State of California
Air Resources Board

UPDATED INFORMATIVE DIGEST

AMENDMENTS TO ADOPT NOT-TO-EXCEED AND EURO III EUROPEAN STATIONARY CYCLE EMISSION TEST PROCEDURES FOR THE 2005 AND SUBSEQUENT MODEL YEAR HEAVY-DUTY DIESEL ENGINES

Sections Affected: This action amends the following chapter and sections of California Code of Regulations (CCR), Title 13, Article 1.5; Section 1956.8; and Section 2065, and the incorporated "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles."

Background: The California Clean Air Act as codified in the Health and Safety Code §43104 directs the ARB to adopt test procedures to ensure compliance with emission standards from new motor vehicles.

In the 1990s, seven large manufacturers of heavy-duty diesel engines (HDDEs) violated certification regulations by turning off, or defeating, emission control equipment during in-use highway driving. To address this violation, the Department of Justice, the United States Environmental Protection Agency (U.S. EPA) and the ARB signed consent decrees with the seven engine manufacturers. A consent decree is a judicial decree that recognizes a mutual settlement between the parties — in this case, between the government and the engine manufacturers (herein referred to as the "settling manufacturers").

In the consent decrees, the settling manufacturers are required, among other things, to produce HDDEs that comply with prescribed emission standards that are lower than those required in current state and federal regulations, as measured by the Federal Test Procedure (FTP). Specifically, these engines must meet a 2.5 gram per brake horsepower-hour (g/bhp-hr) standard for non-methane hydrocarbons (NMHC) plus oxides of nitrogen (NOx) emissions no later than October 1, 2002 (about 50 percent cleaner than current engines). In addition, because it was found that the FTP was not adequate to ensure that exhaust emissions were controlled during all in-use driving, it was agreed that compliance with supplemental test procedures would be necessary. Thus, the majority of the settling manufacturers agreed to produce engines by October 1, 2002, that would meet supplemental test procedures including the Not-To-Exceed (NTE) test and the EURO III European Stationary Cycle (ESC) test. The consent decree states that these requirements must be met for a period of two years. Together with the FTP test, the supplemental test procedures will require control of emissions during the majority of real world operating conditions, ensuring that in the future defeat devices will no longer be employed.

Recognizing the effectiveness of the supplemental tests, the U.S. EPA published a Notice of Proposed Rulemaking (Vol. 64, Federal Register, pp. 58472- 58566, October 29, 1999) proposing to adopt similar supplemental test procedures for 2004 and subsequent model year HDDEs. However, because of federal timing constraints, the NTE and ESC test procedures will not be required until the 2007 model year for federally certified HDDEs (65 FR 59896, October 6, 2000). Therefore, once the HDDE consent decree requirements expire in 2004, the settling manufacturers will not be obligated to comply with the supplemental test procedures in 2005 or 2006. Not until the 2007 model year, when the federal rule comes into effect, will HDDE manufacturers be required to comply with similar supplemental test procedures federally.

The Amendments: On December 8, 2000, the Board considered and adopted without substantive modification the amendments that staff proposed. In order to assure continued compliance during model years 2005 and 2006 by the settling manufacturers and to begin compliance by all other manufacturers in 2005, staff proposed the inclusion of the NTE and ESC tests in the required California certification process for 2005 and subsequent model year HDDEs. The supplemental test procedures are parallel to those in the Consent Decrees. In addition, staff proposed the exemption of "ultra-small volume manufacturers[1]" and "urban buses[2]" from the proposed supplemental test procedures until the 2007 model year in order to allow additional lead time for compliance.

The amendments to the test procedures include three basic components explained below.

1. Not-to-Exceed Test Procedure

   The NTE test establishes an area (NTE control area) under the torque curve of an engine where emissions must not exceed a specified cap for a given pollutant. The NTE cap is set at 1.25 times the FTP emission limit. For 2005 model year heavy-duty engines, the FTP emission limit for NMHC plus NOx is 2.5 grams per brake horsepower-hour, and thus the NTE cap is 3.125 grams per brake horsepower-hour. As in the consent decree requirements, an additional 0.5 grams per brake horsepower-hour is proposed for determining compliance with the supplemental procedures in in-use compliance testing.

   The basic NTE control area for diesel engines has three primary boundaries on the engine's torque and speed map. The upper boundary

[1] An "ultra-small volume manufacturer" is defined as any manufacturer with California sales less than or equal to 300 new passenger cars, light-duty trucks, medium-duty vehicles, heavy-duty vehicles, and heavy-duty engines per model year based on the average number of vehicles and engines sold by the manufacturer in the previous three consecutive model years.
[2] An "urban bus" is defined in proposed title 13, California Code of Regulations, section 1956.2.

is an engine's maximum torque at a given speed. The lower boundary is 30 percent of maximum torque. Only operation above this boundary is included in the NTE control area. The third boundary is determined based on the lowest engine speed at 50 percent of maximum power and highest engine speed at 70 percent of maximum power. Only engine operation within these engine speed boundaries are included in the NTE control area. Additionally, there are two small areas which are "carved out" of the basic NTE control area because of uncertain technical feasibility.

Notwithstanding the conditions outside the NTE control area specified above, the NTE requirement would apply under any engine operating conditions that could reasonably be expected in normal vehicle use. A vehicle can be tested for compliance with the NTE procedure either on the road or in emissions testing laboratory using an engine or chassis dynamometer. Instead of using a specific driving cycle such as the FTP, compliance testing 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 test cap. These requirements would apply to new engines and throughout their applicable useful life.

The NTE test procedures are applicable for a wide range of ambient conditions. For example, NTE ambient temperature coverage can range from 55 °F to 95 °F compared to the FTP ambient conditions of 68 °F to 86 °F. Two different options related to temperature and altitude will be available for manufacturers to comply with the NTE requirements. Under option one, manufacturers must comply with the NTE requirements within the ambient temperature range of 55 °F to 95 °F, and an altitude range of up to 5,500 feet above sea level. Within this NTE altitude and temperature zone, the engine must meet the NTE requirements. For testing at a given altitude outside of this zone, NOx and PM emission results may be corrected for temperature.

Under option two, manufacturers must comply with the NTE requirements between 55 °F and 100 °F at sea-level and between 55 °F and 86 °F at 5,500 feet above sea-level. The maximum temperatures for the corresponding altitudes between those points are determined linearly. At temperatures above the NTE zone, NTE requirements do not apply. Option two is not contained in the consent decrees although it is in the U.S. EPA's Final Rule. It is provided here because it provides even better control of off-cycle emissions under typical California conditions while providing additional flexibility for manufacturers.

In U.S. EPA's Final Rule, a NTE deficiency provision for 2007 through 2009 model year engines provides manufacturers with a relief mechanism for failing to comply with some of the NTE requirements. Because the NTE control area and test procedures 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 compliance with proposed NTE requirements prior to the effective date of this proposal. However, it may be possible that manufacturers will have technical difficulties that are limited in nature. Therefore, staff proposes the inclusion of NTE deficiencies from 2005 through 2007 model years. This provision is optional and increases manufacturer flexibility compared to the consent decrees.

2. EURO III European Stationary Cycle Test Procedure

The Euro III ESC test cycle, or 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, then through a defined sequence of 12 modes at various speeds and engine loads. The test modes are at three different operational engine speeds and at 25%, 50%, 75%, and 100% of maximum load. The engine is operated for two minutes at each non-idle mode. The emission results at each mode are then weighted and averaged.

Manufacturers would be required to show compliance with the following:

Average Allowable Testing Caps

At each mode of operation of the ESC test, the concentration of the gaseous pollutants is measured. The weighted average emissions for each pollutant must not be greater than the existing FTP emission limit which is 2.5 grams per brakehorsepower-hour for NMHC plus NOx 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. The ARB may select 3 additional test points between the 12 non-idle test modes for gaseous pollutants only. The purpose of the additional tests is to ensure that the engine emission controls are not optimized for the specific test modes and then defeated when operating in modes not specified for testing.

Maximum Allowable Testing Caps

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

3. Measuring Smoke Emissions Within the NTE Control Area

Within the NTE control area, an engine must meet either a filter smoke cap or an opacity cap. The filter smoke cap is 1.0 on the Bosch number scale, a measure of smoke opacity. There are two alternatives for the smoke opacity cap. The first opacity cap is 4 percent averaged over 30 seconds using a 5-inch path. This cap is for transient testing. The second opacity cap is also 4 percent, but averaged over 10 seconds using a 5-inch path. This cap is for steady state testing. Smoke emissions at these low levels would not be visible.