Memo

To: Interested Parties
From: Michael P. Walsh
Date: August 2, 2000
Subject: EPA Final Rule Regarding 2004 Requirements For Heavy Duty Vehicles and Engines

1. Overview

On August 1, 2000, US EPA Administer Browner signed a Final Rule regarding the 2004 standards for heavy duty vehicles and engines. The Final Rule contains requirements that can generally be separated into those that apply to diesel engines and vehicles and those that apply to Otto-cycle engines and vehicles. Some elements of the program harmonize EPA's regulatory program with California's Medium-duty vehicle (MDV) program (e.g., vehicle-based standards for complete Otto-cycle heavy-duty vehicles below 14,000 pounds GVWR), while others may differ from California's current requirements.

Due to lead time requirements in the Clean Air Act,[1] EPA was not able to finalize some of the new provisions described below to be in effect in time to apply to the 2004 model year as EPA originally proposed.[2] These are delayed until the 2007 model year, which avoids uncertainties regarding lead time and stability issues. New standards for heavy-duty Otto-cycle vehicles and engines can not be implemented earlier than the 2005 model year due to the lead time provisions in the Act. However, manufacturers of these vehicles and engines are given two optional compliance programs that they may select in lieu of the 2005 program, one that starts in 2003 (referred to as "Option 1") and one that starts in 2004 (Option 2). The 2003 and 2004 implementation options offer some incentives relative to the 2005 program to encourage adoption by manufacturers. The two early-introduction options would result in greater emission reductions than the 2005 program.

a. Diesel Engines and Vehicles

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[1] Clean Air Act Section 202(a)(3)(C) requires that "Any standard promulgated or revised under this paragraph and applicable to classes or categories of heavy duty vehicles or engines shall apply for a period of no less than 3 model years beginning no earlier than the model year commencing 4 years after such revised standard is promulgated."

[2] An exception is the 2004 NMHC+NOx standard for heavy-duty diesel engines, which was finalized in a 1997 rulemaking. EPA did not revise or reconsider this standard in this final rule.

The Final Rule concludes that the 2004 NMHC+NOx standard for heavy-duty diesel engines (HDDEs) is technologically feasible, cost-effective, and appropriate under the Clean Air Act, in the context of the current PM standard. This includes a finding that a change in diesel fuel formulation is not required to meet these standards.

In addition, the Rule finalizes a new set of supplemental test procedures to more closely represent the range of real world driving conditions of heavy-duty diesel engines. These elements are specifically designed to provide additional certainty that the standards will be met under a wide range of operating conditions. These elements apply to all heavy-duty diesel engines, except those in Medium-duty Passenger Vehicles, which are subject to the Tier 2 program. First, EPA is adding a steady-state test requirement to the current Federal test procedures (FTP) for HD diesel engines. Emission results from this test must meet the numerical standards for the pre-existing Federal test procedure (i.e., the NMHC+NOx standards noted above, a CO standard of 15.5 g/bhp-hr, and a PM standard of 0.10 g/bhp-hr). This steady-state test requirement becomes effective starting with the 2007 model year. Second, EPA is also finalizing Not-to-Exceed (NTE) test procedures for testing of in-use engines. These NTE procedures apply under any conditions that could reasonably be expected to be seen in normal vehicle operation and use, including an expanded range of ambient conditions. Emission results from this test procedure must be less than or equal to 1.25 times the pre-existing Federal test procedure standards noted above. The NTE test and associated emission limits are effective starting with the 2007 model year. Third, EPA is finalizing a Load Response Test (LRT) certification data submittal requirement for heavy-duty diesel engines, effective starting with the 2004 model year.

EPA is also finalizing on-board diagnostic (OBD) requirements applicable to heavy-duty diesel vehicles and engines up to 14,000 pounds GVWR. Heavy-duty diesel vehicles and engines must be equipped with an OBD system capable of detecting and alerting the driver of certain emission-related malfunctions or deterioration. These requirements are phased in from the 2005 through 2007 model years.

Lastly, EPA has adopted provisions that require engine manufacturers to provide, to EPA, documentation necessary to read and interpret information broadcast by engine on-board computers and ECM's which relate to emission control devices and auxiliary emission control devices (AECDs).

b. Otto-cycle Engines and Vehicles

The Final Rule includes new, more stringent emission standards for all Otto-cycle heavy-duty engines and vehicles. One of the key elements of the Rule is to begin regulating a subset of heavy-duty vehicles using chassis-based requirements. The heavy-duty vehicles that are subject to chassis-based requirements are complete Otto-cycle heavy-duty vehicles with a gross vehicle weight rating (GVWR) up to 14,000 pounds.[3] EPA retained an engine-based approach for engines

[3] "Complete" vehicles are those that are manufactured with their primary cargo carrying container or device attached, whereas "incomplete" vehicles are those that are manufactured without the primary cargo carrying container or device attached. Incomplete vehicles (basically the engine plus a chassis) are then manufactured into a variety of vehicles, such as recreational vehicles, panel trucks, dump trucks, fire trucks, and tow trucks.

used in incomplete Otto-cycle vehicles up to 14,000 pounds GVWR and all Otto-cycle vehicles above 14,000 pounds GVWR (and optionally, for Otto-cycle complete vehicles, under Option 1, for the 2003 through 2006 model years). As noted earlier, manufacturers have the choice of three options, one that provides the lead time that we must allow by statute (Option 3), and two others that allow earlier introduction of cleaner technologies (Options 1 and 2).

For the primary engine-based program, EPA finalized a new NMHC+NOx standard of 1.0 g/bhp-hr that will start in the 2005 model year and remain in place at least through the 2007 model year (Option 3). As an alternative, manufacturers may select a standard of 1.5 g/bhp-hr NMHC+NOx that would apply to the 2004 through 2007 model years, then change to a 1.0 g/bhp-hr NMHC+NOx standard in the 2008 model year (Option 2).[4] Further, if a manufacturer desires some additional flexibility beyond that provided by Option 2, they may certify their Otto-cycle complete vehicles to engine-based standards (rather than to the California LEV-I chassis-based standards that would apply under Option 2) through the 2006 model year, provided that they implement these new standards for engines and vehicles starting with the 2003 model year (Option 1). Like Option 2, the engine-based standard in Option 1 transitions from 1.5 g/bhp-hr to 1.0 g/bhp-hr in the 2008 model year. EPA believes that manufacturers are capable of meeting the requirements under any of these options, and it encourages them to take advantage of the opportunity to introduce cleaner Otto-cycle heavy-duty vehicles sooner rather than later.

For the vehicle-based program, EPA is harmonizing federal standards with the California Medium-duty Vehicle (MDV) Low Emission Vehicle I (LEV-I) standards. These standards, shown in the table below, would apply to Otto-cycle complete vehicles in the weight categories shown. The standards are for emissions over the FTP and vehicles will be tested at adjusted loaded vehicle weight (ALVW), also known as test weight (TW).[5] The standards apply at a useful life of 120,000 miles. EPA also finalized an averaging, banking, and trading (ABT) program tied specifically to this vehicle-based program. Under Option 3, these standards would begin with the 2005 model year. Under Option 2, these standards would apply starting with the 2004 model year. Under Option 1, Otto-cycle complete vehicles could be certified to these standards or to the engine-based standards through the 2006 model year, as noted earlier, starting with the 2003 model year.

Full-Life Emission Standards for Otto-cycle Complete Vehicles (grams per mile)

Vehicle Weight Category (GVWR)	Nonmethane Organic Gas (NMOG)	NOx	CO
8,500 - 10,000 lbs *	0.28	0.9	7.3

[4] It is very important to note the recent EPA proposal regarding the second phase of its strategy to reduce emissions from heavy-duty vehicles. This second phase includes more stringent emission standards for heavy-duty vehicles and engines (diesel and Otto-cycle) in the 2007/2008 time frame. Consequently, the 2008 standard of 1.0 g/bhp-hr in the final rule is intended to be a placeholder for tighter standards that will result from future final action by EPA prior to 2004; it is not intended to represent the standard that the Agency believes to be ultimately feasible or appropriate in that time frame.

[5] ALVW or TW is the actual weight of the vehicle, known as curb weight, plus half pay load. It is also the average of the curb weight and GVWR, or (CW + GVWR)/2.

10,001 - 14,000 lbs	0.33	1.0	8.1

* Excluding medium-duty passenger vehicles, which are covered by the Tier 2 program.

In addition, the Otto-cycle vehicle-based program includes the chassis-based enhanced evaporative emission test procedures. EPA is also requiring onboard refueling and vapor recovery (ORVR) controls on all complete Otto-cycle heavy-duty vehicles up to 10,000 pounds GVWR. These requirements are phased from 2004 to 2006 under Options 1 and 2, and from 2005 to 2006 under Option 3.

As with diesel heavy-duty vehicles, EPA also finalized OBD requirements applicable to heavy-duty Otto-cycle vehicles and engines up to 14,000 pounds GVWR. Heavy-duty Otto-cycle vehicles and engines must be equipped with an OBD system capable of detecting and alerting the driver of certain emission-related malfunctions or deterioration. These requirements are phased in from 2004 to 2007 under Options 1 and 2, and from 2005 to 2007 under Option 3.

Lastly, as with diesel heavy-duty engines, EPA finalized the proposed provisions that require engine manufacturers to provide, to EPA, documentation necessary to read and interpret information broadcast by engine on-board computers and ECM's which relate to emission control devices and auxiliary emission control devices (AECDs).

To address statutory lead time requirements EPA is offering three options for manufacturers of Otto-cycle heavy-duty engines and vehicles, one that starts with the 2003 model year, one that starts with the 2004 model year, and one that starts with the 2005 model year. A manufacturer must select one option for its entire heavy-duty Otto-cycle product line. (Manufacturers may not select one option for some engine families and another option for other engine families, or one option for engines and another for vehicles. The selected option must apply to all HD Otto-cycle vehicles and engines sold by the manufacturer, for the time prescribed under the regulations that describe the options.) These options are summarized briefly below.

i. Option 1 (2003 implementation)

(1) Engine-based standard of 1.5 g/bhp-hr for the 2003 - 2007 model years.
(2) Engine-based standard of 1.0 g/bhp-hr starting with the 2008 model year.[6]
(3) Chassis-based standards shown in the above Table.
(4) Option to certify Otto-cycle complete vehicles to chassis-based or engine-based standards for 2003 - 2006 model years.
(5) OBD phased in from 2004 to 2007, for 8,500 to 14,000 lbs GVWR.
(6) ORVR phased in from 2004 to 2006, for 8,500 to 10,000 lbs GVWR.

ii. Option 2 (2004 implementation)

(1) Engine-based standard of 1.5 g/bhp-hr for the 2004 - 2007 model years.
(2) Engine-based standard of 1.0 g/bhp-hr starting with the 2008 model year.[7]

[6] The recent EPA proposal would replace the 2008 standards finalized in this Rule by more stringent standards.

[7] Ibid.

(3) Chassis-based standards shown in the above Table; 100% compliance in 2004 model year.
(4) OBD phased in from 2004 to 2007, for 8,500 to 14,000 lbs GVWR.
(5) ORVR phased in from 2004 to 2006, for 8,500 to 10,000 lbs GVWR.

iii. Option 3 (2005 implementation)[8]
(1) Engine-based standard of 1.0 g/bhp-hr starting in 2005 model year.[9]
(2) Chassis-based standards shown in the above Table; 100% compliance in 2005 model year.
(3) OBD phased in from 2005 to 2007, for 8,500 to 14,000 lbs GVWR.
(4) ORVR phased in from 2005 to 2006, for 8,500 to 10,000 lbs GVWR.

2. Enforcement During 2004 to 2006

In the time frame from 2004 through 2006, the Agency believes that it has existing regulatory and enforcement authority, and policy guidelines which it is confident will ensure the majority of the environmental benefits of the supplemental test procedures will be met. This includes the existing CAA prohibition on the use of defeat devices, and its existing guidance policy on the use of AECDs and defeat devices. With these policies and agreements in place, the Agency sees no need to establish a voluntary program which would implement the supplemental test procedures for the time frame prior to 2007.

The great majority of heavy-duty diesel engines are manufactured by companies covered by a Consent Decree (CD) – approximately 90 percent of the estimated model year 1999 total HDDE U.S. production, and greater than 95 percent of heavy-heavy duty diesel engines which power the line-haul truck application. The heavy heavy-duty diesel engines are the largest on-highway engines and accumulate the most miles of usage, therefore the engines manufactured by CD companies represent the vast majority of HDDE emissions.

a. CD Companies Having Difficulty With NTE Provisions

The majority of the engines subject to the CDs must meet a not-to-exceed emission limit of 1.25 times the 2004 HDDE standards, as well as a number of additional supplemental requirements, no later than October 1, 2002 (these are sometimes referred to as "pull-ahead" engines). The CD manufacturers must produce these pull-ahead engines for two years from the date they are in full compliance with all requirements of the Consent Decrees. Therefore, the pull-ahead engines will be manufactured for what is essentially model years 2003 and 2004, and possibly beyond. During the rulemaking process, several of the CD companies made public statements that they were having difficulty in preparing to meet all the CD requirements for pull-ahead engines. If these companies cannot manufacture engines meeting all the CD requirements by October, 2002, the

[8] 2005 model year engines or vehicles whose model year begins prior to 4 years from the date of signature of this final rule may be exempted from the 2005 model year requirements under this option. Exempted engines or vehicles would comply with requirements otherwise applicable to the 2004 model year.

[9] The recent EPA proposal would introduce more stringent standards starting in the 2008 model year.

Agency believes that under the terms of the Consent Decrees, the noncomplying companies may be required to manufacturer pull-ahead engines beyond model year 2004 until they are in full compliance for two straight years.

b. CD Companies in Compliance with NTE

For engines which meet all of the Consent Decree requirements as of October 2002 and therefore would no longer be subject to these requirements for engines produced after October of 2004, EPA would not expect manufacturers to change their designs in ways that would noticeably increase emissions and will closely scrutinize designs and use our defeat device prohibition and guidance policy to assure this does not happen.[10] Therefore, regardless of whether the CD provisions terminate after model year 2004, the Agency believes the CD manufacturers will continue to manufacture engines for model years 2005 and 2006 which demonstrate compliance with the 2004 standards and satisfy the emission performance provisions of the Consent Decrees.

c. Companies Not Covered By CD

There are a number of HDDE companies not covered by a CD, and not all engines covered by a CD must meet a pull-ahead requirement which includes supplemental test procedure limits at the 2.5g/bhp-hr NMHC+NOx level. These engines are concentrated in the light-heavy and medium-heavy-duty diesel market, therefore their overall emission impact is relatively small – less than 25 percent of the emissions from a given year's total HDDE production based on recent certification estimates. However, EPA will continue to apply its existing statutory authority, regulatory authority, and policy guidance to those engines not covered by a consent decree between model years 2004 and 2006 to ensure that these engines comply with all applicable 2004 emission standards and control emissions over the wide range of anticipated operating conditions.

In October of 1998, EPA issued guidance policy on AECDs and the defeat device prohibition for HDDEs. This guidance document includes the recommended use of the not-to-exceed test procedure and the Euro-3 steady state test (on which the 2007 supplemental steady state test is based) as screening tools for the manufacturers to use to provide the Agency additional assurance they are meeting all applicable regulatory requirements. One company not covered by a Consent Decree has already voluntarily submitted documentation and test data for their 2000 model year HDDE engine family as requested in the Agency's October 1998 guidance regarding emissions during the Euro-3 steady state test and not-to-exceed emission performance, including a voluntary statement of compliance with NTE and Euro-3 emission limits.[11] The Agency anticipates engine manufacturers will submit the requested information for model years up to 2006, after which the NTE and supplemental steady state test procedures will be mandatory certification requirements.

3. Enforcement in 2007 and After

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[10] See "Heavy-duty Diesel Engines Controlled by Onboard Computers: Guidance on Reporting and Evaluating Auxiliary Emission Control Devices and the Defeat Device Prohibition of the Clean Air Act", October 15, 1998. Document available in EPA Air Docket A-98-32.

[11] See - Statement of Compliance for Engine Family YNDXH04.6FAB, available in EPA Air Docket A-98-32.

EPA is adding two supplemental sets of requirements for HDDEs: (1) a supplemental steady-state test (SSS); and (2) Not-To-Exceed requirements (NTE). Like current emission requirements, these new requirements apply to certification, production line testing, and vehicles in actual use. These supplemental requirements will take effect with the 2007 model year. All existing compliance provisions (e.g., warranty, certification, production line testing, recall) are applicable to these new requirements as well, except as noted in the regulations. The supplemental requirements establish new emission standards for HDDEs, and these new standards will be enforced in the same manner as the preexisting FTP standard. The new SSS will become part of the Agency's existing selective enforcement audit (SEA) program; however, the NTE, as well as the MAEL and EPA selected steady-state "mystery points" discussed below have been excluded from the SEA regulations. In addition, EPA is finalizing a third supplemental test procedure for heavy-duty diesel engines - a Load Response Test - as a data submittal requirement only, which will take effect with the 2004 model year. These supplemental requirements will provide assurance that engines are designed to achieve the expected level of in-use emissions control over all expected operating regimes in-use.

a. Not-to-Exceed Test under Expanded Conditions

EPA is finalizing a Not-To-Exceed (NTE) requirement applicable to HDDEs. The NTE approach establishes an area (the "NTE control area") under the torque curve of an engine where emissions must not exceed a specified value for any of the regulated pollutants.[12] The NTE requirement would apply under any engine operation conditions that could reasonably be expected to be seen by that engine in normal vehicle operation and use, as well as a wide range of real ambient conditions. The NTE control area, emissions requirements, and ambient conditions and test procedures for HDDEs are described below. These requirements would take effect starting in the 2007 model year and would apply to new engines as well as in use throughout the useful life of the engine. At the time of certification manufacturers would have to submit a statement that its engines will comply with these requirements under all conditions which may reasonably be expected to occur in normal vehicle operation and use. The manufacturer must provide a detailed description of all testing, engineering analysis, and other information that forms the basis for the statement. This certification statement must be based on testing and/or research reasonably necessary to support such a statement. This supporting information must be submitted to EPA at certification upon request; manufacturers are not necessarily required to submit NTE test data during certification. Start up conditions are excluded from NTE testing.

The NTE test procedure can be run in a vehicle on the road or in an emissions testing laboratory using an appropriate dynamometer. The test itself does not involve a specific driving cycle of any specific length (mileage or time), rather it involves driving of any type which could reasonably be expected to occur in normal vehicle operation that could occur within the bounds of the NTE control area. The vehicle (or engine) is operated under conditions that may reasonably be expected to be encountered in normal vehicle operation and use, including operation under steady-state or transient conditions and under varying ambient conditions. Emissions are averaged over a minimum time of thirty seconds and then compared to the applicable emission limits.

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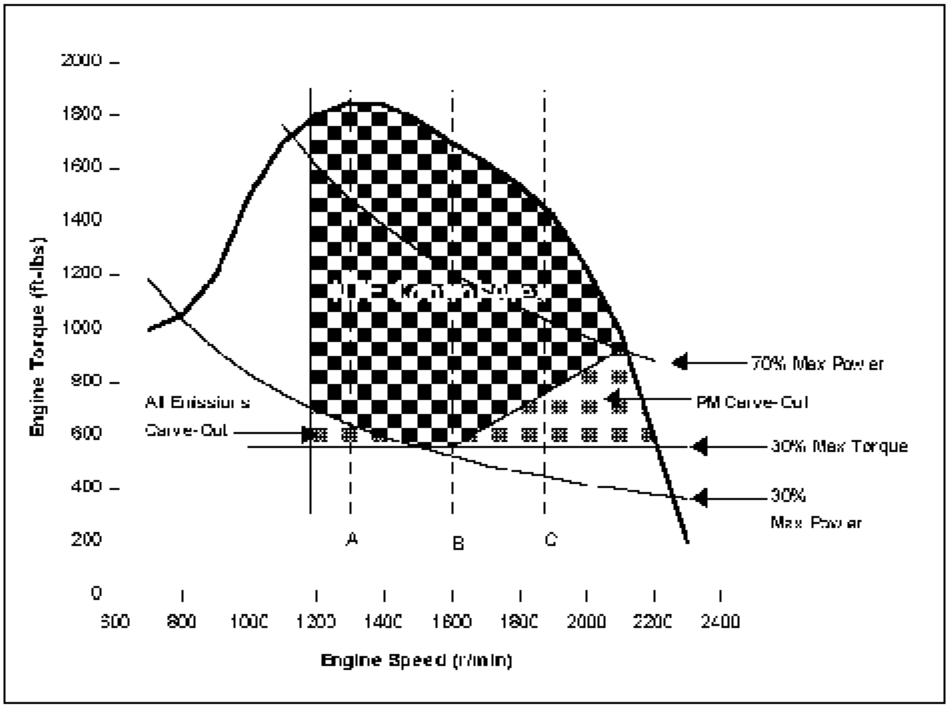
[12] Torque is a measure of rotational force. The torque curve for an engine is determined by an engine "mapping" procedure specified in the Code of Federal Regulations. The intent of the mapping procedure is to determine the maximum available torque at all engine speeds. The torque curve is merely a graphical representation of the maximum torque across all engine speeds.

Examples of the NTE control area are illustrated in Figures 5 and 6. With the exception of two limited regions under the torque curve (described below), the NTE control area for diesels includes all engine operation at or above 30 percent of the maximum torque value of the engine and all engine operation at or above a specific engine speed calculated based on the maximum power of the engine.[13] Two small regions are excluded (or "carved out") from the NTE control area due to the technical challenges associated with controlling emissions in these areas, as well as the fact that engines do not tend to spend a lot time operating in these regions. The combination of the NTE control area and the emission limits within the zone effectively accomplish the Agency's goals of ensuring that emissions are controlled over a wide range of in-use operation. First, we exclude the area under the torque curve that falls below the curve representing 30 percent of the maximum power value of the engine (as distinguished from maximum torque). This region is carved out for all pollutants. Second, a PM-specific region is "carved out" of the NTE control area. The PM-specific area of exclusion is generally in the area under the torque curve where engine speeds are high and engine torque is low, and can vary in shape depending upon several speed-related criteria and calculations detailed in the regulations.

Examples of the NTE control area, including the areas excluded from the zone, are shown below in Figures 5 and 6. The A, B, and C engine speeds are the same as those defined for the supplemental steady state test and described in the regulations. Note that there are two possible constructions of the PM "carve-out" detailed in the regulatory language. The example in Figure 5 shows the PM carve-out as it would look if the C speed is below 2400 revolutions per minute (rpm), while Figure 6 shows the construct of the PM carve-out if the C speed is above 2400 rpm.

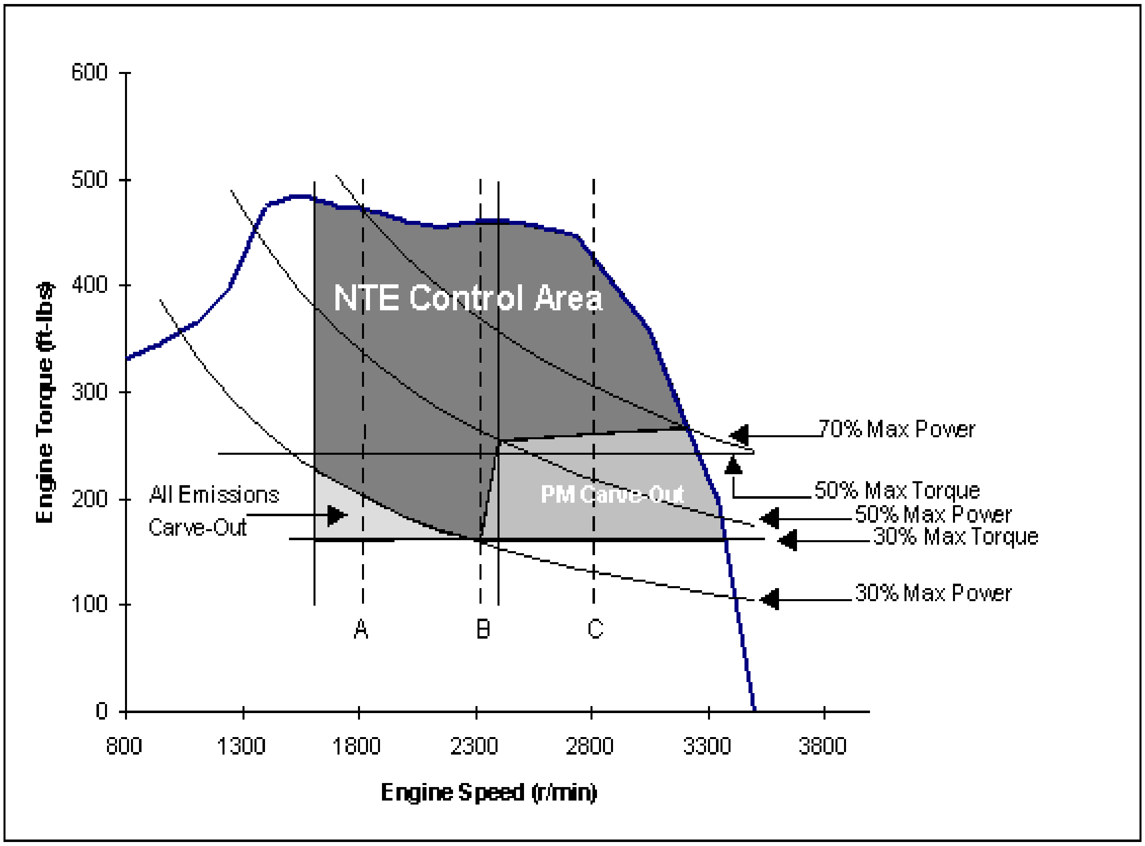
Figure 5 -- Example NTE Control Area for Heavy-Duty Diesel Engines -- C Speed < 2400 rpm

[13] The maximum torque value and maximum power of the engine are derived as part of the engine mapping procedures specified in 40 CFR 86.1332.



2000
1800
1600
1400
1200
1000
800
600
400
200
0
Engine Torque (ft-lbs)
All Emissions
Carve-Out
70% Max Power
PM Carve-Out
30% Max Torque
30%
Max Power
A
B
C
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Engine Speed (r/min)

Figure 6 -- Example NTE Control Area for Heavy-Duty Diesel Engines -- C Speed > 2400 rpm



Within the NTE control area, emissions of each of the regulated pollutants (NMHC + NOx, CO, PM), when averaged over a minimum time of 30 seconds, must not exceed 1.25 times the applicable FTP standards (or FEL if ABT is used). In addition, manufacturers must meet either a smoke limit or an opacity limit within the NTE control area. The filter smoke limit is 1.0 on the Bosch smoke number scale. The alternative opacity limits is a thirty second average smoke opacity of four percent for a five inch path for transient testing and a ten second average smoke opacity of four percent for a five inch path for steady state testing.

b. Deficiencies for NTE Emission Standards

The Final Rule establishes NTE deficiency provisions for HDDEs similar to the deficiency provisions that apply to OBD systems. This will allow the Administrator to accept a HDDE as compliant with the NTE standards even though some specific requirements are not fully met. EPA is finalizing these NTE deficiency provisions because it believes that, despite the best efforts of manufacturers, for the first few model years it is possible some manufacturers may have technical problems that are limited in nature but can not be remedied in time to meet production schedules. This provision will be available for manufacturers through model year 2009. The NTE deficiency provision will only be considered for failures to meet the NTE requirements. EPA will not consider an application for a deficiency for failure to meet the FTP or Supplemental Steady State standards.

The NTE requirements are a new regulatory provision HDDE manufacturers have not been required to meet in the past. The NTE, in combination with the expanded conditions requirements, require compliance with the standard over a wide range of engine operating conditions. Given the complexity of designing, producing, and installing the components and systems that are needed to comply with the emission standards, a number of HDDE manufacturers have expressed concern with their ability to comply with all aspects of the NTE. In particular, manufacturers have expressed concern regarding compliance at the higher ambient temperature and altitude conditions that are covered by the NTE test for higher engine family horsepower ratings under high load operation. While EPA believes that full compliance can and in most cases will be achieved by model year 2007 given other changes in the NTE standards it has made to address these issues, it also believes that some level of relief may be needed to allow for certification of some engines that, despite the best efforts of the manufacturers, are deficient in their ability to achieve the NTE emission requirements.

Manufacturers have identified a number of technical issues which they anticipate having difficulties overcoming. These include the availability of sensors and actuators with the necessary accuracy, precision, and repeatability to control engine and emission control hardware to the degree necessary to meet the NTE requirements under high load conditions during elevated temperatures and altitudes. Another example raised by some engine manufacturers was concerns with the limitation of current generation turbochargers, including compressor exit temperature limits and turbine wheel speed limits. While EPA projects that improvements in sensors, actuators and turbocharger materials, will reduce these limitations in the future, manufacturers are concerned improvements may not be sufficient or may not occur early enough to allow the NTE requirements to be met for all engine families under certain operating conditions by 2007. The NTE deficiency provision will provide additional lead time to manufacturers to resolve those technical compliance issues, if such lead time is needed.

NTE 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 hardware, need for more lead time, or production cycles including phase-in or phase-out of engine designs.

Specific NTE deficiencies 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 NTE deficiency requests that result from the complete failure of a major emission control component or system to operate (“major” emission control components being those for exhaust aftertreatment devices, exhaust gas recirculation system components, turbo-machinery components, other emission control hardware, or other sensor or actuator hardware).

An NTE deficiency request must include a description of all AECDs which would be used by the engine to comply with the deficiency being requested, if applicable. In addition, the NTE deficiency request must included a description of the control system the manufacturer will use to maintain regulated NTE emissions to the lowest practical level.

The EPA NTE deficiency allowance should only be seen as an allowance for minor deviations from the NTE requirements. The NTE deficiency provisions contained in this final rule would allow a manufacturer to apply for relief from the NTE emission requirements under limited conditions. EPA expects that manufacturers should have the necessary functioning emission control hardware in place to comply with the NTE, especially given the lead time afforded to the NTE requirements in this final rule. Nonetheless, it recognizes that there may be situations where a deficiency(ies) is necessary and appropriate. Deficiencies will be approved on an engine model basis, for a single model year, though a manufacturer may request a deficiency for all models and/or horsepower ratings within an engine family, if appropriate. These limitations are intended to prevent a manufacturer from using the deficiency allowance as a means to avoid compliance or delay implementation of any emission control hardware or to compromise the overall effectiveness of the NTE emission requirements.

In the past, EPA has sometimes established non-conformance penalties (NCPs) as an available alternative for manufacturers who want to sell engines which do not meet an emission standard. Once an NCP is established for an emission standard, the NCP is available to all engine manufacturers, i.e., no approval from EPA is required. The NTE deficiency provisions established in the Final Rule are significantly different from NCPs. First, the deficiency provision are for minor deviations from the NTE requirements, such as the failure to meet the NTE emission limit under specific engine operation, during limited regions of the engine map, and during limited temperature and/or altitude conditions, for reasons such as lead time or technological feasibility. NCPs apply under all conditions covered by the applicable FTP, the manufacturer determines the level by which they will fail to meet the applicable standard, and they then calculate the per-engine penalty to be paid. Second, the manufacturer must apply for the deficiency, and EPA must then decide whether or not to grant such a deficiency. Once established, NCP's are available to all manufacturers, i.e., EPA cannot deny an NCP request. The fact that EPA is establishing an NTE deficiency provision in the Final Rule does not foreclose the Agency's ability to establish NCPs for the NTE emission requirements in the future. The Agency intends to continually monitor the status of technological development towards compliance with the NTE requirements and it will establish appropriate NCPs for the NTE emission standards should the criteria for establishing NCPs be met.

c. Supplemental Steady State Test

EPA is adding a steady-state test cycle to the current Federal test procedures for HD diesel engines. This steady-state test cycle is consistent with the test cycle found in the European's "EURO III ESC Test"; however not all aspects are identical to the EURO III ESC Test.[14] Manufacturers are required to meet the standards under this test cycle as well as the standards using the current test procedure (including the current transient test cycle). This test takes effect starting with the 2007 model year.

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[14] "Draft Proposal for a Directive of the European Parliament and the Council Amending Directive 88/77/EEC of 3 December 1987 on the Approximation of the Laws of the Member States Relating to the Measures to be Taken Against the Emission of Gaseous and Particulate Pollutants from Diesel Engines for Use in Vehicles", a proposal adopted by the Commission of the European Union on 3 December 1997, for presentation to the European Council and Parliament.

The supplemental steady-state test cycle consists of 13 modes of speed and power, primarily covering the typical highway cruise operating range of heavy-duty diesel engines. The cycle concentrates on the engine speed range bounded by 50 percent and 70 percent of rated power. This speed range is then divided into bands (engine speeds A, B and C, as defined in § 86.1360-2007(c)). The "control area" is defined by the area between engine speeds A and C, and between 25 to 100 percent load. During the test cycle, the engine is initially run at idle speed, then through a defined sequence of 12 modes at various speeds and engine loads of 25, 50, 75 and 100 percent. Each mode (except idle) is run for two minutes. During each mode of operation, the concentration of the gaseous pollutants is measured and weighted (according to the weighting factors in § 86.1360-2007(b)(1)). The weighted average emissions for each pollutant, as calculated according to this steady-state test procedure, must not be greater than the applicable FTP emission standards. A single, time weighted PM measurement is made for the entire 13 mode test.

Manufacturers will perform the supplemental steady-state test in the laboratory following all applicable test procedures in 40 CFR part 86, subpart N (e.g., procedures for engine warm-up and exhaust emissions measurement). The test must be conducted with all emission-related engine control variables in the maximum NOx producing condition which could be encountered for a 30 second or longer averaging period at the given test point.

In addition to the 13 modes of the test cycle, EPA has the opportunity to select an additional three test points as a check to ensure the effectiveness of the engine's gaseous emission controls within the control area (e.g., ensuring that emissions do not "peak" outside of the 13-mode test points). During the test, the regulated gaseous pollutants would be measured at each of these EPA-selected test points. PM emissions do not need to be measured during the measurement of emissions for the EPA selected points. The manufacturer also will determine an interpolated value of gaseous pollutant emissions at each EPA-selected test point, using the measured emissions of the closest four adjacent test points. EPA is finalizing a four-point linear interpolation procedure that is consistent with that of the European's "EURO III", referenced above. The measured emissions value is then compared to the interpolated emissions value. The measured pollutant value must not exceed the interpolated pollutant value by more than ten percent.

d. Maximum Allowable Emission Limits

The emission levels at the 12 non-idle test points and the calculated emissions values from the four-point interpolation procedure for intermediate test points described in the previous section establish an emissions "surface" of Maximum Allowable Emission Limits (MAELs). This surface will limit gaseous emissions levels during all normal steady-state engine operations that occur within the control area defined above, there is no MAEL surface for PM.

EPA has modified the final regulations such that the MAEL surface is applicable only to steady-state engine operation, and only during standard FTP laboratory conditions. The MAEL is specific to the test engine, and each engine must comply with it's MAEL surface. Each point on this surface will have a MAEL associated with it.[15] The MAEL for each point is calculated using the same four-point

[15] The emissions surface would include all points in the Supplemental Steady-State control area, as defined above.

linear interpolation procedure used to determine the emission value for the EPA test points discussed above. The MAEL applies throughout the regulatory useful life of the engines.

At certification, manufacturers would be responsible for testing the MAELs by performing the "check" described above for the three EPA-selected test points. To determine compliance, test results from operation within the control area must comply with the MAEL generated from running the 12 non-idle points of the supplemental steady state test for the specific test engine. These requirements are effective starting with the 2007 model year.

4. Altitude Requirements and Expanded Temperature and Humidity Conditions for NTE Testing

The FTP , Supplemental Steady State, and MAEL tests are laboratory-based test procedures that would be conducted under standard laboratory conditions defined in the regulations, with emission results corrected according to existing regulations regarding laboratory testing procedures.[16] The NTE could be conducted in the laboratory or during on-the-road driving, and the standards associated with these tests, where applicable, apply under a wide range of conditions. The manufacturer must choose between two options for the range of conditions over which the engine must comply with the NTE requirements.

First, manufacturers can choose to comply with the NTE limits at all altitudes less than or equal to 5,500 feet above sea level, under all temperature conditions. For temperatures outside a range of 55 - 95 deg. Fahrenheit (F), a correction factor for NOx and PM is allowed. Inside the 55 - 95 deg. F range no correction factor for temperature is allowed.

Under option two, a manufacturer can choose to comply with the NTE limits at all altitudes less than or equal to 5,500 feet above sea level, for all temperatures less than a specified temperature at each altitude. The upper temperature limit under option two is 100 deg. F at sea-level and 86 deg. F at 5,500 feet above sea-level, with a linear interpolation for altitudes in between. Temperature correction factors for PM and NOx are allowed for temperatures less than 55 deg. F. However, unlike option one, under option two NTE limits do not apply above the upper temperature limits defined in the regulations. However, the prohibition against defeat devices would apply above the high temperature limits.

Under either operating condition option, emissions of NOx can be corrected for humidity outside a range from 50 to 75 grains of water per pound of dry air (7.14 to 10.71 grams of water per kilogram of dry air).

Within the specific altitude, temperature and humidity ranges, emissions from heavy-duty diesel engines must meet the requirements described above, without corrections for temperature and humidity. For situations within the specified altitude limits in which the temperature and humidity conditions are outside these ranges, NOx is corrected for humidity and both NOx and PM are corrected for temperature. Corrections are to the end of the specified temperature or humidity

[16] The acceptable temperature range for FTP testing is defined by regulation as 68 - 86 degrees Fahrenheit. There is no specified humidity range in the regulations, but NOx emission results are to be corrected to 75 grains of water per pound of dry air.

range nearest the actual conditions. Good engineering judgement is to be used when correcting for humidity and temperature outside of the specified ranges, as specified in the regulations.

5. On-board Diagnostics for Heavy-duty Diesel Engines

The final rule establishes new on-board diagnostic requirements for HD diesel engines used in the 8,500 to 14,000 pound GVWR category. In general, the OBD system must monitor emission-related engine components for deterioration or malfunction causing emissions to exceed 1.5 times the applicable standards. Upon detecting a malfunction, a dashboard malfunction indicator light (MIL) must be illuminated informing the driver of the need for repair. To assist the repair technician in diagnosing and repairing the malfunction, the OBD system must also incorporate standardization features (e.g., the diagnostic data link connector; computer communication protocols; etc.) the intent of which is to allow the technician to diagnose and repair any OBD compliant truck or engine through the use of a "generic" hand-held OBD scan tool.

a. OBD Malfunction Thresholds and Monitoring Requirements

This final rule requires that, beginning in the 2005 model year, heavy-duty diesel engines used in vehicles less than 14,000 pounds must be equipped with an OBD system capable of detecting and alerting the driver of the following emission-related malfunctions or deterioration as evaluated over the appropriate certification test procedure:[17]

(i) Catalyst deterioration or malfunction - before it results in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC+NOx. This monitoring would not need to be done if the manufacturer can demonstrate that deterioration or malfunction of the system will not result in exceedance of the threshold. The above requirement only applies to reduction catalysts; oxidation catalysts are not required to be monitored.

(ii) Particulate trap malfunction - any particulate trap whose complete failure results in exhaust emissions exceeding 1.5 times the applicable standard or FEL for NMHC+NOx or PM must be monitored. Particulate trap monitoring must be capable of detecting a catastrophic failure of the device. Monitoring to the precise 1.5 threshold is not necessary. This monitoring would not need to be done if the manufacturer can demonstrate that a catastrophic failure of the system will not result in exceedance of the threshold.

(iii) Engine misfire - lack of combustion must be monitored.

[17] The FTP minus the Supplemental FTP for chassis certified systems; the engine certification test procedure minus any supplemental test procedures for engine certified systems. While malfunction thresholds are based on certification test procedure emissions, this does not mean that OBD monitors need operate only during the test procedure. All OBD monitors that operate continuously during the test procedure should operate in a similar manner during non-test procedure conditions. The prohibition against defeat devices in §86.004-16 applies to these OBD requirements.

(iv) If the vehicle or engine contains an oxygen sensor, then oxygen sensor deterioration or malfunction before it results in an exhaust emission exceedance of 1.5 times the applicable standard or FEL for NMHC+NOx or CO.

(v) If the vehicle or engine contains an evaporative emission control system, then any vapor leak in the evaporative and/or refueling system (excluding the tubing and connections between the purge valve and the intake manifold) greater than or equal in magnitude to a leak caused by a 0.040 inch diameter orifice; an absence of evaporative purge air flow from the complete evaporative emission control system. On vehicles with fuel tank capacity greater than 25 gallons, the Administrator would be required to revise the size of the orifice to the feasibility limit, based on test data, if the most reliable monitoring method available was unable to reliably detect a system leak equal to a 0.040 inch diameter orifice.

(vi) Any deterioration or malfunction occurring in an engine system or component directly intended to control emissions, including but not necessarily limited to, the 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+NOx, PM, or CO. For vehicles equipped with a secondary air system, a functional check may satisfy the requirements of this paragraph provided the manufacturer can demonstrate that deterioration of the flow distribution system is unlikely. This demonstration would be subject to Administrator approval and, if the demonstration and associated functional check are approved, the diagnostic system would be required to indicate a malfunction when some degree of secondary airflow is not detectable in the exhaust system during the check.

(vii) Any other deterioration or malfunction occurring in an electronic emission-related engine system or component not otherwise described above 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 would be satisfied by employing electrical circuit continuity checks and, wherever feasible, 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); malfunctions would be defined as a failure of the system or component to meet the electrical circuit continuity checks or the rationality or functionality checks.

Upon detection of a malfunction, the MIL would be required to illuminate and a fault code stored no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again detected. Alternatively, upon Administrator approval, a manufacturer would be allowed to use a diagnostic strategy that employs statistical algorithms for malfunction determination. Manufacturers would be required to determine the appropriate operating conditions for diagnostic system monitoring with the limitation that monitoring conditions are encountered at least once during the applicable certification test procedure or a similar test cycle as approved by the Administrator. This is not meant to suggest that monitors be designed to operate only under test procedure conditions, as such a design would not encompass the complete operating range required for OBD malfunction detection.

As an option to the above requirements, EPA will allow compliance demonstration according to the California OBDII requirements for HD diesel with one exception. This option allows manufacturers to concentrate on one set of OBD requirements for nationwide implementation (although federal OBD emission malfunction thresholds and monitoring requirements are essentially equivalent to those of the California OBDII regulation) and provides the highest level of OBD system effectiveness toward meeting nationwide clean air goals. However, the exception to this option is the requirement for catalyst and particulate trap monitoring. CARB does not require catalyst or aftertreatment monitoring, but as described above, this final rule does. Therefore, if a manufacturer chooses the California OBDII compliance option for a diesel engine, that manufacturer would still be required to satisfy the catalyst or particulate trap OBD monitoring requirements established in the EPA final rule.

b. Standardization Requirements

The light-duty OBD regulations contain requirements for standardization of certain critical aspects of the OBD system. These critical aspects include the design of the data link connector, protocols for on-board to off-board computer communication, formats for diagnostic trouble codes, and types of test modes the on-board system and the off-board scan tool must be capable of supporting. The Final Rule contains similar standards for heavy-duty OBD systems.

c. Deficiency Provisions

The Final Rule also establishes the same deficiency provisions for heavy-duty diesel OBD systems as currently apply to light-duty OBD systems. This would allow the Administrator to accept an OBD system as compliant even though specific requirements are not fully met.

To clarify their deficiency provisions, EPA does not expect to certify vehicles with federal OBD systems that have more than one OBD system 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. Nonetheless, EPA recognizes that there may be situations where more than one deficiency is necessary and appropriate, or where carry-over of a deficiency(ies) for more than one year is necessary and 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 OBD compliance. These 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.

d. Applicability and Waivers

The federal HD diesel OBD requirements would be implemented beginning with the 2005 model year. OBD requirements for diesel heavy-duty engines used in vehicles up to 14,000 pounds GVWR would be phased in over a three year period, from 2005 until 2007. The percentage phase-in schedule will be 60/80/100 for the 2005/06/07 model years, respectively, based on projected sales. For those manufacturers with a single heavy-duty engine family (including otto-cycle and diesel), implementation of OBD requirements would not have to occur until the 2007 model year. This final rule establishes OBD requirements for heavy-duty Otto-cycle engines and vehicles up to 14,000 pounds GVWR which are similar to the requirements for HD diesel, including an identical phase-in schedule. For Otto-cycle manufacturers who choose options 1 or 2, the phase-in schedule is 40/60/80/100 percent for the 2004/05/06/07 model years, respectively. HD manufacturers will be allowed to meet the OBD phase-in requirements by combining their projected sales of HD Otto-cycle and HD diesel engines to meet a combined diesel and Otto-cycle phase-in, at their option.

For heavy-duty vehicles and engines up to 14,000 pounds GVWR operating on alternative fuel, EPA would grant OBD waivers during alternative fuel operation through the 2006 model year to the extent that manufacturers can justify the inability to fully comply with any of the Rule's OBD requirements.[18] Such inability would have to be based upon technological infeasibility, not resource reasons. Further, any heavy-duty vehicles and engines that are subsequently converted for operation on alternative fuel would not be expected to comply with the OBD requirements if the non-converted vehicle or engine does not comply. In other words, if the vehicle or engine never completes any assembly stage in OBD compliance, it need not comply with the OBD requirements while operating on the alternative fuel. If the vehicle or engine does complete any assembly stage with a compliant OBD system, it would have to comply with the OBD requirements while operating on the fuel of original intent and, to the extent feasible, while operating on the alternative fuel. Beginning in the 2007 model year, all heavy-duty alternative fueled vehicles and engines up to 14,000 pounds GVWR will have to be fully compliant during both operation on the fuel of original intent and alternative fuel.

6. Onboard Refueling Vapor Recovery For Otto Cycle Vehicles & Engines

Onboard refueling vapor recovery (ORVR) systems prevent the fuel vapors that are displaced from a vehicle's fuel tank during refueling from entering the atmosphere. Typically, the displaced fuel vapors are routed to a charcoal canister where they are subsequently routed to the engine to be burned as fuel. EPA previously adopted ORVR requirements applicable to light-duty vehicles and light-duty trucks which are being phased in beginning with the 1998 model year for LDVs, the 2001 model year for light LDTs (6,000 lb and under GVWR), and 2004 for heavy LDTs (6,001 through 8,500 lb GVWR).

In this Final Rule, EPA is requiring ORVR controls on all complete HDVs up to 10,000 lb GVWR in the same manner and generally on the same schedule as heavy LDTs. Thus, complete HDVs will be required to meet a refueling emission standard of 0.20 grams per gallon of fuel dispensed. For purposes of ORVR applicability, complete vehicle means a vehicle that leaves the primary manufacturer's control with its primary load carrying device or container attached.

The ORVR standard will be phased in with 80 percent compliance in the 2005 model year and 100 percent compliance in the 2006 model year. This phase-in is the same as that currently in place for heavy LDTs except that no compliance is required in the 2004 model year. For those manufacturers choosing the 2003 or 2004 compliance option discussed previously (Option 1 or 2), the ORVR standard will be phased in with 40 percent compliance required in the 2004 model year, 80 percent compliance in the 2005 model year, and 100 percent compliance in the 2006 model year.

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[18] Note that this provision currently exists for light-duty vehicles and trucks operating on alternative fuel through the 2004 model year; that existing provision does not change with this Rule.

Heavy LDTs and HDVs will be considered a single category for the purposes of the phase in. In other words, the percent compliance requirements for a given model year apply to heavy LDTs and HDVs as a single group, rather than to each group separately. EPA is including an exception to this phase-in approach to allow additional lead time for complete HDVs that do not have light-duty counterparts and those whose fuel tank capacity is greater than 35 gallons. Thus, for those complete HDVs up to 10,000 lb GVWR that do not share an identical fuel system with a light-duty counterpart, and for those whose fuel tank(s) have a total capacity of more than 35 gallons, the ORVR requirements take effect with the 2006 model year. This additional lead time is appropriate for these vehicles in EPA's view because ORVR systems will have to be developed specifically for them, whereas for those heavy-duty vehicles that have light-duty counterparts the required ORVR development work is already underway in order to comply with the heavy light-duty truck ORVR requirements.

7. On-board Diagnostics Requirements for Otto-cycle Vehicles

The final rule establishes new on-board diagnostic requirements for complete HD Otto-cycle vehicles in the 8,500 to 14,000 pound GVWR category. The new OBD requirements for heavy-duty Otto-cycle vehicles are identical to those already in place for light-duty Otto-cycle vehicles and trucks. In general, the OBD system must monitor emission-related powertrain components for deterioration or malfunction causing emissions to exceed 1.5 times the applicable standards. Upon detecting a malfunction, a dashboard MIL must be illuminated informing the driver of the need for repair. To assist the repair technician in diagnosing and repairing the malfunction, the OBD system must also incorporate standardization features (e.g., the diagnostic data link connector; computer communication protocols; etc.) the intent of which is to allow the technician to diagnose and repair any OBD compliant truck or engine through the use of a "generic" hand-held OBD scan tool. The following is a summary of the requirements for HD Otto-cycle vehicles.

a. Federal OBD Malfunction Thresholds and Monitoring Requirements

This final rule requires that, beginning in the 2005 model year (or 2004 under Option 1), complete heavy-duty Otto-cycle vehicles must be equipped with an OBD system capable of detecting and alerting the driver of the following emission-related malfunctions or deterioration as evaluated over the appropriate certification test procedure:[19]

(i) Catalyst deterioration or malfunction before it results in an increase in NMHC[20] emissions equal to or greater than 1.5 times the NMHC standard or FEL, as compared to the NMHC emission level measured using a representative 4,000 mile catalyst system.

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[19] The FTP minus the Supplemental FTP for chassis certified systems; the engine certification test procedure minus any supplemental test procedures for engine certified systems. While malfunction thresholds are based on certification test procedure emissions, this does not mean that OBD monitors need operate only during the test procedure. All OBD monitors that operate continuously during the test procedure should operate in a similar manner during non-test procedure conditions. The prohibition against defeat devices in §86.004-16 applies to these OBD requirements.

[20] As a point of clarification, federal emissions standards are expressed in terms of NMHC. Therefore, in order to remain consistent, all references to HC will be referred to as NMHC.

(ii) Engine misfire before it results in an exhaust emission exceedance of 1.5 times the applicable standard or FEL for NMHC, CO or NOx.

(iii) If the vehicle or engine contains an oxygen sensor, then oxygen sensor deterioration or malfunction before it results in an exhaust emission exceedance of 1.5 times the applicable standard or FEL for NMHC, CO or NOx.

(iv) If the vehicle or engine contains an evaporative emission control system, then any vapor leak in the evaporative and/or refueling system (excluding the tubing and connections between the purge valve and the intake manifold) greater than or equal in magnitude to a leak caused by a 0.040 inch diameter orifice; an absence of evaporative purge air flow from the complete evaporative emission control system. On vehicles with fuel tank capacity greater than 25 gallons, the Administrator will revise the size of the orifice to the feasibility limit, based on test data, if the most reliable monitoring method available is unable to reliably detect a system leak equal to a 0.040 inch diameter orifice.

(v) Any deterioration or malfunction occurring in a powertrain system or component directly intended to control emissions, including but not necessarily limited to, the 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, CO, NOx. For vehicles equipped with a secondary air system, a functional check, as described in paragraph (vi) below, may satisfy the requirements of this paragraph provided the manufacturer demonstrates 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 is required to indicate a malfunction when some degree of secondary airflow is not detectable in the exhaust system during the check.

(vi) Any other deterioration or malfunction occurring in an electronic emission-related powertrain system or component not otherwise described above 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 may be satisfied by employing electrical circuit continuity checks and, wherever feasible, 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); malfunctions are defined as a failure of the system or component to meet the electrical circuit continuity checks or the rationality or functionality checks.

Upon detection of a malfunction, the MIL is required to illuminate and a fault code stored no later than the end of the next driving cycle during which monitoring occurs provided the malfunction is again detected. Alternatively, upon EPA approval, a manufacturer is allowed to use a diagnostic strategy that employs statistical algorithms for malfunction determination. Manufacturers are required to determine the appropriate operating conditions for diagnostic system monitoring with the limitation that monitoring conditions are encountered at least once during the applicable certification test procedure or a similar test cycle as approved by EPA. This is not meant to suggest that monitors be designed to operate only under test procedure conditions, as such a design would not encompass the complete operating range required for OBD malfunction detection.

As an option to the above requirements, EPA will allow compliance demonstration according to the California OBDII requirements for HD Otto-cycle vehicles. This option allows manufacturers to concentrate on one set of OBD requirements for nationwide implementation (although federal OBD emission malfunction thresholds and monitoring requirements are essentially equivalent to those of the California OBDII regulation) and provides the highest level of OBD system effectiveness toward meeting nationwide clean air goals.