw approval, the manufacturer shall within three months following notice of this decision, obtain EPA approval for a revised pricing structure and amounts by following the approval process described in this paragraph.

(9) *Unavailable information.* Any information which is not provided at a fair and reasonable price shall be considered unavailable, in violation of these regulations and section 202(m)(5) of the Clean Air Act.

(10) *Third party information providers.* By January 1, 2011 manufacturers shall, for model year 2010 and later engines, make available to third-party information providers as defined in paragraph (j)(3)(ii) of this section with whom they engage in licensing or business arrangements;

(i) The required emissions-related information as specified in paragraph (j)(6) of this section either:

(A) Directly in electronic format such as diskette or CD–ROM using non-proprietary software, in English; or

(B) Indirectly via a Web site other than that required by paragraph (j)(4) of this section;

(ii) For any manufacturer who utilizes an automated process in their manufacturer-specific scan tool for diagnostic fault trees, the data schema, detail specifications, including category types/codes and engine codes, and data format/content structure of the diagnostic trouble trees.

(iii) Manufacturers can satisfy the requirement of paragraph (j)(10)(ii) of this section by making available diagnostic trouble trees on their manufacturer Web sites in full-text.

(iv) Manufacturers are not responsible for the accuracy of the information distributed by third parties. However, where manufacturers charge information intermediaries for information, whether through licensing agreements or other arrangements, manufacturers are responsible for inaccuracies contained in the information they provide to third party information providers.

(11) *Required emissions-related training information.* By January 1, 2011, for emissions-related training information, manufacturers shall:

(i) Video tape or otherwise duplicate and make available for sale on manufacturer Web sites within 30 days after transmission any emissions-related training courses provided to manufacturer franchised dealerships via the Internet or satellite transmission;

(ii) Provide on the manufacturer Web site an index of all emissions-related training information available for purchase by aftermarket service providers for 2010 and newer engines. The required information must be made available for purchase within 3 months of model introduction and then must be made available at the same time it is made available to manufacturer franchised dealerships, whichever is earlier. The index shall describe the title of the course or instructional session, the cost of the video tape or duplicate, and information on how to order the item(s) from the manufacturer Web site. All of the items available must be shipped within 24 hours of the order being placed and are to made available at a fair and reasonable price as described in paragraph (j)(8) of this section. Manufacturers unable to meet the 24 hour shipping requirement under circumstances where orders exceed supply and additional time is needed by the distributor to reproduce the item being ordered, may exceed the 24 hour shipping requirement, but in no instance can take longer than 14 days to ship the item.

(iii) Provide access to third party training providers as defined in paragraph (j)(3)(ii) of this section all emission-related training courses transmitted via satellite or Internet offered to their manufacturer franchised dealerships. Manufacturers may not charge unreasonable up-front fees to third party training providers for this access, but may require a royalty, percentage, or other arranged fee based on per-use enrollment/subscription basis. Manufacturers may take reasonable steps to protect any copyrighted information and are not required to provide this information to parties that do not agree to such steps.

(12) *Timeliness and maintenance of information dissemination.*

(i) Subsequent to the initial launch of the manufacturer's Web site, manufacturers must make the information required under paragraph (j)(6) of this section available on their Web site within six months of model introduction, or at the same time it is made available to manufacturer franchised dealerships. After this six month period, the information must be available and updated on the manufacturer Web site at the same time that the updated information is made available to manufacturer franchised dealerships, except as otherwise specified in this section.

(ii) *Archived information.* Manufacturers must maintain the required information on their Web sites in full-text as defined in paragraph (j)(6) of this section for a minimum of 15 years after model introduction. Subsequent to this fifteen year period, manufacturers may archive the information in the manufacturer's format of choice and provide an index of the archived information on the manufacturer Web site and how it can be obtained by interested parties. Manufacturers shall index their available information with a title that adequately describes the contents of the document to which it refers. Manufacturers may allow for the ordering of information directly from their Web site, or from a Web site hyperlinked to the manufacturer Web site. In the alternate, manufacturers shall list a phone number and address where aftermarket service providers can call or write to obtain the desired information. Manufacturers 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, manufacturers shall update the index as appropriate. Manufacturers will be responsible for ensuring that their information distributors do so within one regular business day of receiving the order. Items that 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. Archived information must be made available on demand and at a fair and reasonable price.

(13) *Recalibration Information.*

(i) Manufacturers shall make available to the persons specified in paragraph (j)(3)(i) of this section all emissions-related recalibration or reprogramming events (including driveability reprogramming events that may affect emissions) in the format of their choice at the same time they are made available to manufacturer franchised dealerships. This requirement takes effect on July 1, 2010.

(ii) Manufacturers shall provide persons specified in paragraph (j)(3)(i) of this section with an efficient and cost-effective method for identifying whether the calibrations on engines are the latest to be issued. This requirement takes effect on July 1, 2010.

(iii) For all 2010 and later OBD engines equipped with reprogramming capability, manufacturers shall comply with either SAE J2534, ''Recommended Practice for Pass-Thru Vehicle Programming'' , December 2004, or the Technology and Maintenance Council's (TMC) Recommended Practice RP1210A. ''Windows™ Communication API'' , July 1999. These documents are Incorporated by Reference in § 86.1.

(iv) For model years 2010 and later, manufacturers shall make available to aftermarket service providers the necessary manufacturer-specific software applications and calibrations needed to initiate pass-through reprogramming. This software shall be able to run on a standard personal computer that utilizes standard operating systems as specified in either J2534 or RP1210A.

(v) Manufacturers may take any reasonable business precautions necessary to protect proprietary business information and are not required to provide this information to any party that does not agree to these reasonable business precautions. The requirements to make hardware available and to release the information to equipment and tool companies takes effect on July 1, 2010, and within 3 months of model introduction for all new model years.

(14) *Generic and enhanced information for scan tools.* By July 1, 2010, manufacturers shall make available to equipment and tool companies all generic and enhanced service information including bi-directional control and data stream information as defined in paragraph (j)(4)(ii) of this section. This requirement applies for 2010 and later model year engines.

(i) The information required by this paragraph (j)(14) shall be provided electronically using common document formats to equipment and tool companies with whom they have appropriate licensing, contractual, and/or confidentiality arrangements. To the extent that a central repository for this information (e.g. the TEK–NET library developed by the Equipment and Tool Institute) is used to warehouse this information, the Administrator shall have free unrestricted access. In addition, information required by this paragraph (j)(14) shall be made available to equipment and tool companies who are not otherwise members of any central repository and shall have access if the non-members have arranged for the appropriate licensing, contractual and/or confidentiality arrangements with the manufacturer and/or a central repository.

(ii) In addition to the generic and enhanced information defined in paragraph (j)(3)(ii) of this section, manufacturers shall also make available the following information necessary for developing generic diagnostic scan tools:

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

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

(C) 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),

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

(iii) Any manufacturer who utilizes an automated process in their manufacturer-specific scan tool for diagnostic fault trees shall make available to equipment and tool companies the data schema, detail specifications, including category types/codes and codes, and data format/content structure of the diagnostic trouble trees.

(iv) Manufacturers can satisfy the requirement of paragraph (j)(14)(iii) of this section by making available diagnostic trouble trees on their manufacturer Web sites in full-text.

(v) Manufacturers shall make all required information available to the requesting equipment and tool company within 14 days after the request to purchase has been made unless the manufacturer requests Administrator approval to refuse to disclose such information to the requesting company or requests Administrator approval for additional time to comply. After receipt of a request and consultation with the affected parties, the Administrator shall either grant or refuse the petition based on the evidence submitted during the consultation process:

(A) If the evidence demonstrates that the engine manufacturer has a reasonably based belief that the requesting equipment and tool company could not produce safe and functionally accurate tools that would not cause damage to the engine, the petition for non-disclosure will be granted. Engine manufacturers are not required to provide data stream and bi-directional control information that would permit an equipment and tool company's products to modify an EPA-certified engine or transmission configuration.

(B) If the evidence does not demonstrate that the engine manufacturer has a reasonably-based belief that the requesting equipment and tool company could not produce safe and functionally accurate tools that would not cause damage to the engine, the petition for non-disclosure will be denied and the engine manufacturer, as applicable, shall make the requested information available to the requesting equipment and tool company within 2 days of the denial.

(vi) If the manufacturer submits a request for Administrator approval for additional time, and satisfactorily demonstrates to the Administrator that the engine manufacturer is able to comply but requires additional time within which to do so, the Administrator shall grant the request and provide additional time to fully and expeditiously comply.

(vii) Manufacturers may require that tools using information covered under paragraph (j)(14) of this section comply with the Component Identifier message specified in SAE J1939–71 as Parameter Group Number (PGN) 65249 (including the message parameter's make, model, and serial number) and the SAE J1939–81 Address Claim PGN.

(15) *Availability of manufacturer-specific scan tools.* Manufacturers shall make available for sale to the persons specified in paragraph (j)(3)(i) of this section their own manufacturer-specific diagnostic tools at a fair and reasonable cost. These tools shall also be made available in a timely fashion either through the manufacturer Web site or through a manufacturer-designated intermediary. Manufacturers shall ship purchased tools in a timely manner after a request and training, if any, has been completed. Any required training materials and classes must be made available at a fair and reasonable price. Manufacturers who develop different versions of one or more of their diagnostic tools that are used in whole or in part for emission-related diagnosis and repair shall also insure that all emission-related diagnosis and repair information is available for sale to the aftermarket at a fair and reasonable cost. Factors for determining fair and reasonable cost include, but are not limited to:

(i) The net cost to the manufacturer's franchised dealerships for similar tools obtained from manufacturers, less any discounts, rebates, or other incentive programs;

(ii) The cost to the manufacturer for preparing and distributing the tools, excluding any research and development costs;

(iii) The price charged by other manufacturers of similar sizes for similar tools;

(iv) The capabilities and functionality of the manufacturer tool;

(v) The means by which the tools are distributed;

(vi) Inflation;

(vii) The ability of aftermarket technicians and shops to afford the tools. Manufacturers shall provide technical support to aftermarket service providers for the tools described in this section, either themselves or through a third-party of their choice.

(16) *Changing content of manufacturer-specific scan tools.* Manufacturers who opt to remove non-emissions related content from their manufacturer-specific scan tools and sell them to the persons specified in paragraph (j)(3)(i) of this section shall adjust the cost of the tool accordingly lower to reflect the decreased value of the scan tool. All emissions-related content that remains in the manufacturer-specific tool shall be identical to the information that is contained in the complete version of the manufacturer specific tool. Any manufacturer who wishes to implement this option must request approval from the Administrator prior to the introduction of the tool into commerce.

(17) *Reference Materials.* Manufacturers shall conform with the following Society of Automotive Engineers (SAE) standards. These documents are incorporated by reference in § 86.1.

(i) For Web-based delivery of service information, manufacturers shall comply with SAE Recommended Practice J2403, Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature; August 2004. This recommended practice standardizes various terms, abbreviations, and acronyms associated with on-board diagnostics. Manufacturers shall comply with SAE J2403 beginning with the Model Year 2013.

(ii) For identification and scaling information necessary to interpret and understand data available through Diagnostic Message 8, manufacturers shall comply with SAE Recommended Practice J1939–73, Application Layer—Diagnostics, revised June 2001. In the alternate, manufacturers may comply with Service/Mode $06 pursuant to SAE Recommended Practice J1979, E/E Diagnostic Test Modes—Equivalent to ISO/DIS 15031–5: April 30, 2002. These recommended practices describe the implementation of diagnostic test modes for emissions related test data. Manufacturers shall comply with either SAE J1939–73 or SAE J1979 beginning with Model Year 2013. These recommended practices describe the implementation of diagnostic test modes for emissions related test data.

(iii) For pass-thru reprogramming capabilities, manufacturers shall comply with Technology and Maintenance Council's (TMC) Recommended Practice RP1210A, ''Windows™ Communication API'' , July 1999. In the alternate, manufacturers may comply with SAE J2534, Recommended Practice for Pass-Thru Vehicle Programming, December 2004. These recommended practices provide technical specifications and information that manufacturers must supply to equipment and tool companies to develop aftermarket pass-thru reprogramming tools. Manufacturers shall comply with either RP1210A or SAE J2534 beginning with Model Year 2013.

(18) *Reporting Requirements.* Performance reports that adequately demonstrate that each manufacturer's Web site meets the information requirements outlined in paragraphs (j)(6)(i) through (j)(6)(vi) of this section shall be submitted to the Administrator annually or upon request by the Administrator. These reports shall 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.) Manufacturers shall provide to the Administrator reports on an annual basis within 30 days of the end of the calendar year. These annual reports shall be submitted to the Administrator electronically utilizing non-proprietary software in the format as agreed to by the Administrator and the manufacturers.

(19) *Prohibited Acts, Liability and Remedies.*

(i) It is a prohibited act for any person to fail to promptly provide or cause a failure to promptly provide information as required by this paragraph (j), or to otherwise fail to comply or cause a failure to comply with any provision of this subsection.

(ii) Any person who fails or causes the failure to comply with any provision of this paragraph (j) is liable for a violation of that provision. A corporation is presumed liable for any violations of this subpart that are committed by any of its subsidiaries, affiliates or parents that are substantially owned by it or substantially under its control.

(iii) Any person who violates a provision of this paragraph (j) shall be subject to a civil penalty of not more than $31,500 per day for each violation. This maximum penalty is shown for calendar year 2002. Maximum penalty limits for later years may be set higher based on the Consumer Price Index, as specified in 40 CFR part 19. In addition, such person shall be liable for all other remedies set forth in Title II of the Clean Air Act, remedies pertaining to provisions of Title II of the Clean Air Act, or other applicable provisions of law.

10. Section 86.013–2 is added to Subpart A to read as follows:

§ 86.013–2 Definitions.

The definitions of § 86.004–2 continue to apply to 2004 and later model year vehicles, and the definitions of § 86.010–2 continue to apply to 2010 and later model year vehicles. The definitions listed in this section apply beginning with the 2013 model year.

Onboard Diagnostics (OBD) group means a combination of engines, engine families, or engine ratings that use the same OBD strategies and similar calibrations.

11. Section 86.013–17 is added to Subpart A to read as follows:

§ 86.013–17 On-board Diagnostics for engines used in applications less than or equal to 14,000 pounds GVWR.

Section 86.013–17 includes text that specifies requirements that differ from § 86.005–17, § 86.007–17, and § 86.010–17. Where a paragraph in § 86.005–17 or § 86.007–17 or § 86.010–17 is identical and applicable to § 86.013–17, 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.'' or ''[Reserved]. For guidance see § 86.010–17.''

(a) through (b)(1)(i) [Reserved]. For guidance see § 86.010–17.

(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 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 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 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 times the applicable NMHC standard; or, 2 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 times the applicable NMHC standard; or, 2 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) through (j) [Reserved]. For guidance see § 86.010–17.

(k) [Reserved.]

12. Section 86.013–18 is added to Subpart A to read as follows:

§ 86.013–18 On-board Diagnostics for engines used in applications greater than 14,000 pounds GVWR.

Section 86.013–18 includes text that specifies requirements that differ from § 86.010–18. Where a paragraph in § 86.010–18 is identical and applicable to § 86.013–18, this may be indicated by specifying the corresponding paragraph and the statement ''[Reserved]. For guidance see § 86.010–18.'' However, where a paragraph in § 86.010–18 is identical and applicable to § 86.013–18, and there appears the statement ''[Reserved]. For guidance see § 86.010–18,'' it shall be understood that any referenced tables within § 86.010–18 shall actually refer to the applicable table shown in § 86.013–18.

(a) *General.* All 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), and (i) of this section and paragraph (h) of § 86.010–18 although the OBD system is not required to use a unique monitor to detect each of those malfunctions.

(a)(1) [Reserved]. For guidance see § 86.010–18.

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

(a)(3) and (a)(4) [Reserved]. For guidance see § 86.010–18.

(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) The MIL must be located on the driver's side instrument panel and be of sufficient illumination and location to be readily visible under all lighting conditions. The MIL must be amber (yellow) in color; the use of red for the OBD-related MIL is prohibited. More than one general purpose malfunction indicator light for emission-related problems shall not be used; separate specific purpose warning lights (e.g., brake system, fasten seat belt, oil pressure, etc.) are permitted. When activated, the MIL must display the engine symbol designated as F01 by the International Standards Organization (ISO) in ''Road vehicles—Symbols for controls, indicators and tell-tales,'' ISO 2575:2004.

(b)(1)(ii) through (b)(1)(iv) [Reserved]. For guidance see § 86.010–18.

(b)(1)(v) The MIL required by this paragraph (b) must not be used in any other way than is specified in this section.

(b)(2) [Reserved]. For guidance see § 86.010–18.

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

(i) *Deactivating the MIL.* Except as otherwise provided for in paragraph (g)(2)(iv)(E) of this section and § 86.010–18(g)(6)(iv)(B) for diesel misfire malfunctions and empty reductant tanks, and paragraphs (h)(1)(iv)(F), (h)(2)(viii), and (h)(7)(iv)(B) of § 86.010–18 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 § 86.010–18(b)(2).

(b)(3)(ii) through (b)(4) [Reserved.] For guidance see § 86.010–18.

(c) *Monitoring conditions.* The OBD system must monitor and detect the malfunctions specified in paragraphs (g) and (i) of this section and § 86.010–18(h) 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) and (i) of this section and §86.010–18(h).

(1) As specifically provided for in paragraphs (g) and (i) of this section and § 86.010–18(h), 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.

(c)(2) [Reserved]. For guidance see § 86.010–18.

(c)(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)(1)(ii) of this section.

(d) through (d)(1)(i) [Reserved]. For guidance see § 86.010–18.

(d)(1)(ii) Manufacturers must define monitoring conditions that, in addition to meeting the criteria in paragraph (c)(1) of this section and § 86.010–18(d) through (d)(1)(i), ensure that the monitor yields an in-use performance ratio (as defined in § 86.010–18(d)(2) that meets or exceeds the minimum acceptable in-use monitor performance ratio of 0.100 for all monitors specifically required in paragraphs (g) and (i) of this section and § 86.010–18(h) to meet the monitoring condition requirements in § 86.010–(18)(d)(1)(i).

(iii) If the most reliable monitoring method developed requires a lower ratio for a specific monitor than that specified in paragraph (d)(1)(ii) of this section, the Administrator may lower the minimum acceptable in-use monitoring performance ratio.

(d)(2) through (d)(3)(iv) [Reserved]. For guidance see § 86.010–18.

(d)(3)(v) Manufacturers that use alternative statistical MIL activation protocols as allowed in § 86.010–18(b)(2)(iii) 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, and the overall equivalence of the incrementing approach in determining that the minimum acceptable in-use performance ratio of paragraph (d)(1)(ii) of this section has been satisfied.

(d)(4) through (f) [Reserved]. For guidance see § 86.010–18.

(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 ENGINES PLACED 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)	2x			
NO_X aftertreatment system	(g)(6) (g)(7)			+0.3	
Diesel particulate filter (DPF) system	(g)(8)	2x			0.05/+0.04
Air-fuel ratio sensors upstream of aftertreatment devices	(g)(9)	2x	2x	+0.3	0.03/+0.02
Air-fuel ratio sensors downstream of aftertreatment devices	(g)(9)	2x		+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)(2) (g)(3) (g)(4) (g)(10)	2x	2x	+0.3	0.03/+0.02

Notes: FEL=Family Emissions Limit; 2x std means a multiple of 2 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, whichever level is higher; these emissions thresholds apply to the monitoring requirements of paragraph (g) of this § 86.013–18.

(1) *Fuel system monitoring.*

(g)(1)(i) through (g)(1)(iii)(A) [Reserved]. For guidance see § 86.010–18.

(g)(1)(iii)(B) The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(g)(1)(ii)(B) and (g)(1)(ii)(C) and Table 1 of paragraph (g) of this section 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.*

(g)(2)(i) [Reserved]. For guidance see § 86.010–18.

(g)(2)(ii) *Engine misfire malfunction criteria.*

(A) 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 continuously misfiring, 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.

(B) On engines equipped with sensors that can detect combustion or combustion quality (e.g., for use in engines with homogeneous charge compression ignition (HCCI) control systems), the OBD system must detect a misfire malfunction causing emissions to exceed the applicable thresholds for "other monitors" shown in Table 1 of this paragraph (g). To determine what level of misfire would cause emissions to exceed the applicable emissions thresholds, the manufacturer must determine the percentage of misfire evaluated in 1,000 revolution increments that would cause emissions from an emission durability demonstration engine to exceed the emissions thresholds if the percentage of misfire were present from the beginning of the test. To establish this percentage of misfire, the manufacturer must use misfire events occurring at equally spaced, complete engine cycle intervals, across randomly selected cylinders throughout each 1,000-revolution increment. If this percentage of misfire is determined to be lower than one percent, the manufacturer may set the malfunction criteria at one percent. Any misfire malfunction must be detected if the percentage of misfire established via this testing is exceeded regardless of the pattern of misfire events (e.g., random, equally spaced, continuous). The manufacturer may employ other revolution increments besides the 1,000 revolution increment. To do so, the manufacturer must demonstrate that the strategy is equally effective and timely in detecting misfire.

(iii) *Engine misfire monitoring conditions.*

(g)(2)(iii)(A) and (g)(2)(iii)(B) [Reserved]. For guidance see § 86.010–18.

(g)(2)(iii)(C) For engines equipped with sensors that can detect combustion or combustion quality the OBD system must monitor continuously for engine misfire under all positive torque engine speed and load conditions. If a monitoring system cannot detect all misfire patterns under all required engine speed and load conditions, the manufacturer may request that the Administrator approve the monitoring system nonetheless. In evaluating the manufacturer's request, the Administrator will consider the following factors: the magnitude of the region(s) in which misfire detection is limited; the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events); the frequency with which said region(s) are expected to be encountered in-use; the type of misfire patterns for which misfire detection is troublesome; and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under required conditions (i.e., compliance can be achieved on other engines). The evaluation will be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders; single cylinder continuous misfire; and, paired cylinder (cylinders firing at the same crank angle) continuous misfire.

(iv) *Engine misfire MIL activation and DTC storage.*

(A) General requirements for MIL activation and DTC storage are set forth in paragraph (b) of this section.

(B) For engines equipped with sensors that can detect combustion or combustion quality, upon detection of the percentage of misfire specified in paragraph (g)(2)(ii)(B) of this section, the following criteria shall apply for MIL activation and DTC storage: A pending DTC must be stored no later than after the fourth exceedance of the percentage of misfire specified in paragraph (g)(2)(ii) of this section during a single drive cycle; if a pending fault code has been stored, the OBD system must activate the MIL and store a MIL-on DTC within 10 seconds if the percentage of misfire specified in paragraph (g)(2)(ii) of this section is again exceeded four times during the drive cycle immediately following storage of the pending DTC, regardless of the conditions encountered during the drive cycle, or on the next drive cycle in which similar conditions are encountered to those that were occurring when the pending DTC was stored. Similar conditions means an engine speed within 375 rpm, engine load within 20 percent, and the same warm up status (i.e., cold or hot). The Administrator may approve other definitions of similar conditions based on comparable timeliness and reliability in detecting similar engine operation. The pending DTC may be erased at the end of the next drive cycle in which similar conditions are encountered to those that were occurring when the pending DTC was stored provided the specified percentage of misfire was not again exceeded. The pending DTC may also be erased if similar conditions are not encountered during the 80 drive cycles immediately following initial detection of the malfunction.

(C) For engines equipped with sensors that can detect combustion or combustion quality, the OBD system must store and erase freeze frame conditions either in conjunction with storing and erasing a pending DTC or in conjunction with storing and erasing a MIL-on DTC. If freeze frame conditions are stored for a malfunction other than a misfire malfunction when a DTC is stored as specified in paragraph (g)(2)(iv)(B) of this section, the stored freeze frame information must be replaced with the freeze frame information regarding the misfire malfunction.

(D) For engines equipped with sensors that can detect combustion or combustion quality, upon detection of misfire according to paragraph (g)(2)(iv)(B) of this section, the OBD system must also store the following engine conditions: engine speed, load, and warm up status of the first misfire event that resulted in the storage of the pending DTC.

(E) For engines equipped with sensors that can detect combustion or combustion quality, the MIL may be deactivated after three sequential drive cycles in which similar conditions have been encountered without an exceedance of the specified percentage of misfire.

(3) *EGR system monitoring.*

(g)(3)(i) and (g)(3)(ii) [Reserved]. For guidance see § 86.010–18.

(g)(3)(iii) *EGR system monitoring conditions.*

(g)(3)(iii)(A) [Reserved]. For guidance see § 86.010–18.

(g)(3)(iii)(B) The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(g)(3)(ii)(C) and Table 1 of paragragh (g) 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 § 86.010–18(c)(2). For purposes of tracking and reporting as required in § 86.010–18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in § 86.010–18(g)(3)(ii)(C) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in § 86.010–18(e)(1)(iii).

(C) The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(g)(3)(ii)(E) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in § 86.010–18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in § 86.010–18(g)(3)(ii)(E) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in § 86.010–18(e)(1)(iii).

(g)(3)(iii)(D) [Reserved]. For guidance see § 86.010–18.

(g)(3)(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.*

(g)(4)(i) and (g)(4)(ii) [Reserved]. For guidance see § 86.010–18.

(g)(4)(iii) *Turbo boost control system monitoring conditions.*

(g)(4)(iii)(A) [Reserved]. For guidance see § 86.010–18.

(g)(iii)(3)(B) The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(g)(4)(ii)(C) and Table 1 of paragraph (g) 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 § 86.010–18(c)(2). For purposes of tracking and reporting as required in § 86.010–18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in § 86.010–18(g)(4)(ii)(C) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in § 86.010–18(e)(1)(iii).

(C) The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(g)(4)(ii)(E) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in § 86.010–18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in § 86.010–18(g)(4)(ii)(E) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in § 86.010–18(e)(1)(iii).

(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.*

(g)(5)(i) and (g)(5)(ii) [Reserved]. For guidance see § 86.010–18.

(g)(5)(iii) *NMHC converting catalyst monitoring conditions.* The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(g)(5)(ii)(A) and (g)(5)(ii)(B) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in § 86.010–18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in § 86.010–18(g)(5)(ii)(A) and (g)(5)(ii)(B) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in § 86.010–18(e)(1)(iii).

(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.*

(g)(6)(i) and (g)(6)(ii) [Reserved]. For guidance see § 86.010–18

(g)(6)(iii) *SCR and lean NO_X* catalyst *monitoring conditions.*

(A) The manufacturers must define the monitoring conditions for malfunctions identified in § 86.010–18(g)(6)(ii)(A) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in § 86.010–18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in § 86.010–18(g)(6)(ii)(A) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in § 86.010–18(e)(1)(iii).

(g)(6)(iii)(B) [Reserved]. For guidance see § 86.010–18.

(g)(6)(iv) *SCR and lean NO_X catalyst MIL activation and DTC storage.*

(A) For malfunctions identified in § 86.010–18(g)(6)(ii)(A) and Table 1 of paragraph (g) of this section, the MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(g)(6)(iv)(B) and (g)(6)(iv)(C) [Reserved]. For guidance see § 86.010–18.

(g)(7) *NO_X adsorber system monitoring.*

(g)(7)(i) and (g)(7)(ii) [Reserved]. For guidance see § 86.010–18.

(g)(7)(iii) *NO_X adsorber system monitoring conditions.*

(A) The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(g)(7)(ii)(A) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in § 86.010–18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in § 86.010–18(g)(7)(ii)(A) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in of § 86.010–18(e)(1)(iii).

(g)(7)(iii)(B) [Reserved]. For guidance see § 86.010–18.

(g)(7)(iv) *NO_X adsorber 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.

(8) *Diesel particulate filter (DPF) system monitoring.*

(g)(8)(i) and (g)(8)(ii) [Reserved]. For guidance see § 86.010–18.

(g)(8)(iii) *DPF monitoring conditions.* The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(g)(8)(ii) and Table 1 of paragraph (g) 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 § 86.010–18(c)(2). For purposes of tracking and reporting as required in § 86.010–18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in § 86.010–18(g)(8)(ii) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in § 86.010–18(e)(1)(iii).

(iv) *DPF 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.

(9) *Exhaust gas sensor and sensor heater monitoring.*

(g)(9)(i) through (g)(9)(vi) [Reserved]. For guidance see § 86.010–18.

(g)(9)(vii) *Monitoring conditions for exhaust gas sensors.*

(A) The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(g)(9)(ii)(A), (g)(9)(iii)(A), and (g)(9)(iv)(A) (i.e., sensor performance) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section. For purposes of tracking and reporting as required in § 86.010–18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in § 86.010–18(g)(9)(ii)(A), (g)(9)(iii)(A), and(g)(9)(iv)(A) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in § 86.010–18(e)(1)(iii).

(B) The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(g)(9)(ii)(D), (g)(9)(iii)(D), and (g)(9)(iv)(D) (i.e., monitoring function) and Table 1 of paragraph (g) 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 § 86.010–18(c)(2).

(g)(9)(vii)(C) and (g)(9)(vii)(D) [Reserved]. For guidance see § 86.010–18.

(g)(9)(viii) *Monitoring conditions for exhaust gas sensor heaters.*

(A) The manufacturer must define monitoring conditions for malfunctions identified in § 86.010–18(g)(9)(A) (i.e., sensor heater performance) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section.

(g)(9)(viii)(B) [Reserved]. For guidance see § 86.010–18.

(g)(9)(ix) *Exhaust gas sensor and sensor heater MIL activation and DTC storage.* The MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(10) *Variable valve timing (VVT) system monitoring.*

(g)(10)(i) and (g)(10)(vii) [Reserved]. For guidance see § 86.010–18.

(g)(10)(iii) *VVT system monitoring conditions.* Manufacturers must define the monitoring conditions for VVT system malfunctions identified in § 86.010–18(g)(10)(ii) and Table 1 of paragraph (g) 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 § 86.010–18(c)(2). For purposes of tracking and reporting as required in § 86.010–18(d) through (d)(1)(i), all monitors used to detect malfunctions identified in § 86.010–18(g)(10)(ii) and Table 1 of paragraph (g) of this section must be tracked separately but reported as a single set of values as specified in § 86.010–18(d)(1)(iii).

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

(h) [Reserved]. For guidance see § 86.010–18.

(i) *OBD monitoring requirements for all engines.*

(1) *Engine cooling system monitoring.*

(i)(1)(i) through (i)(1)(iii) [Reserved]. For guidance see § 86.010–18.

(i)(1)(iv) *Monitoring conditions for the thermostat.*

(A) The manufacturer must define the monitoring conditions for malfunctions identified in paragraph § 86.010–18(i)(1)(ii)(A) and Table 1 of paragraph (g) of this section in accordance with paragraph (c) of this section. Additionally, except as provided for in § 86.010–18(i)(1)(iv)(B) and (i)(1)(iv)(C), monitoring for malfunctions identified in § 86.010–18(i)(1)(ii)(A) and Table 1 of paragraph (g) of this section must be conducted once per drive cycle on every drive cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria in § 86.010–18(i)(1)(ii)(A) and Table 1 of paragraph (g) of this section.

(i)(1)(iv)(B) and (i)(1)(iv)(C) [Reserved]. For guidance see § 86.010–18.

(i)(1)(v) *Monitoring conditions for the ECT sensor.*

(i)(1)(v)(A) [Reserved]. For guidance see § 86.010–18.

(i)(1)(v)(B) The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(i)(1)(iii)(B) and Table 1 of paragraph (g) of this section in accordance with paragraph (c) of this section. Additionally, except as provided for in § 86.010–18(i)(1)(v)(D), monitoring for malfunctions identified in § 86.010–18(i)(1)(iii)(B) and Table 1 of paragraph (g) of this section must be conducted once per drive cycle on every drive cycle in which the ECT sensor indicates a temperature lower than the closed-loop enable temperature at engine start (i.e., all engine start temperatures greater than the ECT sensor out-of-range low temperature and less than the closed-loop enable temperature).

(C) The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(i)(1)(iii)(C) and (i)(1)(iii)(D) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section.

(i)(1)(v)(D) and (i)(1)(v)(E) [Reserved]. For guidance see § 86.010–18.

(i)(1)(vi) *Engine cooling 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) *Crankcase ventilation (CV) system monitoring.*

(i)(2)(i) and (i)(2)(ii) [Reserved]. For guidance see § 86.010–18.

(i)(2)(iii) *Crankcase ventilation system monitoring conditions.* The manufacturer must define the monitoring conditions for malfunctions identified in § 86.010–18(i)(2)(ii) and Table 1 of paragraph (g) of this section in accordance with paragraphs (c) and (d) of this section.

(iv) *Crankcase ventilation 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. The stored DTC need not identify specifically the CV system (e.g., a DTC for idle speed control or fuel system monitoring can be stored) if the manufacturer can demonstrate that additional monitoring hardware would be necessary to make such an identification and provided the manufacturer's diagnostic and repair procedures for the detected malfunction include directions to check the integrity of the CV system.

(3) *Comprehensive component monitoring.*

(i) *General.* Except as provided for in paragraph (i)(4) of this section, the OBD system must detect a malfunction of any electronic engine component or system not otherwise described in paragraphs (g), (i)(1), and (i)(2) of this section and § 86.010–18(h) that either provides input to (directly or indirectly, such components may include the crank angle sensor, knock sensor, throttle position sensor, cam position sensor, intake air temperature sensor, boost pressure sensor, manifold pressure sensor, mass air flow sensor, exhaust temperature sensor, exhaust pressure sensor, fuel pressure sensor, fuel composition sensor of a flexible fuel vehicle, etc.) or receives commands from (such components or systems may include the idle speed control system, glow plug system, variable length intake manifold runner systems, supercharger or turbocharger electronic components, heated fuel preparation systems, the wait-to-start lamp on diesel applications, the MIL, etc.) the onboard computer(s) and meets either of the criteria described in § 86.010–18(i)(3)(i)(A) and/or (i)(3)(i)(B). Note that, for the purposes of this paragraph (i)(3), ''electronic engine component or system'' does not include components that are driven by the engine and are not related to the control of the fueling, air handling, or emissions of the engine (e.g., PTO components, air conditioning system components, and power steering components).

(i)(3)(i)(A) through (i)(3)(iii) [Reserved]. For guidance see § 86.010–18.

(i)(3)(iv) *Monitoring conditions for input components.*

(i)(3)(iv)(A) [Reserved]. For guidance see § 86.010–18.

(i)(3)(iv)(B) For input component rationality checks (where applicable), the manufacturer must define the monitoring conditions for detecting malfunctions in accordance with paragraphs (c) and (d) of this section, with the exception that rationality checks must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in § 86.010–18(c)(2).

(v) *Monitoring conditions for output components/systems.*

(i)(3)(v)(A) [Reserved]. For guidance see § 86.010–18.

(i)(3)(v)(B) For output component/system functional checks, the manufacturer must define the monitoring conditions for detecting malfunctions in accordance with paragraphs (c) and (d) of this section. Specifically for the idle control system, the manufacturer must define the monitoring conditions for detecting malfunctions in accordance with paragraphs (c) and (d) of this section, with the exception that functional checks must occur every time the monitoring conditions are met during the drive cycle rather than once per drive cycle as required in § 86.010–18(c)(2).

(vi) *Comprehensive component MIL activation and DTC storage.*

(A) Except as provided for in § 86.010–18(i)(3)(vi)(B) and (i)(3)(vi)(C), the MIL must activate and DTCs must be stored according to the provisions of paragraph (b) of this section.

(i)(3)(vi)(B) and (i)(3)(vi)(C) [Reserved]. For guidance see § 86.010–18.

(i)(4) *Other emission control system monitoring.*

(i) *General.* For other emission control systems that are either not addressed in § 86.010–18(h) and paragraphs (g) and (i)(1) through (i)(3) of this section (e.g., hydrocarbon traps, homogeneous charge compression ignition control systems), or addressed in paragraph (i)(3) of this section but not corrected or compensated for by an adaptive control system (e.g., swirl control valves), the manufacturer must submit a plan for Administrator approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production engine. The plan must demonstrate the effectiveness of the monitoring strategy, the malfunction criteria used, the monitoring conditions required by the monitor, and, if applicable, the determination that the requirements of § 86.010–18(i)(4)(ii) are satisfied.

(i)(4)(ii) through (i)(5)(v) [Reserved]. For guidance see § 86.010–18.

(i)(6) *Feedback control system monitoring.* If the engine is equipped with feedback control of any of the systems covered in paragraphs (g) and (i) of this section and § 86.010–18(h), then the OBD system must detect as malfunctions the conditions specified in this paragraph (i)(6) for each of the individual feedback controls.

(i)(6)(i) through (i)(6)(iv) [Reserved]. For guidance see § 86.010–18.

(j) *Production evaluation testing.*

(1) *Verification of standardization requirements.*

(i) The manufacturer must perform testing to verify that production vehicles meet the requirements of paragraphs (k)(3) and (k)(4) of this section relevant to the proper communication of required emissions-related messages to a SAE J1978/J1939 scan tool.

(ii) *Selection of test vehicles.*

(A) The manufacturer must perform this testing every model year on ten unique production vehicles (i.e., engine rating and chassis application combination) per engine family. If there are less than ten unique production vehicles for a certain engine family, the manufacturer must test each unique production vehicle in that engine family. The manufacturer must perform this testing within either three months of the start of engine production or one month of the start of vehicle production, whichever is later. The manufacturer may request approval to group multiple production vehicles together and test one representative vehicle per group. To do so, the software and hardware designed to comply with the standardization requirements of paragraph (k) of this section (e.g., communication protocol message timing, number of supported data stream parameters, engine and vehicle communication network architecture) in the representative vehicle must be identical to all others in the group and any differences in the production vehicles cannot be relevant with respect to meeting the criteria of paragraph (j)(1)(iv) of this section.

(B) For 2016 and subsequent model years, the required number of vehicles to be tested shall be reduced to five per engine family provided zero vehicles fail the testing required by paragraph (j)(1) of this section for two consecutive years.

(C) For 2019 and subsequent model years, the required number of vehicles to be tested shall be reduced to three per engine family provided zero vehicles fail the testing required by paragraph (j)(1) of this section for three consecutive years.

(D) The requirement for submittal of data from one or more of the production vehicles shall be waived if data have been submitted previously for all of the production vehicles. The manufacturer may request approval to carry over data collected in previous model years. To do so, the software and hardware designed to comply with the standardization requirements of paragraph (k) of this section must be identical to the previous model year and there must not have been other hardware or software changes that affect compliance with the standardization requirements.

(iii) *Test equipment.* For the testing required by paragraph (j)(1) of this section, the manufacturer shall use an off-board device to conduct the testing. The manufacturer must be able to show that the off-board device is able to verify that the vehicles tested using the device are able to perform all of the required functions in paragraph (j)(1)(iv) of this section with any other off-board device designed and built in accordance with the SAE J1978/J1939 generic scan tool specifications.

(iv) *Required testing.* The testing must verify that communication can be established properly between all emission-related on-board computers and any SAE J1978/J1939 scan tool designed to adhere strictly to the communication protocols allowed in paragraph (k)(3) of this section. The testing must also verify that all emission-related information is communicated properly between all emission-related on-board computers and any SAE J1978/J1939 scan tool in accordance with the requirements of paragraph (k) of this section and the applicable ISO and SAE specifications including specifications for physical layer, network layer, message structure, and message content. The testing must also verify that the onboard computer(s) can properly respond to any SAE J1978/J1939 scan tool request to clear emissions-related DTCs and reset the ready status in accordance with paragraph (k)(4)(ix) of this section. The testing must further verify that the following information can be properly communicated to any SAE J1978/J1939 scan tool:

(A) The current ready status from all onboard computers required to support ready status in accordance with SAE J1978/J1939–73 and paragraph (k)(4)(i) of this section in the key-on, engine-off position and while the engine is running.

(B) The MIL command status while a deactivated MIL is commanded and while an activated MIL is commanded in accordance with SAE J1979/J1939 and paragraph (k)(4)(ii) of this section in the key-on, engine-off position and while the engine is running, and in accordance with SAE J1979/J1939 and § 86.010–18(b)(1)(ii) during the MIL functional check and, if applicable, (k)(4)(i)(C) of this section during the MIL ready status check while the engine is off.

(C) All data stream parameters required in paragraph (k)(4)(ii) of this section in accordance with SAE J1979/J1939 including, if applicable, the proper identification of each data stream parameter as supported in SAE J1979 (e.g., Mode/Service $01, PID $00).

(D) The CAL ID, CVN, and VIN as required by paragraphs (k)(4)(vi), (k)(4)(vii), and (k)(4)(viii) of this section and in accordance with SAE J1979/J1939.

(E) An emissions-related DTC (permanent, pending, MIL-on, previous-MIL-on) in accordance with SAE J1979/J1939–73 (including the correct indication of the number of stored DTCs (e.g., Mode/Service $01, PID $01, Data A for SAE J1979)) and paragraph (k)(4)(iv) of this section.

(v) *Reporting of results.* The manufacturer must submit to the Administrator the following, based on the results of the testing required by paragraph (j)(1)(iv) of this section:

(A) If a variant meets all the requirements of paragraph (j)(1)(iv) of this section, a statement specifying that the variant passed all the tests. Upon request from the Administrator, the detailed results of any such testing may have to be submitted.

(B) If any variant does not meet the requirements of paragraph (j)(1)(iv) of this section, a written report detailing the problem(s) identified and the manufacturer's proposed corrective action (if any) to remedy the problem(s). This report must be submitted within one month of testing the specific variant. The Administrator will consider the proposed remedy and, if in disagreement, will work with the manufacturer to propose an alternative remedy. Factors to be considered by the Administrator in considering the proposed remedy will include the severity of the problem(s), the ability of service technicians to access the required diagnostic information, the impact on equipment and tool manufacturers, and the amount of time prior to implementation of the proposed corrective action.

(vi) *Alternative testing protocols.* Manufacturers may request approval to use other testing protocols. To do so, the manufacturer must demonstrate that the alternative testing methods and equipment will provide an equivalent level of verification of compliance with the standardization requirements as is required by paragraph (j)(1) of this section.

(2) *Verification of monitoring requirements.*

(j)(2)(i) through (j)(2)(ii)(C) [Reserved]. For guidance see § 86.010–18.

(j)(2)(iii) *Evaluation requirements.*

(A) The evaluation must demonstrate the ability of the OBD system on the selected test vehicle to detect a malfunction, activate the MIL, and, where applicable, store an appropriate DTC readable by a SAE J1978/J1939 scan tool when a malfunction is present and the monitoring conditions have been satisfied for each individual monitor required by this section.

(j)(2)(iii)(B) through (j)(2)(iv) [Reserved]. For guidance see § 86.010–18.

(j)(3) *Verification of in-use monitoring performance ratios.*

(j)(3)(i) through (j)(3)(iii) [Reserved]. For guidance see § 86.010–18.

(j)(3)(iv) For each monitoring performance group, the data must include all of the in-use performance tracking data reported through SAE J1979/J1939 (i.e., all numerators, denominators, the general denominator, and the ignition cycle counter), the date the data were collected, the odometer reading, the VIN, and the calibration ID.

(j)(3)(v) and (j)(3)(vi) [Reserved]. For guidance see § 86.010–18.

(k) *Standardization requirements.*

(k)(1) through (k)(1)(i)(B) [Reserved]. For guidance see § 86.010–18.

(k)(1)(i)(C) SAE J1962 ''Diagnostic Connector—;Equivalent to ISO/DIS 15031–3: December 14, 2001,'' April 2002.

(k)(1)(i)(D) through (k)(1)(ii)(A) [Reserved]. For guidance see § 86.010–18.

(k)(2) *Diagnostic connector.* A standard data link connector conforming to SAE J1962 or SAE J1939–13 specifications (except as provided for in paragraph (k)(2)(iii) of this section) must be included in each vehicle.

(i) The connector must be located in the driver's side foot-well region of the vehicle interior in the area bound by the driver's side of the vehicle and the driver's side edge of the center console (or the vehicle centerline if the vehicle does not have a center console) and at a location no higher than the bottom of the steering wheel when in the lowest adjustable position. The connector shall not be located on or in the center console (i.e., neither on the horizontal faces near the floor-mounted gear selector, parking brake lever, or cup-holders nor on the vertical faces near the car stereo, climate system, or navigation system controls). The location of the connector shall be capable of being easily identified and accessed (e.g., to connect an off-board tool). For vehicles equipped with a driver's side door, the connector must be identified and accessed easily by someone standing (or ''crouched'') on the ground outside the driver's side of the vehicle with the driver's side door open. The Administrator may approve an alternative location upon request from the manufacturer. In all cases, the installation position of the connector must be both identified and accessed easily by someone standing outside the vehicle and protected from accidental damage during normal vehicle use.

(ii) If the connector is covered, the cover must be removable by hand without the use of any tools and be labeled ''OBD'' to aid technicians in identifying the location of the connector. Access to the diagnostic connector shall not require opening or the removal of any storage accessory (e.g., ashtray, coinbox). The label must clearly identify that the connector is located behind the cover and is consistent with language and/or symbols commonly used in the automobile and/or heavy truck industry.

(iii) If the ISO 15765–4 communication protocol is used for the required OBD standardized functions, the connector must meet the ''Type A'' specifications of SAE J1962. Any pins in the connector that provide electrical power must be properly fused to protect the integrity and usefulness of the connector for diagnostic purposes and shall not exceed 20.0 Volts DC regardless of the nominal vehicle system or battery voltage (e.g., 12V, 24V, 42V).

(iv) If the SAE J1939 protocol is used for the required OBD standardized functions, the connector must meet the specifications of SAE J1939–13. Any pins in the connector that provide electrical power must be properly fused to protect the integrity and usefulness of the connector for diagnostic purposes.

(v) The manufacturer may equip engines/vehicles with additional diagnostic connectors for manufacturer-specific purposes (i.e., purposes other than the required OBD functions). However, if the additional connector conforms to the ''Type A'' specifications of SAE J1962 or the specifications of SAE J1939–13 and is located in the vehicle interior near the required connector as described in this paragraph (k)(2) of this section, the connector(s) must be labeled clearly to identify which connector is used to access the standardized OBD information required by paragraph (k) of this section.

(3) *Communications to a scan tool.* All OBD control modules (e.g., engine, auxiliary emission control module) on a single vehicle must use the same protocol for communication of required emission-related messages from on-board to off-board network communications to a scan tool meeting SAE J1978 specifications or designed to communicate with an SAE J1939 network. Engine manufacturers shall not alter normal operation of the engine emission control system due to the presence of off-board test equipment accessing information required by this paragraph (k). The OBD system must use one of the following standardized protocols:

(i) ISO 15765–4. All required emission-related messages using this protocol must use a 500 kbps baud rate.

(ii) SAE J1939. This protocol may only be used on vehicles with diesel engines.

(4) *Required emission related functions.* The following standardized functions must be implemented in accordance with the specifications in SAE J1979 or SAE J1939 to allow for access to the required information by a scan tool meeting SAE J1978 specifications or designed to communicate with an SAE J1939 network:

(i) *Ready status.* In accordance with SAE J1979/J1939–73 specifications, the OBD system must indicate ''complete'' or ''not complete'' for each of the installed monitored components and systems identified in paragraphs (g), and (i)(3) of this section, and paragraph (h) with the exception of § 86.010–18(h)(4). All components or systems identified in § 86.010–18(h)(1) or (h)(2), or (i)(3) of this section that are monitored continuously must always indicate ''complete.'' Components or systems that are not subject to being monitored continuously must immediately indicate ''complete'' upon the respective monitor(s) being executed fully and determining that the component or system is not malfunctioning. A component or system must also indicate ''complete'' if, after the requisite number of decisions necessary for determining MIL status has been executed fully, the monitor indicates a malfunction of the component or system. The status for each of the monitored components or systems must indicate ''not complete'' whenever diagnostic memory has been cleared or erased by a means other than that allowed in paragraph (b) of this section. Normal vehicle shut down (i.e., key-off/engine-off) shall not cause the status to indicate ''not complete.''

(k)(4)(i)(A) [Reserved]. For guidance see § 86.010–18.

(k)(4)(i)(B) For the evaporative system monitor, the ready status must be set in accordance with this paragraph (k)(4)(i) when both the functional check of the purge valve and, if applicable, the leak detection monitor of the hole size specified in § 86.010–18(h)(7)(ii)(B) indicate that they are complete.

(C) If the manufacturer elects to indicate ready status through the MIL in the key-on/engine-off position as provided for in § 86.010–18(b)(1)(iii), the ready status must be indicated in the following manner: If the ready status for all monitored components or systems is ''complete,'' the MIL shall remain continuously activated in the key-on/engine-off position for at least 10–20 seconds. If the ready status for one or more of the monitored components or systems is ''not complete,'' after at least 5 seconds of operation in the key-on/engine-off position with the MIL activated continuously, the MIL shall blink once per second for 5–10 seconds. The data stream value for MIL status as required in paragraph (k)(4)(ii) of this section must indicate ''commanded off'' during this sequence unless the MIL has also been ''commanded on'' for a detected malfunction.

(ii) *Data stream.* The following signals must be made available on demand through the standardized data link connector in accordance with SAE J1979/J1939 specifications. The actual signal value must always be used instead of a limp home value.

(k)(4)(ii)(A) through (k)(4)(ii)(C) [Reserved]. For guidance see § 86.010–18.

(k)(4)(iii) *Freeze frame.*

(A) ''Freeze frame'' information required to be stored pursuant to § 86.010–18(b)(2)(iv), (h)(1)(iv)(D), and (h)(2)(vi) must be made available on demand through the standardized data link connector in accordance with SAE J1979/J1939–73 specifications.

(k)(4)(iii)(B) [Reserved]. For guidance see § 86.010–18.

(k)(4)(iii)(C) Only one frame of data is required to be recorded. The manufacturer may choose to store additional frames provided that at least the required frame can be read by a scan tool meeting SAE J1978 specifications or designed to communicate with an SAE J1939 network.

(iv) *Diagnostic trouble codes.*

(A) For all monitored components and systems, any stored pending, MIL-on, and previous-MIL-on DTCs must be made available through the diagnostic connector in a standardized format in accordance with SAE J1939 or ISO 15765–4 specifications. Standardized DTCs conforming to the applicable standardized specifications must be employed.

(k)(4)(iv)(B) and (k)(4)(iv)(C) [Reserved]. For guidance see § 86.010–18.

(k)(4)(iv)(D) A pending or MIL-on DTC (as required in paragraphs (g) and (i) of this section and § 86.010–18(h)) must be stored and available to an SAE J1978 or SAE J1939 scan tool within 10 seconds after a monitor has determined that a malfunction or potential malfunction has occurred. A permanent DTC must be stored and available to an SAE J1978 or SAE J1939 scan tool no later than the end of an ignition cycle in which the corresponding MIL-on DTC that caused MIL activation has been stored.

(E) Pending DTCs for all components and systems (including those monitored continuously and non-continuously) must be made available through the diagnostic connector in accordance with the applicable standard's specifications. A manufacturer using alternative statistical protocols for MIL activation as allowed in § 86.010–18(b)(2)(iii) must submit the details of their protocol for setting pending DTCs. The protocol must be, overall, equivalent to the requirements of this paragraph (k)(4)(iv)(E) and provide service technicians with a quick and accurate indication of a potential malfunction.

(F) Permanent DTC for all components and systems must be made available through the diagnostic connector in a standardized format that distinguishes permanent DTCs from pending DTCs, MIL-on DTCs, and previous-MIL-on DTCs. A MIL-on DTC must be stored as a permanent DTC no later than the end of the ignition cycle and subsequently at all times that the MIL-on DTC is commanding the MIL on. Permanent DTCs must be stored in non-volatile random access memory (NVRAM) and shall not be erasable by any scan tool command or by disconnecting power to the on-board computer. Permanent DTCs must be erasable if the engine control module is reprogrammed and the ready status described in paragraph (k)(4)(i) of this section for all monitored components and systems are set to ''not complete.'' The OBD system must have the ability to store a minimum of four current MIL-on DTCs as permanent DTCs in NVRAM. If the number of MIL-on DTCs currently commanding activation of the MIL exceeds the maximum number of permanent DTCs that can be stored, the OBD system must store the earliest detected MIL-on DTC as permanent DTC. If additional MIL-on DTCs are stored when the maximum number of permanent DTCs is already stored in NVRAM, the OBD system shall not replace any existing permanent DTC with the additional MIL-on DTCs.

(v) *Test results.*

(A) Except as provided for in § 86.010–18(k)(4)(v)(G), for all monitored components and systems identified in paragraph (g) of this section and § 86.010–18(h), results of the most recent monitoring of the components and systems and the test limits established for monitoring the respective components and systems must be stored and available through the data link in accordance with the standardized format specified in SAE J1979 (for engines using the ISO 15765–4 protocol) or SAE J1939.

(k)(4)(v)(B) [Reserved]. For guidance see § 86.010–18.

(k)(4)(v)(C) The test results must be standardized such that the name of the monitored component (e.g., catalyst bank 1) can be identified by a generic scan tool and the test results and limits can be scaled and reported by a generic scan tool with the appropriate engineering units.

(k)(4)(v)(D) through (k)(4)(v)(G) [Reserved]. For guidance see § 86.010–18.

(k)(4)(vi) *Software calibration identification (CAL ID).* On all engines, a single software calibration identification number (CAL ID) for each monitor or emission critical control unit(s) must be made available through the standardized data link connector in accordance with the SAE J1979/J1939 specifications. A unique CAL ID must be used for every emission-related calibration and/or software set having at least one bit of different data from any other emission-related calibration and/or software set. Control units coded with multiple emission or diagnostic calibrations and/or software sets must indicate a unique CAL ID for each variant in a manner that enables an off-board device to determine which variant is being used by the vehicle. Control units that use a strategy that will result in MIL activation if the incorrect variant is used (e.g., control units that contain variants for manual and automatic transmissions but will activate the MIL if the selected variant does not match the type of transmission mated to the engine) are not required to use unique CAL IDs.

(vii) *Software calibration verification number (CVN).*

(A) All engines must use an algorithm to calculate a single calibration verification number (CVN) that verifies the on-board computer software integrity for each monitor or emission critical control unit that is electronically reprogrammable. The CVN must be made available through the standardized data link connector in accordance with the SAE J1979/J1939 specifications. The CVN must indicate whether the emission-related software and/or calibration data are valid and applicable for the given vehicle and CAL ID.

(k)(4)(vii)(B) [Reserved]. For guidance see § 86.010–18.

(k)(4)(vii)(C) The CVN must be calculated at least once per drive cycle and stored until the CVN is subsequently updated. Except for immediately after a reprogramming event or a non-volatile memory clear or for the first 30 seconds of engine operation after a volatile memory clear or battery disconnect, the stored value must be made available through the data link connector to a generic scan tool in accordance with SAE J1979/J1939 specifications. The stored CVN value shall not be erased when DTC memory is erased by a generic scan tool in accordance with SAE J1979/J1939 specifications or during normal vehicle shut down (i.e., key-off/engine-off).

(D) The CVN and CAL ID combination information must be available for all engines/vehicles in a standardized electronic format that allows for off-board verification that the CVN is valid and appropriate for a specific vehicle and CAL ID.

(viii) *Vehicle identification number (VIN).*

(A) All vehicles must have the vehicle identification number (VIN) available in a standardized format through the standardized data link connector in accordance with SAE J1979/J1939 specifications. Only one electronic control unit per vehicle may report the VIN to an SAE J1978/J1939 scan tool.

(k)(4)(viii)(B) [Reserved]. For guidance see § 86.010–18.

(k)(4)(ix) *Erasure of diagnostic information.*

(A) For purposes of this paragraph (k)(4)(ix), ''emission-related diagnostic information'' includes all of the following: ready status as required by paragraph (k)(4)(i) of this section; data stream information as required by paragraph (k)(4)(ii) of this section including the number of stored MIL-on DTCs, distance traveled while MIL activated, number of warm-up cycles since DTC memory last erased, and distance traveled since DTC memory last erased; freeze frame information as required by paragraph (k)(4)(iii) of this section; pending, MIL-on, and previous-MIL-on DTCs as required by paragraph (k)(4)(iv) of this section; and, test results as required by paragraph (k)(4)(v) of this section.

(k)(4)(ix)(B) [Reserved]. For guidance see § 86.010–18.

(k)(5) *In-use performance ratio tracking requirements.*

(i) For each monitor required in paragraphs (g) and (i) of this section and § 86.010–18(h) to separately report an in-use performance ratio, manufacturers must implement software algorithms to report a numerator and denominator in the standardized format specified in this paragraph (k)(5) in accordance with the SAE J1979/J1939 specifications.

(ii) For the numerator, denominator, general denominator, and ignition cycle counters required by § 86.010–18(e), the following numerical value specifications apply:

(A) Each number shall have a minimum value of zero and a maximum value of 65,535 with a resolution of one.

(B) Each number shall 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 unit (e.g., battery disconnect). Numbers shall not be reset to zero under any other circumstances including when a scan tool command to clear DTCs or reset KAM is received.

(C) To avoid overflow problems, if either the numerator or denominator for a specific component reaches the maximum value of 65,535 ±2, both numbers shall be divided by two before either is incremented again.

(D) To avoid overflow problems, if the ignition cycle counter reaches the maximum value of 65,535 ±2, the ignition cycle counter shall rollover and increment to zero on the next ignition cycle.

(E) To avoid overflow problems, if the general denominator reaches the maximum value of 65,535 ±2, the general denominator shall rollover and increment to zero on the next drive cycle that meets the general denominator definition.

(F) If a vehicle is not equipped with a component (e.g., oxygen sensor bank 2, secondary air system), the corresponding numerator and denominator for that specific component shall always be reported as zero.

(iii) For the ratio required by § 86.010–18(e), the following numerical value specifications apply:

(A) The ratio shall have a minimum value of zero and a maximum value of 7.99527 with a resolution of 0.000122.

(B) The ratio for a specific component shall be considered to be zero whenever the corresponding numerator is equal to zero and the corresponding denominator is not zero.

(C) The ratio for a specific component shall 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.

(6) *Engine run time tracking requirements.*

(i) For all gasoline and diesel engines, the manufacturer must implement software algorithms to track and report individually in a standardized format the amount of time the engine has been operated in the following conditions:

(A) Total engine run time.

(B) Total idle run time (with ''idle'' defined as accelerator pedal released by the driver, vehicle speed less than or equal to one mile per hour, engine speed greater than or equal to 50 to 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission), and power take-off not active).

(C) Total run time with power take off active.

(ii) For each counter specified in paragraph (k)(6)(i) of this section, the following numerical value specifications apply:

(A) Each number shall be a four-byte value with a minimum value of zero, a resolution of one second per bit, and an accuracy of ± ten seconds per drive cycle.

(B) Each number shall be reset to zero only when a non-volatile memory reset occurs (e.g., reprogramming event). Numbers shall not be reset to zero under any other circumstances including when a scan tool (generic or enhanced) command to clear fault codes or reset KAM is received.

(C) To avoid overflow problems, if any of the individual counters reach the maximum value, all counters shall be divided by two before any are incremented again.

(D) The counters shall be made available to a generic scan tool in accordance with the SAE J1979/J1939 specifications and may be rescaled when transmitted, if required by the SAE specifications, from a resolution of one second per bit to no more than three minutes per bit.

(l) *Monitoring system demonstration requirements for certification.*

(1) *General.*

(l)(1)(i) through (l)(1)(iii) [Reserved]. For guidance see § 86.010–18.

(l)(2) *Selection of test engines.*

(l)(2)(i) [Reserved]. For guidance see § 86.010–18.

(l)(2)(ii) A manufacturer certifying one to five engine families in a given model year must provide emissions test data for a single test engine from one engine rating. A manufacturer certifying six to ten engine families in a given model year must provide emissions test data for a single test engine from two different engine ratings. A manufacturer certifying eleven or more engine families in a given model year must provide emissions test data for a single test engine from three different engine ratings. A manufacturer may forego submittal of test data for one or more of these test engines if data have been submitted previously for all of the engine ratings and/or if all requirements for certification carry-over from one model year to the next are satisfied.

(iii) For a given model year, a manufacturer may elect to provide emissions data for test engines from more engine ratings than required by paragraph (l)(2)(ii) of this section. For each additional engine rating tested in that given model year, the number of engine ratings required for testing in one future model year will be reduced by one.

(iv) For the test engine, the manufacturer must use an engine aged for a minimum of 125 hours fitted with exhaust aftertreatment emission controls aged to be representative of useful life aging. The manufacturer is required to submit a description of the accelerated aging process and/or supporting data. The process and/or data must demonstrate assurance that deterioration of the exhaust aftertreatment emission controls is stabilized sufficiently such that it represents emission control performance at the end of the useful life.

(3) *Required testing.* Except as otherwise described in this paragraph (l)(3) of this section, the manufacturer must perform single malfunction testing based on the applicable test with the components/systems set at their malfunction criteria limits as determined by the manufacturer for meeting the emissions thresholds required in paragraphs (g) and (i) of this section and § 86.010–18(h).

(i) *Required testing for diesel-fueled/compression ignition engines.*

(l)(3)(i)(A) [Reserved]. For guidance see § 86.010–18.

(l)(3)(i)(B) *Engine misfire.* The manufacturer must perform a test at the malfunction limit established by the manufacturer for the monitoring required by paragraph (g)(2)(ii)(B) of this section.

(l)(3)(i)(C) through (l)(3)(i)(K) [Reserved]. For guidance see § 86.010–18.

(l)(3)(ii) *Required testing for gasoline-fueled/spark-ignition engines.*

(l)(3)(ii)(A) through (l)(3)(ii)(I) [Reserved]. For guidance see § 86.010–18.

(l)(3)(iii) *Required testing for all engines.*

(l)(3)(iii)(A) and (l)(3)(iii)(B) [Reserved]. For guidance see § 86.010–18.

(l)(3)(iv) [Reserved]. For guidance see § 86.010–18.

(l)(4) *Testing protocol.*

(l)(4)(i) [Reserved]. For guidance see § 86.010–18.

(l)(4)(ii) *Test sequence.*

(l)(4)(ii)(A) through (l)(4)(ii)(C) [Reserved]. For guidance see § 86.010–18.

(l)(4)(iii) A manufacturer required to test more than one test engine according to paragraph (l)(2)(ii) of this section 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 the emission test data required by this paragraph (l) of this section for all but one of the required test engines. The manufacturer may elect this option if the data from the alternative test procedure are representative of official emissions test results. A manufacturer using this option is still responsible for meeting the malfunction criteria specified in paragraphs (g) and (i) of this section and § 86.010–18(h) if and when emissions tests are performed in accordance with official test procedures.

(l)(4)(iv) [Reserved]. For guidance see § 86.010–18.

(l)(5) *Evaluation protocol.*

(l)(5)(i) [Reserved]. For guidance see § 86.010–18.

(l)(5)(ii) If the MIL activates prior to emissions exceeding the applicable malfunction criteria limits specified in paragraphs (g) and (i) of this section and § 86.010–18(h), no further demonstration is required. With respect to the misfire monitor demonstration test, if the manufacturer has elected to use the minimum misfire malfunction criteria of one percent as allowed in paragraphs (g)(2)(ii)(B) of this section and § 86.010–18(h)(2)(ii)(B), no further demonstration is required provided the MIL activates with engine misfire occurring at the malfunction criteria limit.

(l)(5)(iii) through (l)(5)(iv) [Reserved]. For guidance see § 86.010–18.

(l)(6) *Confirmatory testing.*

(i) The Administrator may perform confirmatory testing to verify the emission test data submitted by the manufacturer as required by paragraph (l) of this section comply with its requirements and the malfunction criteria set forth in paragraphs (g) and (i) of this section and § 86.010–18(h). Such confirmatory testing is limited to the test engine(s) required by paragraph (l)(2) of this section.

(l)(6)(ii) through (l)(7) [Reserved]. For guidance see § 86.010–18.

(m) *Certification documentation requirements.*

(m)(1) through (m)(2)(iv) [Reserved]. For guidance see § 86.010–18.

(m)(2)(v) Emissions test data, a description of the testing sequence (e.g., the number and types of preconditioning cycles), approximate time (in seconds) of MIL activation during the test, diagnostic trouble code(s) and freeze frame information stored at the time of detection, corresponding test results (e.g. SAE J1979 Mode/Service $06, SAE J1939 Diagnostic Message 8 (DM8)) stored during the test, and a description of the modified or deteriorated components used for malfunction simulation with respect to the demonstration tests specified in paragraph (l) of this section. The freeze frame data are not required for engines subject to paragraph (o)(3) of this section.

(m)(2)(vi) through (m)(2)(x) [Reserved]. For guidance see § 86.010–18.

(m)(2)(xi) A written identification of the communication protocol utilized by each engine for communication with a SAE J1978/J1939 scan tool.

(xii) A pictorial representation or written description of the diagnostic connector location including any covers or labels.

(m)(2)(xiii) [Reserved]. For guidance see § 86.010–18.

(m)(2)(xiv) Build specifications provided to engine purchasers or chassis manufacturers detailing all specifications or limitations imposed on the engine purchaser relevant to OBD requirements or emissions compliance (e.g., allowable MIL locations, connector location specifications, cooling system heat rejection rates). A description of the method or copies of agreements used to ensure engine purchasers or chassis manufacturers will comply with the OBD and emissions relevant build specifications (e.g., signed agreements, required audit/evaluation procedures).

(m)(2)(xv) [Reserved]. For guidance see § 86.010–18.

(n) [Reserved]. For guidance see § 86.010–18.

(o) *Implementation schedule.* Except as provided for in paragraph (o)(4) of this section, the requirements of this section must be met according to the following provisions:

(1) *OBD groups.* The manufacturer shall define one or more OBD groups to cover all engine ratings in all engine families. The manufacturer must submit a grouping plan for Administrator review and approval detailing the OBD groups and the engine families and engine ratings within each group for a given model year.

(2) *Full OBD.*

(i) For all engine ratings subject to § 86.010–18, the manufacturer must implement an OBD system meeting the requirements of this section.

(ii) On one engine rating within each of the manufacturer's OBD groups, the manufacturer must implement an OBD system meeting the requirements of this section. These ''full OBD'' ratings will be known as the ''OBD parent'' ratings. The OBD parent rating for each OBD group must be chosen as the rating having the highest weighted projected U.S. sales within the OBD group, with U.S. sales being weighted by the useful life of the engine rating.

(3) *Extrapolated OBD.* For all other engine ratings within each OBD group, the manufacturer must implement an OBD system meeting the requirements of this section except that the OBD system is not required to detect a malfunction prior to exceeding the emission thresholds shown in Table 1 of paragraph (g) of this section and Table 2 of § 86.010–18(h). These extrapolated OBD engines will be known as the ''OBD child'' ratings. On these OBD child ratings, rather than detecting a malfunction prior to exceeding the emission thresholds, the manufacturer must submit a plan for Administrator review and approval that details the engineering evaluation the manufacturer will use to establish the malfunction criteria for the OBD child ratings. The plan must demonstrate both the use of good engineering judgment in establishing the malfunction criteria, and robust detection of malfunctions, including consideration of differences of base engine, calibration, emission control components, and emission control strategies.

(4) Engines certified as alternative fueled engines shall meet the following requirements:

(i) To the extent feasible, those specified in paragraph (i)(3) of this section.

(ii) Monitor the NO_X aftertreatment system on engines so equipped. A malfunction must be detected if:

(A) The NO_X aftertreatment system has no detectable amount of NO_X aftertreatment capability (i.e., NO_X catalyst conversion or NO_X adsorption).

(B) The NO_X aftertreatment substrate is completely destroyed, removed, or missing.

(C) The NO_X aftertreatment assembly is replaced with a straight pipe.

(p) *In-use compliance standards.* For monitors required to indicate a malfunction before emissions exceed a certain emission threshold (e.g., 2 times any of the applicable standards):

(1) On the full OBD ratings as defined in paragraph (o)(2) of this section, separate in-use emissions thresholds shall apply. These thresholds are determined by doubling the applicable thresholds as shown in Table 1 of paragraph (g) of this section and Table 2 of § 86.010–18(h). The resultant thresholds apply only in-use and do not apply for certification or selective enforcement auditing.

(2) The extrapolated OBD ratings as defined in paragraph (o)(3) of this section shall not be evaluated against emissions levels for purposes of OBD compliance in-use.

(3) Only the test cycle and standard determined and identified by the manufacturer at the time of certification in accordance with § 86.010–18(f) as the most stringent shall be used for the purpose of determining OBD system noncompliance in-use.

(4) For monitors subject to meeting the minimum in-use monitor performance ratio of 0.100 in paragraph (d)(1)(ii) of this section, the OBD system shall not be considered noncompliant unless a representative sample indicates the in-use ratio is below 0.050.

(5) An OBD system shall not be considered noncompliant solely due to a failure or deterioration mode of a monitored component or system that could not have been reasonably foreseen to occur by the manufacturer.

13. Section 86.013–30 is added to Subpart A to read as follows:

§ 86.013–30 Certification.

Section 86.013–30 includes text that specifies requirements that differ from § 86.010–30. Where a paragraph in § 86.010–30 is identical and applicable to § 86.013–30, this may be indicated by specifying the corresponding paragraph and the statement ''[Reserved]. For guidance see § 86.010–30.''

(a) introductory text through (f)(1)(i) [Reserved]. For guidance see § 86.010–30.

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

(A) If monitored for emissions performance—a reduction catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NO_X emissions exceeding the applicable NO_X FEL+0.3 g/bhp-hr. Also if monitored for emissions performance—an oxidation catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NMHC emissions exceeding 2 times the applicable NMHC standard.

(B) If monitored for performance—a particulate trap is replaced with a deteriorated or defective trap, or an electronic simulation of such, resulting in either exhaust PM emissions exceeding the applicable FEL+0.04 g/bhp-hr or 0.05 g/bhp-hr PM, whichever is higher; or, exhaust NMHC emissions exceeding 2 times the applicable NMHC standard. Also, if monitored for performance—a particulate trap is replaced with a catastrophically failed trap or a 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.*

(f)(3)(i)(A) [Reserved]. For guidance see § 86.007–30.

(f)(3)(i)(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, the applicable NO_X FEL+0.3 g/bhp-hr; or, 2 times the applicable NMHC standard.

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

(f)(3)(ii)(A) [Reserved]. For guidance see § 86.007–30.

(f)(3)(ii)(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+0.02 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 times the applicable NMHC standard; or, 2 times the applicable CO standard.

(iii) *NO_X sensors.*

(f)(3)(iii)(A) [Reserved]. For guidance see § 86.007–30.

(f)(3)(iii)(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, the applicable NO_X FEL+0.3 g/bhp-hr.

(f)(4) [Reserved]. For guidance see § 86.010–30.

(f)(5)(i) [Reserved]. For guidance see § 86.007–30.

(f)(5)(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+0.02 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 times the applicable NMHC standard; or, 2 times the applicable CO standard.

(f)(6) [Reserved]. For guidance see § 86.010–30.

14. Section 86.016–18 is added to Subpart A to read as follows:

§ 86.016–18 On-board Diagnostics for engines used in applications greater than 14,000 pounds GVWR.

Section 86.016–18 includes text that specifies requirements that differ from § 86.013–18. Where a paragraph in § 86.013–18 is identical and applicable to § 86.016–18, this may be indicated by specifying the corresponding paragraph and the statement ''[Reserved]. For guidance see § 86.013–18.''

(a) through (n) [Reserved]. For guidance see § 86.013–18.

(o) *Implementation schedule.* Except as provided for in paragraph (o)(3) of this section, the requirements of this section must be met according to the following provisions:

(1) *OBD groups.* The manufacturer shall define one or more OBD groups to cover all engine ratings in all engine families. The manufacturer must submit a grouping plan for Administrator review and approval detailing the OBD groups and the engine families and engine ratings within each group for a given model year.

(2) *Full OBD.* The manufacturer must implement an OBD system meeting the requirements of this section on all engine ratings in all engine families.

(3) Engines certified as alternative fueled engines shall meet the following requirements:

(i) To the extent feasible, those specified in § 86.013–18(i)(3).

(ii) Monitor the NO_X aftertreatment system on engines so equipped. A malfunction must be detected if:

(A) The NO_X aftertreatment system has no detectable amount of NO_X aftertreatment capability (i.e., NO_X catalyst conversion or NO_X adsorption).

(B) The NO_X aftertreatment substrate is completely destroyed, removed, or missing.

(C) The NO_X aftertreatment assembly is replaced with a straight pipe.

(p) *In-use compliance standards.* For monitors required to indicate a malfunction before emissions exceed a certain emission threshold (e.g., 2 times any of the applicable standards):

(1) On the engine ratings tested according to § 86.013–18(l)(2)(ii), the certification emissions thresholds shall apply in-use.

(2) On the manufacturer's remaining engine ratings, separate in-use emissions thresholds shall apply. These thresholds are determined by doubling the applicable thresholds as shown in Table 1 of § 86.013–18(g) and Table 2 of § 86.010–18(h). The resultant thresholds apply only in-use and do not apply for certification or selective enforcement auditing.

(3) An OBD system shall not be considered noncompliant solely due to a failure or deterioration mode of a monitored component or system that could not have been reasonably foreseen to occur by the manufacturer.

15. Section 86.019–18 is added to subpart A to read as follows:

§ 86.019–18 On-board diagnostics for engines used in applications greater than 14,000 pounds GVWR.

Section 86.019–18 includes text that specifies requirements that differ from §§ 86.013–18 and 86.016–18. Where a paragraph in § 86.013–18 is identical and applicable to § 86.019–18, this may be indicated by specifying the corresponding paragraph and the statement ''[Reserved]. For guidance see § 86.013–18.''

(a) through (k)(6) [Reserved]. For guidance see § 86.013–18.

(k)(7) For 2019 and subsequent model year alternative-fueled engines derived from a diesel-cycle engine, a manufacturer may meet the standardization requirements of § 86.013–18(k) that are applicable to diesel engines rather than the requirements applicable to gasoline engines.

(l) through (n) [Reserved]. For guidance see § 86.013–18.

(o) *Implementation schedule.* The manufacturer must implement an OBD system meeting the requirements of this section on all engines.

(p) *In-use compliance.* An OBD system shall not be considered noncompliant solely due to a failure or deterioration mode of a monitored component or system that could not have been reasonably foreseen to occur by the manufacturer.

16. Section 86.1806–07 is added to Subpart S to read as follows:

§ 86.1806–07 On-board diagnostics for vehicles less than or equal to 14,000 pounds GVWR.

Section 86.1806–07 includes text that specifies requirements that differ from § 86.1806–05. Where a paragraph in § 86.1806–05 is identical and applicable to § 86.1806–07, this may be indicated by specifying the corresponding paragraph and the statement ''[Reserved]. For guidance see § 86.1806–05.''

(a) through (a)(2) [Reserved]. For guidance see § 86.1806–05.

(a)(3) An OBD system demonstrated to fully meet the requirements in § 86.007–17 may be used to meet the requirements of this section, provided that such an OBD system also incorporates appropriate transmission diagnostics as may be required under this section, and provided that the Administrator finds that a manufacturer's decision to use the flexibility in this paragraph (a)(3) is based on good engineering judgement.

(b) through (h) [Reserved]. For guidance see § 86.1806–05.

(i) *Deficiencies and alternative fueled vehicles.* 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 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 vehicles (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 light-duty vehicles, light-duty trucks, and heavy-duty vehicles weighing 14,000 pounds GVWR or less, demonstration of compliance with California OBD II requirements (Title 13 California Code of Regulations § 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 § 86.1806–05(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) through (m) [Reserved]. For guidance see § 86.1806–05.

(n) For diesel complete heavy-duty vehicles, in lieu of the malfunction descriptions of § 86.1806–05(b), the malfunction descriptions of this paragraph (n) shall apply. The OBD system must detect and identify malfunctions in all monitored emission-related powertrain systems or components according to the following malfunction definitions as measured and calculated in accordance with test procedures set forth in subpart B of this part (chassis-based test procedures), excluding those test procedures defined as ''Supplemental'' test procedures in § 86.004–2 and codified in §§ 86.158, 86.159, and 86.160.

(1) *Catalysts and particulate traps.*

(i) If equipped, catalyst deterioration or malfunction before it results in exhaust emissions exceeding 3 times the applicable NO_X standard. 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.

(ii) If equipped with a particulate trap, catastrophic failure of the device must be detected. Any particulate trap whose complete failure results in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NO_X or PM must be monitored for such catastrophic failure. This monitoring need not be done if the manufacturer can demonstrate that a catastrophic failure of the system will not result in exceedance of the threshold.

(2) *Engine misfire.* Lack of cylinder combustion must be detected.

(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, 3 times the applicable NO_X standard; or, 2.5 times the applicable NMHC standard.

(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, 3 times the applicable NO_X standard; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(iii) NO_X sensors. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: 5 times the applicable PM standard; or, 4 times the applicable NO_X standard.

(4) [Reserved.]

(5) *Other emission control systems and components.* 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: 4 times the applicable PM standard; or, 3 times the applicable NO_X standard; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard. A functional check, as described in paragraph (n)(6) of this section, may satisfy the requirements of this paragraph (n)(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.

(6) *Other emission-related powertrain components.* Any other deterioration or malfunction occurring in an electronic emission-related powertrain system or component not otherwise described in paragraphs (n)(1) through (n)(5) of this section that either provides input to or receives commands from the on-board computer and has a measurable impact on emissions; monitoring of components required by this paragraph (n)(6) must be satisfied by employing electrical circuit continuity checks and rationality checks for computer input components (input values within manufacturer specified ranges based on other available operating parameters), and functionality checks for computer output components (proper functional response to computer commands) except that the Administrator may waive such a rationality or functionality check where the manufacturer has demonstrated infeasibility. Malfunctions are defined as a failure of the system or component to meet the electrical circuit continuity checks or the rationality or functionality checks.

(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.

(o) For diesel complete heavy-duty vehicles, in lieu of the certification provisions of § 86.1806–05(k), the certificate provisions of this paragraph (o) shall apply. For test groups required to have an OBD system, certification will not be granted if, for any test vehicle approved by the Administrator in consultation with the manufacturer, the malfunction indicator light does not illuminate under any of the following circumstances, unless the manufacturer can demonstrate that any identified OBD problems discovered during the Administrator's evaluation will be corrected on production vehicles.

(1)(i) 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 3 times the applicable NO_X standard. This requirement applies only to reduction catalysts.

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

(2) An engine misfire condition is induced and is not detected.

(3)(i) 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: 4 times the applicable PM standard; or, 3 times the applicable NO_X standard; or, 2.5 times the applicable NMHC standard.

(ii) 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: 4 times the applicable PM standard; or, 3 times the applicable NO_X standard; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(iii) 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: 5 times the applicable PM standard; or, 4 times the applicable NO_X standard.

(4) [Reserved.]

(5) 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: 4 times the applicable PM standard; or, 3 times the applicable NO_X standard; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(6) A malfunction condition is induced in an electronic emission-related powertrain system or component not otherwise described in this paragraph (o) that either provides input to or receives commands from the on-board computer resulting in a measurable impact on emissions.

17. Section 86.1806–10 is added to Subpart S to read as follows:

§ 86.1806–10 On-board diagnostics for vehicles less than or equal to 14,000 pounds GVWR.

Section 86.1806–10 includes text that specifies requirements that differ from § 86.1806–05 and § 86.1806–07. Where a paragraph in § 86.1806–05 or § 86.1806–07 is identical and applicable to § 86.1806–10, this may be indicated by specifying the corresponding paragraph and the statement ''[Reserved]. For guidance see § 86.1806–05.'' or ''[Reserved]. For guidance see § 86.1806–07.''

(a) *General.*

(1) All light-duty vehicles, light-duty trucks and complete heavy-duty vehicles weighing 14,000 pounds GVWR or less (including MDPVs) must be equipped with an onboard diagnostic (OBD) system capable of monitoring all emission-related powertrain systems or components during the applicable useful life of the vehicle. All systems and components required to be monitored by these regulations must be evaluated periodically, but no less frequently than once per applicable certification test cycle as defined in paragraphs (a) and (d) of Appendix I of this part, or similar trip as approved by the Administrator.

(2) [Reserved.]

(3) An OBD system demonstrated to fully meet the requirements in § 86.010–17 may be used to meet the requirements of this section, provided that such an OBD system also incorporates appropriate transmission diagnostics as may be required under this section, and provided that the Administrator finds that a manufacturer's decision to use the flexibility in this paragraph (a)(3) is based on good engineering judgement.

(b) through (m) [Reserved]. For guidance see § 86.1806–07.

(n) For diesel complete heavy-duty vehicles, in lieu of the malfunction descriptions of § 86.1806–05(b), the malfunction descriptions of this paragraph (n) shall apply. The OBD system must detect and identify malfunctions in all monitored emission-related powertrain systems or components according to the following malfunction definitions as measured and calculated in accordance with test procedures set forth in subpart B of this part (chassis-based test procedures), excluding those test procedures defined as ''Supplemental'' test procedures in § 86.004–2 and codified in §§ 86.158, 86.159, and 86.160.

(1) *Catalysts and particulate traps.*

(i) If equipped, reduction catalyst deterioration or malfunction before it results in exhaust NO_X emissions exceeding the applicable NO_X standard+0.3 g/mi. 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.

(ii) If equipped, diesel particulate trap deterioration or malfunction before it results in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; 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.

(2) *Engine misfire.* Lack of cylinder combustion must be detected.

(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, the applicable NO_X standard+0.3 g/mi; or, 2.5 times the applicable NMHC standard.

(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: The applicable PM standard+0.02 g/mi; or, the applicable NO_X standard+0.3 g/mi; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(iii) *NO_X sensors.* If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: 4 times the applicable PM standard; or, the applicable NO_X standard+0.3 g/mi.

(4) [Reserved.]

(5) *Other emission control systems and components.* 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: 4 times the applicable PM standard; or, the applicable NO_X standard+0.3 g/mi;

or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard. A functional check, as described in paragraph (n)(6) of this section, may satisfy the requirements of this paragraph (n)(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.

(6) *Other emission-related powertrain components*. Any other deterioration or malfunction occurring in an electronic emission-related powertrain system or component not otherwise described in paragraphs (n)(1) through (n)(5) of this section that either provides input to or receives commands from the on-board computer and has a measurable impact on emissions; monitoring of components required by this paragraph (n)(6) must be satisfied by employing electrical circuit continuity checks and rationality checks for computer input components (input values within manufacturer specified ranges based on other available operating parameters), and functionality checks for computer output components (proper functional response to computer commands) except that the Administrator may waive such a rationality or functionality check where the manufacturer has demonstrated infeasibility. Malfunctions are defined as a failure of the system or component to meet the electrical circuit continuity checks or the rationality or functionality checks.

(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.

(o) For diesel complete heavy-duty vehicles, in lieu of the certification provisions of § 86.1806–5(k), the certification provisions of this paragraph (o) shall apply. For test groups required to have an OBD system, certification will not be granted if, for any test vehicle approved by the Administrator in consultation with the manufacturer, the malfunction indicator light does not illuminate under any of the following circumstances, unless the manufacturer can demonstrate that any identified OBD problems discovered during the Administrator's evaluation will be corrected on production vehicles.

(1)(i) If monitored for emissions performance—a reduction catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NO_X emissions exceeding the applicable NO_X standard+0.3 g/mi. Also if monitored for emissions performance—an oxidation catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NMHC emissions exceeding 2.5 times the applicable NMHC standard.

(ii) If monitored for performance—a particulate trap is replaced with a deteriorated or defective trap, or an electronic simulation of such, resulting in exhaust PM emissions exceeding 4 times the applicable PM standard or exhaust NMHC emissions exceeding 2.5 times the applicable NMHC standard. Also, if monitored for performance—a particulate trap is replaced with a catastrophically failed trap or a simulation of such.

(2) An engine misfire condition is induced and is not detected.

(3)(i) 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: 4 times the applicable PM standard; or, the applicable NO_X standard+0.3 g/mi; or, 2.5 times the applicable NMHC standard.

(ii) 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 standard+0.02 g/mi; or, the applicable NO_X standard+0.3 g/mi; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(iii) 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: 4 times the applicable PM standard; or, the applicable NO_X standard+0.3 g/mi.

(4) [Reserved.]

(5) 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: 4 times the applicable PM standard; or, the applicable NO_X standard+0.3 g/mi; or, 2.5 times the applicable NMHC standard; or, 2.5 times the applicable CO standard.

(6) A malfunction condition is induced in an electronic emission-related powertrain system or component not otherwise described in this paragraph (o) that either provides input to or receives commands from the on-board computer resulting in a measurable impact on emissions.

18. Section 86.1806–13 is added to Subpart S to read as follows:

§ 86.1806–13 On-board diagnostics for vehicles less than or equal to 14,000 pounds GVWR.

Section 86.1806–13 includes text that specifies requirements that differ from § 86.1806–05, § 86.1806–07 and § 86.1806–10. Where a paragraph in § 86.1806–05 or § 86.1806–07 or § 86.1806–10 is identical and applicable to § 86.1806–13 this may be indicated by specifying the corresponding paragraph and the statement ''[Reserved]. For guidance see § 86.1806–05.'' or ''[Reserved]. For guidance see § 86.1806–07.'' or ''[Reserved]. For guidance see § 86.1806–10.''

(a)(1) [Reserved]. For guidance see § 86.1806–10.

(a)(2) [Reserved.]

(3) An OBD system demonstrated to fully meet the requirements in § 86.013–17 may be used to meet the requirements of this section, provided that such an OBD system also incorporates appropriate transmission diagnostics as may be required under this section, and provided that the Administrator finds that a manufacturer's decision to use the flexibility in this paragraph (a)(3) is based on good engineering judgement.

(b) through (m) [Reserved]. For guidance see § 86.1806–07.

(n) For diesel complete heavy-duty vehicles, in lieu of the malfunction descriptions of § 86.1806–05(b), the malfunction descriptions of this paragraph (n) shall apply. The OBD system must detect and identify malfunctions in all monitored emission-related powertrain systems or components according to the following malfunction definitions as measured and calculated in accordance with test procedures set forth in subpart B of this part (chassis-based test procedures), excluding those test procedures defined as ''Supplemental'' test procedures in § 86.004–2 and codified in §§ 86.158, 86.159, and 86.160.

(1) *Catalysts and particulate traps*.

(i) If equipped, reduction catalyst deterioration or malfunction before it results in exhaust NO_X emissions exceeding the applicable NO_X

standard+0.3 g/mi. If equipped, oxidation catalyst deterioration or malfunction before it results in exhaust NMHC emissions exceeding 2 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.

(ii) If equipped, diesel particulate trap deterioration or malfunction before it results in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.04 g/mi; or, exhaust NMHC emissions exceeding 2 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.

(2) *Engine misfire*. Lack of cylinder combustion must be detected.

(3)(i) *Oxygen sensors and air-fuel ratio sensors downstream of aftertreatment devices*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.04 g/mi; or, the applicable NO_X standard+0.3 g/mi; or, 2 times the applicable NMHC standard.

(ii) *Oxygen sensors and air-fuel ratio sensors upstream of aftertreatment devices*. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.02 g/mi; or, the applicable NO_X standard+0.3 g/mi; or, 2 times the applicable NMHC standard; or, 2 times the applicable CO standard.

(iii) *NO_X* sensors. If equipped, sensor deterioration or malfunction resulting in exhaust emissions exceeding any of the following levels: the applicable PM standard+0.04 g/mi; or, the applicable NO_X standard+0.3 g/mi.

(4) [Reserved.]

(5) *Other emission control systems and components*. 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 standard+0.02 g/mi; or, the applicable NO_X standard+0.3 g/mi; or, 2 times the applicable NMHC standard; or, 2 times the applicable CO standard. A functional check, as described in paragraph (n)(6) of this section, may satisfy the requirements of this paragraph (n)(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.

(6) *Other emission-related powertrain components*. Any other deterioration or malfunction occurring in an electronic emission-related powertrain system or component not otherwise described in paragraphs (n)(1) through (n)(5) of this section that either provides input to or receives commands from the on-board computer and has a measurable impact on emissions; monitoring of components required by this paragraph (n)(6) must be satisfied by employing electrical circuit continuity checks and rationality checks for computer input components (input values within manufacturer specified ranges based on other available operating parameters), and functionality checks for computer output components (proper functional response to computer commands) except that the Administrator may waive such a rationality or functionality check where the manufacturer has demonstrated infeasibility. Malfunctions are defined as a failure of the system or component to meet the electrical circuit continuity checks or the rationality or functionality checks.

(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.

(o) For diesel complete heavy-duty vehicles, in lieu of the certification provisions of paragraph (k) of this section, the certification provisions of this paragraph (o) shall apply. For test groups required to have an OBD system, certification will not be granted if, for any test vehicle approved by the Administrator in consultation with the manufacturer, the malfunction indicator light does not illuminate under any of the following circumstances, unless the manufacturer can demonstrate that any identified OBD problems discovered during the Administrator's evaluation will be corrected on production vehicles.

(1)(i) If monitored for emissions performance—a reduction catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NO_X emissions exceeding the applicable NO_X standard+0.3 g/mi. Also if monitored for emissions performance—an oxidation catalyst is replaced with a deteriorated or defective catalyst, or an electronic simulation of such, resulting in exhaust NMHC emissions exceeding 2 times the applicable NMHC standard.

(ii) If monitored for performance—a particulate trap is replaced with a deteriorated or defective trap, or an electronic simulation of such, resulting in exhaust PM emissions exceeding the applicable standard+0.04 g/mi or exhaust NMHC emissions exceeding 2 times the applicable NMHC standard. Also, if monitored for performance—a particulate trap is replaced with a catastrophically failed trap or a simulation of such.

(2) An engine misfire condition is induced and is not detected.

(3)(i) 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 standard+0.04 g/mi; or, the applicable NO_X standard+0.3 g/mi; or, 2 times the applicable NMHC standard.

(ii) 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 standard+0.02 g/mi; or, the applicable NO_X standard+0.3 g/mi; or, 2 times the applicable NMHC standard; or, 2 times the applicable CO standard.

(iii) 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 standard+0.04 g/mi; or, the applicable NO_X standard+0.3 g/mi.

(4) [Reserved.]

(5) 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 standard+0.02 g/mi; or, the applicable NO_X standard+0.3 g/mi; or, 2 times the applicable NMHC standard; or, 2 times the applicable CO standard.

(6) A malfunction condition is induced in an electronic emission-related powertrain system or component not otherwise described in this

paragraph (o) that either provides input to or receives commands from the on-board computer resulting in a measurable impact on emissions.

[FR Doc. 07–110 Filed 1–23–07; 8:45 am]

BILLING CODE 6560–50–P