

2007 Highway Diesel Questions and Answers from the Clean Diesel Engine Implementation Workshop

The Environmental Protection Agency (EPA) along with the American Trucking Association (ATA), the Engine Manufacturers Association (EMA), the Manufacturers of Emission Control Association (MECA), the Truck Manufacturers Association (TMA), the Truck Renting and Leasing Association (TRALA) and the California Air Resources Board (CARB) organized and sponsored an implementation workshop to discuss issues related to the heavy-duty 2007 (HD 2007) emissions program. The workshop held in Chicago, IL on August 6-7, 2003 included a number of panel sessions with extended periods for questions and answers.

At the workshop, questions were submitted to the panel on notecards from the audience. The following are responses to questions that were submitted to panels during the workshop but were unanswered at the workshop due to time constraints. The questions relate to the implementation of the HD 2007 rule for diesel fuel and heavy-duty vehicles. This document was prepared by EPA's Office of Transportation and Air Quality (OTAQ).

Regulated parties may use this document to aid in achieving compliance with the regulations for heavy-duty vehicles (40 Code of Federal Regulations, CFR Part 86) and diesel fuel (40 CFR Part 80). However, this document does not in any way alter the requirements of these regulations. While the answers provided in this document represent the Agency's interpretation and general plans for implementation of the regulations at this time, some of the responses may change as additional information becomes available, or as the Agency further considers certain issues.

This question and answer document does not establish or change legal rights or obligations. It does not establish binding rules or requirements and is not fully determinative of the issues addressed. Agency decisions in any particular case will be made applying the law and regulations on the basis of specific facts and actual action.

While we have attempted to include answers to all of the unanswered questions from the workshop, the necessity for policy decisions and/or resource constraints may have prevented the inclusion of certain questions. Questions not answered in this document will be answered in a subsequent document. Questions that merely require a justification of the regulations, or that have been previously answered or discussed at the workshop, or in the preamble to the regulations have been omitted.

Questions and Answers

1. **Question:** What safeguards will be in place to insure that the right fuel gets to the right engine given the phase-in allowance for multiple on-highway sulfur levels?

Answer: The potential for fueling vehicles with the wrong fuel during the transition period from 2007 through 2009 was an important issue for the Agency in the 2007 rulemaking. We adopted a number of provisions in the HD 2007 rule for engine and vehicle manufacturers as well as for fuel retailers intended to reduce the likelihood of unintentional misfueling. Following is an excerpt from the Response to Comments document (EPA420-R-00- 027) for the HD 2007 rulemaking responding to the same question.

Response to Comment 6.1.2(C):

We do not believe the fuel program we are adopting, which allows refiners to produce and distribute both 15 ppm and 500 ppm sulfur diesel fuels for a period of time, will jeopardize the effectiveness of the emission control technologies or the emission reductions expected from the new standards. Under the provisions of the final rule, 15 ppm sulfur diesel fuel will be the dominant fuel in the distribution system from the start of the program, limiting the likelihood that 500 ppm sulfur fuel will contaminate 15 ppm sulfur fuel. (Additional discussion of contamination is addressed under Issue 8.1.2. of this document.) The preponderance of 15 ppm sulfur diesel fuel will also limit the likelihood that someone will misfuel a 2007 and later model year truck with the wrong fuel. In addition, we are requiring that all fuel pumps dispensing highway diesel fuel have labels that identify what fuel is being dispensed. We are also requiring that all 2007 and later model year heavy-duty diesel vehicles have labels that specify the use of 15 ppm sulfur diesel fuel only. Furthermore, as discussed in response to issue 6.1.2(D)(1) and the RIA, we expect there to be little or no price differential to exist between the fuels in most markets, minimizing any incentive to misfuel. Finally, we expect truckers will want to use the correct fuel in their 2007 and later model year trucks to ensure their warranty is not voided. Chapter IV of the RIA for today's rule contains a more detailed discussion of the misfueling issue and the reasons we believe it will not be a serious problem under the fuel program being adopted today.

2. **Question:** How is the military expected to handle using aftertreatment when overseas sulfur levels can reach 3,000 ppm?

Answer: As the question implies, the emission control technologies likely to be necessary to meet the 2007 standards are harmed by sulfur in diesel fuel. This is the primary reason that the Agency set a new 15 ppm cap on diesel fuel sulfur in the HD 2007 rulemaking. The possibility that military vehicles would be fueled on high sulfur diesel fuel was raised during the HD 2007 rulemaking. Following is an excerpt from the HD 2007 Response to Comments document (EPA420-R-00- 027) answering this question.

Response to Comments 6.4(C) & (D):

We agree that it will be appropriate for the Department of Defense (DOD) to seek a National Security Exemption for tactical heavy-duty vehicles from the emission standards under our program based on the necessity that these vehicles be fueled on high sulfur military fuel. Due to national security considerations, EPA's existing regulations allow the military to request and receive national security exemptions (NSE) for their motor vehicles from emissions regulations if the operational requirements for such vehicles warrant such an exemption. These provisions have worked successfully in the past to enable us to meet both our national air quality and security goals simultaneously. Today's final rule does not change these provisions.

Based on EPA's existing definition of diesel fuel, we previously concluded that JP-8 military fuel is not subject to EPA's existing requirements for diesel fuel. A provision in our sulfur program revises the definition of diesel fuel so that JP-5 and JP-8 military fuel that is used or intended for use in diesel motor vehicles will be subject to all of the requirements applicable to diesel fuel under our program. However, we also included a provision in our program that exempts JP-5 and JP-8 fuels from EPA's diesel fuel requirements if it is used in tactical military vehicles that have a national security exemption or if it is used in tactical military vehicles that are not covered by a national security exemption but for national security reasons, such as the need to be ready for immediate deployment overseas, need to be fueled on the same fuel as motor vehicles with a national security exemption. The provision for this exemption will be sufficient to address DOD's comment that tactical military vehicles must be fueled on JP-8 or JP-5 while in the United States to facilitate their readiness for deployment overseas. Use of JP-5 and JP-8 fuel not meeting the highway diesel fuel standards in a motor vehicle other than the tactical military vehicle described above is prohibited under today's rule. We believe that this prohibition is necessary to ensure that JP-8 is not used in vehicles equipped with the sulfur sensitive emissions control hardware that we believe will be needed to meet the emissions standards under our program.

In discussions with the Department of Defense (DOD), DOD stated that certain tactical military vehicles must be ready to be shipped overseas quickly in response to an emergency and must be ready to be fueled on whatever fuel is available under tactical conditions (typically JP-8). The use of the high sulfur fuel normally supplied under tactical situations overseas in engines equipped with the aftertreatment technology thought to be necessary to meet the emissions requirements of today's rule could result in driveability problems and permanently destroy the emission control system. To avoid problems experienced in the past when switching between fuel types, tactical vehicles which may need to be shipped overseas are commonly fueled with JP-8 military fuel while in the U.S. as well.

Therefore, it appears that requiring tactical military vehicles that may be used outside of the U.S. to comply with the vehicle emissions requirements under our program is not compatible with the operational requirements for such vehicles. We recognize the national security concerns raised by DOD, and will address this issue using the Agency procedures established for this

purpose. These guidelines are contained in EPA's "Guidelines for National Security Exemptions of Motor Vehicles and Motor Vehicle Engines – Guidelines for Tactical Vehicles/Engines" We also recognize that tactical military vehicles manufactured before the requirements of today's rule become effective may need to continue to be operated on JP-8 or JP-5 fuel while in the U.S. to facilitate their readiness to be fueled on whatever fuel is available overseas. Consistent with an exemption for certain military vehicles, EPA is also exempting diesel fuel from the sulfur standard under our program, where the fuel is used in vehicles exempted from the emissions standards in this rule (pursuant to 40 CFR 85.1708) or in tactical motor vehicles that are not covered by a national security exemption but for national security reasons need to be fueled on the same fuel as motor vehicles with a national security exemption. The exemption for fuel used in tactical motor vehicles not covered by a national security exemption will require prior EPA approval in order for it to be in effect.

3. **Question:** Will "safety valve" fuel up to 500 ppm be sufficiently diluted with ultra-low sulfur fuel to ensure that emission control systems will not be damaged?

Answer: 500 ppm fuel is not lawful for use in new heavy-duty diesel vehicles beginning in 2007. This will be clear to end-users because all 2007 and later vehicles will be clearly labeled as will fuel dispensing pumps. Model year 2006 and older engines can choose to use either 15 ppm sulfur or 500 ppm sulfur fuel in the transition period from 2007-2009. The 2007 rule allows refiners to produce up to 20 percent of their refining volume at 500 ppm. This provision is commonly referred to as the 80/20 fuel program because at minimum 80 percent of fuel volume must be 15 ppm or lower sulfur, while up to 20 percent can be 500 ppm or lower sulfur. Beginning in 2010, all highway diesel fuel must be 15 ppm sulfur fuel.

The refinery pre-compliance reports submitted by refineries to EPA in 2003 indicate that refiners are planning to produce less than 5 percent of diesel fuel in the transition period at 500 ppm (i.e., they are planning to produce primarily 15 ppm fuel, more than 96 percent by volume). Based on this data, EPA suggested at the workshop that should the overall demand for diesel fuel be higher than anticipated by the refining industry (e.g., if economic growth is much higher than projected), additional 500 ppm fuel could be brought to the U.S. market without violating the provisions of the 80/20 fuel program. In fact based on the current projections from industry, fuel volume could be increased by more than 10 percent without violating the provisions of the 80/20 program. This is the 500 ppm "safety valve" that EPA referred to during the workshop.

Regardless of the percentage of 500 ppm sulfur fuel in the market in 2007, be it less than 5 percent, as currently projected by industry, or as much as 20 percent, as allowed under the 80/20 program, the 500 ppm fuel can only be used in engines certified prior to the 2007 model year.

4. **Question:** With 15 ppm fuel, will anti-gel additives be allowed to be used in the fuel?

Answers: Yes. The Agency had originally proposed during the HD2007 process that any fuel additives, including anti-gel additives, be limited to a sulfur content no higher than 15 ppm. Based on comments from industry, the final rule was implemented without a cap on additive sulfur content provided that the sulfur content of the fuel and the additive together does not exceed 15 ppm sulfur. For aftermarket additives, a 15 ppm sulfur cap was put in place because there is no other mechanism to ensure that the total sulfur content of aftermarket additives and diesel fuel will not exceed 15 ppm sulfur. Following are excerpts from the HD 2007 Response to Comments document (EPA420-R-00- 027) related to this question.

Response to Comments 8.1.4(A), (B), & (C):

In response to these comments, we are allowing the use of diesel fuel additives with a sulfur content greater than 15 ppm provided their use does not result in an exceedance of the 15 ppm cap on the sulfur content of highway diesel fuel.

Our review of data submitted by additive and fuel manufacturers to comply with EPA's Fuel and Fuel Additive Registration (F&FAR) requirements (40 CFR Part 79), which is summarized below, indicates that additives to meet every purpose (including static dissipation) are currently in common use which meet a 15 ppm cap on sulfur content. The ability of industry to provide additives for use in 15 ppm highway diesel fuel is further supported by the fact that diesel fuel meeting a 10 ppm cap on sulfur content has been marketed in Sweden for some time, and ARCO Petroleum recently began marketing fuel meeting a 15 ppm sulfur cap in California. Even if low sulfur additives were not yet available for certain purposes, we believe that it is reasonable to assume that they would become available before our sulfur program is implemented in 2006. The summary of the data in the F&FAR database also indicates that the industry could adapt to use only additives that contain less than 15 ppm sulfur. However, we agree that it is not necessary to force the additives that contain greater than 15 ppm sulfur to be retired. By allowing their continued use under certain conditions, we avoid any significant impacts from our sulfur program related to diesel fuel additives.

Response to Comment 8.1.4(D):

We clarified the requirements applicable to aftermarket diesel fuel additives under our program. Additives that exceed 15 ppm in sulfur content may not be used as aftermarket additives for use by the ultimate consumer once our diesel sulfur requirements go into effect. The use of aftermarket additives that exceed 15 ppm in highway diesel fuel by consumers would result in significant harm to the sulfur sensitive the emissions control that we anticipate will be needed to meet the emissions standards under our program.

5. **Question:** Will systems such as the Cummins Sentinel Oil replacement systems be allowed with the new EPA 07 Emission Standards?

Answer: It is the practice for some fleets to either add used engine oil to diesel fuel or to use an integrated product, such as the Cummins Sentinel system, to add used oil to diesel fuel. This is done as an easy means for oil disposal. Because of the potentially harmful impacts of oil ash and other oil contaminants on catalyst based emission control systems, the HD 2007 rule puts specific limits on the practice of adding used engine oil to diesel fuel. The following excerpt from the HD 2007 Response to Comments document (EPA420-R-00- 027) discusses these provisions.

Response to Comment 7.5(A):

We agree that ash formation can be potentially problematic for aftertreatment technologies. Thus, we are prohibiting the practice of adding used motor oil to diesel fuel, with one important exception. We will allow manufacturers to certify engines that are specifically designed to use such mixed fuel. For these engines, used oil can be added to the fuel, but only as specified by the certifying manufacturer. Adding more oil than allowed by the manufacturer, or adding oil that does not meet the manufacturer's specification, would be considered to be a violation of the new section 40 CFR 80.522.

6. **Question:** Active Regeneration.– For non-continuous active regeneration events of aftertreatment components (Particulate filters, NO_x, traps, etc.) That last longer than a single FTP, Caterpillar would like to run sequential FTP cycles and then weight the results with a non-active regeneration FTP cycle based on the time that the regeneration event is active (20 minutes of every 4 hours)

Answer: The possibility that active regeneration functions, be they for sulfur regeneration or PM filter regeneration, could occur so infrequently as to not be captured in a single FTP test cycle was considered during the development of the 2007 regulations. To address this possibility, the Agency amended the test provisions in the Code of Federal Regulations (CFR) to allow a means to account for these emissions. The regulations (excerpted below) specify that manufacturers may develop adjustment factors to account for these emissions.

If a regeneration event is longer than a single FTP, we will allow a manufacturer to average the results of sequential FTP cycles to determine the impact of the regeneration event necessary to calculate the Emission Factor High (EF_H) value defined in the regulations. This emission factor would then be weighted according to the frequency of regeneration events with the Emission Factor Low (EF_L), from a FTP cycle in which a regeneration event did not occur, in order to calculate the average emission rate (EF_A). This average emission rate is the emission rate against which compliance with the emission standards are judged. The regulations also provide mechanisms to adjust the emissions rate from a single test to the average emissions rate

using an Upward Adjustment Factor (UAF) or a Downward Adjustment Factor (DAF) as appropriate. Please see the excerpt from the CFR below.

40 CFR

§86.004-28 Compliance with emission standards.

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(i) Emission results from heavy-duty engines equipped with exhaust aftertreatment may need to be adjusted to account for regeneration events. This provision only applies for engines equipped with emission controls that are regenerated on an infrequent basis. For the purpose of this paragraph (i), the term "regeneration" means an event during which emissions levels change while the aftertreatment performance is being restored by design. Examples of regenerations are increasing exhaust gas temperature to remove sulfur from an adsorber or increasing exhaust gas temperature to oxidize PM in a trap. For the purpose of this paragraph (i), the term "infrequent" means having an expected frequency of less than once per transient test cycle. Calculation and use of adjustment factors are described in paragraphs (i)(1) through (i)(5).

(1) Development of adjustment factors. Manufacturers must develop separate pairs of adjustment factors (an upward adjustment factor and a downward adjustment factor) for each pollutant based on measured emission data and observed regeneration frequency. Adjustment factors may be carried-over to subsequent model years or carried-across to other engine families only where the Administrator determines that such carry-over or carry-across is consistent with good engineering judgment. Adjustment factors should generally apply to an entire engine family, but manufacturers may develop separate adjustment factors for different engine configurations within an engine family. All adjustment factors for regeneration are additive.

(2) Calculation of adjustment factors. The adjustment factors are calculated from the following parameters: the measured emissions from a test in which the regeneration occurs (EF_H), the measured emissions from a test in which the regeneration does not occur (EF_L), and the frequency of the regeneration event in terms of fraction of tests during which the regeneration occurs (F). The average emission rate (EF_A) is calculated as:

$$EF_A = (F)(EF_H) + (1-F)(EF_L)$$

(i) The upward adjustment factor (UAF) is calculated as: $UAF = EF_A - EF_L$

(ii) The downward adjustment factor (DAF) is calculated as: $DAF = EF_A - EF_H$

(3) Use of adjustment factors. Upward adjustment factors are added to measured emission rates for all tests in which the regeneration does not occur. Downward adjustment factors are added to measured emission rates for all tests in which the regeneration occurs. The occurrence of the regeneration must be identified in a manner that is readily apparent during all testing. Where no regeneration is identified, the upward adjustment factor shall be applied.

(4) Sample calculation. If EF_L is 0.10 g/bhp-hr, EF_H is 0.50 g/bhp-hr, and F is 0.1 (i.e., the regeneration occurs once for each ten tests), then:

$$EF_A = (0.1)(0.5 \text{ g/bhp-hr}) + (1.0 - 0.1)(0.1 \text{ g/bhp-hr}) = 0.14 \text{ g/bhp-hr}$$

$$\text{UAF} = 0.14 \text{ g/bhp-hr} - 0.10 \text{ g/bhp-hr} = 0.04 \text{ g/bhp-hr}$$

$$\text{DAF} = 0.14 \text{ g/bhp-hr} - 0.50 \text{ g/bhp-hr} = -0.36 \text{ g/bhp-hr}$$

(5) Options. (i) A manufacturer may elect to omit adjustment factors for one or more of its engine families (or configurations) because the effect of the regeneration is small, or because it is not practical to identify when regenerations occur. In these cases, no upward or downward adjustment factor shall be added, and the manufacturer is liable for compliance with the emission standards for all tests, without regard to whether a regeneration occurs.

(ii) Upon request by the manufacturer, the Administrator may account for regeneration events differently than is provided in this paragraph (i). However, this option only applies for events that occur extremely infrequently, and which cannot be practically addressed using the adjustment factors described in this paragraph (i).

41. Section 86.1370-2007 is amended by revising paragraphs (a), (b)(6) and (d), reserving paragraph (b)(5), and adding paragraphs (e)(7) and (g) to read as follows:

§ 86.1370-2007 Not-To-Exceed test procedures.

(a) General. The purpose of this test procedure is to measure in-use emissions of heavy-duty diesel engines while operating within a broad range of speed and load points (the Not-To-Exceed Control Area) and under conditions which can reasonably be expected to be encountered in normal vehicle operation and use. Emission results from this test procedure are to be compared to the Not-To-Exceed Limits specified in § 86.007-11 (a)(4), or to later Not-To-Exceed limits. The Not-To-Exceed Limits do not apply for engine starting conditions.

(b) * * *

(5) [Reserved]

(6)(i) For petroleum-fueled diesel cycle engines, the manufacturer may identify particular engine - vehicle combinations and may petition the Administrator at certification to exclude operating points from the Not-to-Exceed Control Area defined in § 86.1370(b)(1) through (5) if the manufacturer can demonstrate that the engine is not capable of operating at such points when used in the specified engine - vehicle combination(s).

(ii) For diesel cycle engines that are not petroleum-fueled, the manufacturer may petition the Administrator at certification to exclude operating points from the Not-to-Exceed Control Area defined in § 86.1370(b)(1) through (5) if the manufacturer can demonstrate that the engine is not expected to operate at such points in normal vehicle operation and use.

(7) Manufacturers may petition the Administrator to limit NTE testing in a single defined region of speeds and loads. Such a defined region must generally be of elliptical or rectangular shape, and must share some portion of its boundary with the outside limits of the NTE zone. Under this provision testing would not be allowed with sampling periods in which operation within that region constitutes more than 5.0 percent of the time-weighted operation within the sampling period. Approval of this limit by the Administrator is contingent on the manufacturer satisfactorily demonstrating that operation at the speeds and loads within that region accounts for less than 5.0 percent of all in-use operation (weighted by vehicle-miles-traveled or other

EPA-approved weightings) for the in-use engines of that configuration (or sufficiently similar engines). At a minimum, this demonstration must include operational data from representative in-use vehicles.

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(d) Not-to-exceed control area limits. (1) When operated within the Not-To-Exceed Control Area defined in paragraph (b) of this section, diesel engine emissions shall not exceed the applicable Not-To-Exceed Limits specified in § 86.007-11 (a)(4) when averaged over any period of time greater than or equal to 30 seconds, except where a longer averaging period is required by paragraph (d)(2) of this section.

(2) For engines equipped with emission controls that include discrete regeneration events, if a regeneration event occurs during the NTE test, then the averaging period must be at least as long as the time between the events multiplied by the number of full regeneration events within the sampling period. The requirement in this paragraph (2) only applies for engines that send an electronic signal indicating the start of the regeneration event.

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(g) NO_x and NMHC aftertreatment warm-up. For engines equipped with one or more aftertreatment devices that reduce NO_x or NMHC emissions, the NTE NO_x and NMHC emission limits do not apply when the exhaust gas temperature is measured within 12 inches of the outlet of the aftertreatment device and is less than 250°C. For multi-bed systems, it is the temperature at the outlet of the device with the maximum flow rate that determines whether the NTE limits apply.

7. **Question:** We heard 435,000 miles- for some trucks that is forever,....is this true? Even the 150,000 mile interval is a very long time for a dump truck.

Answer: The useful life definitions for 2004 and newer heavy-duty diesel engines are included below from the CFR. As you can see, the useful life is defined both in terms of mileage and years of operation. For example, the useful life definition for a heavy heavy-duty diesel vehicle is 10 years or 435,000 miles, whichever comes first. In the case of a dump truck, it may be that the vehicle will reach 10 years of operation (i.e., full useful life) prior to reaching the mileage defined useful life of 435,000 miles. These provisions are intended to address the possibility that some vehicles may accumulate limited annual miles.

40 CFR

§86.004-2 Definitions.

1. The definitions of §86.001-2 continue to apply to 2001 and later model year vehicles. The definitions listed in this section apply beginning with the 2004 model year.

Useful life means:

(4) For a diesel HDE family:

(i) For light heavy-duty diesel engines, for carbon monoxide, particulate, and oxides of nitrogen plus non-methane hydrocarbons emissions standards, a period of use of 10 years or 110,000 miles, whichever first occurs.

(ii) For medium heavy-duty diesel engines, for carbon monoxide, particulate, and oxides of nitrogen plus non-methane hydrocarbons emission standards, a period of use of 10 years or 185,000 miles, whichever first occurs.

(iii) For heavy heavy-duty diesel engines, for carbon monoxide, particulate, and oxides of nitrogen plus non-methane hydrocarbon emissions standards, a period of use of 10 years or 435,000 miles, or 22,000 hours, whichever first occurs, except as provided in paragraphs (4)(iv) and (4)(v) of this definition.

(iv) The useful life limit of 22,000 hours in paragraph (4)(iii) of this definition is effective as a limit to the useful life only when an accurate hours meter is provided by the manufacturer with the engine and only when such hours meter can reasonably be expected to operate properly over the useful life of the engine.

(v) For an individual engine, if the useful life hours limit of 22,000 hours is reached before the engine reaches 10 years or 100,000 miles, the useful life shall become 10 years or 100,000 miles, whichever occurs first, as required under Clean Air Act section 202(d).

(5) As an option for both light-duty trucks under certain conditions and HDE families, an alternative useful life period may be assigned by the Administrator under the provisions of §86.094-21(f).