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September 15, 2000

Mail Out #MSC-00-20

TO: ALL INTERESTED PARTIES

SUBJECT: CONSIDERATION OF AMENDMENTS TO ADOPT NOT-TO-EXCEED AND EURO III EUROPEAN STATIONARY CYCLE EMISSION STANDARDS AND TEST PROCEDURES FOR THE 2005 AND SUBSEQUENT MODEL YEAR HEAVY-DUTY ENGINES AND VEHICLES.

The current certification requirements of new heavy-duty diesel engines for sale in California include the Federal Test Procedure (FTP). The FTP is a prescribed set of engine operation test points conducted in the laboratory that represents the typical operation of a vehicle in-use. In the 1990s, it was found that seven of the largest heavy-duty diesel engine (HDDE) manufacturers violated certification regulations by turning off emission control devices, used to comply with the FTP emission standard, during in-use highway driving. Consequently, the Department of Justice, the United States Environmental Protection Agency (U.S. EPA) and the Air Resources Board (ARB or "Board") signed consent decrees with these engine manufacturers. A consent decree is a judicial decree which recognizes the mutual settlement between two parties; in this case, between the government and the engine manufacturers (herein referred to as the "settling manufacturers").

In these consent decrees, the settling manufacturers are required, among other things, to produce HDDEs that meet a 2.5 gram per brake horsepower (g/bhp-hr) hour limit on non-methane hydrocarbons (NMHC) plus oxides of nitrogen (NOx) emissions no later than October 1, 2002 (about 50 percent cleaner than current engines). The majority of these settling manufacturers have also agreed to produce engines by October 1, 2002 that meet supplemental certification standards and test procedures including the Not-To-Exceed (NTE) test and the EURO III European Stationary Cycle (ESC) test. The consent decree stipulates that these requirements must be met for a period of 2 years. Together with the FTP test, these supplemental procedures will require control of emissions from a majority of real world operation and conditions.

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Recognizing the effectiveness of the supplemental tests, the U.S. EPA published a Notice of Proposed Rulemaking (October, 1999) proposing to adopt the supplemental standards and test procedures for 2004 and subsequent model year HDDEs. However, because of legal timing constraints imposed on the U.S. EPA, the NTE and ESC standards and test procedures will not be required until the 2007 model year. Therefore, once the HDDE consent decree requirements expire in 2004, diesel engine manufacturers will not be obligated to comply with the supplemental test procedures starting in 2005, and ending with the 2007 model year, when the Federal Rule comes into effect.

In order to fill the 2005 and 2006 model year gap, staff proposes the inclusion of the NTE and ESC tests in the required certification procedure for the 2005 and subsequent model year HDDEs. Taking this action will prevent the consent decree manufacturers from producing 2005 and 2006 model year engines that will emit significantly greater NOx emissions during in-use steady state driving compared to engines produced from 2002 through 2004. The proposed NTE and ESC requirements would also apply to the manufacturers which were not covered by the consent decree. These new NTE and ESC compliant engines produced in 2005 and 2006 model years will contribute to significant emission benefits during the 2005 and 2006 calendar years, as well as throughout the lifetime of the engines. The remainder of this notice provides greater detail on the supplemental tests, standards, feasibility of these standards, and preliminary emission benefit calculations.

A. Proposed Amendments

As indicated above, the U.S. EPA has already adopted the NTE and ESC supplemental tests for 2007 and subsequent model year heavy-duty diesel engines. Staff is proposing to incorporate these supplemental test procedures into the California certification procedures two years earlier, beginning in the 2005 model year. To incorporate these supplemental test procedures, ARB staff is proposing amendments to Section 1956.8 (Exhaust Emissions Standards and Test Procedures – 1985 and Subsequent Model Heavy-Duty Engines and Vehicles) of Title 13 of the California Code of Regulations as shown in Appendix A. In addition, staff is also proposing to amend the California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles, as shown in Appendix B. Incomplete medium-duty diesel engines and vehicles above 8,500 and below 14,000 pounds gross vehicle weight rating and heavy-duty diesel engines and vehicles over 14,000 pounds gross vehicle weight rating are subject to the requirements in the proposed amendments.

The proposed amendments contain the following three main requirements for 2005 and subsequent model year heavy-duty diesel engines:

- The new NTE Test with numerical emission standards of 1.25 times the FTP emission standards,
- The new ESC with numerical emission standards equivalent to the FTP emission standards, and
- Maximum Allowable Emission Limits.

These proposed emission standards are applicable for NMHC plus NO_x, particulate matter, and carbon monoxide emissions. The proposed emission tests are referred to as the HDDE supplemental FTP tests since they supplement the standard Federal FTP test.

Not-To-Exceed Test

The NTE test, as defined in CFR 86.1370-2007, establishes an area (NTE control area) under the torque curve of an engine where emissions must not exceed a specified standard for a given pollutant. The NTE control area for diesel engines is a function of engine speed and all engine operation at or above 30 percent of the maximum torque value of the engine. The NTE requirement would apply under any engine operating conditions that could reasonably be expected in normal vehicle use. In addition, the NTE is applicable in a wide range of ambient conditions. For example, NTE ambient temperature coverage can range from 55° to 95°F compared to the FTP ambient conditions of 68° to 86°F. These requirements would apply to new engines throughout their useful life.

A vehicle can be tested over the NTE procedure either on the road or in an emission testing laboratory using an engine or chassis dynamometer. Instead of using a specific driving cycle such as the FTP, it can involve driving of any type which could reasonably be expected to occur in normal vehicle operation within the boundaries of the NTE control area, including operation under steady-state or transient conditions and under varying ambient conditions. Measured emissions are averaged over a minimum of thirty seconds and compared to the NTE emission limit.

Additionally, two different options related to temperature and altitude will be available for manufacturers to comply with the NTE requirement. Under option one, manufacturers can choose to comply with the NTE emission standards

within the ambient temperature range of 55°F to 95°F, up to 5,500 feet above sea level. There is no temperature correction for different altitudes. Under option two, manufacturers can use correction factors for the temperature at different altitudes. For example, the upper temperature limit is 100°F at sea-level and 86°F at 5,500 feet above sea-level.

In U.S. EPA's Final Rule¹, an NTE deficiency provision for 2007 and subsequent model year engines provides manufacturers with a relief mechanism for failing to comply with some of the NTE requirements. Unlike the U.S. EPA's Final Rule, however, this proposal does not include deficiency provisions for NTE. Because the NTE control area, test procedures, and associated emission standards in the proposed regulation are identical to the NTE requirements in the HDDE consent decree for model years 2003 and 2004, the settling manufacturers will be in full compliance with proposed NTE standards prior to the effective date of this proposal.

Euro III European Stationary Cycle Test

The ESC test cycle, as defined in CFR §86.1360-2007 as the "supplemental steady state test", consists of 13 modes at different speed and power conditions, primarily representing the typical highway cruise operating conditions of heavy-duty diesel vehicles.

During the test cycle, the engine is initially operated at idle speed, then through a defined sequence of 12 modes at various speeds and engine loads. The test modes are at three different engine speeds at 25%, 50%, 75%, and 100% of maximum load. Each mode (except idle) requires that the engine be operated for two minutes. Manufacturers would be required to show compliance with the following:

Average Allowable Emission Limits

During each mode of operation of the ESC test, the concentration of the gaseous pollutants is measured. The weighted average emissions for each pollutant, as calculated according to this steady-state test procedure, must not be greater than 1.0 times the Federal Test Procedure emission standard which is 2.5 g/bhp-hr for NMHC plus NO_x for 2005 and subsequent model year engines. A single, particulate matter measurement is made of the entire 13 modes at the end of the test.

¹ U.S. EPA Final Rule on the Control of Emissions of Air Pollution from 2004 and Later Model Year Heavy-Duty Highway Engines and Vehicles; Revision of Light-Duty On-Board Diagnostics Requirements.

Maximum Allowable Emission Limits

Maximum allowable emission limits are determined from the 12 non-idle test points of the ESC tests. The maximum allowable emission limit at any set of speed and load conditions between the test points is determined by using a four-point interpolation procedure. Emissions of gaseous pollutants at any point within the maximum allowable emission limit operational zone must not exceed the limit as determined by interpolation. Maximum allowable emission limits only apply to gaseous pollutants and do not apply to particulate matter.

The ARB is seeking manufacturers' comments on technical feasibility and economic impact of complying with the supplemental standards listed above.

B. Technical Feasibility

As described in the U.S. EPA Final Rule, significant technological progress has been made in the last few years to achieve emission reductions from heavy-duty diesel engines. The following examples of technologies have been demonstrated to effectively lower emissions: second generation fuel injection systems, cooled exhaust gas recirculation for heavy-duty diesels, advanced turbocharging systems (such as variable geometry and multiple turbochargers), and advanced electronic control systems. These systems have been proven technically feasible and effective in numerous demonstrations and documented in scientific and engineering publications. These emission control technologies can produce substantial emission reductions in NO_x, particulate matter and hydrocarbons, over a broad range of engine operating conditions. Emission reductions of approximately 50 to 90 percent from current generation heavy-duty diesel engines, have been demonstrated using combinations of these technologies.

In response to U.S. EPA's 1999 Notice of Proposed Rulemaking to adopt these supplemental test procedures, several consent decree manufacturers provided U.S. EPA and ARB with information and data regarding testing and development work they have performed. The data show that under some extreme ambient and operating conditions, some engines have technical challenges meeting the NTE and ESC requirements without sacrificing performance. Overall however, under typical operating conditions, the data demonstrate that engines are capable of fully complying with the NTE and ESC standards. Additionally, the settling manufacturers are required to meet the supplemental test standards

beginning October 1, 2002 pursuant to the HDDE consent decree. Thus, the proposed standards and test procedures, identical to those in the consent decree, will be technically feasible for the 2005 model year, about two years after the first consent decree engines have been manufactured.

The ARB is seeking specific comment and information on the technology required to comply with the proposed requirements. Additionally, the ARB is interested in the cost of such technology as well as any additional consumer costs to purchase, fuel, and maintain the new engines.

C. Preliminary Emission Estimates

Preliminary emission benefits as a result of adopting the HDDE supplemental FTP tests were estimated. Emissions from engines produced in 2005 and 2006 without NTE and ESC requirements were calculated to quantify the excess emissions. These excess emissions can also be viewed as reductions we can achieve if NTE and ESC requirements are adopted. Any reductions would exclude the emissions emitted by out-of-state vehicles. Out-of-state vehicles account for approximately 25 percent of the heavy heavy-duty vehicle miles traveled. Calculations were based on the relationship among vehicle miles traveled, emission factors, and different types of engine operations. A preliminary emission factor of 2.5 g/bhp-hr of NO_x emissions in excess of the proposed NTE emissions standards is used in the calculations. This emission factor was provided by a diesel engine manufacturer as an approximation of excess emissions of a HDDE that does not have to comply with the NTE and ESC standards versus one that is compliant with the NTE and ESC standards. Other input data such as estimating the number of new engines in 2005 and 2006 are projected by running ARB's EMFAC2000 model.

The equation used to calculate the excess emissions if the NTE and ESC standards were not required for the 2005 and 2006 model years is as follows:

$$\begin{array}{l} \text{Excess} \\ \text{Emissions} \\ \text{(tons/day)} \end{array} = [\text{EF} \times \text{CF} \times (\text{Daily_VMT}) \times (\text{Percent_steady_state})] / 90,901$$

Where:

EF = Incremental NOx emission factor in grams per bhp-hr (2.5 g/bhp-hr)
CF = Conversion factor from grams per bhp-hr to grams per mile.
= 2.3 for medium-heavy diesel engines or
= 2.6 for heavy-heavy diesel engines
(both are from California's previous Motor Vehicle Emission Factor Model – MVEI7G)

Daily_VMT
= Total daily vehicle miles traveled (from EMFAC2000)

Percent_steady_state
= Percent of VMT under steady-state conditions.
= 72% for heavy-heavy diesel engines or
= 25% for medium-heavy diesel engines
(both are estimated from data in U.S. EPA's MOBILE5 Heavy-Duty Diesel Vehicle Defeat Device Spreadsheet Model)

90,901 = Conversion factor from grams per day to tons per day.

Using the equation above, preliminary excess emissions are in excess of 20 tons of NOx in the 2006 calendar year from new heavy-duty diesel vehicles (Gross Vehicle Weight Rating of 14,001 pounds and greater) in California. The excess emission in the absence of the proposed rule on life long emission reductions from these engines should not be overlooked. Preliminary estimates indicate that lifetime excess emissions are 1 ton per engine from medium heavy-duty diesel engines² and 4 tons per engine from heavy heavy-duty diesel engines³ if they are not obligated to comply with NTE and ESC requirements. ARB staff believes that the excess emissions are significant and can be prevented by adopting the proposed emission standards and test procedures.

The ARB is seeking additional comparative emission data between 2.5 g/bhp-hr NMHC plus NOx compliant engines that are not subject to the proposed supplemental standards (non-consent decree engines) and engines that are required to comply with the proposed standards.

² Engines used in vehicles with Gross Vehicle Weight Rating equal to and greater than 14,001 pounds and less than 33,000 pounds.

³ Engines used in vehicles with Gross Vehicle Weight Rating equal to and greater than 33,000 pounds.

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This regulatory proposal is scheduled for consideration by the Board on December 7, 2000. Comments to the proposed amendments should be mailed by October 5, 2000 to the following address.

Air Resources Board
Attn: Mr. Michael Carter
Chief, Emission Research and Regulatory Development Branch
9528 Telstar Avenue
El Monte, California 91731

Further inquiries regarding this matter should be directed to Ms. Susan O'Connor, Manager, On-Road Heavy Duty Diesel Section, at (626) 450-6162.

Sincerely,

Robert H. Cross, Chief
Mobile Source Control Division

Attachment