

UPDATED INFORMATIVE DIGEST

AMENDMENTS TO ADOPT MORE STRINGENT EMISSION STANDARDS FOR 2007 AND SUBSEQUENT MODEL YEAR NEW HEAVY-DUTY DIESEL ENGINES

Sections Affected: This action amends Section 1956.8 of the California Code of Regulations (CCR), Title 13, Chapter 1, Article 1.5; 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 Health and Safety Code (HSC) §43013 and 43018 directs the Air Resources Board (ARB or Board) to adopt emission standards for new heavy-duty motor vehicles to achieve maximum feasible emission reductions. HSC §43104 directs the ARB to adopt test procedures to ensure compliance with those emission standards. Further, in 2000, the Board approved the Diesel Risk Reduction Plan, which recommended tightening emission standards for heavy-duty vehicles beginning in the 2007 model year.

Heavy-duty diesel engines (HDDEs) are used in a variety of applications such as large trucks, school buses, and motor homes. For large trucks in particular, HDDEs have proven to be reliable, durable, and very fuel efficient. Because of this, HDDEs play a vital role in the transportation of goods and material in California, as well as the rest of the nation. Consequently, HDDEs are a key element of a strong economy.

Compared to gasoline-fueled automobiles and light-duty trucks, HDDEs have significantly lagged behind in the use of aftertreatment-based emission control systems. This is primarily because HDDEs emit relatively low levels of hydrocarbons, particulate matter (PM) reductions have been achieved through engine modifications, and aftertreatment systems to reduce oxides of nitrogen (NOx) emissions from HDDEs have been slower to develop. However, in recent years, PM filters have become available to address diesel PM health risk concerns, and NOx aftertreatment devices are rapidly developing. These devices offer the opportunity to achieve substantial reductions in HDDE emissions.

In October of 2000, the United States Environmental Protection Agency (U.S. EPA) adopted a rule that reaffirmed¹ emission standards for 2004 and

¹ The emission standards were originally promulgated in October 1997.

subsequent model year HDDEs.² This rulemaking also included supplemental test procedures required for certification in addition to the existing Federal Test Procedure (FTP). Because aftertreatment technologies for diesel engines have been fully developed for PM and are on the near horizon for NOx, in January of 2001 the U.S. EPA followed the 2004 Final Rule with another rule to reduce emission standards for 2007 and subsequent model year heavy-duty engines,³ including both Otto-cycle and diesel-cycle engines. These emission standards represent a 90% reduction of NOx emissions, 72% reduction of non-methane hydrocarbon (NMHC) emissions, and 90% reduction of PM emissions compared to the 2004 emission standards. In addition to the more stringent emission standards, in the 2007 Final Rule, the U.S. EPA adopted minor changes to the previously adopted supplemental test procedures.

The 2007 Final Rule breaks new ground by setting emission standards that are projected to need aftertreatment-based technologies. The 2007 Final Rule is analogous to the regulations that first required the use of aftertreatment devices (i.e., catalytic converters) on gasoline-fueled automobiles and light-duty trucks in the mid 1970s. The 2007 Final Rule is also a “systems” approach in that it relies on the use of required low sulfur fuel, analogous to the requirement for unleaded gasoline in the mid 1970s.

The Amendments: On October 25, 2001, the Board considered and adopted, without modifications, the amendments to California’s current HDDE standards and test procedures that staff proposed. To harmonize federal and California requirements for 2007 and subsequent HDDEs, the Board adopted more stringent emission standards and slight changes to the supplemental test requirements used in the California certification process for 2007 and subsequent model year HDDEs. The adopted requirements are identical to those adopted by the U.S. EPA.

The amendments to the emission standards and test procedures include four basic components explained below:

1. *Emission Standards*

Identical to the U.S. EPA’s 2007 Final Rule, the adopted amendments include more stringent emission standards for 2007 and subsequent model year heavy-duty diesel-cycle engines and medium-duty diesel engines. Heavy-duty diesel-cycle engines include diesel-cycle engines fueled with diesel, natural gas, and liquefied petroleum gas. The adopted

² U.S. EPA’s 2004 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 (65 FR 59896, October 6, 2000). Referred to as the “U.S. EPA’s 2004 Final Rule” or “2004 Final Rule.”

³ U.S. EPA’s 2007 Final Rule on the Control of Emissions of Air Pollution from 2007 and Later Model Year Heavy-Duty Highway Engines and Vehicles; Revision of Light-Duty On-Board Diagnostics Requirements (66 FR 5002, January 18, 2001). Referred to as the “U.S. EPA’s 2007 Final Rule” or “2007 Final Rule.” See <http://www.epa.gov/otaq/diesel.htm#hd2007>.

emission standards are 0.20 grams per brake horsepower-hour of NOx, 0.14 grams per brake horsepower-hour of NMHC, and 0.01 grams per brake horsepower-hour of PM. To harmonize the ARB medium-duty diesel engine emission standards with those of the U.S. EPA, the adopted CO emission standard is 15.5 grams per brake horsepower-hour. The adopted optional NOx and NMHC super ultra low-emission vehicle (SULEV) emission standards will be 83% of the newly adopted heavy-duty diesel engine emissions standards, while the adopted optional PM and CO SULEV emission standards for medium-duty diesel engines will be half of the newly adopted heavy-duty diesel engine emissions standards: 0.17 grams per brake horsepower-hour of NOx, 0.12 grams per brake horsepower-hour of NMHC, 0.005 grams per brake horsepower-hour of PM, and 7.7 grams per brake horsepower-hour of CO.⁴ Additionally, for medium-duty diesel engines, the formaldehyde emission standard will remain at 0.050 grams per brake horsepower-hour.

Identical to the U.S. EPA's 2007 Final Rule, only the NOx and NMHC emission standards will be phased-in. The phase-in period for these emission standards will be four years, as follows: 50% for model year 2007 through 2009, and 100% for model year 2010 and subsequent. There is no phase-in of the PM and CO emission standards; therefore, those standards will be fully implemented beginning in the 2007 model year.

Identical to the U.S. EPA's 2007 Final Rule, the requirements include the elimination of the current exception for turbocharged diesel engines from controlling crankcase emissions. Due to technological advances in crankcase filtration, crankcase emissions can be filtered and returned to the engine inlet or controlled by venting the crankcase emissions prior to the emission control device.

Identical to the U.S. EPA's 2007 Final Rule, the requirements provide incentives for early introduction of lower emitting engines. Engines that satisfy the adopted requirements and that are introduced into the marketplace before 2007, will receive credits equal to 1.5 times the number of diesel-cycle engines that are introduced prior to 2007. For example, two early introduction engines will reduce the number of required phased-in engines (2007-2009) by three. Each early engine must meet all requirements applicable to the 2007 model year engines. If the engine complies only with the PM requirements, then the offsets may be used only for 2007 PM credits. Engines that can meet one half of the adopted NOx emission standard (0.10 grams per brake horsepower-hour) earlier than the phase-in period, in addition to all other requirements applicable to the 2007 model year engines, will be classified as "Blue Sky Series"

⁴ Optional standards are provided for smaller engines to provide incentives for engine manufacturers to introduce lower emitting engines.

engines. These engines will receive a credit of 2.0 times the number of 2007 model year compliant engines. For example, two “Blue Sky Series” engines will reduce the number of required phased-in engines by four.

2. *Test Procedures*

The U.S. EPA’s 2004 Final Rule adopted supplemental certification test procedures that apply to 2007 and subsequent model year heavy-duty diesel-cycle engines certified to the 2.4 gram per brake horsepower-hour NOx plus NMHC standard. These test procedures are slightly different compared to those in the federal consent decrees and California settlement agreements, and the 2005 supplemental test procedures adopted by the Board.

The U.S. EPA’s 2007 Final Rule included several changes to the 2004 Final Rule test procedures that will apply to all 2007 and subsequent model year heavy-duty diesel-cycle engines. The amendments adopted in this action include identical revisions to the 2004 Final Rule test procedures.⁵ The major revisions that were adopted by the Board and therefore amended in California’s test procedures, are detailed below:

- a) Due to the lower emission standards adopted, the maximum allowable emission limit (MAEL) test and the three “mystery points” will be removed from the test procedures for engines with a NOx family emission limit (FEL) less than 1.5 grams per brake horsepower-hour. Further, the NOx Not-to-Exceed (NTE) cap will be increased from 1.25 to 1.5 times the FTP-based standard for engines with a NOx FEL less than 1.5 grams per brake horsepower-hour. The PM NTE cap will be increased from 1.25 to 1.5 times the FTP-based standard. There is no adopted change to the CO and NMHC NTE cap. Note that MAEL test requirements and a NTE cap of 1.25 times the FTP-based standard still apply to engines with a NOx FEL of 1.5 grams per brakehorsepower-hour, or greater. The increased NTE cap multiplier is intended to allow increased flexibility when using the test to compare the emissions to the newly adopted emission standards.
- b) In addition to the higher NOx NTE emissions cap for phased-in engines, NOx and NMHC aftertreatment devices are allowed warm-up time. When the exhaust temperature at the outlet of the aftertreatment device is less than 250 degrees C, the NTE NOx and NMHC caps do not apply.

⁵ The amendments of California’s test procedures on July 25, 2001 included the U.S. EPA’s 2004 Final Rule test procedure amendments.

- c) Another change is the elimination of the PM carve-out areas of the NTE control zone.⁶ Due to the expected effectiveness of advanced diesel PM filters, relief from the NTE through the PM carve-out areas is not necessary. However, relief from the NTE test is provided, if necessary, by allowing manufacturers to exclude certain regions of the NTE control zone. This is allowed if the vehicle is not capable of operating at the specific conditions or where operation is minimal. The ARB also modified the sampling time for the NTE test to account for aftertreatment regeneration events.⁷ The sampling time for the NTE test will be at least 30 seconds. If regeneration of the aftertreatment device occurs during the NTE test, the averaging period will be at least as long as the time between the regeneration events multiplied by the number of complete regeneration events that occur in the sampling period. This revised sampling period will only be allowed for engines that send an electronic signal indicating the start of the regeneration event. In addition, up to three deficiencies from the NTE test may be approved per engine family for the 2010 through 2013 model years.⁸
- d) Due to manufacturer concerns, the requirements will also include amendments to the test procedures adopted in the U.S. EPA's 2007 Final Rule that improve the precision of emission measurements. There are three general changes to the emission measurement requirements. One change involves the type of PM filters that are used, improvements to the method of weighing PM filters, and requirements for more precise microbalances. Another change allows lower dilution ratios during emission measurements.⁹ The final change adopts a new NOx calibration procedure that provides more precise and continuous measurements of low NOx concentrations. Additional allowances are adopted to provide manufacturers the option of using their current test procedures if they are more convenient or cost-effective in the short term.

⁶ The PM carve-out area is the area within the NTE control area where the NTE cap on PM emissions does not apply. Operation in the PM carve-out area does not require compliance with NTE requirements, although all other requirements during operation in that area still apply.

⁷ A regeneration event occurs when the storage media in the aftertreatment device is cleansed. The event can be triggered naturally with higher exhaust heat and extra fuel, or triggered externally using a heating element.

⁸ Criteria for deficiencies occurring during 2007 through 2009 model years, including phased-in engines, is detailed in the U.S. EPA's 2004 Final Rule. Deficiencies during this time period are approved on an engine model and/or horsepower rating basis within an engine family. Additionally, deficiencies are applicable for one model year at a time.

⁹ Reduced dilution ratio reduces the amount of dilution air during the emission sampling period. This helps to improve measurement of both gaseous and particulate emissions.

3. *Certification Test Fuel Specifications*

To ensure that the proper fuel is used for emissions testing and service accumulation, the certification test fuel sulfur content specification will range from 7 to 15 parts per million. Manufacturers will continue to have the option to use an alternative certification test fuel provided there is sufficient evidence indicating that this test fuel will be the predominant in-use fuel.

4. *ABT*

The amendments provide an ABT program identical to the federal ABT program as revised through the U.S. EPA's 2007 Final Rule. However, the basic structure of the adopted ABT program will remain similar to the ARB's existing program. Manufacturers will continue to be allowed to certify engine families such that the aggregate average does not exceed the emission standard. Additionally, manufacturers may bank excess emission credits for later use or trade these credits to other manufacturers.

Due to the phase-in of the NO_x emission standard, engines are classified as either "phased-out" or "phased-in." The phased-out engines are those subject to the previously adopted 2.5 gram per brake horsepower-hour NO_x plus NMHC emission standard. The phased-in engines are those subject to the adopted 0.2 gram per brake horsepower-hour NO_x emission standard. Credits generated from phased-out engines may be used for phased-in engines. However, NO_x plus NMHC credits will be subject to a 20% discount when converted to NO_x only credits.

Identical to the U.S. EPA's ABT program adopted in the 2007 Final Rule, averaging will be allowed between different service class averaging sets. This allowance is only for the phase-in period. For example, emissions from heavy heavy-duty diesel engines may be averaged with emissions from medium heavy-duty diesel engines.

Engine families opting into the adopted ABT program must not exceed the maximum FELs. For phased-in engines subject to the 0.2 gram per brake horsepower-hour emission standard during the 2007 through 2009 model years, the adopted maximum NO_x FEL cap is 2.00 grams per brake horsepower-hour. After all engines have been phased-in for the 2010 and subsequent model years, the adopted maximum NO_x FEL cap is 0.50 grams per brake horsepower-hour. The adopted maximum PM FEL cap is 0.02 grams per brake horsepower-hour for all engines beginning in the 2007 model year.