SUMMARY OF BOARD ITEM

ITEM # 01-8-1: **PUBLIC HEARING TO CONSIDER AMENDMENTS ADOPTING MORE STRINGENT EMISSION STANDARDS FOR 2007 AND SUBSEQUENT MODEL YEAR NEW HEAVY-DUTY DIESEL ENGINES**

STAFF RECOMMENDATION: The staff recommends that the Board adopt California Code of Regulations (CCR) amendments to section 1956.8, title 13. Division 3, Air Resources Board, Chapter 1-Motor Vehicle Pollution Control Devices, Article 2-Approval of Motor Vehicle Pollution Control Devices (New Vehicles); and the incorporated "California Exhaust Emission Standards And Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles."

DISCUSSION: Medium-duty diesel engines are used in vehicles with a gross vehicle weight rating of 8,501 to 14,000 pounds and heavy-duty diesel engines are used in vehicles with a gross vehicle weight rating of 14,001 pounds and greater. Vehicles using these engines play a vital role in the transportation of goods and material in California, as well as the rest of the nation. The primary pollutants of concern from diesel engines are oxides of nitrogen (NOx) and particulate matter. The high temperatures of combustion and excess air cause the nitrogen in the air to combine with available oxygen to form NOx. Particulate matter emissions result from fuel droplets that have not completely combusted. Additionally, lubrication oil that enters the cylinder contributes to particulate matter emissions.

Compared to gasoline-fueled automobiles and light-duty trucks, heavy-duty diesel engines (HDDE) have significantly lagged behind with respect to the use of aftertreatment-based emission control systems. Therefore, in January of 2001, the United States Environmental Protection Agency (U.S. EPA) adopted a rule to reduce emission standards for 2007 and subsequent model year heavy-duty engines, including both spark-ignited (e.g., gasoline-

fueled) and compression-ignited (e.g., diesel-fueled) engines. These emission standards represent a 90 percent reduction of NOx emissions, 72 percent reduction of non-methane hydrocarbon (NMHC) emissions, and 90 percent reduction of particulate matter (PM) emissions compared to the 2004 emission standards. In addition to the more stringent emission standards, the U.S. EPA adopted minor changes to the previously adopted supplemental test procedures. This U.S. EPA 2007 Final Rule breaks new ground by setting emission standards that require aftertreatment-based technologies.

In this item, staff proposes that the Board adopt nearly identical emission standards, test procedures, and other requirements contained in the U.S. EPA's 2007 Final Rule. In addition to the emission standards and test procedures, other requirements included in the proposal are the elimination of the exemption that allows turbocharger-equipped engines to vent crankcase emissions to the ambient air. The proposal ensures that California's requirements for 2007 and subsequent model year HDDEs are identical to those adopted by the U.S. EPA in January 2001.

SUMMARY AND IMPACTS:

The businesses affected by the proposal are the manufacturers of heavy-duty and medium-duty diesel engines sold in California. Based on previous sales data, there are 21 companies that manufacture these types of engines. Since the proposed emission standards and test procedures harmonize ARB requirements with the U.S. EPA, there may be a net decrease in costs to the engine manufacturers. The cost decrease would be due to reduced manufacturing costs from the manufacturing of one national line of engines rather than two lines of engines. The decreased costs are expected to be passed on to the consumers or purchasers of medium-duty and heavy-duty vehicles with a gross vehicle weight rating of 8,501 pounds and greater.

Any increase in costs to engines and vehicles would be due to the previously adopted federal

requirements. If the entire costs, due to the federal requirements, are passed on to the consumer, vehicle retail prices would increase by approximately $3,400 per heavy heavy-duty vehicle, $2,700 per medium heavy-duty vehicle, and $2,100 per light heavy-duty vehicle after full implementation in the 2010 model year. The U.S. EPA estimates that average vehicle costs are $108,000 per heavy heavy-duty vehicle, $52,000 per medium heavy-duty vehicle, and $25,000 per light heavy-duty vehicle. Based on the U.S. EPA's estimated vehicle costs, the estimated price increase would represent a 3-8 percent price increase.

The potential cost increase could be greater in 2007 if the proposed ARB requirements and federal requirements are not harmonized. Consequently, the impact to manufacturers and dealers of heavy-duty vehicles due solely to the amendments in this proposal are not expected to be significant. The expected price increase is also not expected to impact California employment, business expansion, creation and elimination, or the ability of California businesses to compete with businesses from other states.

If the entire hardware costs, due to the federal requirements, are passed on to the consumer, heavy-duty vehicle retail prices would increase by approximately $2,100 to $3,400 per medium-duty and heavy-duty diesel vehicle. Further, operating costs are expected to increase by approximately $500 to $3,400 per medium-duty and heavy-duty diesel vehicle in present value over its lifetime. The operating cost increases are due to maintenance of the aftertreatment system, maintenance of the closed crankcase system, and low sulfur diesel fuel. Additionally, there is an associated maintenance savings due to the use of the low sulfur diesel fuel.

The expected reductions of NOx emissions are 49 tons per day, reactive organic gas (ROG) emissions are 2 tons per day, and PM emissions are 3 tons per day in 2010 statewide, from California and out-of-state registered medium-duty and heavy-duty vehicles. Harmonizing the existing ARB medium-

duty carbon monoxide (CO) emission standard with the U.S. EPA's 2007 and subsequent model year HDDE emission standard, however, will result in an increase in statewide CO emissions by 0.1 tons per day in 2010. Based on the total cost increase, the cost effectiveness of the proposed reduced emission standards ranges from $0.29 to $0.63 per pound of NOx and NMHC emissions reduced and from $3.03 to $6.65 per pound of PM emissions reduced. This compares to the cost-effectiveness of California mobile source and motor vehicle fuels regulations adopted over the past decade that ranges from $0.17 to $2.55 per pound of ozone precursors (NOx and NMHC) reduced and approximately $17.90 per pound of PM reduced. These values compare favorably to the cost effectiveness of other, recently adopted emission control measures.

TITLE 13. CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC HEARING TO CONSIDER AMENDMENTS ADOPTING MORE STRINGENT EMISSION STANDARDS FOR 2007 AND SUBSEQUENT MODEL YEAR NEW HEAVY-DUTY DIESEL ENGINES

The Air Resources Board (Board or ARB) will conduct a public hearing at the time and place noted below to consider adopting amendments to the emission standard regulations for 2007 and subsequent model year new heavy-duty diesel engines. The proposal includes amendments to the supplemental emission test procedures, including the Not-to-Exceed and EURO III European Stationary Cycle tests.

DATE: October 25, 2001

TIME: 9:00 a.m.

PLACE: Monterey Bay Unified Air Pollution Control District
Board Room, 3rd Floor
24580 Silver Cloud Court
Monterey, CA 93940

This item will be considered at a two-day meeting of the ARB, which will commence at 9:00 a.m., October 25, 2001, and may continue at 8:30 a.m., October 26, 2001. This item may not be considered until October 26, 2001. Please consult the agenda for the meeting, which will be available at least 10 days before October 25, 2001, to determine the day on which this item will be considered.

This facility is accessible to persons with disabilities. If accommodation is needed, please contact the Clerk of the Board at (916) 322-5594, or Telephone Device for the Deaf (TDD) (916) 324-9531 or (800) 700-8326 for TDD calls from outside the Sacramento area, by October 10, 2001, to ensure accommodation.

INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

Sections Affected: California Code of Regulations (CCR), title 13, division 3. Air Resources Board, chapter 1. Motor Vehicle Pollution Control Devices, article 2. Approval of Motor Vehicle Pollution Control Devices (New Vehicles); section 1956.8; and the incorporated "California Exhaust Emission Standards And Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles," last amended July 25, 2001.

A. Background

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

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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 with respect to the use of aftertreatment-based emission control systems. This is primarily because regulatory agencies have acknowledged that HDDEs emit relatively low levels of hydrocarbons, significant reductions in particulate matter (PM) 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 the growing concern that diesel PM causes cancer, and NOx aftertreatment devices are rapidly developing. These devices offer the opportunity to achieve substantial additional reductions in HDDE emissions.

In October of 2000, the United States Environmental Protection Agency (U.S. EPA) adopted a rule that reaffirmed[1] emission standards for 2004 and 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, the U.S. EPA, in January of 2001, 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, 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 require aftertreatment-based technologies. The 2007 Final Rule is analogous to the regulations which 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 requires the use of low sulfur fuel, analogous to the requirement for unleaded gasoline in the mid 1970s.

Heavy-duty diesel vehicles, with gross vehicle weight ratings (GVWR) of 14,001 pounds and greater, contribute a large portion of California's inventory of several key air pollutants including NOx, reactive organic gases (ROG), and PM. On-road heavy-duty diesel vehicles are estimated to account for as much as 28 percent of the statewide mobile source NOx inventory and 16 percent of the statewide mobile source PM inventory in 2010. This is of particular concern due to the relatively small population of heavy-duty diesel vehicles. In addition to heavy-duty diesel-cycle engines, the proposal

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[1] The emission standards were originally promulgated in October 1997.
[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.

will apply to both natural gas fueled engines and liquefied petroleum gas fueled engines that are derived from the diesel-cycle engine, and to medium-duty diesel engines that certify using engine-based emission standards. The proposed standards are considered optional for medium-duty diesel vehicles since those vehicles may certify to either chassis-based or engine-based emission standards. Medium-duty diesel engines are those used in vehicles with a GVWR of 8,501 pounds to 14,000 pounds. Additionally, included in the inventory of heavy-duty diesel vehicles are motor homes and school buses.

B. Current California Requirements for 2004 and Subsequent Model Years

1. Emission Standards

The current California 2004 and subsequent model year emission standards for heavy-duty diesel-cycle engines and medium-duty diesel engines are 2.4 grams per brake horsepower-hour of NOx plus NMHC, 0.10 grams per brake horsepower-hour of PM, and 15.5 grams per brake horsepower-hour of CO. There is also an optional NOx plus NMHC emission standard of 2.5 grams per brake horsepower-hour. When certifying using this option, NMHC emissions are not to exceed 0.5 grams per brake horsepower-hour. For medium-duty diesel engines, the CO emission standard is 14.4 grams per brake horsepower-hour and there is an additional formaldehyde emission standard of 0.050 grams per brake horsepower-hour. Further, for medium-duty diesel engines, there are optional super-ultra-low-emission-vehicle (SULEV) emission standards.[4] The medium-duty NOx and NMHC SULEV emission standards are 83% more stringent than the required emission standard. For PM and CO, however, the medium-duty SULEV emission standards are 50% more stringent than the required emission standards. Due to performance concerns and possible damage to the turbocharger and/or aftercooler when crankcase emissions are routed back to the engine intake, currently there is an exemption from controlling crankcase emissions from turbocharged diesel engines.

2. Test Procedures

For certification, heavy-duty diesel-cycle engines and medium-duty diesel engines are required to be tested using the FTP. During the FTP, an engine operates through a narrowly defined test cycle. Additionally, those engines are required to conduct the supplemental Not-to-Exceed (NTE) and European Stationary Cycle (ESC) tests. These supplemental tests are identical to those in the heavy-duty diesel consent decrees and were adopted by the Board in 2000. The NTE test includes an emissions cap of 1.25 times the FTP-based emission standard. The test is applicable to operation within the NTE control zone that represents most operation of a heavy-duty diesel vehicle. Emission samples taken during the test are averaged over a period of at least 30 seconds.

[4] The existing SULEV emission standards were created as an opportunity to allow manufacturers to design and sell engines that emitted significantly lower emitting engines.

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The ESC test includes an emissions cap equivalent to the FTP-based emission standard. This test verifies emissions over thirteen combinations of engine speed and power, including idle. The weighted average total of each test point is compared to the emissions cap. The test also includes the maximum allowable emission limit (MAEL) test. This test ensures that there are no excess emissions between the ESC test points. Additional test points are selected to verify compliance with the test.

3. Certification Test Fuel Specifications

The current diesel fuel sulfur content specification for certification test fuel ranges from 100 to 500 parts per million. This specification is identical for both exhaust emission testing and service accumulation. Manufacturers also 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. Averaging, Banking, and Trading (ABT)

The current ABT program allows averaging among various engine families only within an averaging set. Each averaging set depends on the U.S. EPA's weight classification, or GVWR, ranges of the engines. There are three U.S. EPA weight class ranges, light heavy-duty (8,501 pounds to 19,500 pounds GVWR), medium heavy-duty (19,501 pounds to 33,000 pounds GVWR), and heavy heavy-duty (33,001 pounds and greater GVWR). Further, engine manufacturers may also bank excess credits. These banked credits may be used in future years, or traded to other engine manufacturers.

C. Proposed Amendments

The ARB staff is proposing the adoption of emission standards and supplemental test procedure modifications to reduce emissions from 2007 and subsequent model year heavy-duty diesel-cycle engines and vehicles. Applicable engines include both natural gas fueled engines and liquefied petroleum gas fueled engines that are derived from the diesel cycle engine. The proposal will not apply to heavy-duty spark-ignited (e.g., gasoline-fueled) engines and urban bus engines. Similar requirements for the spark-ignited engines are scheduled for consideration in 2002. More stringent urban bus engine emission standards were adopted in 2000. In addition, in-use diesel fuel standards similar to those adopted by the U.S. EPA are currently being workshopped and scheduled for consideration in 2002.[5]

1. Emission Standards

Identical to the U.S. EPA's 2007 Final Rule, the proposed 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-

[5] ARB staff held public meetings April 5, 2001 and May 18, 2001, to discuss potential diesel fuel sulfur amendments.

cycle engines include diesel-cycle engines fueled with diesel, natural gas, and liquefied petroleum gas. The proposed 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 proposed CO emission standard is 15.5 grams per brake horsepower-hour. The proposed optional NOx and NMHC SULEV emission standards will be 83% of the proposed heavy-duty diesel engine emissions standards, while the proposed optional PM and CO SULEV emission standards for medium-duty diesel engines will be half of the proposed 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. 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 are proposed to be phased-in. The phase-in period for these emission standards is proposed to be four years, as follows: 50% for model year 2007, 50% for model year 2008, 50% for model year 2009 and 100% for model year 2010 and subsequent. There is no proposed phase-in of the PM and CO emission standards; therefore, the PM and CO emission standards are proposed to be fully implemented beginning in the 2007 model year.

Identical to the U.S. EPA's 2007 Final Rule, the proposal includes 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 even prior to the emission control device.

Identical to the U.S. EPA's 2007 Final Rule, the proposal provides incentives for early introduction of lower emitting engines. Engines that satisfy the proposed 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 early. For example, two early introduction engines will reduce the number of required phased-in engines by three. Each early engine must meet all requirements applicable to model year 2007 engines. If the engine complies only with the PM requirements, the offsets may be used only for PM compliant engine credits. Engines that can meet one half of the proposed NOx emission standard, or 0.10 grams per brake horsepower-hour, earlier than the phase-in period in addition to all other requirements applicable to model year 2007 engines will be classified as "Blue Sky Series" engines. These engines will receive a credit of 2.0 times the number of "Blue Sky Series" engines. For example, two "Blue Sky Series" engines will reduce the number of required phased-in engines by four.

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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 those 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. This proposal will adopt identical revisions to the 2004 Final Rule test procedures.[6] The major revisions that were adopted federally and are therefore proposed for modification to the California test procedures are detailed below.

Due to the more stringent emission standards proposed, the MAEL test and the three "mystery points" are proposed to 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 NTE cap is proposed to 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 is proposed to be increased from 1.25 to 1.5 times the FTP-based standard. There is no proposed 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 family emission limit (FEL) of 1.5 grams per brakehorsepower-hour, or greater.

In addition to the increased 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.

Another change is the elimination of the PM carve-out areas of the NTE control zone. 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 to 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 staff is also proposing that the sampling time for the NTE test be modified to account for aftertreatment regeneration events. The sampling time for the NTE test is proposed to be at least 30 seconds. If regeneration of the aftertreatment device occurs during the NTE test, the averaging period is proposed to 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 is only proposed for engines that send an electronic signal indicating the start of the regeneration event. In

[6] The amendments of California's test procedures on July 25, 2001 included the U.S. EPA's 2004 Final Rule test procedure amendments.

addition, up to three deficiencies from the NTE test may be approved per engine family for model years 2010 through 2013.[7]

Due to manufacturer concerns, the proposal 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. The final change adopts a new NOx calibration procedure that provides more precise and continuous measurements of low NOx concentrations. Additional allowances are proposed to provide manufacturers the option of using their current test procedures if they are more convenient or cost-effective in the short term.

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 is proposed to 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 staff is proposing an ABT program identical to the federal ABT program as revised through the U.S. EPA's 2007 Final Rule. By adopting most of the 2007 Final Rule as California's, the basic structure of the proposed ABT program will be 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 NOx 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 NOx plus NMHC emission standard. The phased-in engines are those subject to the proposed 0.2 gram per brake horsepower-hour NOx emission standard. Credits generated from phased-out engines may be used for phased-in engines. However, NOx plus NMHC credits will be subject to a 20% discount when converted to NOx only credits.

[7] 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.

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

To be included in the proposed ABT program, engine families must not exceed the proposed 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 proposed maximum NOx 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 proposed maximum NOx FEL cap is 0.50 grams per brake horsepower-hour. The proposed maximum PM FEL cap is 0.02 grams per brake horsepower-hour for all engines beginning in the 2007 model year.

AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

The Board staff has prepared a Staff Report: Initial Statement of Reasons (ISOR) for the proposed regulatory action, which includes a summary of the potential environmental and economic impacts of the proposal, if any. The Staff Report is entitled, "Public Hearing to Consider Amendments Adopting More Stringent Emission Standards for the 2007 and Subsequent Model Year Heavy-Duty Diesel Engines."

Copies of the Staff Report, and the full text of the proposed regulatory language, in underline and strikeout format to allow for comparison to existing regulations, may be obtained from the Public Information Office, Air Resources Board, 1001 "I" Street, Environmental Services Center, 1st Floor, Sacramento, CA 95814, (916) 322-2990 at least 45 days prior to the scheduled hearing (October 25, 2001).

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on the world wide web (Internet) site listed below.

Inquiries concerning the substance of the proposed regulations may be directed to the designated agency contact persons: Mr. Gregory Ushijima, Air Resources Engineer, On-Road Heavy-Duty Diesel Section, at (626) 459-4365, or Mr. Michael Carter, Branch Chief, Emission Research and Regulatory Development Branch, at (626) 575-6632.

Further, the agency representative and designated back-up contact persons to whom non-substantive inquiries concerning the proposed administrative action may be directed are Artavia Edwards, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-6070, or Amy Whiting, Regulations Coordinator, (916) 322-6533. The Board staff has compiled a record which includes all information upon which the proposal is based. This material is available for inspection upon request to the agency contact persons identified above.

If you are a person with a disability and desire to obtain this document or the ISOR in an alternate format, please contact the Air Resources Board's ADA Coordinator at (916) 323-4916, TDD (916) 324-9531, or (800) 700-8326 for TDD calls from outside the Sacramento area. This notice, the ISOR, and all subsequent regulatory documents, including the FSOR, are made available on the ARB's Internet site for this rulemaking at: http:// www.arb.ca.gov/regact/HDDE2007/HDDE2007.htm.

COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED

The determinations of the Board's Executive Officer concerning the costs or savings necessarily incurred in reasonable compliance with the proposed regulations are presented below.

The Executive Officer has determined that the proposed regulatory action will not create costs or savings, as defined in Government Code section 11346.5(a)(6), to any state agency or in federal funding to the state, costs or mandate to any local agency or school district whether or not reimbursable by the state pursuant to part 7 (commencing with section 17500), division 4, title 2 of the Government Code, or other non-discretionary savings to local agencies.

The Executive Officer has also made an initial determination that adoption of the proposed regulatory action will not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states. While not significant, the ARB has identified the following potential cost impacts that a representative private person or business may necessarily incur in reasonable compliance with the proposed action.

The businesses affected by the proposed supplemental test procedures are the manufacturers of heavy-duty and medium-duty diesel engines sold in California. Based on previous sales data, there are 21 companies that manufacture these types of engines. Since the proposed emission standards and test procedures harmonize ARB requirements with the U.S. EPA, there may be a net decrease in costs to the engine manufacturers. The cost decrease would be due to reduced manufacturing costs from the manufacturing of one national line of engines rather than two lines of engines. The decreased costs are expected to be passed on to the consumers or purchasers of heavy-duty vehicles with a gross vehicle weight rating of 8,501 pounds and greater.

Any increase in costs to engines and vehicles would be due to adoption of federal requirements. If the entire costs, due to the federal requirements, are passed on to the consumer, heavy-duty vehicle retail prices would increase by approximately $3,400 per heavy heavy-duty vehicle, $2,700 per medium heavy-duty vehicle, and $2,100 per light heavy-duty vehicle after full implementation in the 2010 model year. The U.S. EPA estimates that average vehicle costs are $108,000 per heavy heavy-duty vehicle, $52,000 per medium heavy-duty vehicle, and $25,000 per light heavy-duty vehicle. Based on the U.S. EPA's estimated vehicle costs, the estimated price increase would represent a 3-8 percent price increase. The potential cost increase could be greater if the proposed ARB requirements and federal requirements are not harmonized. Consequently, the impact to manufacturers and dealers of heavy-duty vehicles due

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solely to the amendments in this proposal are not expected to be significant. The expected price increase is also not expected to impact California employment, business expansion, creation and elimination, or the ability of California businesses to compete with businesses from other states.

Due to the additional emission control technologies that may be required by the U.S. EPA's 2007 Final Rule, manufacturers of those technologies may experience higher sales volume. The higher sales volume may also increase employment for those businesses that supply parts between the related businesses. Compared to overall California employment, this effect is expected to be minor. Additionally, to the extent that manufacturers use contract laboratories located in California for testing or other research and development efforts, there is a potential increase in contract laboratory employment. No other associated businesses are expected to be affected by the proposed regulatory action.

The estimated statewide emissions expected to be reduced due to the proposed emission standards and supplemental test procedures is 48.7 tons per day of NOx, 1.5 tons per day of NMHC, and 2.7 tons per day of PM in 2010. In addition, there will be an expected 0.1 tons per day increase of CO emissions in 2010 due to the harmonization of the ARB medium-duty emission standard. This estimate is for both California registered and out-of-state vehicles. Based on the costs due to the federal requirements described above, the cost effectiveness is estimated to range from $0.29 to $0.63 per pound of NOx plus NMHC reduced and from $3.03 to $6.65 per pound of PM reduced. The range depends upon the weight class of the heavy-duty vehicle. Based on current sales distribution of the three weight classes, overall cost effectiveness is estimated at $0.42 per pound of NOx plus NMHC reduced and $3.42 per pound of PM reduced. These values compare favorably to the cost effectiveness of other, recently adopted emission control measures.

In accordance with Government Code sections 11346.3(c) and 11346.5(a)(11), the ARB's Executive Officer has found that the reporting requirements of the regulation which apply to businesses are necessary for the health, safety, and welfare of the people of the State.

The Executive Officer has also determined that the proposed regulatory action will affect small businesses. Furthermore, the Executive Officer's initial assessment is that the proposed regulatory action will not adversely affect the creation or elimination of jobs within the State of California, the creation of new businesses or elimination of existing businesses within California, or the expansion of businesses currently doing business within California. A full assessment of the economic impact of the proposed regulatory action can be found in the Staff Report.

Before taking final action on the proposed regulatory action, the ARB must determine that no reasonable alternative considered by the agency, or that has otherwise been identified and brought to the attention of the agency, would be more effective in carrying out the purpose for which the action is proposed, or would be as effective and less burdensome to affected private persons than the proposed action.

SUBMITTAL OF COMMENTS

The public may present comments relating to this matter orally or in writing at the hearing, and in writing, or by e-mail before the hearing. To be considered by the Board, written submissions not physically submitted at the hearing must be received by no later than **12:00 noon October 24, 2001**, and addressed to the following:

Postal Mail is to be sent to:

Clerk of the Board
Air Resources Board
1001 "I" Street, 23rd Floor
Sacramento, California 95814

Electronic mail is to be sent to: hdde2007@listserv.arb.ca.gov and received at the ARB by no later than **12:00 noon October 24, 2001.**

Facsimile submissions are to be transmitted to the Clerk of the Board at (916) 322-3928 and received at the ARB no later than **12:00 noon, October 24, 2001.**

The Board requests, but does not require, 30 copies of any written statement be submitted and that all written statements be filed at least 10 days prior to the hearing so that ARB staff and Board Members have time to fully consider each comment. The ARB encourages members of the public to bring any suggestions for modification of the proposed regulatory action to the attention of staff in advance of the hearing.

STATUTORY AUTHORITY

This regulatory action is proposed under that authority granted in California Health and Safety Code sections 39600, 39601, 43013, 43018, 43101, 43104, 43105, and 43806, and Vehicle Code section 28114. This action is proposed to implement, interpret and make specific California Health and Safety Code sections 39002, 39003, 39500, 43000, 43013, 43018, 43100, 43101, 43101.5, 43102, 43104, 43106, 43202, 43203, 43204, 43206, 43210-43213, and 43806, and Vehicle Code section 28114.

HEARING PROCEDURES

The public hearing will be conducted in accordance with the California Administrative Procedure Act, title 2, division 3, part 1, chapter 3.5 (commencing with section 11340) of the Government Code. Following the public hearing, the ARB may adopt the regulatory language as originally proposed or with nonsubstantial or grammatical modifications. The ARB may also adopt the proposed regulatory language with other modifications if the modifications are sufficiently related to the originally proposed text that the public was adequately placed on notice that the regulatory language as modified could result

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from the proposed regulatory action. In the event that such modifications are made, the full regulatory text, with the modifications clearly indicated, will be made available to the public for written comment at least 15 days before it is adopted. The public may request a copy of the modified regulatory text from the ARB's Public Information Office, Environmental Services Center, 1001 "I" Street, First Floor, Sacramento, California 95814, (916) 322-2990.

CALIFORNIA AIR RESOURCES BOARD

MICHAEL P. KENNY
EXECUTIVE OFFICER

Date: August 28, 2001

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs see our Web-site at www.arb.ca.gov.

State of California
AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS

PUBLIC HEARING TO CONSIDER AMENDMENTS ADOPTING MORE STRINGENT EMISSION STANDARDS FOR 2007 AND SUBSEQUENT MODEL YEAR NEW HEAVY-DUTY DIESEL ENGINES

Date of Release: September 7, 2001
Scheduled for Consideration: October 25, 2001

This report has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Air Resources Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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EXECUTIVE SUMMARY

Heavy-duty diesel engines (HDDE) 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, the use of HDDEs is a key element of a strong economy.

Compared to gasoline-fueled automobiles and light-duty trucks, HDDEs have significantly lagged behind with respect to the use of aftertreatment-based emission control systems. This is primarily because regulatory agencies have acknowledged that HDDEs emit relatively low levels of hydrocarbons, and efforts to reduce oxides of nitrogen (NOx) emissions would likely adversely impact the HDDE's fuel economy advantage. However, in recent years, the "benefits" of HDDEs have been overshadowed by the increase in their relative contribution of NOx emissions to the overall State inventory and by their potential for causing cancer. Specifically, the Air Resources Board (ARB) identified diesel particulate matter (PM) as a toxic air contaminant in 1998.

In October of 2000, the United States Environmental Protection Agency (U.S. EPA) adopted a rule that reaffirmed[1] emission standards for 2004 and 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, the U.S. EPA, in January of 2001, followed the 2004 Final Rule with another rule to reduce emission standards for 2007 and subsequent model year heavy-duty engines,[3] including both spark-ignited (e.g., gasoline-fueled) and compression-ignited (e.g., diesel-fueled) 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, 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 require aftertreatment-based technologies. The 2007 Final Rule is analogous to the regulations which first required the use of aftertreatment devices (i.e., catalytic converters) on gasoline-fueled automobiles and light-duty trucks in the mid 1970s. The

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[1] The emission standards were originally promulgated in October 1997.

[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.

2007 Final Rule will also be a "systems" approach in that it will require the use of low sulfur fuel, analogous to the requirement for unleaded gasoline in the mid 1970s.

The ARB staff is proposing that the Board adopt nearly identical emission standards, test procedures, and other requirements contained in the U.S. EPA's 2007 Final Rule. Although the proposal will include diesel certification test fuel specifications, a major difference in this proposal is the low sulfur, in-use diesel fuel requirement. A proposal to require the production of low sulfur, in-use diesel fuel will be part of a separate rulemaking scheduled to be presented to the Board in 2002. In addition to the emission standards and test procedures, other requirements to be proposed include the elimination of the exemption that allows turbocharger-equipped engines to vent crankcase emissions to the ambient air. The proposed amendments will not apply to heavy-duty spark-ignited engines and vehicles. Similar emission standard and test procedure requirements for the spark-ignited engines and vehicles are scheduled for consideration in 2002.

The proposal ensures that the requirements for 2007 and subsequent model year HDDEs are identical to those adopted by the U.S. EPA in January 2001. By adopting the proposed reduced emission standards, the ARB is expecting to reduce NOx emissions by 49 tons per day, reactive organic gas (ROG) emissions by 2 tons per day, and PM emissions by 3 tons per day in 2010 statewide, from California and out-of-state registered medium-duty and heavy-duty vehicles. Harmonizing the existing ARB medium-duty CO emission standard with the U.S. EPA's 2007 and subsequent model year HDDE emission standard, however, will result in an increase in statewide CO emissions by 0.1 tons per day in 2010.

If the entire hardware costs, due to the federal requirements, are passed on to the consumer, heavy-duty vehicle retail prices would increase by approximately $2,100 to $3,400 per medium-duty and heavy-duty diesel vehicle. Further, operating costs are expected to increase by approximately $500 to $3,400 per medium-duty and heavy-duty diesel vehicle in present value over its lifetime. The operating cost increases are due to maintenance of the aftertreatment system, maintenance of the closed crankcase system, low sulfur diesel fuel, and additional maintenance savings. Based on the total cost increase, the cost effectiveness of the proposed reduced emission standards ranges from $0.29 to $0.63 per pound of NOx and NMHC emissions reduced and from $3.03 to $6.65 per pound of PM emissions reduced. This compares to the cost-effectiveness of California mobile source and motor vehicle fuels regulations adopted over the past decade that ranges from $0.17 to $2.55 per pound of ozone precursors (NOx and NMHC) reduced and approximately $17.90 per pound of PM reduced.

I. INTRODUCTION

California is the only state that has the authority to establish new mobile source emission standards and/or test procedures that differ from federal standards and test procedures (Federal Clean Air Act Section 209(b)). California emission standards and test procedures must be, in the aggregate, at least as protective of public health and welfare as applicable federal standards and test procedures. This proposal is an effort to align California emission requirements with federal requirements to further reduce emissions from a significant emissions source.

Heavy-duty diesel motor vehicles, with a gross vehicle weight rating (GVWR) of 14,001 pounds and greater, contribute a large portion of California's inventory of several key air pollutants including NOx, ROG, and PM. Both NOx and ROG are precursors to ozone. Ozone is a concern because it has been shown to adversely impact human health. NOx alone can also be harmful to humans by aggravating common respiratory illnesses and even prematurely aging lung tissue. NOx can also be transformed in the atmosphere to nitrate, a form of PM that can cause lung disease and premature death. Further, in August of 1998, California identified diesel PM as a toxic air contaminant. Assessment of carcinogenic risk in California due to diesel PM accounts for approximately 70 percent of all air toxics in 2000. Statewide, the average potential cancer risk associated with diesel PM is over 500 excess cases per million people.[4] Further information on adverse health effects of diesel PM can be found in the ARB's Diesel Risk Reduction Plan.[5]

On-road heavy-duty diesel vehicles are estimated to account for as much as 28 percent of the statewide mobile source NOx inventory and 16 percent of the statewide mobile source exhaust PM inventory in 2010. This is of particular concern due to the relatively small population of heavy-duty diesel vehicles. Compared to emissions from passenger cars, to date heavy-duty diesel vehicle emissions have been less controlled. While catalytic converters have been required on passenger cars for over 30 years, diesel exhaust from HDDEs is released directly into the atmosphere. Currently, there are many demonstration projects ongoing worldwide to show the effectiveness of heavy-duty diesel aftertreatment devices. Additionally, improvements to the effectiveness of these devices are ongoing.

This proposal will apply to HDDEs and medium-duty diesel engines (MDDE). The ARB is proposing to align both the heavy-duty and medium-duty emission standards with those adopted in the U.S. EPA's 2007 Final Rule. This will result in a decrease to the

[4] The Scientific Review Panel concluded that 300 excess cancers per million people, per microgram per cubic meter of diesel PM, is appropriate as a point estimate of unit risk.

[5] Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles, Air Resources Board - Stationary Source Division and Mobile Source Control Division, October 2000. This and many other ARB documents mentioned in this report are available on the internet at http://www.arb.ca.gov/.

medium-duty NOx, NMHC, and PM emission standards and a slight increase in the medium-duty CO emission standard. Unlike the U.S. EPA's 2007 Final Rule, this proposal will not apply to spark-ignited engines and vehicles, except those that are "derived from the diesel-cycle engine."[6] For those that are not derived from a diesel-cycle engine, separate spark-ignited engine and vehicle emission standards will be included in a proposal scheduled for consideration by the Board in 2002. Since the proposed emission standards will dramatically reduce emission levels, there has been concern about how to measure these emissions during certification. Therefore, identical to the U.S. EPA's 2007 Final Rule, the proposal also includes new and amended calibration and sampling methods.

Due to the extensive demonstration of aftertreatment devices, the U.S. EPA and the ARB consider these devices the next step to control emissions from diesel engines. Demonstration programs have shown the effectiveness of NOx reduction technologies such as NOx adsorbers and selective catalytic reduction (SCR). Separate demonstration programs have shown the effectiveness of PM reduction technologies such as oxidation catalysts, diesel particulate filters, and catalyzed particulate filters. Most recent data show that NOx adsorbers in conjunction with diesel particulate filters, or catalyzed particulate filters, can provide the necessary reductions in emissions to meet the proposed emission standards.

Many of the catalyst-based aftertreatment systems are sensitive to the sulfur content in the diesel fuel. Therefore, the proposal includes a lower emission test and service accumulation diesel fuel, sulfur content specification. However, in-use diesel fuel sulfur requirements are not included in this proposal. They will be included in a separate proposal scheduled for consideration by the Board in 2002 that will consider the benefits of maintaining a separate in-use California diesel fuel. The U.S. EPA has already adopted national low sulfur diesel fuel requirements, in their 2007 Final Rule, that will provide a backstop and ensure availability of the low sulfur, in-use diesel fuel.

In addition to the review of the U.S. EPA's Regulatory Impact Analysis for their 2007 Final Rule, ARB staff also reviewed on-going research and demonstration projects conducted by various government and industry groups. Review of current data has shown that the proposed requirements are technically feasible in the proposed time frame.

The remainder of this report provides details of the proposal. It discusses the feasibility of the proposed emission standards and cost effectiveness of the proposal. In addition, emission reduction calculations are provided. The proposal is consistent with the requirements adopted by the U.S. EPA so that similar engines can be produced in California as well as the rest of the nation.

[6] Pursuant to Title 13, California Code of Regulations, Section 1956.8.

The following is a summary of each Section of this Staff Report.

- Sections I and II of the Staff Report contain the introduction and background, respectively.
- Section III contains a discussion on the need for the proposed emission standards.
- Section IV is a summary of the proposed requirements.
- Section V describes areas in which the proposal differs from the federal requirements.
- Section VI addresses the technological feasibility of the proposal.
- Section VII discusses remaining issues that have arisen during the development of the requirements, and discusses how the issues are addressed by the proposal.
- Section VIII describes the regulatory alternatives that were considered.
- Section IX discusses the economic impacts.
- Section X assesses the environmental impacts of the proposal, along with the cost-effectiveness analysis for the proposal.
- Section XI summarizes the staff's findings and recommendations.
- Section XII lists references used in this Staff Report.

II. BACKGROUND

This section provides an overview of the emissions from diesel engines, the current regulations and the State Implementation Plan (SIP) commitments for HDDEs.

A. HEAVY-DUTY DIESEL-CYCLE ENGINES

Diesel-cycle engines are those engines that use a compression-ignited system to initiate combustion of the fuel in the engine's combustion chamber. By contrast, a spark-ignited engine typically uses a spark plug to ignite the fuel. However, regardless of how the fuel is ignited, if engines are derived from diesel-cycle engines[7] (i.e., having similar torque-speed characteristics and are used in similar vehicle applications as HDDEs), they would be subject to the proposed HDDE regulatory requirements. Thus, spark-ignited natural gas fueled engines and liquefied petroleum gas fueled engines that are derived from the diesel-cycle engine would, for the purposes of this rulemaking, be considered HDDEs.

The proposed emission standards would apply to HDDEs and would be optional for MDDEs.[8] HDDEs are used in vehicles with a GVWR of 14,001 pounds and greater. MDDEs are used in vehicles with a GVWR of 8,501 to 14,000 pounds. MDDEs have the option to certify using chassis-based emission standards or engine-based emission standards. Except for formaldehyde and CO, the current medium-duty diesel engine-based emission standards are identical to the HDDE emission standards.

For emission inventory purposes, HDDEs are segregated into heavy heavy-duty diesel engines and medium heavy-duty diesel engines. Heavy heavy-duty diesel engines are those used in vehicles with a GVWR of 33,001 pounds and greater and medium heavy-duty diesel engines are those used in vehicles with a GVWR of 14,001 to 33,000 pounds. Noteworthy is the inclusion of both school buses and motor homes in the medium heavy-duty vehicle inventory. Weight classifications for the regulatory requirements and emission inventory are summarized in Table 1 below.

[7] Pursuant to Title 13, California Code of Regulations, Section 1956.8.

[8] HDDE emission standards are optional for engines used in medium-duty vehicles 8,501 to 14,000 pounds GVWR, pursuant to the LEV II requirements in Title 13, California Code of Regulations, Section 1956.8(h).

Table 1 - ARB Weight Class Identification and Regulatory Requirements Summary

Regulatory Classification	GVWR (lbs.)	HDDE Standards Required?
Heavy-Duty	14,001 +	Yes
Medium-Duty[9]	8,501 - 14,000	Optional

B. DIESEL ENGINE EMISSIONS

Unlike Otto-cycle (spark-ignited) engines, a typical diesel-cycle engine operates by compression ignition.[10] Diesel fuel is typically injected directly to the combustion chamber and mixed with hot compressed air that is already present. The fuel is ignited by high temperature in the combustion chamber that results from compressing the air, rather than by spark plugs like those used in gasoline-fueled engines. The amount of air introduced into the combustion chamber remains constantly in excess of the chemically ideal stoichiometric air-to-fuel ratio. Power from a diesel engine, is controlled by regulating the amount of fuel that is injected into the combustion chamber.

The primary pollutants of concern from diesel engines are NOx and PM, since both are harmful to human health. The high combustion and exhaust temperatures, and excess air cause the nitrogen in the air to combine with available oxygen to form NOx. Since diesel-cycle combustion operates with excess air, by-products due to incomplete combustion are emitted at relatively low levels. These by-products include HC and CO. Evaporative emissions from diesel engines are not significant since diesel fuel has a low vapor pressure and thus, a low evaporation rate. In addition to the PM emissions resulting from incomplete combustion of fuel, lubrication oil entering the cylinder contributes to overall PM emissions.

Another source of emissions from a diesel engine is the crankcase. Crankcase emissions are similar to exhaust emissions. These emissions result when the combustion gases "blow by" the piston rings into the crankcase. Consequently, these gases are vented to reduce the pressure in the crankcase. Currently, venting crankcase emissions to the ambient air is permitted in all on-road HDDEs equipped with turbochargers, which is essentially all of them. The staff's proposal would require all HDDEs to recirculate the crankcase gases back into the combustion chamber, like is done in gasoline engines.

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[9] Includes school buses and motor homes.

[10] Natural gas fueled engines and liquefied petroleum gas fueled engines derived from diesel-cycle engines typically operate using spark-ignition identical to the Otto-cycle engine.

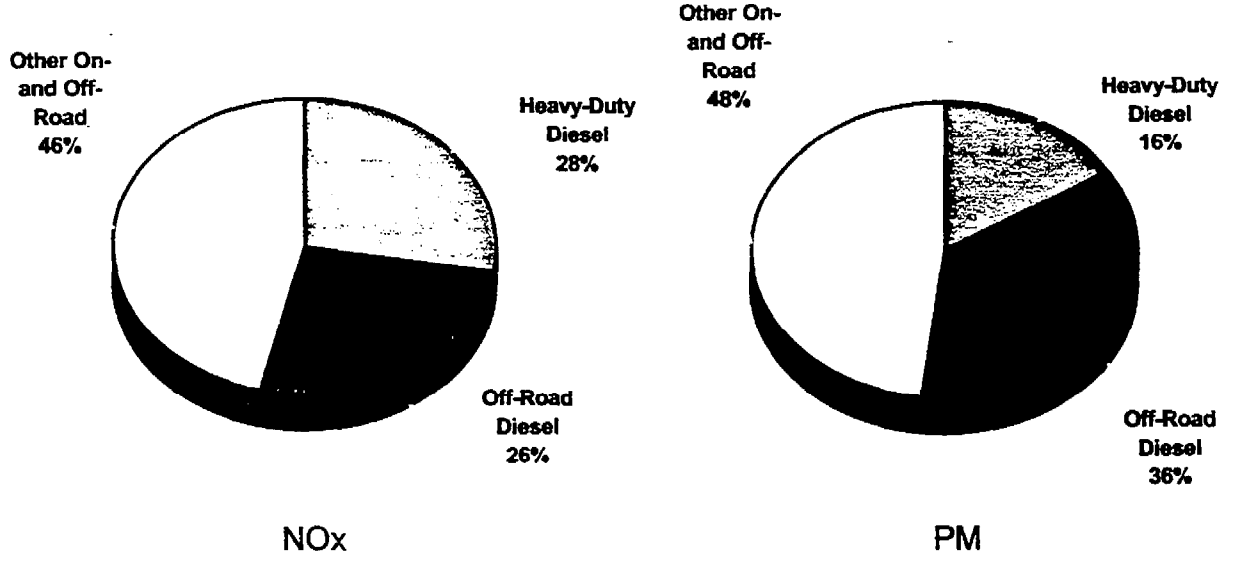
C. EMISSIONS INVENTORY

The modelling program used to determine California's emissions inventory for HDDEs is called EMFAC2000. This program was adopted by the Board in May 2000. The emissions information in this report is based on the updated emissions inventory from EMFAC2000 Version 2.02.[11]

As shown in the charts in Figure 1, the projected NOx and PM emissions from on-road HDDEs will contribute approximately 28 percent of the mobile source NOx emissions and 16 percent of the mobile source exhaust PM emissions in California in 2010. The "other on- and off-road" sources, shown in Figure 1, include passenger cars, gasoline-fueled trucks, motorcycles, and urban buses.

Figure 1

Statewide Mobile Source Emissions in 2010



D. EXISTING EMISSION STANDARDS

In 1995, the U.S. EPA, ARB, and the leading manufacturers of HDDEs signed a Statement of Principles (SOP) with the understanding that the two agencies would harmonize any new emission standards. The SOP is intended to create uniform and consistent standards for heavy-duty engines, due to the widespread affect of heavy-duty trucks that often travel between states. In October 1997, the U.S. EPA adopted new emission standards for model year 2004 and subsequent model year HDDEs. In February 1998, the ARB subsequently adopted identical, new HDDE standards for the same model years to harmonize the heavy-duty

[11] It should be noted that an update to EMFAC2000, called EMFAC2001, was adopted by the Board in July 2001. To ensure consistent emission calculations throughout this staff report, only results from EMFAC2000 are used.

vehicle regulations between the ARB and the U.S. EPA. For 2004 and subsequent model year HDDEs, manufacturers will have the flexibility to certify their engines to one of the two options given in Table 2, below.

Table 2 - ARB and U.S. EPA Emission Standards for MY 2004 and Subsequent Heavy-Duty Diesel-Cycle Engines (grams per brake horsepower-hour) [12]

Option	NMHC plus NOx	NMHC[13]	CO	PM
1	2.4	n/a	15.5	0.10
2	2.5	0.5	15.5	0.10

MDDEs have the option to certify using either a chassis test or an engine test. For the chassis test, the applicable emission standards are shown below in Tables 3 and 4.

Table 3 - ARB Emission Standards for MY 2004 and Subsequent Medium-Duty Diesel Vehicles, GVWR 8,501-10,000 lbs. (grams per mile)

Option	NMOG	NOx	CO	PM	Formaldehyde[14]
LEV	0.195	0.2	6.4	0.12	32
ULEV	0.143	0.2	6.4	0.06	16
SULEV	0.100	0.1	3.2	0.06	8

Table 4 - ARB Emission Standards for MY 2004 and Subsequent Medium-Duty Diesel Vehicles, GVWR 10,001-14,000 lbs. (grams per mile)

Option	NMOG	NOx	CO	PM	Formaldehyde[15]
LEV	0.230	0.4	7.3	0.12	40
ULEV	0.167	0.4	7.3	0.06	21
SULEV	0.117	0.2	3.7	0.06	10

[12] The emission standards shown apply to all heavy-duty diesel engines except urban bus engines.
[13] The NMHC emission standard shown in this table is the NMHC portion of the NOx plus NMHC emission standard. This emission standard is maximum allowable portion of the NOx plus NMHC emission standard.
[14] Medium-duty diesel vehicle formaldehyde emission standards are displayed in terms of milligrams per mile.
[15] Medium-duty diesel vehicle formaldehyde emission standards are displayed in terms of milligrams per mile.

For the engine test, MDDEs may certify to the same emission standards as those of HDDEs. The 2004 and subsequent model year MDDEs are required to certify to the ULEV emission standards or equivalent fleet average non-methane organic gas (NMOG) requirements. These engines also have the flexibility to certify their engines to one of the two ultra-low-emission-vehicle (ULEV) options using an engine test. In addition, MDDEs, may certify their engines to a super-ultra-low-emission-vehicle (SULEV) emission standard that is equivalent to one half of the ULEV emission standard (except for the NOx plus NMHC emission standard that is 83% of the ULEV emission standard). Engines certified to the SULEV emission standard may generate NMOG vehicle-equivalent credits (VEC). The VECs can, in turn, be used to assist a manufacturer in meeting medium-duty diesel vehicle phase-in requirements. The optional, engine test-based emission standards are given in Table 5, below.

Table 5 - ARB Emission Standards for MY 2004 and Subsequent Medium-Duty Diesel Engines (grams per brake horsepower-hour)

Option	NMHC plus NOx	NMHC[16]	CO	PM	Formaldehyde
ULEV A	2.4	n/a	14.4	0.10	0.05
ULEV B	2.5	0.5	14.4	0.10	0.05
SULEV	2.0	n/a	7.2	0.05	0.025

It should be noted that, unlike HDDEs, MDDEs are required to comply with a formaldehyde emission standard (see Table 5, above). The primary reason for this is that compared to HDDEs, many MDDEs are fueled by natural gas or liquefied petroleum gas. These alternative fuels tend to produce higher levels of formaldehyde compared to a diesel-fueled engine.

E. EXISTING TEST PROCEDURES

Currently, California's 2005 and subsequent model year HDDEs[17] require compliance with several emission tests for certification of engines including the federal test procedure (FTP), the Not-to-Exceed (NTE) test, and the Euro III European Stationary Cycle (ESC) test. The FTP test cycles the engine through a fixed set of conditions meant to simulate actual driving, both urban stop and go traffic, and crowded freeway/expressway traffic. However, the FTP alone is not adequate to ensure that emissions are controlled during all in-use driving conditions. As a result, in December 2000, the ARB adopted additional test procedures, the NTE test and the ESC test. The adopted test procedures are

[16] The NMHC emission standard shown in this table is the NMHC portion of the NOx plus NMHC emission standard. This emission standard is maximum allowable portion of the NOx plus NMHC emission standard.

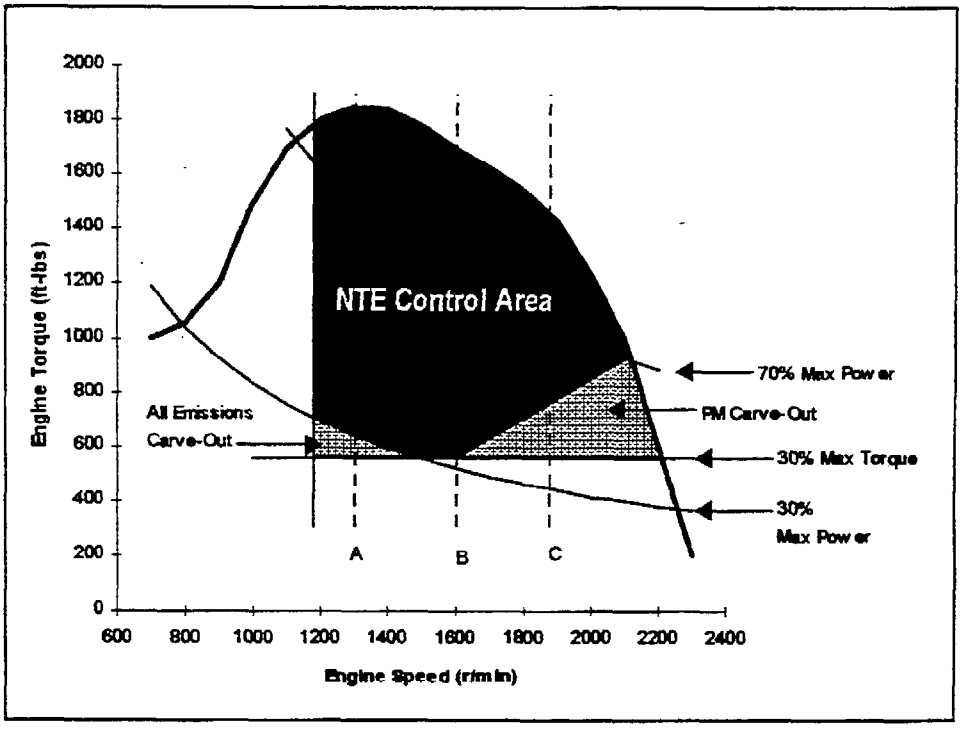
[17] Regulatory documents can be found at http://www.arb.ca.gov/regact/ntetest/ntetest.htm.

similar to those required in the heavy-duty diesel consent decrees and the U.S. EPA's 2004 Final Rule and became effective in California on July 25, 2001.

The NTE test, as defined in 40 CFR §86.1370-2007, establishes an area (NTE control area) under the torque curve of an engine where emissions must not exceed a specified emission cap for a given pollutant. Instead of using a fixed operating cycle, the NTE covers an area of operation, or the NTE control area. Emissions sampled while operating the engine within the control area, are limited to the NTE emissions cap. The basic NTE control area for diesel engines has three basic boundaries on the engine's torque and speed map. The first is the upper boundary that is represented by an engine's maximum torque at a given speed. The second boundary is 30 percent of maximum torque. Only operation above this second 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. This engine speed is considered the "15 percent operational engine speed". Only engine operation above that engine speed is included in the NTE control area. The control area is bound by operating conditions typical of in-use operation with the exception of two "carve-out" areas of operation. The first carve out area applies to emissions of all air contaminants. All engine operation less than 30 percent of maximum power is removed from the basic NTE control area on the engine's torque and speed map, since excess emissions are unlikely to occur in this operating region. The second carve-out area is determined from several engine power, torque, and speed points. This carve-out area excludes only PM emissions from the NTE control area. The NTE cap is based on the FTP emission standard and includes a 25 percent allowance to comply with the NTE test. The minimum sampling time for this test is 30 seconds, where average NTE emissions over a 30-second interval must comply with the emissions cap. A sample NTE control area is shown in Figure 2, below.

Figure 2

Example NTE Control Area for Heavy-Duty Diesel Engine With 100% Operational Engine Speed Less Than 2400 rpm



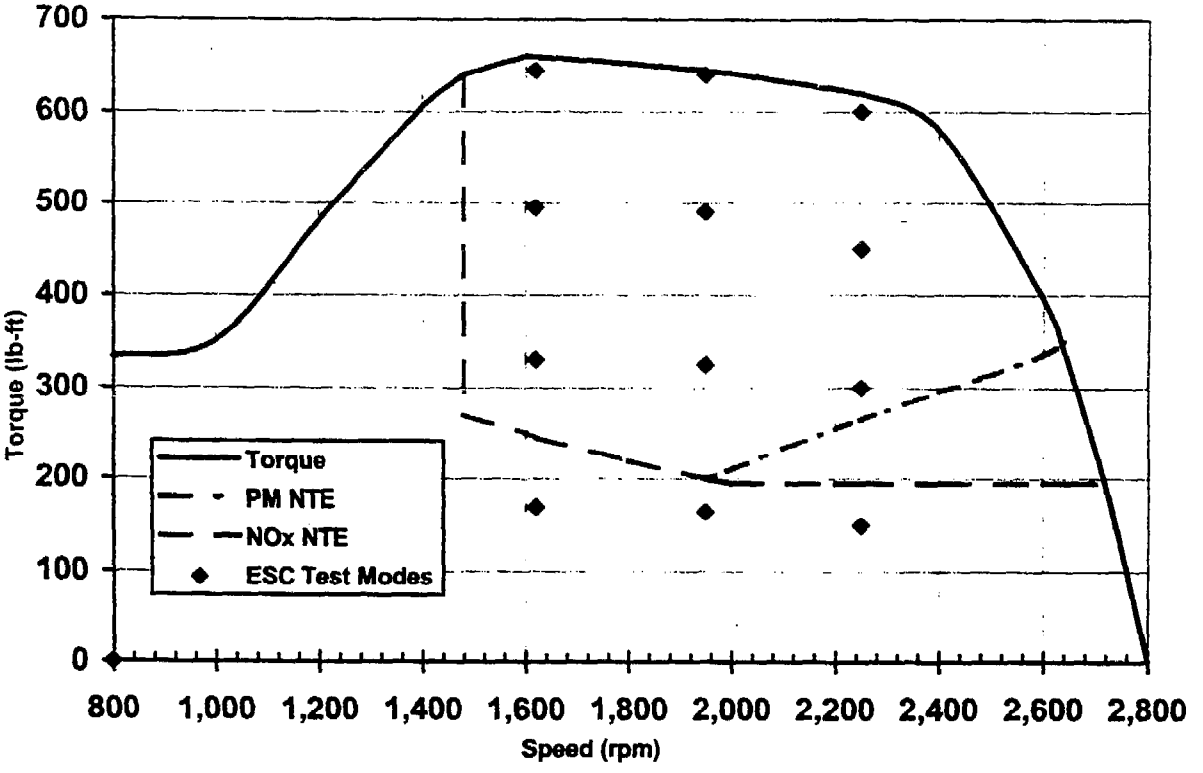
The NTE test also includes two temperature and altitude options to comply with the test requirements. Combinations of temperature and altitude create a NTE zone that is typical of California driving conditions. NOx and PM emission results at temperatures outside the NTE zone are corrected to the levels at the boundaries of the NTE zone. Due to the flexibility of the NTE control area, the NTE test may be conducted in an emission testing laboratory or on the road.

As opposed to transient testing conducted with the NTE test, the ESC test consists of steady state operation. The Euro III ESC test cycle, defined in 40 CFR §86.1360-2007 as the "supplemental steady state test", consists of 13 modes at specified speed and power conditions, primarily representing the typical highway cruise operating conditions of heavy-duty diesel vehicles. The sum of the weighted emission results at each test mode is compared to the FTP-based emission standard. Maximum allowable emission limits (MAEL) are determined through interpolation of the 12 non-idle test points (the thirteenth operating mode, idle, is excluded) of the ESC test. A 10 percent interpolation allowance is added to the results of each of the 12 test points. The 10 percent allowance is added to provide additional allowance for possible errors in interpolation. Three random test points may be selected, by the ARB, within the MAEL area to verify that emissions do not exceed the MAEL cap. A sample of

the ESC test modes is shown in Figure 3. The test modes are shown compared to a NTE control zone.

Figure 3

Example ESC Test Modes with NTE Control Area for Heavy-Duty Diesel Engine



F. CERTIFICATION TEST FUEL SPECIFICATIONS

The current diesel sulfur content specification for certification test fuel ranges from 100 to 500 parts per million. This specification is identical for both exhaust emission testing and service accumulation. Manufacturers also 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.

G. EXISTING AVERAGING, BANKING, AND TRADING PROGRAM

Currently, 2007 and subsequent model year heavy-duty engine manufacturers may include any or all engine families in the averaging, banking, and trading (ABT) program. In the ABT program, an engine manufacturer may "average" among current model year engine families, "bank" emissions from current model year engine families, and "trade" banked emissions to other engine manufacturers. Averaging and trading of banked emissions may only be

completed between engine families within the same "averaging set." Averaging sets are based on the U.S. EPA's weight classes, shown in Table 6 below.

Table 6 - U.S. EPA Weight Class/Averaging Set Identification

U.S. EPA and ARB	GVWR (lbs.)
Heavy Heavy-Duty	33,001+
Medium Heavy-Duty	19,501 - 33,000
Light Heavy-Duty	8,501 - 19,500

For ABT purposes only, the light heavy-duty engine averaging set includes ARB medium-duty engines (GVWR between 8,501 and 14,000 pounds) and a small portion of ARB heavy-duty engines (GVWR between 14,001 and 19,500 pounds). Additionally, there may be multiple engine families in each averaging set.

NMHC and PM credits generated in the ABT program have no expiration date. However, NOx credits generated in the ABT program are only available for 3 model years following the model year of credit generation. Further, credits generated before 2004 from engines sold outside California, may not be used to certify light heavy-duty and medium-duty engines sold in California. While the ABT program provides flexibility by allowing averaging, it does specify upper limits to the engine family emission limits (FEL). The current FEL upper limits are shown in the table below.

Table 7 – Current Family Emission Limits (grams per brake horsepower-hour)

NOx + NMHC	NMHC[18]	PM
4.5	0.50	0.25

H. STATE IMPLEMENTATION PLAN (SIP)

In November 1994, the ARB approved the SIP for Ozone, which outlines the measures to be taken to bring the state's air quality into attainment with the federal ambient air quality standards for ozone. During the SIP's development, it became clear that reducing emissions of NOx from on-road HDDEs operating within the state is imperative for cleaning California's air.

[18] NMHC FEL is for engine families certifying to the optional emission standards.

Although many of the measures included in the SIP have been adopted, State air quality goals are still not expected to be satisfied in the necessary timeframes. This proposal is expected to further reduce emissions of NOx, PM, and ROG to help meet California's air quality goals.

I. DIESEL RISK REDUCTION PLAN

In August of 1998, California identified diesel PM as a toxic air contaminant. Diesel PM has been found to contain over 40 substances that are individually identified as toxic air contaminants and is associated with increases in lung disease, heart disease, mortality, and other chronic non-cancer health effects. In addition, an assessment of carcinogenic risk in California finds diesel PM to account for approximately 70 percent of the total ambient cancer risk in 2000. Statewide, the average potential cancer risk associated with diesel PM is over 500 excess cases per million people.[19] In September 2000, the ARB approved the Diesel Risk Reduction Plan which identified the impacts of diesel PM, identified current technologies to control diesel PM, and outlined measures necessary to reduce diesel PM. One measure included in the Diesel Risk Reduction Plan is the adoption of lower PM emission standards for new HDDEs. These emission standards are contained in the staff proposal and are identical to the emission standards adopted by the U.S. EPA in their 2007 Final Rule.

[19] The Scientific Review Panel concluded that 300 excess cancers per million people, per microgram per cubic meter of diesel PM, is appropriate as a point estimate of unit risk.

III. NEED FOR CONTROL

The proposed emission standards will provide additional emission reductions beyond those estimated to result from the measures identified in the 1994 SIP for Ozone. This section summarizes the air quality need that justifies the proposed emission standards.

Simply put, without further emission controls, California will not attain state air quality standards. As shown previously in Figure 1, on-road HDDEs are a significant contributor to statewide NOx and PM emissions. The projected statewide NOx and PM emissions from these engines in 2010 will contribute approximately 28 percent of the mobile source NOx emissions and 16 percent of the mobile source exhaust PM emissions. In 2020, the projected statewide NOx contribution becomes 34 percent of the mobile source NOx inventory (the PM contribution remains at 16 percent). From these projections, it is clear that if California is expected to attain state air quality standards, additional controls are necessary for HDDEs. Thus, given the favorable cost effectiveness and lack of aftertreatment control strategies on current HDDEs, emissions from HDDEs are a good target for further reductions.

Ozone is a result of the photochemical reaction of primarily NOx and HC. Evidence shows that ozone is the cause of harmful respiratory effects, including chest pain, coughing, and shortness of breath. Those who may be severely affected include children, the elderly, and people with poor respiratory systems. Even healthy people may be affected by the elevated ozone levels if they are active outdoors during smoggy days. NOx can also be transformed in the atmosphere to nitrate, a form of PM that can cause lung disease and premature death. NOx alone can also directly harm human health by aggravating common respiratory illnesses, such as asthma and bronchitis, and contributes to the premature aging of lung tissue and various other chronic lung diseases. In addition to human health effects, negative environmental effects are also associated with ozone and NOx. Ozone has been shown to adversely impact plants and many man-made materials, while NOx contributes to acid deposition and the overgrowth of algae in coastal estuaries.

In addition to harmful NOx, diesel engines also produce diesel exhaust PM. After many years of review, California identified diesel exhaust PM as a toxic air contaminant in August of 1998. A toxic air contaminant is any air pollutant that may cause or contribute to an increase in mortality or serious illness, or that may pose a present or potential hazard to human health. As previously stated, diesel PM contains over 40 substances that are, in themselves, identified as toxic air contaminants. These substances include benzene and formaldehyde to name just two. As a result, assessment of carcinogenic risk in California finds diesel PM to account for approximately 70 percent of the total ambient cancer risk in 2000. Statewide, the average potential cancer risk associated with diesel PM is over 500 excess cases per million people.

IV. SUMMARY OF PROPOSED REQUIREMENTS

The staff recommends that the Board amend section 1956.8, Title 13, California Code of Regulations, and the incorporated "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles", as set forth in Appendices 1 and 2. The proposed regulatory language for the emission standards and test procedures duplicate the requirements adopted by the U.S. EPA.[20] Staff proposes to adopt the emission standards and test procedures beginning in the 2007 model year, the same year that these standards and test procedures apply federally. Specific provisions of this proposal include:

HDDE emission standards and phase-in

- More stringent emission standards as follows: NOx emissions at 0.2 grams per brake horsepower-hour, NMHC emissions at 0.14 grams per brake horsepower-hour, and PM emissions at 0.01 grams per brake horsepower-hour,
- NOx and NMHC emission standard phase-in of 50 percent from 2007 through 2009 model years, and 100 percent in 2010 and subsequent model years,
- Full implementation of the HDDE PM emission standard beginning in the 2007 model year,

MDDE emission standards and phase-in

- A slight increase in the MDDE CO emission standard to 15.5 grams per brake horsepower-hour,
- Reduced MDDE SULEV emission standards to half of the proposed PM and CO emission standards,
- Reduced MDDE SULEV emission standards to 83% of the proposed NOx and NMHC emission standards,
- NOx and NMHC emission standard phase-in of 50 percent from 2007 through 2009 model years, and 100 percent in 2010 and subsequent model years,
- Full implementation of the MDDE PM and CO emission standard beginning in the 2007 model year,

Elimination of crankcase emission exemption

- Elimination of the crankcase emission exemption from turbocharged HDDEs,

[20] Federal regulations published at 66 FR 5002, January 18, 2001.

Supplemental emission test procedures

- Elimination of PM "carve-out" areas of the NTE control zone,
- Elimination of the MAEL test and the three "mystery points" for engines that certify to reduced emission standards,
- The allowance of engine deficiencies for 2010 through 2013 model years,

Supplemental emission test procedure caps

- The allowance of higher NOx and PM NTE caps for engines that certify to reduced emission standards,

Certification test fuel specifications

- Reduced sulfur content for emission test and service accumulation fuel,

ABT program

- A revised ABT program that allows trading of emissions between phased-in engines and phased-out engines, and
- A revised ABT program that allows averaging of emissions between weight classes during the phase-in period.

A. APPLICABILITY

The provisions in this proposal apply to all MDDEs and HDDEs[21] produced for sale in California in the 2007 and subsequent model years. MDDEs are used in vehicles with a GVWR of 8,501 to 14,000 pounds. HDDEs are used in vehicles with a GVWR of 14,001 pounds and greater. Although urban bus engines can be classified as HDDEs, this proposal does not apply to urban bus engines. Lower emission standards for urban bus engines have already been adopted by the ARB. Additionally, there are no proposed exemptions for any engines within the heavy-duty or medium-duty weight classes.

B. HEAVY-DUTY DIESEL CYCLE AND MEDIUM-DUTY DIESEL EMISSION STANDARDS

In contrast to the currently combined NOx plus NMHC emission standard, the proposal includes separate emission standards for NOx and NMHC. The proposal also includes a PM emission standard. There is no proposed change to the existing CO emission standard for HDDEs. However, the ARB is

[21] Including both natural gas fueled engines and liquefied petroleum gas fueled engines that are derived from the diesel-cycle engine, as described in Section II.A above.

proposing to harmonize the MDDE CO emission standard for ULEVs with the federal emission standard at 15.5 grams per brake horsepower-hour.

MDDEs also have the flexibility to certify their engines to optional SULEV emission standards that would be equivalent to one half of the PM and CO ULEV emission standards (the NOx and NMHC emission standards would be 83% of the ULEV emission standards). The SULEV emission standards are currently used when calculating non-methane organic gas vehicle-equivalent credits and debits. In order to continue allowing the option to certify 2007 and subsequent model year MDDEs to SULEV emission standards for the purpose of generating credits, staff proposes reduced SULEV emission standards, as shown in Table 8, below.

Thus, as shown in Table 8, the proposed HDDE and MDDE ULEV emission standards for NOx, NMHC, PM, and CO are 0.2 grams per brake horsepower-hour, 0.14 grams per brake horsepower-hour, 0.01 grams per brake horsepower-hour, and 15.5 grams per brake horsepower-hour, respectively. The proposed MDDE SULEV emission standards for NOx, NMHC, PM, and CO are 0.17 grams per brake horsepower-hour, 0.12 grams per brake horsepower-hour, 0.005 grams per brake horsepower-hour, and 7.7 grams per brake horsepower-hour, respectively.

Table 8 - Summary of Proposed Heavy-Duty Diesel Cycle and Medium-Duty Diesel Engine Emission Standards (grams per brake horsepower-hour)

ARB Weight Class		Pollutant			
		NOx	NMHC	PM	CO
Heavy-Duty		0.2	0.14	0.01	15.5
Medium-Duty	ULEV	0.2	0.14	0.01	15.5[22]
	SULEV	0.17	0.12	0.005	7.7

C. HEAVY-DUTY DIESEL CYCLE AND MEDIUM-DUTY DIESEL EMISSION STANDARDS PHASE-IN

The above described emission standards for HDDEs and MDDEs are also proposed to be phased-in. The NOx and NMHC emission standards are proposed to be phased-in at 50 percent of engines sold in the 2007 model year, 50 percent in the 2008 model year, 50 percent in the 2009 model year, and 100

[22] The current ARB heavy-duty diesel-cycle engine CO emission standard is 15.5 grams per brake horsepower-hour. However, the current ARB medium-duty diesel engine CO emission standard is 14.4 grams per brake horsepower-hour. For the purpose of harmonizing with the U.S. EPA, the allowable CO emission standard would be increased to 15.5 grams per brake horsepower-hour.

percent in the 2010 model year. The proposed implementation of the PM and CO emission standards is 100 percent of engines sold in the 2007 and subsequent model years. Phase-in will be determined based on U.S.-directed production. The phase-in schedule is summarized in Table 9 below.

Table 9 - Summary of Phase-In Schedule

Pollutant	Model Year			
	2007	2008	2009	2010+
NOx NMHC	50%	50%	50%	100%
PM	100%	100%	100%	100%
CO	100%	100%	100%	100%

D. SUPPLEMENTAL TEST PROCEDURE AMENDMENTS

The supplemental test procedures were originally adopted by the Board on December 8, 2000. The proposal includes changes to the test procedures that are identical to those adopted by the U.S. EPA in their 2007 Final Rule and are detailed below.

1. Not-to-Exceed Test Procedure

There are no proposed changes to the basic NTE control area. As previously described under "Existing Test Procedures" (Section II.E), there are currently two areas which are "carved out" of the basic NTE control area. There are no proposed changes to the first carve out area that applies to all air contaminants. The second carve out area that applies to PM emissions is proposed to be removed due to the high efficiency of the PM control technologies that will be necessary to comply with the proposed emission standard. Therefore, removing this "carve out" area will require control of PM emissions over the entire NTE control area.

The NTE requirement will continue to apply under any engine operating condition that could reasonably be expected in normal vehicle use. Since engine manufacturers may potentially utilize aftertreatment devices, the averaging period to determine compliance with the test procedures has been increased. When a regeneration event occurs during the NTE test of an engine equipped with control devices that perform discrete regeneration events, the averaging period is increased to the time between regeneration events multiplied by the number of full regeneration events that occurred. However, this only applies to those engines that send electronic signals that indicate the beginning of a regeneration event.

An additional warm-up allowance is proposed for engines with NOx or NMHC aftertreatment devices. If an engine is equipped with one or more devices that reduce NOx or NMHC emissions, NTE emission caps for NOx and NMHC do not apply when the exhaust temperature (at the outlet of the aftertreatment device) is less than 250 degrees C.

In addition, up to three deficiencies may be approved per engine family for model years 2010 through 2013.[23] 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.

2. Euro III European Stationary Cycle Test Procedure

Since the proposed lower emission standards will not allow as many adjustments outside the ESC test points, MAEL requirements are proposed to be removed for engines with a NOx FEL less than 1.50 grams per brake horsepower-hour.

E. SUPPLEMENTAL TEST EMISSION CAPS

Emission caps for the supplemental test procedures are based on the existing emission limits determined by the FTP test cycle. There are three sets of proposed changes to California's emission caps contained in the test procedures, which are identical to those contained in the U.S. EPA's 2007 Final Rule. Use of the additional caps is based upon the emissions of the certified engine family. The emission cap for the Euro III ESC test will continue to be 1.0 times the FTP emission limit. For engines with a NOx FEL less than 1.50 grams per brake horsepower-hour, the MAEL test will not be required (as mentioned above in Section II.D).

For engines with a NOx FEL less than 1.50 grams per brake horsepower-hour, the NTE cap is proposed to be 1.5 times the applicable NOx or NMHC emission standard or FEL. All other engines with a NOx FEL of 1.50 grams per brake horsepower-hour and greater will continue to be 1.25 times the applicable NOx or NMHC emission standard or FEL. Due to the complete phase-in of the PM emission standards, the PM NTE cap for all 2007 and subsequent model year engines is proposed to be 1.5 times the applicable PM emission standard or FEL. The larger NTE caps are proposed due to the proposed lower emission standards, thereby providing a greater allowance for compliance with the requirements. The proposed changes to the emission caps are summarized in Table 10 below.

[23] 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.

Table 10 - Summary of Proposed Emission Caps

Test Procedure	Pollutant	Qualification	Proposed Cap
MAEL	All	NOx < 1.50 g/bhp-hr	Not Required
NTE	NOx	NOx < 1.50 g/bhp-hr	1.5 x FTP standard
	NMHC	NOx < 1.50 g/bhp-hr	1.5 x FTP standard
	PM	None	1.5 x FTP standard

F. 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 is proposed to 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.

G. CALIBRATION AND SAMPLING TECHNIQUES

The proposal includes 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 is an allowance for lower dilution ratios during emission measurements, which improves the measurement of both gaseous and particulate emissions. The final change is the adoption of a new NOx calibration procedure that provides more precise and continuous measurements of low concentrations of NOx. An additional allowance is also proposed to provide manufacturers the option of using their current test procedures if they are more convenient or cost-effective in the short term. However, the ARB may conduct tests to confirm the results of any manufacturer testing to confirm the validity of the results.

H. AVERAGING, BANKING, AND TRADING 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. Credits will continue to be based on the difference between the emission standard and the FEL. During the phase-in implementation of the proposed NOx emission standard, engines are classified as either "phased-out" or "phased-in." The phased-out engines would meet the previously adopted 2.5 gram per brake horsepower-hour NOx plus NMHC

emission standard. The phased-in engines would meet the proposed 0.2 gram per brake horsepower-hour NOx emission standard. NOx plus NMHC credits generated from phased-out engines may be used for NOx credit deficits from phased-in engines. However, NOx plus NMHC credits from phased-out engines will be subject to a 20% discount when converted to NOx only credits for phased-in engines.

Similar to the U.S. EPA's 2007 Final Rule, averaging is proposed to be allowed between different weight class averaging sets. For example, emissions from heavy heavy-duty diesel engines may be averaged with emissions from medium heavy-duty diesel engines. This flexibility will only be allowed during the phase-in period, from the 2007 through 2009 model years. Comments have been received that the three model year averaging provision adopted in the U.S. EPA's 2007 Final Rule may put manufacturers of medium heavy-duty diesel engines at a competitive disadvantage to manufacturers of both heavy and medium heavy-duty diesel engines. However, staff is not aware of any strong evidence that would support a "competitive disadvantage" argument, but rather that this three-year provision will provide manufacturers greater flexibility to introduce new technologies into the marketplace.

To be included in the ABT program, engine families must not exceed the proposed 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 proposed maximum NOx 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 proposed maximum NOx FEL cap is 0.50 grams per brake horsepower-hour. The proposed maximum PM FEL cap is 0.02 grams per brake horsepower-hour for all engines beginning in the 2007 model year.

I. EARLY INTRODUCTION OF LOWER EMITTING ENGINES

Identical to the U.S. EPA's 2007 Final Rule, the proposal provides incentives for early introduction of lower emitting engines. Engines that satisfy the proposed requirements and are introduced into the marketplace, prior to 2007, will receive credits equal to 1.5 times the number of diesel-cycle engines that are introduced early. For example, two early introduction engines will reduce the number of required phased-in engines by three. Each early engine must meet all requirements applicable to model year 2007 engines. If the engine only complies with the PM requirements, the offsets may only be used for PM compliant engine credits.

Engines that can meet one half of the proposed NOx emission standard, or 0.10 grams per brake horsepower-hour, earlier than the phase-in period in addition to all other requirements applicable to model year 2007 engines will be classified as "Blue Sky Series" engines. These engines will receive a credit of 2.0 times the

number of "Blue Sky Series" engines. For example, two "Blue Sky Series" engines will reduce the number of required phased-in engines by four.

Both early introduction programs detailed above will be based on U.S.-directed production.

V. DIFFERENCES AND SIMILARITIES BETWEEN FEDERAL AND CALIFORNIA REGULATIONS

The proposed emission standards and revised supplemental test procedures are intended to be identical to those adopted by the U.S. EPA in January 2001. This would reduce emissions from a group of vehicles that contribute greatly to California's emission inventory and would harmonize both California and federal requirements for HDDEs. Therefore, HDDE class applicability, emission standards, phase-in schedule, supplemental test procedures, the ABT program, and improvements to the calibration and sampling techniques are all identical to those adopted by the U.S. EPA in their 2007 Final Rule. The only differences from the federal rule are detailed below.

A. APPLICABILITY

The U.S. EPA adopted requirements applicable to both heavy-duty spark-ignited engines and heavy-duty diesel-cycle engines. Staff's proposal is only applicable to HDDEs and (all) MDDEs. Similar heavy-duty spark-ignited engine requirements will be considered in 2002.

B. ARB MEDIUM-DUTY EMISSION STANDARDS

The U.S. EPA's 2007 Final Rule includes emission standards for NOx, NMHC, PM, and CO for both MDDEs and HDDEs. The staff's proposal is identical with the exception that it also includes a formaldehyde standard (0.05 grams per brake horsepower-hour) for MDDEs. This is because this standard is already in place for MDDEs in California. Thus, the proposal only seeks to maintain this emission standard.

C. URBAN BUS EMISSION STANDARDS

The U.S. EPA's requirements for heavy-duty engine and vehicles include applicability to urban buses. Although the staff's proposal applies to both HDDEs and MDDEs, the proposal is not applicable to urban buses. Urban bus requirements were previously adopted by the Board in February 2000.

D. DIESEL FUEL REQUIREMENTS

The U.S. EPA's 2007 Final Rule includes requirements for low sulfur, in-use diesel fuel (less than 15 ppm sulfur by weight) and the phase-in of that fuel. Although the ARB is not including the in-use diesel fuel requirements with this proposal, the low sulfur diesel fuel is necessary to comply with the proposed emission standards (further described in Section VI below). As mentioned previously, ARB staff plans to propose low-sulfur in-use diesel fuel requirements

to the Board in 2002. In the case that low sulfur, in-use diesel fuel requirements are not proposed and adopted by the ARB, the default fuel will be the same as that adopted by the U.S. EPA in their 2007 Final Rule.

E. PROPOSED FINDING

Section 209 of the federal Clean Air Act and Division 26, Part 5, Chapter 2 of California's Health & Safety Code provide the authority for California and the ARB, respectively, to establish and maintain its own new motor vehicle emissions certification and related enforcement programs. This authority reflects California's unique air quality problems and resulting need for flexibility to implement programs that may or may not mirror federal controls.

While continuing to maintain a separate program for these engines, throughout this ISOR staff has referred to its efforts to avoid conflicts with applicable federal regulations. Indeed, this proposal would adopt nearly identical requirements for California. And as detailed in Section IX of this ISOR, this proposal will not increase and may actually decrease costs of producing engines for the California market.

Therefore, to the extent this regulatory proposal has any differences from adopted federal regulations, such differences are both authorized by law and are justified by ARB's ongoing program to benefit human health and the environment.

VI. TECHNOLOGICAL FEASIBILITY

A. GENERAL REVIEW

Previous tightening of HDDE emission standards has primarily resulted in modifications to engine and combustion related components. Engine modifications included such changes as improved electronic controls, improved turbocharger systems, and improved exhaust gas recirculation. Combustion modifications included such changes as improved engine timing, improved fuel injection systems, and improved cylinder design. These types of technological changes continue, as documented in ongoing demonstration programs and scientific and engineering publications. However, to reduce emissions significantly further, other methods of control must be examined and utilized.

The U.S. EPA's 2007 Final Rule discusses the technological progress that has been made to further reduce emissions from HDDEs. This progress has primarily related to the use of aftertreatment systems. Compared to passenger cars, aftertreatment systems are a relatively new technology for HDDEs. However, throughout the United States and Europe there are ongoing demonstration programs evaluating the effectiveness of the aftertreatment systems. A majority of these programs have proven that aftertreatment systems are technically feasible. Further support for these systems is included in scientific and engineering publications. These aftertreatment-based emission control technologies are capable of reducing NOx, PM, and HC emissions.

One key to the durability of aftertreatment-based systems is the sulfur content of the diesel fuel. In general, lower fuel sulfur content allows longer aftertreatment system life and greater control efficiency. Specifically, sulfur adversely impacts the emission reducing capability of the aftertreatment device by attaching to the chemical sites that are needed for the catalytic reaction that reduces the emissions. Currently, California limits the sulfur level of diesel fuel used in on-road vehicles to 500 ppm. Actual average sulfur levels are about 120 ppm, less than one-quarter of the maximum limit. Currently, the U.S. EPA also limits sulfur levels of diesel fuel for on-road vehicles to 500 ppm with the average national, in-use sulfur level of 350 ppm. For manufacturers to take advantage of the emissions reduction potential of aftertreatment technologies, use of diesel fuel with a sulfur limit of 15 ppm or less will be necessary. Part of the U.S. EPA's 2007 Final Rule includes introduction of diesel fuel with 15 ppm sulfur content beginning in 2006. The ARB intends on proposing similar in-use diesel fuel requirements in 2002. If these in-use fuel requirements are not adopted by the ARB, in-use diesel fuel in California will at least meet the federal requirements. This will ensure that lower sulfur in-use diesel fuel is available for the aftertreatment systems described below.

In the next section below, overviews of various control technologies are included. The first four control technologies are existing methods of control used to reduce

emissions to current emission standards and test procedures. The last four control technologies are the specific aftertreatment systems that are expected to be used to comply with the emission standards in this proposal. Although details of each technology are somewhat brief, further discussion of the technologies can be found in the Regulatory Impact Analyses for both the U.S. EPA's 2004 and 2007 Final Rules. More extensive research references can be found in both aforementioned documents. In addition to the review of the U.S. EPA's Regulatory Impact Analysis for their 2007 Final Rule, ARB staff also reviewed on-going research and demonstration projects conducted by various government and industry groups. Review of current data has shown that the proposed requirements are technically feasible in the proposed time frame.

B. EXAMPLES OF TECHNOLOGY

1. *Exhaust Gas Recirculation*

Exhaust gas recirculation (EGR) operates by returning a portion of the exhaust gas back into the engine's combustion chamber. The recirculated exhaust gas reduces peak combustion temperatures by absorbing some of the combustion heat. Since NOx is formed as a result of high combustion temperatures and EGR reduces the combustion temperature, NOx emissions are reduced. The lower combustion temperature also reduces combustion efficiency and consequently, increases PM. However, PM increases can be minimized by controlling the amount of exhaust gas that is recirculated.

In addition to the increased PM emissions, another concern is that particulate soot from the recirculated exhaust may increase engine wear, damage a turbocharger, or reduce the efficiency of an aftercooler. Development is ongoing to reduce the particulate soot being recirculated back into the engine. Additional development continues to optimize the correlation between exhaust gas recirculation rate and combustion efficiency. HDDEs using EGR to meet the NOx plus NMHC emission standard of 2.4 grams per brake horsepower-hour, are expected to be offered for sale by mid-2002.

2. *Turbocharging and Aftercooling*

Turbochargers are used to increase power from a given engine size, or displacement. Exhaust gas is used to drive a turbine, which in turn increases the pressure of the engine's inlet air. With more air being forced into the combustion chamber, more fuel can be added. This results in higher power while large particulate formation is prevented. Since the mass emissions remain the same, increasing power from an engine decreases the brake specific emission rate.

Current turbocharger development efforts are focused on the use of variable geometry turbochargers. These turbochargers can increase or decrease the boost pressure depending on the operating conditions of the engine. Consequently, power, fuel consumption, and brake specific emission rate can be optimized.

Aftercooling was initially developed to increase the power of an engine by increasing the density of air entering the combustion chamber. This is of particular importance when turbochargers are used since, due to basic thermodynamic principles, the increase in pressure is accompanied by an increase in temperature, resulting in decreased air density. A positive side effect of aftercooling is that NOx emissions are reduced due to the reduced combustion temperature. There are two methods of aftercooling: air-to-water, which releases the heat from the inlet air to the engine coolant system; and air-to-air, which releases the heat directly to the ambient air.

3. *Timing Retard*

Timing retard is an adjustment to the engine that changes the time when fuel is injected into the engine's cylinder. This can reduce NOx emissions by reducing the time available for combustion and lowering the cylinder's temperature and pressure. However, this same action increases HC, CO, PM, and fuel consumption. In most cases, timing retard will be used with other control equipment and/or strategies to offset any emission increases that may occur.

4. *Advanced Fuel Injection Controls*

The fuel injection system is an important component of a compression-ignition (diesel) engine. By injecting fuel at higher pressure, fuel atomization and mixing with air is optimized. As a result, there is more complete combustion within the combustion chamber. Another method of fuel injection modification is through fuel injection rate shaping. Fuel is injected at different rates and times near the combustion event. Typically, fuel is injected pre- and post-combustion to ensure complete combustion of the fuel. Fuel injection is maintained with electronic controls and improved valves. The control of the combustion event minimizes any rapid increases in temperature and pressure and reduces NOx formation. Ongoing development is expected to result in additional NOx reductions from these advanced fuel injection controls.

5. *Crankcase Filtration/Ventilation*

Most analyses of diesel engine emissions only account for emissions in the exhaust. The crankcase of a diesel engine is also responsible for emitting NOx, NMHC, and PM. In the U.S. EPA's Regulatory Impact Analysis for the 2007 Final Rule, crankcase emissions are estimated to account for over 100 pounds of NOx, NMHC, and PM over the 30-year lifetime of the engine. To date, control of crankcase emissions has been required in all diesel engines except for those equipped with turbochargers. The premise for this exemption was that the particulate soot and engine oil from the crankcase would damage the turbocharger and/or aftercooler if those emissions were recirculated (similar to the use of EGR).

Technology in the control of crankcase emissions has improved. Two primary methods of control are closed crankcase filter systems and transfer of the crankcase gases to the exhaust system prior to the aftertreatment control system. A closed crankcase filtration system operates by routing the crankcase gases through a filter. The filtered oil is returned to the oil sump while the filtered crankcase gases are returned to the engine's intake manifold. Closed crankcase filtration systems have been in use for several years in stationary source applications. Although these systems must be adapted for on-road applications, the technology has been demonstrated. Transfer of the crankcase gases to the exhaust is a method of control that does not require much additional technology. Since these gases are transferred prior to the aftertreatment system, control of the gases is completed with all the other exhaust. A concern for this method of control may be the potentially high sulfur content in the crankcase oil. Similar to a high sulfur content in the fuel, high sulfur content in the crankcase oil also has the potential to damage certain aftertreatment control devices.

6. *Diesel Particulate Filters*

Diesel particulate filters are primarily used to reduce PM emissions. The filter typically consist of a ceramic substrate that filters, or traps, the exhaust. Eventually, particulate filters require some periodic "cleansing" by either reversing the direction of the exhaust flow, or cleaning the filter in a liquid. Particulate filters may also be "regenerated" to prolong their effective use by burning the trapped PM. There are two methods of regeneration: active and passive. Active regeneration utilizes an external device or event to actively regenerate the filter. The use of external heating elements is an example of an active regeneration method where the heating elements periodically raise the temperature of the filter to burn the trapped PM. A passive regeneration system typically uses filters that are coated with a catalyst material. The catalyst provides a catalytic reaction to lower the combustion temperature required to burn the trapped PM. Consequently, exhaust temperatures normally occurring in MDDEs and HDDEs are suitable to burn most of the PM emissions. Further, there is also a reduction in hydrocarbon emissions.

A variation to the catalyzed particulate filter is the use of fuel borne catalysts. Rather than coating the filter with the catalyst, a small percentage of catalyst solution is mixed into the fuel. Since the catalyst is present in the combustion chamber, the catalyst also immediately becomes a component of the exhaust and the catalytic reaction begins earlier. By using the fuel borne catalyst in conjunction with the catalyzed diesel particulate filter a better reduction of PM emissions compared to use of a catalyzed diesel particulate filter alone.

Diesel particulate filters have been proven successful in a variety of worldwide applications and demonstration programs. Though some failures have occurred, they mainly involved later model engines and engines using diesel fuel with a high sulfur content. For catalyzed particulate traps, high fuel sulfur content results in high levels of sulfate-based PM, making low "tail pipe" PM levels infeasible. Recent tests using diesel particulate filters have demonstrated a reduction of PM emissions by 90 percent and more.

7. *Lean-NOx Catalysts*

A lean-NOx catalyst operates similarly to the catalyzed diesel particulate filter. However, fuel is injected in the exhaust stream after the combustion chamber, upstream of the lean-NOx catalyst. With the catalyzed filter, the additional hydrocarbons (in the form of diesel fuel) initiate the reduction of NOx. There are typically two types of lean-NOx catalysts, each with different catalyst formulations. One catalyst formulation is used to operate in the high exhaust temperature range, while the other catalyst formulation is used to operate in the low exhaust temperature range. Since the lean-NOx catalyst utilizes fuel injection, the excess fuel in the exhaust can also be used to regenerate a diesel particulate filter.

Although technical improvements and testing are ongoing, recent tests of the lean-NOx catalysts have shown NOx reductions between 30 percent and 40 percent. The proposed emission standards will require an approximate 90 percent reduction of NOx emissions. Therefore, it is expected that this catalyst may be used in combination with other control strategies.

8. *NOx Adsorbers*

Basic operation of a NOx adsorber stores NOx and releases nitrogen and carbon dioxide. The engine must cycle between fuel lean and fuel rich conditions to reduce NOx emissions. Fuel lean conditions, typical of diesel-cycle operation, occur when less than the stoichiometrically required fuel is injected into the combustion chamber. This results in lower exhaust temperatures. "Trapping" of NOx emissions occurs during fuel lean operating conditions, when NOx is converted to inorganic nitrates ($-NO_3$) and is adsorbed onto a catalyst material.

Fuel rich conditions occur when more than the stoichiometrically required fuel is injected into the combustion chamber prior to combustion. This results in higher exhaust temperatures and additional hydrocarbons (fuel) in the exhaust. Regeneration occurs during fuel rich operating conditions, when the elevated temperatures reduce the trapped, or adsorbed, nitrate compounds. As stated above, the nitrate reduction generally results in the formation of nitrogen and carbon dioxide.

Research and demonstrations of this technology are ongoing. Current testing has shown NOx reductions of at least 90%.[24] However, NOx adsorbers are extremely sensitive to the sulfur content in the diesel fuel. The resulting oxides of sulfur emissions more readily react with the catalyst material. This slowly degrades the ability of the catalyst to adsorb NOx emissions. Further, the resulting sulfate compounds are more stable than the nitrate compounds on the catalyst. Therefore, removal of the sulfate compounds to regenerate the catalyst is more difficult.

9. *Selective Catalytic Reduction (SCR)*

SCR technology has been used for many years in stationary source applications, particularly with power plants, and has been recently applied to mobile source applications. SCR typically utilizes ammonia to selectively reduce NOx as the exhaust passes through a catalyst substrate. Due to adverse health effects, ammonia is typically stored on-board the vehicle as an aqueous urea solution and injected separately into the exhaust stream. Depending upon the formulation of the catalyst, an SCR system may be sensitive to sulfur.

One concern with the injection of ammonia into the exhaust stream is that the injection rate has to be precise and constantly monitored. If the injection rate is too low, the amount of NOx control efficiency is reduced. If the injection rate is too high, excess ammonia is released (also known as "ammonia slip"). This can pose a health concern in urban areas where population is dense. Another concern is the maintenance and distribution of urea. A control system is necessary to ensure urea levels in the vehicle are sufficient at all times, similar to

[24] See Diesel Emission Control - Sulfur Effects program "Phase II Summary Report: NOx Adsorber Catalysts", October 2000.

a fuel indicator lamp. Additionally, there is no current distribution system or infrastructure in place to ensure a sufficient supply of urea to the public.

Despite these concerns, research and demonstration of SCR is ongoing. SCR has demonstrated[25] average NOx reductions of 70 percent using 230 ppm sulfur content diesel fuel[26].

10. *HC and H2S Clean-up Catalyst*

NOx adsorber performance can deteriorate due to the sulfur in the diesel fuel with sulfur contents as low as 3 ppm.[27] To increase the durability of the NOx adsorber, a sulfur regeneration event, or desulfation event, is required. Byproducts of this desulfation event are hydrogen sulfide (H_2S) and sulfur dioxide (SO_2). Hydrogen sulfide is an unwanted byproduct since, at even low concentrations, this gas has a strong, undesirable odor. Therefore, clean-up catalysts are expected to be utilized downstream of the NOx adsorber. The clean-up catalyst operates similar to a NOx adsorber by storing hydrogen sulfide during fuel "lean" conditions, and oxidize the hydrogen sulfide during fuel "rich" conditions. When hydrogen sulfide is oxidized, the resulting byproducts would be sulfur dioxide and water. Typically, the catalyst would consist of nickel oxide formulation. Therefore, except for the catalyst formulation, the design of the clean-up catalyst is identical to the NOx adsorber.

[25] SAE 2001-01-0514.
[26] Similar to other catalyst based control systems, the sulfur in the diesel exhaust reduces the NOx control efficiency and degrades the ability of the catalyst to reduce NOx emissions.
[27] Also see the U.S. EPA's Regulatory Impact Analysis for their 2007 Final Rule.

VII. REMAINING ISSUES

Most of the catalyst-based emission control systems that are likely to be used to comply with the 2007 emission standards are highly sensitive to the diesel fuel sulfur content. Consequently, when the U.S. EPA adopted their 2007 Final Rule in January 2001, they included requirements for lower sulfur diesel fuel with a maximum fuel sulfur content of 15 ppm. Although there are no in-use diesel fuel sulfur requirements included in this proposal, lower in-use diesel fuel sulfur content requirements are planned for consideration in 2002. Federal adoption of low sulfur diesel fuel requirements provides a backstop to ensure in-use fuel availability for the various aftertreatment control systems. Further, fuel specifications have been proposed for emission testing and service accumulation.

Manufacturers and organizations have voiced concern that the U.S. EPA's 2007 Final Rule applies to urban transit buses, while the ARB's proposal excludes urban transit buses. Of particular concern is that the ARB's existing NMHC and CO emission standards for transit buses are significantly lower (by almost two-thirds) than the U.S. EPA's adopted emission standards and that the ARB's existing emission standard phase-in is more aggressive. The ARB staff is not planning to revise its existing emission standards and phase-in for urban transit buses at this time. There is concern over the potential adverse impact of relaxing emission standards for urban bus engines that typically operate in highly populated areas. Additionally, there is sufficient lead time to review technology development for urban bus engines at a later date.

Of additional concern to engine manufacturers has been the current state of aftertreatment technology. Current testing of the various types of control systems by the U.S. EPA[28] has shown that the systems are capable of complying with the proposed requirements. However, while diesel particulate filters have been demonstrated to be durable in a variety of applications, engine manufacturers would argue that the other aftertreatment based technologies previously discussed have limited in-field experience. While this may be true, staff believes that in-field experience is only needed to explore and/or uncover any unforeseen technical challenges one might observe with varying vehicle applications and operating conditions. That is, the staff does not believe there are any issues with regard to performance capabilities of any of the aftertreatment-based technologies described previously. Thus, to address any technical challenges, staff plans to carefully track in-field demonstration projects and expects engine manufacturers to complete more extensive on-road testing compared to previous years. Further, engine manufacturers have over 5 years of lead time to refine their emission reduction strategies and technologies. Engine manufacturers involved in the California settlement agreements have shown that less time is necessary to develop engine technology to comply with reduced emission standards. In addition, the ABT

[28] See the Regulatory Impact Analysis for the 2007 Final Rule for more details.

provisions included in the proposal will provide additional flexibility for the engine manufacturers.

VIII. REGULATORY ALTERNATIVES

The staff evaluated various alternatives to the proposed amendments. A brief description of the alternatives and the staff's reasoning for rejecting them follows.

A. DO NOT AMEND CURRENT CALIFORNIA REGULATIONS

One alternative to this proposal would be to continue using the current on-road heavy-duty diesel emission standards and test procedures for 2004 and subsequent model years. The current emission standards are 10 times greater for NOx and PM emissions and over 3 times greater for NMHC emissions as compared to the proposed emission standards. Consequently, the current requirements will allow engines to emit more during the same time period. The current emission standards will result in excess emissions in California from HDDEs of approximately 40 tons per day of NOx, 2 tons per day of PM, and 1 ton per day of ROG in 2010. Because of these potential emissions, and because the technologies needed to achieve the reductions have been demonstrated, staff rejected this alternative.

B. ADOPT MORE STRINGENT EMISSION STANDARDS

The staff recognizes that emission standards for the control of emissions from HDDEs more stringent than those in this proposal may be necessary to attain ambient air quality standards for ozone and particulate matter. Emission benefits of this proposal are discussed in Section X. However, the current state of technological development has only demonstrated reductions equivalent to the reductions being proposed. Therefore, at this time, staff is not recommending more stringent requirements compared to those adopted by the U.S. EPA in their 2007 Final Rule.

IX. ECONOMIC IMPACTS

The proposed emission standards and supplemental test procedures are essentially identical to those adopted by the U.S. EPA for 2007 and subsequent model year HDDEs in their 2007 Final Rule. Adoption of the proposed emission standards and supplemental test procedures would not impose additional costs above the costs to comply with the requirements set forth in the U. S. EPA's 2007 Final Rule.

Staff believes that the proposed emission standards and supplemental test procedures will not impose additional costs on the engine and vehicle manufacturers since they will have to meet the identical requirements nationwide in the same time period. The proposed adoption of the emission standards and supplemental test procedures is expected to have no noticeable impact on California business competitiveness, employment, or on business creation, elimination, and expansion beginning in 2007. A detailed discussion of the potential cost and economic impacts of the proposed amendments follows, based primarily on the U.S. EPA's 2007 Final Rule.

A. LEGAL REQUIREMENT

Sections 11346.3 and 11346.5 of the Government Code require State agencies to assess the potential for adverse economic impacts on California business enterprises and individuals when proposing to adopt or amend any administrative regulation. The assessment includes a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination, or creation, and the ability of California business to compete.

State agencies are required to estimate the cost or savings to any state or local agency, and school districts. The estimate is to include any non-discretionary cost or savings to local agencies and the cost or savings in federal funding to the State.

B. AFFECTED BUSINESSES

Any business that is involved in manufacturing on-road HDDEs and MDDEs may be affected by the proposed emission standards and supplemental test procedure modifications. ARB has identified 21 major engine manufacturers worldwide. Based on California's emission inventory model, EMFAC2000 Version 2.0, a projected total of 464,000 and 488,000 on-road medium heavy-duty[29] and heavy heavy-duty diesel engines will be operating in California in 2007 and 2010, respectively. Projections indicate that approximately 12,000 new, medium-duty and heavy-duty diesel vehicles may be affected each model year from 2007 through 2009, and 24,000 beginning in the 2010 model year.

[29] Including school buses and motor homes.

Since the proposed requirements harmonize requirements with the U.S. EPA in their 2007 Final Rule, there may be a net decrease in engine and vehicle costs to the consumers. The decrease in costs is expected due to the consolidation of engine manufacturing lines.

The U.S. EPA's adopted emission standards and supplemental test procedures may require additional or upgraded engine accessories. As a result, the HDDEs meeting the U.S. EPA adopted standards may be more costly to manufacture, and hence heavy-duty vehicles may cost more nationwide. However, this will not put California businesses at a disadvantage since similar costs will be incurred by businesses in other states. The baseline average costs for a heavy-duty diesel engine, vehicle, and the operating costs based on a 30-year lifetime are shown in Table 11, with potential nationwide increases shown in Table 12.

Table 11 - Baseline Heavy-Duty Engine and Vehicle Costs

Heavy-Duty Class	Engine Cost	Vehicle Cost	Operating Cost
Light Heavy-Duty	$ 8,995.00	$ 25,952.00	$ 14,357.00
Medium Heavy-Duty	$ 14,300.00	$ 53,199.00	$ 36,028.00
Heavy Heavy-Duty	$ 25,024.00	$111,272.00	$124,577.00

Source: U.S. EPA's Final Regulatory Impact Analysis: Heavy Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, December 2000. Costs are in year 2001 dollars.

Table 12 - Potential Nationwide Cost Increases for Transportation Businesses

Heavy-Duty Class	Increased Engine and Vehicle Cost (2007)	Increased Annual Operating Cost[30]	Total Annualized Cost (20 year)[31]
Light Heavy-Duty	$ 2,095.00	$ 43.36	$ 241.11
Medium Heavy-Duty	$ 2,705.00	$ 80.10	$ 335.44
Heavy Heavy-Duty	$ 3,405.00	$ 321.78	$ 643.19

Source: U.S. EPA's Final Regulatory Impact Analysis: Heavy Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, December 2000. Costs are in year 2001 dollars.

Light and medium heavy-duty vehicles are assumed (from the EMFAC 2000 emissions inventory model) to only operate within the State. The net impact of increasing vehicle and operating costs will not increase competition from

[30] These costs include low sulfur diesel fuel costs and the associated decrease in maintenance costs due to use of low sulfur diesel fuel.

[31] These costs include low sulfur diesel fuel costs and the associated decrease in maintenance costs due to use of low sulfur diesel fuel.

transportation companies that register their vehicles outside of California since these costs will be incurred by companies from other states. However, the harmonization of California and federal requirements may actually improve manufacturing efficiency due to the consolidation of various engine manufacturing lines, therefore benefiting California businesses.

C. ESTIMATED COSTS TO ENGINE MANUFACTURERS

Since the proposed emission standards and supplemental test procedures are identical to those adopted by the U.S. EPA in their 2007 Final Rule, there is no increase in costs for engine manufacturers to produce California HDDEs. There may actually be a decrease in costs since engine manufacturers only need to produce a single line of clean engines. However, costs presented here examine the potential increase in engine costs due to the U.S. EPA's 2007 Final Rule. These costs are provided for information only as they are not attributable to the amendments and California emission standards proposed herein.

Costs have been estimated and are based on U.S. EPA's analysis for their 2007 Final Rule. The U.S. EPA's analysis includes not only costs to comply with identical emission standards and supplemental test procedures, but also costs for using low sulfur diesel fuel.[32] All engine manufacturers are assumed to utilize multiple technologies to satisfy the proposed requirements for 2007 and subsequent model year medium- and heavy-duty engines. The technologies that are assumed to be used, include a NOx adsorber system, a catalyzed diesel particulate filter (DPF), a hydrocarbon (HC) and hydrogen sulfide (H_2S) clean-up catalyst, a closed crankcase system, and low sulfur diesel fuel. Additionally, there is an expected savings in maintenance costs due to the use of low sulfur diesel fuel. These costs are included since, at this time, the assumed technologies require the use of low sulfur diesel fuel (see Section VI, above). Using the assumed technologies results in the most conservative cost estimate[33] since manufacturers will likely use several of the technologies, in addition to averaged and banked emission credits, and does not account for improvements in technology. Assuming that engine manufacturers pass on the entire costs of the new federal requirements to the end users, the incremental increase in per-engine price and overall lifetime operating costs have been estimated. These cost estimates are presented in Table 13 and are identical to those determined by the U.S. EPA.

[32] Low sulfur diesel fuel includes diesel fuel with a sulfur content of 15 parts per million or less. Low sulfur diesel fuel requirements have been adopted federally in the 2007 Final Rule will be included in a separate California proposal.

[33] i.e., assuming highest costs per engine.

Table 13 - Projected Additional Unit Costs per Engine

Light Heavy Heavy-Duty (8,501 – 14,000 lbs. GVWR)			30 yr NPV
Item	Fixed Cost	Variable Cost	Operating Cost[34]
NOx Adsorber System	$ 87.00	$ 925.00	$ 0.00
Catalyzed DPF	$ 41.00	$ 690.00	$ 55.00
HC and H2S Clean-up Catalyst	$ 0.00	$ 206.00	$ 0.00
Closed Crankcase System	$ 0.00	$ 37.00	$ 31.00
Low Sulfur Diesel Fuel	$ 0.00	$ 0.00	$ 576.00
Maintenance Savings	$ 0.00	$ 0.00	$ (153.00)
TOTAL	$ 128.00	$ 1,858.00	$ 509.00
Medium Heavy-Duty (14,001 – 33,000 lbs. GVWR)			**30 yr NPV**
Item	Fixed Cost	Variable Cost	Operating Cost[28]
NOx Adsorber System	$ 231.00	$ 1,080.00	$ 0.00
Catalyzed DPF	$ 98.00	$ 852.00	$ 56.00
HC and H2S Clean-up Catalyst	$ 0.00	$ 261.00	$ 0.00
Closed Crankcase System	$ 0.00	$ 42.00	$ 59.00
Low Sulfur Diesel Fuel	$ 0.00	$ 0.00	$ 1,077.00
Maintenance Savings	$ 0.00	$ 0.00	$(249.00)
TOTAL	$ 329.00	$ 2,235.00	$ 943.00
Heavy Heavy-Duty (33,001 lbs. and greater GVWR)			**30 yr NPV**
Item	Fixed Cost	Variable Cost	Operating Cost[28]
NOx Adsorber System	$ 191.00	$ 1,456.00	$ 0.00
Catalyzed DPF	$ 89.00	$ 1,103.00	$ 208.00
HC and H2S Clean-up Catalyst	$ 0.00	$ 338.00	$ 0.00
Closed Crankcase System	$ 0.00	$ 49.00	$ 218.00
Low Sulfur Diesel Fuel	$ 0.00	$ 0.00	$ 3,969.00
Maintenance Savings	$ 0.00	$ 0.00	$ (610.00)
TOTAL	$ 280.00	$ 2,946.00	$ 3,785.00

Source: U.S. EPA's Final Regulatory Impact Analysis: Heavy Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, December 2000. Costs are in year 2001 dollars.

The estimated costs are separated into incremental engine purchase price and annual operating costs. The incremental engine purchase price for new engines includes the fixed and variable costs. Fixed costs are costs associated with research and development, retooling, and certification. Variable costs are costs associated with hardware and assembly. Annual operating costs include any

[34] Costs shown in parenthesis are negative costs, or cost savings.

expected increases in maintenance and/or fuel consumption. U.S. EPA relied on two studies of the economic impacts on heavy-duty highway engines. One study is by ICF Consulting[35] and the other study is by Engine, Fuel, and Emissions Engineering.[36] All costs in the ICF Consulting and Engine, Fuel, and Emissions Engineering studies were presented in 1999 dollars, although the costs shown in the table above are in 2001 dollars.

These estimated costs are expected to decrease over time due to decreased costs for mass production. However, using the conservative costs shown above and an annual discount rate of 7.0 percent, the resulting lifetime costs per engine represented as net present value are detailed in Table 14, below.

Table 14 - Projected Lifetime Net Present Value Cost Increase per Engine

	Lifetime NPV Cost	
Light Heavy-Duty	$	2,554.31
Medium Heavy-Duty	$	3,553.61
Heavy Heavy-Duty	$	6,813.96
Weighted Average of All Heavy-Duty	*$*	*4,221.02*

D. POTENTIAL COSTS TO VEHICLE MANUFACTURERS

Since the proposed emission standards and supplemental test procedures are identical to those adopted by the U.S. EPA in their 2007 Final Rule, there is no expected increase in costs to engine and vehicle manufacturers attributable solely to the amendments proposed herein. There may actually be a decrease in costs since the engine and vehicle manufacturers will not be required to produce multiple lines of engines and vehicles.

E. POTENTIAL IMPACTS ON BUSINESS

There are no known potential impacts on businesses other than the additional costs for the engines and the additional annual operating costs, both described above. These costs, however, are a result of the federal requirements in the 2007 Final Rule. By harmonizing federal and California requirements, engine manufacturers will only be required to manufacture one line of clean engines. This is expected to result in lower costs due to more efficient manufacturing.

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[35] "Economic Analysis of Vehicle and Engine Changes Made Possible by the Reduction of Diesel Fuel Sulfur Content, Task 2 - Benefits for Durability and Reduced Maintenance," prepared by ICF Consulting for the U.S. EPA, December 9, 1999.

[36] "Economic Analysis of Vehicle and Engine Changes Made Possible by the Reduction of Diesel Fuel Sulfur Content," prepared by Engine, Fuel, and Emissions Engineering for the U.S. EPA, December 15, 1999.

The costs summarized by vehicle class and model year are detailed in Table 15, below.

Table 15 - Estimated Price and Cost Increases for New On-Road Diesel Vehicles (per vehicle)

	2007 MY	Operating Costs NPV (20 yr)	Annualized Total Cost
Light Heavy-Duty	$ 2,095.00	$ 459.31	$ 241.11
Medium Heavy-Duty	$ 2,705.00	$ 848.61	$ 335.44
Heavy Heavy-Duty	$ 3,405.00	$ 3,408.96	$ 643.19
Weighted Average of All Heavy-Duty	*$ 2,772.37*	*$ 1,441.89*	*$ 398.43*

Based on: U.S. EPA's Final Regulatory Impact Analysis: Heavy Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, December 2000. Costs are in year 2001 dollars.

The costs shown above are only for engines that are phased in during the 2007 model year. Due to projected changes in purchasing, the weighted average costs will be slightly different (less than 1 percent) from year to year.

F. POTENTIAL IMPACT ON BUSINESS COMPETITIVENESS

The proposed amendments would have no significant impact on the ability of California businesses to compete with businesses in other states. This is because the proposed emission standards and test procedures are identical to those adopted by the U.S. EPA in their 2007 Final Rule. Therefore, any increase in costs due to federal requirements will also be experienced by non-California businesses. Further, all manufacturers that manufacture diesel engines for sale in California are subject to the proposed amendments regardless of where they are located and where the engines are planned for sale. Most manufacturers of diesel engine have no major manufacturing facilities in California.

California trucking companies, which use HDDEs, are not expected to experience any increase in the price of a new truck because of the proposed amendments, relative to those in other states. The federal amendments in the 2007 Final Rule are expected to increase the price of a new truck by about 3 to 8 percent compared to the estimated vehicle price of $26,000 for a light heavy-duty vehicle, $53,000 for a medium heavy-duty vehicle, and $111,000 for a heavy heavy-duty vehicle. Price increases of this magnitude are not expected to dampen the demand for heavy-duty trucks in California relative to other states, since price increases will be the same nationwide.

G. POTENTIAL IMPACT ON EMPLOYMENT

California accounts only for a small share of manufacturing employment for diesel engine production. According to the U.S. Department of Commerce, California employment in the internal combustion engines industry (NAICS 333618), which includes manufacturers of diesel engines, was 1,635 persons in 1998 or less than 0.1 percent of total manufacturing jobs in California. These employees work in 28 businesses across the state. One business employed over 500 people, two employed between 100 and 500, and the rest had less than 100 employees. Employment in these businesses is unlikely to be affected adversely because the price increase that would result from the implementation of federal standards nationwide are not attributable to the amendments proposed herein. Thus, the proposed amendments are not expected to cause a noticeable adverse impact on the California employment.

However, some jobs may be created in research and development to enhance the design of current engine models and develop additional systems to reduce emissions from HDDEs. Currently, engine manufacturers lack significant experience with aftertreatment systems expected to be used for compliance. This may result in additional jobs from developers and manufacturers of aftertreatment systems. Some jobs may also be created in businesses manufacturing and distributing parts related to the aftertreatment systems. Some of these jobs may be created in California.

H. POTENTIAL IMPACT ON BUSINESS CREATION, ELIMINATION OR EXPANSION

The proposed amendments would have no noticeable impact on the status of California businesses. The amendments would not impose additional costs on HDDE manufacturers. Adoption of the proposed amendments may actually reduce costs for HDDE manufacturers. We estimate the cost increase due to the U.S. EPA's 2007 Final Rule would range from about $2,095 to $3,405 per engine in the 2007 model year.[37] As noted above, the vehicle prices are expected to decrease with time due to reduced manufacturing costs. Since the costs will be applied nationwide, the proposal is not expected to alter the status of California businesses. The proposed amendments may actually result in creation or expansion of businesses that are engaged in manufacturing of aftertreatment systems and parts in California.

[37] Hardware costs only. Does not include operating cost increases and decreases.

I. POTENTIAL COSTS TO LOCAL AND STATE AGENCIES

The proposed amendments have no impact on the current budget and the budget for the next two fiscal years since the proposed requirements begin in the 2007 model year.

The proposed amendments will harmonize California requirements with federal requirements. Any increase in engine costs is due to compliance with federal requirements. Net costs may actually decrease because of improved manufacturing efficiency. We expect no additional costs for local and state agencies because there should be no price increase to end users attributable solely to the amendments proposed herein.

All implementation "costs" to the state as a result of this rulemaking should be costs to the ARB to implement the amendments. All implementation costs are expected to be negligible and absorbable within the existing ARB budget. The ARB currently enforces its heavy-duty emission standards by reviewing and acting upon applications for certification, and monitoring in-use compliance. These actions are currently completed by staff from ARB's Enforcement Division (ED), Mobile Source Control Division (MSCD), and Mobile Source Operations Division (MSOD). The amendments should not affect the number of models certified in California or the number of vehicles sold in the state.

X. ENVIRONMENTAL IMPACTS AND COST-EFFECTIVENESS

The air quality benefits and the cost-effectiveness of the proposed emission standards and revised supplemental test procedures are presented in this section. The analysis, though based on the U.S. EPA's Regulatory Impact Analysis for their 2007 Final Rule, is adjusted to reflect costs in California, emissions reduced in California, and the slight increase in CO emissions in California due to the alignment of the MDDE CO emission standard. Because of these adjustments, the presented cost-effectiveness for the proposed supplemental test procedures is conservative. Yet, because the proposed requirements would apply statewide, they would provide significant cost-effective emission reductions throughout California. Due to the proposed phase-in of the NOx emission standard, calendar years 2007 through 2009 are not included in statewide and regional emissions calculations. Since the proposed emission standards are identical to those adopted by the U.S. EPA in their 2007 Final Rule, all calculations include out-of-state vehicle emissions generated while operating within California. These emissions account for approximately 20 percent additional emissions within California.

A. AIR QUALITY BENEFITS

1. Statewide Benefits

Using the methodology described below, Table 16 shows emissions that would be reduced with the proposal statewide and in several California air basins that have not yet achieved National Ambient Air Quality Standards for the 2010, 2015, and 2020 calendar years. Over the lifetime of a typical phased-in vehicle from the 2007 and subsequent model years, the average amount of emissions reduced is 4.2 tons of NOx plus NMHC per vehicle and 0.1 tons of PM per vehicle. The slight increase in CO emissions will result in negligible emissions increased over the lifetime of the vehicle.

Table 16 - Emissions Reduced by Air Basin in 2010, 2015, and 2020 (tons per day)

	Calendar Year	Criteria Air Pollutant			
		NOx	ROG	PM	CO[38]
San Francisco Bay Area Air Basin	2010	6.4	0.2	0.4	0.0
	2015	17.1	0.7	0.8	0.0
	2020	24.9	1.1	1.1	(0.1)
Sacramento Valley Air Basin	2010	3.9	0.1	0.2	0.0
	2015	10.8	0.4	0.5	0.0
	2020	15.7	0.6	0.7	0.0
San Joaquin Valley Air Basin	2010	7.5	0.2	0.4	0.0
	2015	22.7	0.8	1.0	0.0
	2020	33.1	1.4	1.3	(0.1)
South Coast Air Basin	2010	24.3	0.9	1.2	0.0
	2015	68.5	2.4	2.8	(0.1)
	2020	105.1	4.1	4.0	(0.2)
Statewide	2010	48.0	1.5	2.7	(0.1)
	2015	140.0	5.1	5.9	(0.2)
	2020	209.5	8.5	8.3	(0.3)

As shown in Table 16, aligning California's emission standards for medium-duty diesel engines with the federal emission standards would result in a very small carbon monoxide increase, estimated to be about 0.1 tpd statewide in 2010. This increase is negligible when compared to total statewide carbon monoxide emissions of 13,000 tons per day (of which, about 100 tpd come from heavy-duty diesel trucks). Furthermore, the increase will not impact the overall declining trend in carbon monoxide emissions; between 2000 and 2010, statewide carbon monoxide emission are expected to drop by over 35 percent.

All of California, with the exception of Los Angeles County and Calexico in Imperial County, meets the ambient air quality standards for carbon monoxide. Localized strategies are being developed to bring the remaining areas into attainment. With the overall declining trend in emissions, the small CO impact of this regulation would not affect the prospects of Los Angeles and Calexico meeting the standard and the rest of the state maintaining the standard.

[38] Reduced CO emissions shown in parenthesis are negative reductions, or CO emission increases.

2. Methodology to Calculate Emission Reductions

The emission reductions are calculated for each air contaminant below using the ratio of the proposed emission standard and the pre-2007 emission standard (also known as the "2004 standard"). Each calculation yields the amount of emissions that would be reduced from the baseline emissions inventory.

ROG = 1 - (proposed standard / 2004 standard)
= 1 - (0.14 grams per brake horsepower-hour / 0.5 grams per brake horsepower-hour)
= 1 - 0.28
= 0.72 or 72% reduction

NOx = 1 - (proposed standard / 2004 standard)
= 1 - (2.0 grams per brake horsepower-hour / 0.2 grams per brake horsepower-hour)
= 1 - 0.1
= 0.90 or 90% reduction

PM = 1 - (proposed standard / 2004 standard)
= 1 - (0.1 grams per brake horsepower-hour / 0.01 grams per brake horsepower-hour)
= 1 - 0.1
= 0.90 or 90% reduction

CO = 1 - (proposed standard / 2004 standard)
= 1 - (15.5 grams per brake horsepower-hour / 14.4 grams per brake horsepower-hour)
= 1 – 1.08
= -0.08 or 8% increase

3. Impacts on the State Implementation Plan

The 1994 Ozone SIP is California's plan for achieving the federal ozone standard in all areas of the state by the federally required date. For the South Coast Air Basin, the 1994 SIP requires that the federal ozone standard must be met by 2010. The SIP includes state measures to control emissions from motor vehicles and fuels, consumer products and pesticide usage, local measures for stationary and area sources, and federal measures for sources under exclusive or practical federal control. U.S. EPA approved the 1994 SIP in September 1996.

Once U.S. EPA approved the 1994 SIP (and the 1999 update for the South Coast), the emission inventories and assumptions used in the SIP are

frozen. Evaluations of the impacts on the SIP of new measures or modifications to existing measures must use the same emission inventories and assumptions used in developing the SIP.

The Ozone SIP contains several measures to reduce emissions from heavy-duty diesel trucks. These include: (1) measure M4 – early introduction of cleaner engines, which is being implemented through the Carl Moyer Program; (2) measures M5 and M6 – 2 grams per brake horsepower-hour emission standard of NOx for new trucks in California and nationwide, which is already adopted by the ARB and the U.S. EPA; and (3) measure M17 – additional reductions from heavy-duty vehicles, which is on schedule to be adopted by 2004.

As ARB has implemented the SIP over the last seven years, some measures have delivered more reductions than anticipated, while other measures have delivered fewer reductions due to technical or economic concerns. In some cases, measures not originally envisioned in the 1994 SIP are providing benefits which will help meet the SIP emission reduction obligations.

The South Coast Air Quality Management District revised its part of the Ozone SIP in 1997 and again in 1999. These revisions focused on the measures under local jurisdiction and did not alter the state motor vehicle strategies with the exception of updating the emission inventory. (The motor vehicle emission inventory for the 1994 SIP was based on the EMFAC 7F model, while the South Coast's 1999 SIP revision was based on the EMFAC 7G model.) U.S. EPA approved the South Coast's 1999 Ozone SIP revision in April 2000.

Although the 2007 diesel truck standards were not originally including in the 1994 SIP, this proposal will provide emission reductions needed to help meet California's remaining SIP commitments including the South Coast's long-term "Black Box" commitments. The benefits of the proposal in the SIP inventory are provided in Table 17. Because the reductions do not take effect until 2007, we have quantified the benefits for the only area with a post-2007 attainment date – the South Coast.

Table 17 - South Coast Emission Reductions From Proposed 2007 Diesel Truck Standards (measured in inventory of approved 1999 South Coast Ozone SIP, tons per day)

Year	ROG	NOx
2010	0.7	15

The benefits of the proposal in the SIP inventory are smaller than those based on the latest inventory (about 15 tons per day NOx versus 24 tons per day in the South Coast in 2010 – see Table 17 for comparison). The SIP inventory contains fewer NOx emissions from trucks than the latest motor vehicle emission inventory that is based on the EMFAC 2000 model. Consequently, the corresponding NOx emission reductions from the 2007 emission standards are also less in the SIP inventory.

B. COST-EFFECTIVENESS

This proposal contains the most conservative cost estimates, as described in the sections above. The estimated cost of complying with the emission standards and supplemental test procedures will vary depending on the GVWR class.

As shown in Figure 2, the cost-effectiveness of California mobile source and motor vehicle fuels regulations adopted over the past decade range from $0.17 to $2.55 per pound of ozone precursors reduced. The cost-effectiveness of the proposed emission standards and revised supplemental test procedures by weight class is $0.29 per pound of NOx plus NMHC reduced for light heavy-duty vehicles, $0.63 per pound of NOx plus NMHC reduced for medium heavy-duty vehicles, and $0.32 per pound of NOx plus NMHC reduced for heavy heavy-duty vehicles. Combining the cost-effectiveness for all heavy-duty vehicles based on predicted sales, results in $0.42 per pound of NOx plus NMHC reduced for all heavy-duty vehicles (identified with a X marker on Figure 4).

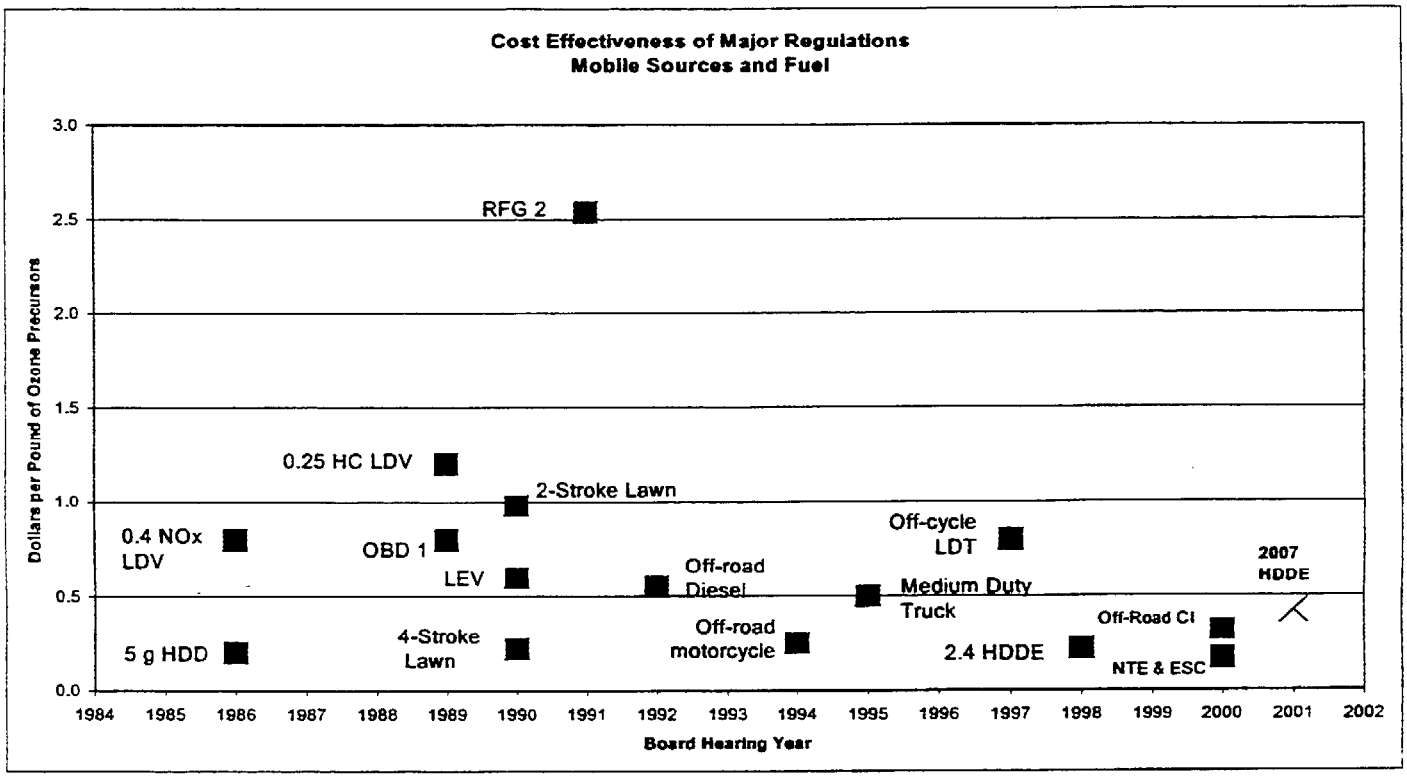

Figure 4

Cost-effectiveness is also calculated for the reductions of PM emissions. The cost-effectiveness by weight class is $6.65 per pound of PM reduced for light heavy-duty vehicles, $3.45 per pound of PM reduced for medium heavy-duty vehicles, and $3.03 per pound of PM reduced for heavy heavy-duty vehicles. Combining the cost-effectiveness for all heavy-duty vehicles based on predicted sales, results in $3.42 per pound of PM reduced for all heavy-duty vehicles. Although PM cost-effectiveness seems high, PM mass emission rates are much lower than NOx and NMHC emission rates. As a comparative example, the most recent PM control regulations, the urban transit bus standards, resulted in a cost-effectiveness of $17.90 per pound of PM reduced.

XI. SUMMARY AND STAFF RECOMMENDATION

The proposed emission standards and supplemental test procedures are essential to ensure further emission reductions necessary to meet clean air goals. Although the emission reductions of this proposed regulation are not included in the current federal ozone SIP, further emission reductions to ensure compliance with the federal standard and to meet the more stringent state air quality standard for ozone and the state ambient PM standard are needed. Additionally, the amendments also ensure emission standards are harmonized with those adopted by the U.S. EPA in their 2007 Final Rule.

The technologies that would allow manufacturers to comply with the proposed emission standards and supplemental test procedures are available and being developed for commercial application. One technical requirement to ensure the effectiveness of the anticipated technologies is the availability of low sulfur, in-use diesel fuel. To ensure that the proper fuel is used for emission testing and service accumulation, the low sulfur content certification test fuel is proposed. 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. Standards and requirements for low sulfur, in-use diesel fuel have been adopted federally and will be included in a separate California proposal that is currently proceeding with public review.

Estimates of statewide emission reductions resulting from the proposal are 40.3 tons per day of NOx, 1.3 tons per day of ROG, and 2.3 tons per day of PM in 2010, for California registered vehicles (i.e., not including out-of-state vehicles). Estimates of statewide emission increases resulting from the proposed harmonization of the medium-duty CO emission standard is 0.1 tons per day in 2010, for California registered vehicles (i.e., not including out-of-state vehicles). Since the proposed emission standards and supplemental test procedures are identical to those adopted by the U.S. EPA in the same time period, clean HDDEs will be produced on a national basis. Consequently, the reduction of emissions (including emissions reduced from out-of-state vehicles) would be 48.0 tons per day of NOx, 1.5 tons per day of ROG, and 2.7 tons per day of PM in 2010. As more cleaner trucks enter the fleet, emission reductions will increase – for example, 209.5 tons per day reduction in NOx in 2020.

Since the proposed emission standards and supplemental test procedures are identical to those adopted by the U.S. EPA in their 2007 Final Rule, costs to California agencies and businesses will be similar to those nationwide. With adoption of the staff's proposal, cost-effectiveness ranges from approximately $0.29 to $0.63 per pound of NOx plus NMHC reduced and from approximately $3.03 to $6.65 per pound of PM reduced. Both compare favorably to the cost effectiveness of other recently adopted emission control measures. The staff recommends that the Board adopt these proposed amendments to the emission standards and supplemental test procedures for HDDEs.

XII. REFERENCES

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13. SAE 2001-01-0514. "Advanced Urea Catalysts for Automotive Applications," J. Gieshoff, M. Pfeifer, A. Schäfer-Sindlinger, P.C. Spurk, G. Garr, T. Leprince, and M. Crocker.

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APPENDIX A – PROPOSED AMENDMENTS TO TITLE 13, CALIFORNIA CODE OF REGULATIONS, DIVISION 3 AIR RESOURCES BOARD, CHAPTER 1 MOTOR VEHICLE POLLUTION CONTROL DEVICES, ARTICLE 2 APPROVAL OF MOTOR VEHICLE POLLUTION CONTROL DEVICES (NEW VEHICLES); SECTION 1956.8, EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1985 AND SUBSEQUENT MODEL YEAR HEAVY-DUTY ENGINES AND VEHICLES.

APPENDIX A

PROPOSED REGULATION ORDER

Amend the following section of Title 13, California Code of Regulations, to read as set forth in the following pages:

Section 1956.8	Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Year Heavy-Duty Engines and Vehicles

Notes:

a) Paragraphs within this section that are not proposed for amendment in this rulemaking are indicated by "[No Change]".

b) The proposed regulatory amendments are shown in underline to indicate additions to the text and ~~strikeout~~ to indicate deletions.

c) [ ] in the proposed §1956.8(b) indicates text that can be finalized only upon Board adoption.

Amend Title 13, California Code of Regulations, section 1956.8, to read:

1956.8. Exhaust Emissions Standards and Test Procedures - 1985 and Subsequent Model Heavy-Duty Engines and Vehicles.

(a)(1) [No Change]

(2)(A) The exhaust emissions from new 2004 and subsequent model heavy-duty diesel engines, heavy-duty natural gas-fueled and liquefied-petroleum-gas-fueled engines derived from diesel-cycle engines, and heavy-duty methanol-fueled diesel engines, and the optional, reduced-emission standards for 2002 and subsequent model engines produced beginning October 1, 2002, except in all cases engines used in medium-duty vehicles, shall not exceed:

Exhaust Emission Standards for 2004 and Subsequent Model Heavy-Duty Engines, and Optional, Reduced Emission Standards for 2002 and Subsequent Model Heavy-Duty Engines Produced Beginning October 1, 2002, Other than Urban Bus Engines (grams per brake horsepower-hour [g/bhp-hr])

Model Year	Oxides of Nitrogen Plus Non-methane Hydrocarbons	Optional Oxides of Nitrogen Plus Non-methane Hydrocarbons	Oxides of Nitrogen	Non-methane Hydrocarbons	Carbon Monoxide	Particulates ~~Matter~~
2004-2006[H] ~~and subsequent~~	2.4 [A,C,E,J]	2.5 [B,C,E,J]	n/a	n/a	15.5	0.10 [C]
October 1, 2002 ~~and subsequent~~ – 2006	n/a	1.8 to 0.3 [A,D,F]	n/a	n/a	15.5	0.03 to 0.01 [G]
2007 and subsequent	n/a	n/a	0.2 [I]	0.14	15.5	0.01 [K]

[A] This is the standard for the arithmetic sum of the oxides of nitrogen exhaust component certification value and the non-methane hydrocarbon exhaust component certification value, without individual restriction on the individual component values.

[B] This is the ~~the~~ standard for the arithmetic sum of the oxides of nitrogen exhaust component certification value and the non-methane hydrocarbon exhaust component certification value, with the non-methane hydrocarbon individual component value not to exceed 0.5 g/bhp-hr.

[C] For 2004 through 2006 model years, ~~E~~emissions averaging may be used to meet this standard. Averaging must be based on the requirements of the averaging, banking and trading programs described in "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles" incorporated by reference in section 1956.8 (b), below.

[D] A manufacturer may elect to certify to an optional reduced-emission NOx+NMHC standard between the values, inclusive, by 0.3 grams per brake horsepower-hour increments. Engines certified to any of these optional reduced-emission NOx standards are not eligible for participation in any averaging, banking or trading programs described in "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles" incorporated by reference in section 1956.8 (b), below.

[E] May be used as the certification standard for the higher emitting fueling mode of an engine certified under the dual fueling mode certification process of section 1956.8 (a)(4), below.

[F] May be used as the certification standard for the lower emitting fueling mode of an engine certified under the dual fueling mode certification process of section 1956.8 (a)(4), below.

[G] A manufacturer may elect to certify to an optional reduced-emission PM standard between the specified values, inclusive, by 0.01 grams per brake horsepower-hour increments. Engines certified to any of these optional reduced-emission PM standards are not eligible for participation in any averaging, banking or trading programs described in "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles" incorporated by reference in section 1956.8 (b), below.

[H] Engine manufacturers subject to the Heavy-Duty Diesel Engine Settlement Agreements (Settlement Agreements)[1] must produce engines in compliance with the requirements contained in their respective Settlement Agreement. Most engine manufacturers subject to the Settlement Agreements are required to manufacture engines meeting the exhaust emission standards for 2004 and subsequent model years engines beginning October 1, 2002.

[I] A manufacturer may elect to include any or all of its heavy-duty diesel engine families in any or all of the NOx emissions averaging, banking, or trading programs for heavy-duty diesel engines, within the restrictions described in "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles" incorporated in section 1956.8 (b), below. If the manufacturer elects to include engine families in any of these programs, the NOx family emission limit (FEL) may not exceed the following FEL caps: 2.00 grams per brake horsepower-hour (0.75 grams per megajoule) for model years before 2010; 0.50

[1] Seven of the largest heavy-duty diesel engine manufacturers will be implementing measures to reduce emissions beginning October 1, 2002, to meet the requirements of the Heavy-Duty Diesel Engine Settlement Agreements reached with the ARB. The Heavy-Duty Diesel Engine Settlements were agreements reached in response to lawsuits brought by the United States Environmental Protection Agency and violations alleged by the ARB pertaining to excess in-use emissions caused by the use of defeat devices and unacceptable algorithms. Navistar signed its Settlement Agreement on October 22, 1998. Cummins, Detroit Diesel Corporation, Caterpillar, Volvo, Mack and Renault signed their Settlement Agreements on December 15, 1998.

grams per brake horsepower-hour (0.19 grams per megajoule) for model years 2010 and later. The FEL cap applies whether credits for the engine family are derived from averaging, banking, or trading programs.

J For 2007 through 2009 model years, a manufacturer may use these emission standards in accordance with section 1956.8 (a)(2)(B). A manufacturer may elect to include any or all of its heavy-duty diesel engine families in any or all of the NOx plus NMHC emissions averaging, banking, or trading programs for heavy-duty diesel engines, within the restrictions described in "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles" incorporated in section 1956.8 (b), below. If the manufacturer elects to include engine families in any of these programs, the NOx family emission limit (FEL) may not exceed the following FEL caps: 2.00 grams per brake horsepower-hour (0.75 grams per megajoule) for model years. The FEL cap applies whether credits for the engine family are derived from averaging, banking, or trading programs.

K A manufacturer may elect to include any or all of its heavy-duty diesel engine families in any or all of the particulate averaging, banking, or trading programs for heavy-duty diesel engines, within the restrictions described in "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles" incorporated by reference in section 1956.8 (b), below. The particulate FEL for each engine family a manufacturer elects to include in any of these programs may not exceed an FEL cap of 0.02 grams per brake horsepower-hour (0.0075 grams per megajoule). The FEL cap applies whether credits for the engine family are derived from averaging, banking, or trading programs.

(B) Phase-in Options. (i) Early NOx compliant engines. For model years 2007, 2008, and 2009, a manufacturer may, at their option, certify one or more of their engine families to the combined NOx plus NMHC standard or FEL applicable to model year 2006 engines under section 1956.8 (a)(2), in lieu of the separate NOx and NMHC standards or FELs applicable to the 2007 and subsequent model years, specified in section 1956.8 (a)(2). Each engine certified under this phase-in option must comply with all other emission requirements applicable to model year 2007 engines. To qualify for this option, a manufacturer must satisfy the U.S.-directed production requirement of certifying no more than 50 percent of engines to the NOx plus NMHC standards or FELs applicable to 2006 engines, as specified in 40 Code of Federal Regulations, part 86, section 86.007-11 (g)(1), as adopted January 18, 2001. In addition, a manufacturer may reduce the quantity of engines that are required to be phased-in using the early certification credit program specified in 40 Code of Federal Regulations, part 86, section 86.007-11 (g)(2), as adopted January 18, 2001, and the "Blue Sky" engine program specified in 40 Code of Federal Regulations, part 86, section 86.007-11 (g)(4), as adopted January 18, 2001.

(ii) Early PM compliant engines. A manufacturer certifying engines to the 2007 and subsequent model year PM standard listed in section 1956.8 (a)(2) (without using credits, as determined in any averaging, banking, or trading program described in "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles," to comply with the standards) before model year 2007 may reduce the number of engines that are required to meet the 2007 and subsequent model year PM standard listed in section 1956.8 (a)(2) in model year 2007, 2008 and/or 2009. To qualify for this option, a manufacturer must satisfy the PM emission requirements pursuant to the methods detailed in 40 Code of Federal Regulations, part 86, section 86.007-11 (g)(2)(ii), as adopted January 18, 2001.

(3) [No Change]

(4) [No Change]

(5) No crankcase emissions shall be discharged directly into the ambient atmosphere from any new 2007 or later model year diesel heavy-duty diesel engine, with the following exception: heavy-duty diesel engines equipped with turbochargers, pumps, blowers, or superchargers for air induction may discharge crankcase emissions to the ambient atmosphere if the emissions are added to the exhaust emissions (either physically or mathematically) during all emission testing. Manufacturers using this exception must manufacture the engines so that all crankcase emissions can be routed into a dilution tunnel (or other sampling system approved in advance by the Executive Officer), and must account for deterioration in crankcase emissions when determining exhaust deterioration factors. For the purpose of section 1956.8 (a)(2), crankcase emissions that are routed to the exhaust upstream of exhaust aftertreatment during all operation are not considered to be "discharged directly into the ambient atmosphere."

(b) The test procedures for determining compliance with standards applicable to 1985 and subsequent heavy-duty diesel engines and vehicles and the requirements for participation in the averaging, banking and trading programs, are set forth in the "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles" adopted April 8, 1985, as last amended ~~November 22 2000~~ [insert date of finalized amendment], which is incorporated herein by reference.

(c) [No Change]

(d) [No Change]

(e) [No Change]

(f) [No Change]

(g) [No Change]

(h) The exhaust emissions from new (1) 1992 through 2004 model-year Otto-cycle engines used in incomplete medium-duty low-emission vehicles, ultra-low-emission vehicles, and super-ultra-low-emission vehicles, and (2) 1992 and subsequent model diesel engines used in medium-duty low-emission vehicles, ultra-low-emission vehicles and super-ultra-low-emission vehicles shall not exceed:

Exhaust Emission Standards for Engines Used in Incomplete Otto-Cycle Medium-Duty Low-Emission Vehicles, Ultra-Low-Emission Vehicles, and Super Ultra-Low-Emission Vehicles, and for Diesel Engines Used in Medium-Duty Low-Emission Vehicles, Ultra-Low-Emission Vehicles, and Super Ultra-Low-Emission Vehicles[A,F]
(grams per brake horsepower-hour)

Model Year	Vehicle Emissions Category[B]	Carbon Monoxide	NMHC + NOx [C]	Non-Methane Hydrocarbons	Oxides of Nitrogen	Formaldehyde	Particulates[D]
1992[E] - 2001	LEV	14.4	3.5 [K]	n/a	n/a	0.050	0.10 [K]
2002-2003[E]	LEV	14.4	3.0 [K]	n/a	n/a	0.050	0.10 [K]
1992-2003[E,H]	ULEV	14.4	2.5 [K]	n/a	n/a	0.050	0.10 [K]
2004 and subsequent [L]	ULEV - Opt A	14.4	2.5 [I,J,K]	n/a	n/a	0.050	0.10 [J,K]
2004 and subsequent [L]	ULEV - Opt. B	14.4	2.4 [I,J,K]	n/a	n/a	0.050	0.10 [J,K]
2007 and subsequent [D]	ULEV	15.5	n/a	0.14	0.2	0.050	0.01
1992 and subsequent [L]	SULEV	7.2	2.0 [K]	n/a	n/a	0.025	0.05 [K]
2007 and subsequent [D]	SULEV	7.7	n/a	0.07	0.1	0.025	0.005

[A] This set of standards is optional. Manufacturers of engines used in incomplete medium-duty vehicles or diesel engines used in medium-duty vehicles from 8501-14,000 pounds gross vehicle weight rating may choose to comply with these standards as an alternative to the primary emission standards and test procedures

specified in section 1960.1, or section 1961, Title 13, California Code of Regulations. Manufacturers that choose to comply with these optional heavy-duty standards and test procedures shall specify, in the application for certification, an in-use compliance test procedure, as provided in section 2139(c), Title 13, California Code of Regulations.

B "LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.
"SULEV" means super ultra-low-emission vehicle.

C This standard is the sum of the individual non-methane hydrocarbon emissions and oxides of nitrogen emissions. For methanol-fueled engines, non-methane hydrocarbons shall mean organic material hydrocarbon equivalent ("OMHCE").

D These~~is~~ standards ~~shall only~~ apply only to diesel engines and vehicles.

E Manufacturers may certify engines used in incomplete medium-duty vehicles or diesel engines used in medium-duty vehicles to these standards to meet the requirements of section 1956.8(g), Title 13, California Code of Regulations.

F In-use compliance testing shall be limited to vehicles or engines with fewer than 90,000 miles.

G [Reserved]

H For engines certified to the 3.5 grams per brake horsepower-hour (g/bhp-hr) LEV standards, the in-use compliance standard shall be 3.7 g/bhp-hr for the first two model years of introduction. For engines certified to the 2002 and 2003 model year LEV standards, the in-use compliance standard shall be 3.2 g/bhp-hr. For engines certified to the 1992 through 2003 model year ULEV standards, the in-use compliance standard shall be 2.7 g/bhp-hr for the first two model years of introduction. For engines certified to the 1992 and subsequent SULEV standards, the in-use compliance standard shall be 2.2 g/bhp-hr for the first two model years of introduction.

I Manufacturers have the option of certifying to either option A or B. Manufacturers electing to certify to Option A must demonstrate that the NMHC emissions do not exceed 0.5 g/bhp-hr.

J Emissions averaging may be used to meet these standards for diesel engines, using the requirements for participation in averaging, banking and trading programs, as set forth in the "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles", incorporated by reference in ~~paragraph~~ section 1956.8 (b), above.

K Engines of 1998 and subsequent model years may be eligible to generate averaging, banking and trading credits based on these standards according to the requirements of the averaging, banking and trading programs described in "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles", incorporated by reference in ~~paragraph~~ section 1956.8 (b), above.

L For 2007 and subsequent model year diesel engines used in medium-duty vehicles, these emission standards are not applicable.

(3) Phase-in Options. (A) Early NOx compliant engines. For model years 2007, 2008, and 2009, a manufacturer may, at their option, certify one or more of their engine families to the combined NOx plus NMHC standard or FEL applicable to model year 2006 engines under section 1956.8 (h)(2), in lieu of the separate NOx and NMHC standards or FELs applicable to the 2007 and subsequent model years, specified in section 1956.8 (h)(2). Each engine certified under this phase-in option must comply with all other emission requirements applicable to model year 2007 engines. To qualify for this option, a manufacturer must satisfy the U.S.-directed production requirement of certifying no more than 50 percent of engines to the NOx plus NMHC standards or FELs applicable to 2006 engines, as specified in 40 Code of Federal Regulations, part 86, section 86.007-11 (g)(1), as adopted January 18, 2001. In addition, a manufacturer may reduce the quantity of engines that are required to be phased-in using the early certification credit program specified in 40 Code of Federal Regulations, part 86, section 86.007-11 (g)(2), as adopted January 18, 2001, and the "Blue Sky" engine program specified in 40 Code of Federal Regulations, part 86, section 86.007-11 (g)(4), as adopted January 18, 2001.

(B) Early PM compliant engines. A manufacturer certifying engines to the 2007 and subsequent model year PM standard listed in section 1956.8 (h)(2) (without using credits, as determined in any averaging, banking, or trading program described in "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles," to comply with the standards) before model year 2007 may reduce the number of engines that are required to meet the 2007 and subsequent model year PM standard listed in section 1956.8 (h)(2) in model year 2007, 2008 and/or 2009. To qualify for this option, a manufacturer must satisfy the PM emission requirements pursuant to the methods detailed in 40 Code of Federal Regulations, part 86, section 86.007-11 (g)(2)(ii), as adopted January 18, 2001.

(4) No crankcase emissions shall be discharged directly into the ambient atmosphere from any new 2007 or later model year diesel heavy-duty diesel engine, with the following exception: heavy-duty diesel engines equipped with turbochargers, pumps, blowers, or superchargers for air induction may discharge crankcase emissions to the ambient atmosphere if the emissions are added to the exhaust

emissions (either physically or mathematically) during all emission testing. Manufacturers taking advantage of this exception must manufacture the engines so that all crankcase emission can be routed into a dilution tunnel (or other sampling system approved in advance by the Executive Officer), and must account for deterioration in crankcase emissions when determining exhaust deterioration factors. For the purpose of section 1956.8 (h)(2), crankcase emissions that are routed to the exhaust upstream of exhaust aftertreatment during all operation are not considered to be "discharged directly into the ambient atmosphere."

NOTE: Authority cited: Sections 39600, 39601, 43013, 43018, 43101, 43104, 43105 and 43806, Health and Safety Code; and Section 28114, Vehicle Code. Reference: Sections 39002, 39003, 39500, 43000, 43013, 43018, 43100, 43101, 43101.5, 43102, 43104, 43106, 43202, 43204, 43206, 43210-43213, and 43806, Health and Safety Code; and Section 28114, Vehicle Code.

APPENDIX B — PROPOSED AMENDMENTS TO CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1985 AND SUBSEQUENT MODEL HEAVY-DUTY DIESEL ENGINES AND VEHICLES.

APPENDIX B

PROPOSED AMENDMENTS TO THE CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1985 AND SUBSEQUENT MODEL HEAVY-DUTY DIESEL ENGINES AND VEHICLES

State of California
AIR RESOURCES BOARD

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1985 AND SUBSEQUENT MODEL HEAVY-DUTY DIESEL-ENGINES AND VEHICLES

Adopted: April 8, 1985
Amended: July 29, 1986
Amended: January 22, 1990
Amended: May 15, 1990
Amended: December 26, 1990
Amended: July 12, 1991
Amended: October 23, 1992
Amended: October 22, 1993
Amended: March 24, 1994
Amended: September 22, 1994
Amended: June 29, 1995
Amended: June 4, 1997
Amended: February 26, 1999
Amended: November 22, 2000
Amended: December 8, 2000
Amended: (insert date of finalized amendment)

NOTES: This document incorporates by reference various sections of the Code of Federal Regulations (CFR), some with modifications. Proposed modifications to portions of paragraphs in the Federal language are indicated by underline for additions and ~~strikeout~~ for deletions. Larger portions of Federal language for a specific section that are not to be included in these procedures are denoted by "DELETE" and larger portions of new California language are indicated by "REPLACE WITH" or "INSERT". The symbols "******" and "....." mean that the remainder of the federal text for a specific section, which is not shown in these procedures, is proposed for inclusion by reference, with only the printed text changed. The symbol "#####" means that the remainder of the text of these procedures, which is not shown in this amendment document, has no proposed changes, including but not limited to text that the Board amended and approved December 8, 2000. A complete version of these test procedures will be available at http://www.arb.ca.gov/msprog/onroadhd/onroadhd.htm upon the effective date of these amendments.

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1985 AND SUBSEQUENT MODEL HEAVY-DUTY DIESEL ENGINES AND VEHICLES

The following provisions of Subparts A, I, and N, Title 40, Code of Federal Regulations, as adopted or amended by the U. S. Environmental Protection Agency on the date listed, and only to the extent they pertain to the testing and compliance of exhaust emissions from heavy-duty diesel-engines and vehicles, are adopted and incorporated herein by this reference as the California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel-Engines and Vehicles, except as altered or replaced by the provisions set forth below.

The federal regulations contained in the Subparts identified above ~~which~~ that pertain to oxides of nitrogen emission averaging shall not be applicable to these procedures except for diesel engines and vehicles produced in the 1998 and subsequent model years. The federal regulations contained in the Subparts identified above which pertain to particulate emission averaging ~~shall not be applicable to~~ are not incorporated in these procedures for 1996 and subsequent model years. The smoke exhaust test procedures shall be applicable to California petroleum-fueled, liquefied-petroleum gas-fueled, and compressed-natural gas fueled heavy-duty diesel engines and vehicles for 1988 and later model years.

The federal regulations contained in the subparts identified above which pertain to nonconformance penaltiesy shall not be applicable.

The federal regulations contained in the subparts identified above which pertain to evaporative emission shall not be applicable to these procedures. Applicable regulations pertaining to evaporative emissions are contained in "California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles," as incorporated in Title 13, California Code of Regulations, Section 1976.

Starting with the 1990 model year, these regulations shall be applicable to all heavy-duty ~~diesel~~ natural-gas-fueled and liquefied-petroleum gas-fueled engines (and vehicles) including those engines derived from existing diesel engines. For any engine ~~which~~ that is not a distinctly diesel engine nor derived from such, the Executive Officer shall determine whether the engine shall be subject to these regulations or alternatively to the heavy-duty Otto-cycle engine regulations, in consideration of the relative similarity of the engine's torque-speed characteristics and vehicle applications with those of diesel and Otto-cycle engines.

The regulations concerning the certification of methanol-fueled urban bus engines are not applicable in California until 1991 and subsequent model years. The regulations concerning the certification of all other methanol-fueled diesel engines and vehicles are not applicable in California until 1993 and subsequent model years. Regulations concerning the certification of incomplete medium-duty diesel low-emission vehicles and engines and ultra-low-emission vehicles and engines operating on any fuel are applicable for the 1992 and subsequent model years.

All references to the "Administrator" in the federal regulations contained in the subparts identified above shall be replaced with the "Executive Officer".

Subpart A, General Provisions for Emission Regulations for 1977 and Later Model Year New Light-Duty Vehicles, Light-Duty Trucks, and Heavy-Duty Engines, and for 1985 and later Model Year New Gasoline-Fueled and Methanol-Fueled Heavy-Duty Vehicles.

Amend § 86.004-2, Title 40, Code of Federal Regulations, to read:

§ 86.004-2 Definitions. ~~October 21, 1997~~ January 18, 2001

* * * * *

Amend § 86.004-28, Title 40, Code of Federal Regulations, to read:

§ 86.004-28 Compliance with emission standards. ~~October 21, 1997~~ January 18, 2001

* * * * *

Adopt and amend § 86.007-11, Title 40, Code of Federal Regulations, to read:

§ 86.007-11 Emission standards and supplemental requirements for 2007 and subsequent ~~later~~ model year heavy-duty diesel ~~heavy-duty~~ engines and vehicles. January 18, 2001

This section applies to new 2007 and later model year heavy-duty diesel engines ~~HDEs~~. Section 86.007-11 includes text that specifies requirements that differ from Sec. 86.004-11. Where a paragraph in Sec. 86.004-11 is identical and applicable to Sec. 86.007-11, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see Sec. 86.004-11.".

(a)(1) Exhaust emissions from new 2007 and later model year heavy-duty diesel engines ~~HDEs~~ shall not exceed the following:

(i) Oxides of Nitrogen (NOx). (A) 0.20 grams per brake horsepower-hour (0.075 grams per megajoule).

(B) A manufacturer may elect to include any or all of its heavy-duty diesel engine ~~HDE~~ families in any or all of the NOx and NOx plus NMHC emissions ABT programs for heavy-duty diesel engines ~~HDEs~~, within the restrictions described in Sec. 86.007-15 or Sec. 86.004-15. If the manufacturer elects to include engine families in any of these programs, the NOx FELs may not exceed the following FEL caps: 2.00 grams per brake horsepower-hour (0.75 grams per megajoule) for model years before 2010; 0.50 grams per brake horsepower-hour (0.19 grams per megajoule) for model years 2010 and later. This ceiling value applies whether credits for the family are derived from averaging, banking, or trading programs.

(ii)(A) Non-Methane Hydrocarbons (NMHC) for engines fueled with either diesel fuel, natural gas, or liquefied petroleum gas. 0.14 grams per brake horsepower-hour (0.052 grams per megajoule).

(B) Non-Methane Hydrocarbon Equivalent (NMHCE) for engines fueled with methanol. 0.14 grams per brake horsepower-hour (0.052 grams per megajoule).

(iii) Carbon monoxide. (A) 15.5 grams per brake horsepower-hour (5.77 grams per megajoule).

(B) 0.50 percent of exhaust gas flow at curb idle (methanol-, natural gas-, and liquefied petroleum gas-fueled heavy-duty diesel engines ~~HDEs~~ only). This does not apply for vehicles certified to the requirements of Sec. 86.005-17

(iv) Particulate. (A) 0.01 grams per brake horsepower-hour (0.0037 grams per megajoule).

(B) A manufacturer may elect to include any or all of its heavy-duty diesel engine ~~HDE~~ families in any or all of the particulate ABT programs for heavy-duty diesel engines ~~HDEs~~, within the restrictions described in Sec. 86.007-15 or other applicable sections. If the manufacturer elects to include engine families in any of these programs, the particulate FEL may not exceed 0.02 grams per brake horsepower-hour (0.0075 grams per megajoule).

(2) The standards set forth in paragraph (a)(1) of this section refer to the exhaust emitted over the operating schedule set forth in paragraph (f)(2) of appendix I to this part, and measured and calculated in accordance with the procedures set forth in subpart N ~~or P~~ of this part, except as noted in Sec. 86.007-23(c)(2).

(3) **DELETE** ~~SET (i) The weighted average exhaust emissions, as determined under Sec. 86.1360-2007(e)(5) pertaining to the supplemental emission test cycle, for each regulated pollutant shall not exceed 1.0 times the applicable emission standards or FELs specified in paragraph (a)(1) of this section.~~

~~(ii) For engines not having a NOx FEL less than1.5 g/bhp-hr, gaseous exhaust emissions shall not exceed the steady-state interpolated values determined by the Maximum Allowable Emission Limits (for the corresponding speed and load), as determined under Sec. 86.1360-2007(f), when the engine is operated in the steady-state control area defined under Sec. 86.1360-2007(d).~~

(4) **DELETE** ~~NTE (i)(A) The brake-specific exhaust NMHC or NOx emissions in g/bhp-hr, as determined under Sec. 86.1370-2007 pertaining to the not-to-exceed test procedures, shall not exceed 1.5 times the applicable NMHC or NOx emission standards or FELs specified in paragraph (a)(1) of this section, during engine and vehicle operation specified in paragraph (a)(4)(ii) of this section except as noted in paragraph (a)(4)(iii) of this section.~~

~~(B) For engines not having a NOx FEL less than1.50 g/bhp-hr, the brake-specific NOx and NMHC exhaust emissions in g/bhp-hr, as determined under Sec. 86.1370-2007 pertaining to the not-to-exceed test procedures, shall not exceed 1.25 times the applicable emission standards or FELs specified in paragraph (a)(1) of this section (or of Sec. 86.004-11, as allowed by paragraph (g) of this section), during engine and vehicle operation specified in paragraph (a)(4)(ii) of this section except as noted in paragraph (a)(4)(iii) of this section.~~

~~(C) The brake-specific exhaust PM emissions in g/bhp-hr, as determined under Sec. 86.1370-2007 pertaining to the not-to-exceed test procedures, shall not exceed 1.5 times the applicable PM emission standards or FEL (for FELs above the standard only) specified in paragraph (a)(1) of this section, during engine and vehicle operation specified in paragraph (a)(4)(ii) of this section except as noted in paragraph (a)(4)(iii) of this section.~~

~~(D) The brake-specific exhaust CO emissions in g/bhp-hr, as determined under Sec. 86.1370-2007 pertaining to the not-to-exceed test procedures, shall not exceed 1.25 times the applicable CO emission standards or FEL specified in paragraph (a)(1) of this section, during engine and vehicle operation specified in paragraph (a)(4)(ii) of this section except as noted in paragraph (a)(4)(iii) of this section.~~

* * * * *

(iv) * * *

(C) **DELETE** ~~For model years 2010 through 2013, the Administrator may allow up to three deficiencies per engine family. The provisions of paragraphs (a)(4)(iv)(A) and (B) of this section apply for deficiencies allowed by this paragraph (a)(4)(iv)(C). In determining whether to allow the additional deficiencies, the Administrator may consider any relevant factors, including the factors identified in paragraph (a)(4)(iv)(A) of this section. If additional deficiencies are approved, the Administrator may set any additional conditions that he/she determines to be appropriate.~~

(v) **DELETE** ~~The emission limits specified in paragraphs (a)(3) and (a)(4) of this section shall be rounded to the same number of significant figures as the applicable standards in paragraph (a)(1) of this section using ASTM E29-93a (Incorporated by reference at Sec. 86.1).~~

* * * * *

(b)(3) and (b)(4) [Reserved]. For guidance see Sec. 86.004-11.

(c) No crankcase emissions shall be discharged directly into the ambient atmosphere from any new 2007 or later model year ~~diesel HDE~~ heavy-duty diesel engines, with the following exception: ~~HDEs~~ heavy-duty diesel engines equipped with turbochargers, pumps, blowers, or superchargers for air induction may discharge crankcase emissions to the ambient atmosphere if the emissions are added to the exhaust emissions (either physically or mathematically) during all emission testing. Manufacturers taking advantage of this exception must manufacture the engines so that all crankcase emission can be routed into a dilution tunnel (or other sampling system approved in advance by the ~~Administrator~~ Executive Officer), and must account for deterioration in crankcase emissions when determining exhaust deterioration factors. For the purpose of this paragraph (c), crankcase emissions that are routed to the exhaust upstream of exhaust aftertreatment during all operation are not considered to be "discharged directly into the ambient atmosphere."

(d) Every manufacturer of new motor vehicle engines subject to the standards prescribed in the California Code of Regulations, title 13, §1956.8 (a), §1956.8 (h), and this section shall, prior to taking any of the actions prohibited by California Health & Safety Code section 43211 ~~specified in section 203(a)(1) of the Act~~, test or cause to be tested motor vehicle engines in accordance with applicable procedures in subpart I or N of ~~this part~~ the "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles" to ascertain that such test engines meet the requirements of paragraphs (a), (b), (c), and (d) of this section.

(e) [Reserved]. For guidance see Sec. 86.004-11.

(f) **DELETE** ~~(1) Model year 2007 and later diesel-fueled heavy-duty engines and vehicles for sale in Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands shall be subject to the same standards and requirements as apply to 2006 model year diesel heavy-duty engines and vehicles, but only if the vehicle or engine bears a permanently affixed label stating:~~

> ~~THIS ENGINE (or VEHICLE, as applicable) CONFORMS TO US EPA EMISSION STANDARDS APPLICABLE TO MODEL YEAR 2006. THIS ENGINE (or VEHICLE, as applicable) DOES NOT CONFORM TO US EPA EMISSION REQUIREMENTS IN EFFECT AT TIME OF PRODUCTION AND MAY NOT BE IMPORTED INTO THE UNITED STATES OR ANY TERRITORY OF THE UNITED STATES EXCEPT GUAM, AMERICAN SAMOA, OR THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS.~~

~~(2) The importation or sale of such a vehicle or engine for use at any location U.S. other than Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands shall be considered a violation of section 203(a)(1) of the Clean Air Act. In addition, vehicles or vehicle engines subject to this exemption may not subsequently be imported or sold into any state or territory of the United States other than Guam, American Samoa, or Commonwealth of the Northern Mariana Islands.~~

* * * * *

Adopt and amend § 86.007-15, Title 40, Code of Federal Regulations, to read:

§ 86.007-15 NOx and particulate averaging, trading, and banking for heavy-duty engines. January 18, 2001

Section 86.007-15 includes text that specifies requirements that differ from Sec. 86.004-15. Where a paragraph in Sec. 86.004-15 is identical and applicable to Sec. 86.007-15, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see Sec. 86.004-15."

(a) through (l) [Reserved]. For guidance see Sec. 86.004-15.

(m) The following provisions apply for model year 2007 and later engines (including engines certified during years 2007-2009 under the phase-in provisions of Sec. 86.007-11(g)(1)~~, Sec. 86.005-10(a), or Sec. 86.008-10(f)(1)~~). These provisions apply instead of the provisions of paragraphs Sec. 86.004-15 (a) through (k) to the extent that they are in conflict.

(1) ~~Manufacturers of Otto-cycle engines may participate in an NMHC averaging, banking and trading program to show compliance with the standards specified in Sec. 86.008-10. The generation and use of NMHC credits are subject to the same provisions in paragraphs Sec. 86.004-15 (a) through (k) that apply for NOx plus NMHC credits, except as otherwise specified in this section.~~ [Reserved]

(2) Credits are calculated as NOx or NMHC credits for engines certified to separate NOx and NMHC standards. NOx plus NMHC credits (including banked credits and credits that are generated during years 2007-2009 under the phase-in provisions of Sec. 86.007-11(g)(1)~~, Sec. 86.005-10(a), or Sec. 86.008-10(f)(1)~~ may be used to show compliance with 2007 or later NOx standards ~~(NOx or NMHC standards for Otto-cycle engines)~~, subject to an 0.8 discount factor (e.g., 100 grams of NOx plus NMHC credits is equivalent to 80 grams of NOx credits).

(3) ~~NOx or NMHC (or NOx plus NMHC) credits may be exchanged between heavy-duty Otto-cycle engine families certified to the engine standards of this subpart and heavy-duty Otto-cycle engine families certified to the chassis standards of subpart S of this part, subject to an 0.8 discount factor (e.g., 100 grams of NOx (or NOx plus NMHC) credits generated from engines would be equivalent to 80 grams of NOx credits if they are used in the vehicle program of subpart S, and vice versa).~~ [Reserved]

(4) Credits that were previously discounted when they were banked according to paragraph (c) of Sec. 86.004-15, are subject to an additional discount factor of 0.888 instead of the 0.8 discount factor otherwise required by paragraph (m)(2) ~~or (m)(3)~~ of this section. This results in a total discount factor of 0.8 (0.9 x 0.888 = 0.8).

(5) For diesel engine families, the combined number of engines certified to FELs higher than 0.50 g/bhp-hr using banked NOx (and/or NOx plus NMHC) credits in any given model year may not exceed 10 percent of the manufacturer's U.S.-directed production of engines in all heavy-duty diesel engine families for that model year.

(6) The FEL must be expressed to the same number of decimal places as the standard (generally, one-hundredth of a gram per brake horsepower-hour). For engines certified to standards expressed only one-tenth of a gram per brake horsepower-hour, if the FEL is below 1.0, then add a zero to the standard in the second decimal place and express the FEL to nearest one-hundredth of a gram per brake horsepower-hour.

(7) Credits are to be rounded to the nearest one-hundredth of a Megagram using ASTM E29-93a ~~(Incorporated by reference at Sec. 86.1)~~.

(8) Credits generated for 2007 and later model year diesel engine families, ~~or generated for 2008 and later model year Otto-cycle engine families~~ are not discounted (except as specified in paragraph (m)(2) ~~or (m)(3)~~ of this section), and do not expire.

(9) For the purpose of using or generating credits during a phase-in of new standards, a manufacturer may elect to split an engine family into two subfamilies (e.g., one which uses credits and one which generates credits). The manufacturer must indicate in the application for certification that the engine family is to be split, and may assign the numbers and configurations of engines within the respective subfamilies at any time prior to the submission of the end-of-year report required by Sec. 86.001-23.

(i) Manufacturers certifying a split diesel engine family to both the ~~Phase 1~~ pre-2007 (phased-out) and ~~Phase 2~~ post-2007 (phased-in) emission standards with equally sized subfamilies may exclude the engines within that split family from end-of-year NOx (or NOx+NMHC) ABT calculations, provided that neither subfamily generates credits for use by other engine families, or uses banked credits, or uses averaging credits from other engine families. All of the engines in that split family must be excluded from the phase-in calculations of Sec. 86.007-11(g)(1) (both from the number of engines complying with the standards being phased-in and from the total number of U.S.-directed production engines.)

(ii) ~~Manufacturers certifying a split Otto-cycle engine family to both the Phase 1 and Phase 2 standards with equally sized subfamilies may exclude the engines within that split family from end-of-year NOx (or NOx+NMHC) ABT calculations, provided that neither subfamily generates credits for use by other engine families, or uses banked credits, or uses averaging credits from other engine families. All of the engines in that split family must be excluded from the phase-in calculations of Sec. 86.008-10(f)(1) (both from the number of engines complying~~

~~with the standards being phased in and from the total number of U.S.-directed production engines.)~~ [Reserved]

(iii) Manufacturers certifying a split engine family may label all of the engines within that family with a single NOx or NOx+NMHC FEL. The FEL on the label will apply for all SEA or other compliance testing.

(iv) Notwithstanding the provisions of paragraph (m)(9)(iii) of this section, for split families, the NOx FEL shall be used to determine applicability of the provisions of Sec. 86.1360-2007(j)(2) and (j)(3) and Sec.1370-2007(d)(1)(iii) and (d)(1)(iv), as modified by these procedures ~~Sec. 86.007-11(a)(3)(ii), (a)(4)(i)(B), and (h)(1), and Sec. 86.008-10(g)~~.

(10) For model years 2007 through 2009, to be consistent with the phase-in provisions of Sec. 86.007-11(g)(1), credits generated from engines in one diesel engine service class (e.g., light-heavy duty diesel engines) may be used for averaging by engines in a different diesel engine service class, provided the credits are calculated for both engine families using the conversion factor and useful life of the engine family using the credits, and the engine family using the credits is certified to the standards listed in Sec. 86.007-11(a)(1). Banked or traded credits may not be used by any engine family in a different service class than the service class of the engine family generating the credits.

Adopt and amend § 86.007-23, Title 40, Code of Federal Regulations, to read:

§ 86.007-23 Required data. January 18, 2001

* * * * *

(c) Emission data.–(1) Certification vehicles. The manufacturer shall submit emission data (including, methane, methanol, formaldehyde, and hydrocarbon equivalent, as applicable) on such vehicles tested in accordance with applicable test procedures and in such numbers as specified. These data shall include zero-mile data, if generated, and emission data generated for certification as required under Sec. 86.000-26(a)(3). In lieu of providing emission data the Administrator may, on request of the manufacturer, allow the manufacturer to demonstrate (on the basis of previous emission tests, development tests, or other information) that the engine will conform with certain applicable emission standards of this part. Standards eligible for such manufacturer requests are those for idle CO emissions, smoke emissions, or particulate emissions from methanol-fueled or gaseous-fueled diesel-cycle certification vehicles, ~~those for particulate emissions from Otto-cycle certification vehicles or gaseous-fueled vehicles,~~ and those for formaldehyde emissions from petroleum-fueled vehicles. Also eligible for such requests are standards for total hydrocarbon emissions from model year 1994 and later certification vehicles. ~~By separate request, including appropriate supporting test data, the manufacturer may request that the Administrator also waive the requirement to measure particulate or formaldehyde emissions when conducting Selective Enforcement Audit testing of Otto-cycle vehicles.~~

(2) Certification engines. The manufacturer shall submit emission data on such engines tested in accordance with applicable emission test procedures of this subpart and in such numbers as specified. These data shall include zero-hour data, if generated, and emission data generated for certification as required under Sec. 86.000-26(c)(4). In lieu of providing emission data on idle CO emissions or particulate emissions from methanol-fueled or gaseous-fueled diesel-cycle certification engines~~, on particulate emissions from Otto-cycle engines,~~ or on CO emissions from diesel-cycle certification engines, the Administrator may, on request of the manufacturer, allow the manufacturer to demonstrate (on the basis of previous emission tests, development tests, or other information) that the engine will conform with the applicable emission standards of this part. In lieu of providing emission data on smoke emissions from methanol-fueled or petroleum-fueled diesel certification engines, the ~~Administrator~~ Executive Officer may, on the request of the manufacturer, allow the manufacturer to demonstrate (on the basis of previous emission tests, development tests, or other information) that the engine will conform with the applicable emissions standards of this part. In lieu of providing emissions data on smoke emissions from diesel-cycle engines when conducting Selective Enforcement Audit testing under subpart K of this part, the ~~Administrator~~ Executive Officer may, on separate request of the manufacturer, allow the manufacturer to demonstrate (on the basis of previous emission tests, development tests, or other

information) that the engine will conform with the applicable smoke emissions standards of this part.

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Adopt § 86.007-25, Title 40, Code of Federal Regulations, to read:

§ 86.007-25 Maintenance. January 18, 2001

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Adopt and amend § 86.007-35, Title 40, Code of Federal Regulations, to read:

§ 86.007-35 Labeling. January 18, 2001

* * * * *

(a)(2) (ii) The name of the ~~Administrator~~ Executive Officer-approved alternative test procedure to be performed.

(2) **DELETE** ~~Light-duty truck and heavy-duty vehicles optionally certified in accordance with the light-duty truck provisions.~~

(i) ~~A legible, permanent label shall be affixed in a readily visible position in the engine compartment.~~

(ii) ~~The label shall be affixed by the vehicle manufacturer who has been issued the certificate of conformity for such vehicle, in such a manner that it cannot be removed without destroying or defacing the label. The label shall not be affixed to any equipment which is easily detached from such vehicle.~~

(iii) ~~The label shall contain the following information lettered in the English language in block letters and numerals, which shall be of a color that contrasts with the background of the label:~~

(A) ~~The label heading: Important Vehicle Information;~~

(B) ~~Full corporate name and trademark of the manufacturer;~~

(C) ~~Engine displacement (in cubic inches or liters), engine family identification, and evaporative/refueling family;~~

* * * * *

Adopt and amend § 86.007-38, Title 40, Code of Federal Regulations, to read:

§ 86.007-38 Maintenance instructions. January 18, 2001

* * * * *

(i) For each new diesel-fueled engine subject to the standards prescribed in the California Code of Regulations, title 13, §1956.8 (a), §1956.8 (h), and Sec. 86.007-11, as applicable, the manufacturer shall furnish or cause to be furnished to the ultimate purchaser a statement that "This engine must be operated only with low sulfur diesel fuel (that is, diesel fuel meeting ~~EPA~~ ARB specifications for highway diesel fuel, including a 15 ppm sulfur cap)."

Subpart N, Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures

Adopt § 86.1306-07, Title 40, Code of Federal Regulations, to read:

§ 86.1306-07 Equipment required and specifications; overview. January 18, 2001

* * * * *

Amend § 86.1309-90, Title 40, Code of Federal Regulations, to read:

§ 86.1309-90 Exhaust gas sampling system; Otto-cycle and non-petroleum-fueled engines. ~~June 30, 1995~~ January 18, 2001

* * * * *

Adopt and amend § 86.1310-2007, Title 40, Code of Federal Regulations, to read:

§ 86.1310-2007 Exhaust gas sampling and analytical system for gaseous emissions from heavy-duty diesel-fueled engines and particulate emissions from all engines. January 18, 2001

* * * * *

(2) The THC analytical system for diesel engines requires a heated flame ionization detector (HFID) and heated sample system (191 ± plus or minus (+/-) 11 deg.C) using either:

(i) Continuously integrated measurement of diluted THC meeting the minimum requirements and technical specifications contained in paragraph (b)(3) of this section. Unless compensation for varying mass flow is made, a constant mass flow system must be used to ensure a proportional sample; or

(ii) Heated (191 ± plus or minus (+/-) 11 deg.C) proportional bag sampling systems for hydrocarbon measurement will be allowed if the bag sampling system meets the performance specifications for outgassing and permeability as defined in paragraph (b)(2) of this section.

* * * * *

(8) The mass of particulate in the exhaust is determined via filtration. The particulate sampling system requires dilution of the exhaust to a temperature of 47 deg.C ± plus or minus (+/-) 5 deg.C, measured upstream of a single high-efficiency sample filter (as close to the filter as practical).

(9) Since various configurations can produce equivalent results, exact conformance with these drawings is not required. Additional components such as instruments, valves, solenoids, pumps, and switches may be used to provide additional information and coordinate the functions of the components of the system. Other components, such as snubbers, which are not needed to maintain accuracy on some systems, may be excluded if their exclusion is based upon good engineering judgment.

(10) Other sampling and/or analytical systems may be used if shown to yield equivalent results and if approved in advance by the ~~Administrator~~ Executive Officer (see Sec. 86.1306-07).

(b) Component description. The components necessary for exhaust sampling shall meet the following requirements:

(1) Exhaust dilution system. The CVS shall conform to all of the requirements listed for the exhaust gas CVS systems in Sec. 86.1309-90(b), (c), and (d). With respect to

PM measurement, the intent of this measurement procedure is to perform the sample cooling primarily via dilution and mixing with air rather than via heat transfer to the surfaces of the sampling system. In addition the CVS must conform to the following requirements:

(i) The flow capacity of the CVS must be sufficient to maintain the diluted exhaust stream at the temperatures required for the measurement of particulate and hydrocarbon emission noted below and at, or above, the temperatures where aqueous condensation in the exhaust gases could occur. This is achieved by the following method. The flow capacity of the CVS must be sufficient to maintain the diluted exhaust stream in the primary dilution tunnel at a temperature of 191 deg.C or less at the sampling zone and as required to prevent condensation at any point in the dilution tunnel. Gaseous emission samples may be taken directly from this sampling point. An exhaust sample must then be taken at this point to be diluted a second time for use in determining particulate emissions. The secondary dilution system must provide sufficient secondary dilution air to maintain the double-diluted exhaust stream at a temperature of 47 C ± plus or minus (+/-) 5 C, measured at a point located between the filter face and 16 cm upstream of the filter face.

* * * * *

(B) Primary dilution air shall be filtered at the dilution air inlet. The manufacturer of the primary dilution air filter shall state that the filter design has successfully achieved a minimum particle removal efficiency of 98% (less than 0.02 penetration) as determined using ASTM test method F 1471-93 ~~(incorporated by reference at section 86.1)~~. Secondary dilution air shall be filtered at the dilution air inlet using a high-efficiency particulate air filter (HEPA). The HEPA filter manufacturer shall state the HEPA filter design has successfully achieved a minimum particle removal efficiency of 99.97% (less than 0.0003 penetration) as determined using ASTM test method F 1471-93. It is recommended that the primary dilution air be filtered using a HEPA filter. EPA intends to utilize HEPA filters to condition primary dilution air in its test facilities. It is acceptable to use of a booster blower upstream or downstream of a HEPA filter in the primary dilution tunnel (and upstream of the introduction of engine exhaust into the CVS) to compensate for the additional pressure loss associated with the filter. The design of any booster blower located downstream of the filter should minimize the introduction of additional particulate matter into the CVS.

(C) Primary dilution air may be sampled to determine background particulate levels, which can then be subtracted from the values measured in the diluted exhaust stream. In the case of primary dilution air, the background particulate filter sample shall be taken immediately downstream of the dilution air filter and upstream of the engine exhaust flow (Figure N07-1). The provisions of paragraphs (b)(7) of this section, and of Sec. 86.1312-2007 also apply to the

measurement of background particulate matter, except that the filter temperature must be maintained below 52 deg.C.

(2) Heated proportional bag sampling systems. If a heated (191 ± plus or minus (+/-) 11 deg.C) proportional bag sampling system is used for THC measurement, sample bags must demonstrate minimal outgassing and permeability by passing the following performance test:

* * * * *

(A) Maintain a wall temperature of 191 deg.C ± plus or minus (+/-) 11 deg.C as measured at every separately controlled heated component (i.e., filters, heated line sections), using permanent thermocouples located at each of the separate components.

(B) Have a wall temperature of 191 deg.C ± plus or minus (+/-) 11 deg.C over its entire length. The temperature of the system shall be demonstrated by profiling the thermal characteristics of the system at initial installation and after any major maintenance performed on the system. The temperature profile of the HC sampling system shall be demonstrated by inserting thermocouple wires (typically Teflon™ coated for ease of insertion) into the sampling system assembled in-situ where possible, using good engineering judgment. The wire should be inserted up to the HFID inlet. Stabilize the sampling system heaters at normal operating temperatures. Withdraw the wires in increments of 5 cm to 10 cm (2 inches to 4 inches) including all fittings. Record the stabilized temperature at each position. The system temperature will be monitored during testing at the locations and temperature described in Sec. 86.1310-90(b)(3)(v)(A).

Note: It is understood that profiling of the sample line can be done under flowing conditions also as required with the probe. This test may be cumbersome if test facilities utilize long transfer lines and many fittings; therefore it is recommended that transfer lines be kept as short as possible and the use of fittings should be kept minimal.

(C) Maintain a gas temperature of 191 deg.C ± plus or minus (+/-) 11 deg.C immediately before the heated filter and HFID. These gas temperatures will be determined by a temperature sensor located immediately upstream of each component.

(vi) The continuous hydrocarbon sampling probe shall:

(A) Be defined as the first 25.4 cm (10 in) to 76.2 cm (30 in) of the continuous hydrocarbon sampling system;

(B) Have a 0.483 cm (0.19 in) minimum inside diameter;

(C) Be installed in the primary dilution tunnel at a point where the dilution air and exhaust are well mixed (i.e., approximately 10 tunnel diameters downstream of the point where the exhaust enters the dilution tunnel);

(D) Be sufficiently distant (radially) from other probes and the tunnel wall so as to be free from the influence of any wakes or eddies; and

(E) Increase the gas stream temperature to 191 deg.C ± plus or minus (+/-) 11 deg.C by the exit of the probe. The ability of the probe to accomplish this shall be demonstrated at typical sample flow rates using the insertion thermocouple technique at initial installation and after any major maintenance. Compliance with the temperature specification shall be demonstrated by monitoring during each test the temperature of either the gas stream or the wall of the sample probe at its terminus.

(vii) The response time of the continuous measurement system shall be no greater than:

(A) 1.5 seconds from an instantaneous step change at the port entrance to the analyzer to within 90 percent of the step change;

(B) 10 seconds from an instantaneous step change at the entrance to the sample probe or overflow span gas port to within 90 percent of the step change. Analysis system response time shall be coordinated with CVS flow fluctuations and sampling time/test cycle offsets if necessary; and

(C) For the purpose of verification of response times, the step change shall be at least 60 percent of full-scale chart deflection.

(4) Primary-dilution tunnel. (i) The primary dilution tunnel shall be:

(A) Small enough in diameter to cause turbulent flow (Reynolds Number greater than 4000) and of sufficient length to cause complete mixing of the exhaust and dilution air. Good engineering judgment shall dictate the use of mixing plates and mixing orifices to ensure a well-mixed sample. To verify mixing, ~~EPA~~ ARB recommends flowing a tracer gas (i.e. propane or CO2) from the raw exhaust inlet of the dilution tunnel and measuring its concentration at several points along the axial plane at the sample probe. Tracer gas concentrations should remain nearly constant (i.e. within 2%) between all of these points.

* * * * *

(v) Additional dilution air must be provided so as to maintain a sample temperature of 47 deg. C ± plus or minus (+/-) 5 deg. C upstream of the sample

filter. Temperature shall be measured with a thermocouple with a 3/16" shank, having thermocouple wires with a gage diameter 24 AWG or smaller, a bare-wire butt-welded junction; or other suitable temperature measurement with an equivalent or faster time constant and an accuracy and precision of ± plus or minus (+/-) 1.9 deg. C.

(vi) The filter holder assembly shall be located within 12.0 in (30.5 cm) of the exit of the secondary dilution tunnel.

(vii) The face velocity through the sample filter shall not exceed 100 cm/s (face velocity is defined as the standard volumetric sample flow rate (i.e., scm3/sec) divided by the sample filter stain area (i.e., cm2)).

(7) Particulate sampling. (i) Filter specifications. (A) Polytetrafluoroethylene (PTFE or Teflon™) coated borosilicate glass fiber high-efficiency filters or polytetrafluoroethylene (PTFE or Teflon™) high-efficiency membrane filters with an integral support ring of polymethylpentene (PMP) or equivalent inert material are required. Filters shall have a minimum clean filter efficiency of 99% as measured by the ASTM D2986-95a DOP test ~~(incorporated by reference at Sec. 86.1)~~.

* * * * *

Adopt and amend § 86.1312-2007, Title 40, Code of Federal Regulations, to read:

§ 86.1312-2007 Filter stabilization and microbalance workstation environmental conditions, microbalance specifications, and particulate matter filter handling and weighing procedures. January 18, 2001

(a) Ambient conditions for filter stabilization and weighing.--(1) Temperature and humidity. (i) The filter stabilization environment shall be maintained at 22 deg.C ± plus or minus (+/-) 3 deg.C and a dewpoint of 9.5 deg.C ± plus or minus (+/-) 1 deg.C. Dewpoint shall be measured with an instrument that exhibits an accuracy of at least 0.25 deg.C NIST traceable as stated by the instrument manufacturer. Temperature shall be measured with an instrument that exhibits an accuracy of at least 0.2 deg.C or better.

(ii) The immediate microbalance workstation environment shall be maintained at 22 deg.C ± plus or minus (+/-) 1 deg.C and a dewpoint of 9.5 deg.C ± plus or minus (+/-) 1 deg.C. If the microbalance workstation environment freely circulates with the filter stabilization environment, and this entire environment meets 22 deg.C ± plus or minus (+/-) 1 deg.C and a dewpoint of 9.5 deg.C ± plus or minus (+/-) 1 deg.C , then there is no requirement to measure temperature and dewpoint at the microbalance separate from the filter stabilization location. Otherwise, temperature at the microbalance workstation shall be measured with an instrument that exhibits an accuracy of at least 0.2 deg.C or better, and dewpoint shall be measured with an instrument that exhibits an accuracy of at least 0.25 deg.C NIST traceable as stated by the instrument manufacturer.

* * * * *

Adopt and amend § 86.1313-2007, Title 40, Code of Federal Regulations, to read:

§ 86.1313-2007 Fuel specifications. January 18, 2001

* * * * *

Section 86.1313-2007 includes text that specifies requirements that differ from Sec. 86.1313-90-4 ~~and Sec. 86.1313-2004~~. Where a paragraph in Sec. 86.1313-90-4 ~~or Sec. 86.1313-2004~~ is identical and applicable to Sec. 86.1313-2007, this may be indicated by specifying the corresponding paragraph and the statement "[Reserved]. For guidance see Sec. 86.1313-90-4." or "[Reserved]. ~~For guidance see Sec. 86.1313-04.~~".

(a) [Reserved]. ~~For guidance see Sec. 86.1313-2004.~~

(b) heading and (b)(1) [Reserved]. For guidance see Sec. 86.1313-90-4.

(b)(2) Petroleum fuel for diesel engines meeting the specifications in Table N07-2, or substantially equivalent specifications approved by the ~~Administrator~~ Executive Officer, shall be used in exhaust emissions testing. The grade of petroleum fuel used shall be commercially designated as "Type 2-D" grade diesel fuel except that fuel commercially designated as "Type 1-D" grade diesel fuel may be substituted provided that the manufacturer has submitted evidence to the Administrator demonstrating to the ~~Administrator's~~ Executive Officer's satisfaction that this fuel will be the predominant in-use fuel. Such evidence could include such things as copies of signed contracts from customers indicating the intent to purchase and use "Type 1-D" grade diesel fuel as the primary fuel for use in the engines or other evidence acceptable to the ~~Administrator~~ Executive Officer. ~~(Note: Vehicles certified under Sec. 86.007-11(f) must be tested using the test fuel specified in Sec. 86.1313-2004, unless otherwise allowed by the Administrator.)~~ Table N07-2 follows:

Table N07-2

Item		ASTM test method No.	Type 1-D	Type 2-D
(i) Cetane Number		D613	40-54	40-50
(ii) Cetane Index		D976	40-54	40-50
(iii) Distillation range:				
(A) IBP	deg.F	D86	330-390	340-400
	(deg.C)		(165.6-198.9)	(171.1-204.4)
(B) 10 pct. point	deg.F	D86	370-430	400-460
	(deg.C)		(187.8-221.1)	(204.4-237.8)
(C) 50 pct. point	deg.F	D86	410-480	470-540
	(deg.C)		(210.0-248.9)	(243.3-282.2)
(D) 90 pct. point	deg.F	D86	460-520	560-630
	(deg.C)		(237.8-271-1)	(293.3-332.2)
(E) EP	deg.F	D86	500-560	610-690
	(deg.C)		(260.0-293.3)	(321.1-365.6)
(iv) Gravity	deg.API	D287	40-44	32-37

(v) Total sulfur	ppm	D2622	7-15	7-15
(vi) Hydrocarbon composition:.				
(A) Aromatics, minimum	pct	D5186	8	27
(Remainder shall be paraffins, naphthenes, and olefins).				
(vii) Flashpoint, min	deg.F	D93	120	130
	(deg.C)		(48.9)	(54.4)
(viii) Viscosity	centistokes	D445	1.6-2.0	2.0-3.2

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Amend § 86.1319-90, Title 40, Code of Federal Regulations, to read:

§ 86.1319-90 CVS calibration. ~~April 11, 1989~~ January 18, 2001

* * * * *

Adopt and amend § 86.1323-2007, Title 40, Code of Federal Regulations, to read:

§ 86.1323-2007 Oxides of nitrogen analyzer calibration. January 18, 2001

This section describes the initial and periodic calibration of the chemiluminescent oxides of nitrogen analyzer.

(a) Prior to introduction into service and at least monthly thereafter, the chemiluminescent oxides of nitrogen analyzer must be checked for NO2 to NO converter efficiency. The ~~Administrator~~ Executive Officer may approve less frequent checks of the converter efficiency. Figure N84-9 is a reference for paragraphs (a) (1) through (11) of this section.

* * * * *

(A) Calculate the volume fraction of water vapor in the wetted span gas, as $H2O_{vol} = (\exp(3.69-(81.28/T_{sat})) + 1.61)/P_{sat}$. This calculation approximates some of the thermodynamic properties of water based on the "1995 Formulation for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use", issued by The International Association for the Properties of Water and Steam (IAPWS). However, this approximation should only be used as prescribed in this section because it is an exponential fit that is accurate for data at 25 deg.C ± plus or minus (+/-) 10 deg.C. Then, assuming a diesel fuel atomic hydrogen to carbon ratio of 1.8, and an intake and dilution air humidity of 75 grains (10.71 $g_{water}/kg_{dry\ air}$ or 54.13 percent RH at 25 deg.C and 101.3 kPa),

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Amend § 86.1330-90, Title 40, Code of Federal Regulations, to read:

§ 86.1330-90 Test sequence; general requirements. ~~April 11, 1989~~ January 18, 2001

* * * * *

Amend § 86.1334-84, Title 40, Code of Federal Regulations, to read:

§ 86.1334-84 Pre-test engine and dynamometer preparation. ~~December 10, 1984~~ January 18, 2001

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Adopt § 86.1337-2007, Title 40, Code of Federal Regulations, to read:

§ 86.1337-2007 Engine dynamometer test run. January 18, 2001

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Adopt § 86.1338-2007, Title 40, Code of Federal Regulations, to read:

§ 86.1338-2007 Emission measurement accuracy. January 18, 2001

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Amend § 86.1339-90, Title 40, Code of Federal Regulations, to read:

§ 86.1339-90 Particulate filter handling and weighing. ~~April 11, 1989~~ January 18, 2001

* * * * *

Amend § 86.1360-2007, Title 40, Code of Federal Regulations, to read:

§ 86.1360-2007 Supplemental steady-state test; test cycle and procedures. October 6, 2000.

(a) Applicability. This section applies to 2005 and subsequent model year heavy duty diesel engines.

(b) Test cycle.

(1)(i) The following 13-mode cycle must be followed in dynamometer operation on the test engine:

Mode Number	Engine Speed	Percent Load	Weighting Factor	Mode Length (minutes)
1	Idle	--	0.15	4
2	A	100	0.08	2
3	B	50	0.10	2
4	B	75	0.10	2
5	A	50	0.05	2
6	A	75	0.05	2
7	A	25	0.05	2
8	B	100	0.09	2
9	B	25	0.10	2
10	C	100	0.08	2
11	C	25	0.05	2
12	C	75	0.05	2
13	C	50	0.05	2

(ii) For 2007 and subsequent model years, upon Executive Officer approval, the manufacturer may use mode lengths other than those listed in subparagraph (b)(1)(i) of this section.

(2) In addition to the 13 test points identified in paragraph (b)(1) of this section, for engines not certified to a NOx emission standard or FEL less than 1.5 g/bhp-hr, ARB may select, and require the manufacturer to conduct the test using, up to 3 additional test points within the control area (as defined in paragraph (d) of this section). ARB will notify the manufacturer of these supplemental test points in writing in a timely manner before the test. Emissions sampling for the additional test

modes must include all regulated gaseous pollutants. Particulate matter does not need to be measured.

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(e) Test requirements. (1) Engine warm-up. Prior to beginning the test sequence, the engine must be warmed-up according to the procedures in § 86.1332-90(d)(3)(i) through (iv).

(2) Test sequence. The test must be performed in the order of the mode numbers in paragraph (b)(1) of this section. Where applicable, ~~T~~the ARB-selected test points identified under paragraph (b)(2) of this section must be performed immediately upon completion of mode 13. The engine must be operated for the prescribed time in each mode, completing engine speed and load changes in the first 20 seconds of each mode. The specified speed must be held to within plus or minus (+/-) 50 rpm and the specified torque must be held to within plus or minus two percent of the maximum torque at the test speed.

(3) Particulate sampling. One ~~pair of~~ filter~~s (primary and back-up)~~ shall be used for sampling PM over the 13-mode test procedure. The modal weighting factors specified in paragraph (b)(1) of this section shall be taken into account by taking a sample proportional to the exhaust mass flow during each individual mode of the cycle. This can be achieved by adjusting sample flow rate, sampling time, and/or dilution ratio, accordingly, so that the criterion for the effective weighting factors is met. The sampling time per mode must be at least 4 seconds per 0.01 weighting factor. Sampling must be conducted as late as possible within each mode. Particulate sampling shall be completed no earlier than 5 seconds before the end of each mode.

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(ii) For PM measurements, a single ~~pair of~~ filter~~s~~ must be used to measure PM over the 13 modes. The brake-specific PM emission level for the test must be calculated as described for a transient hot start test in § 86.1343-88. Only the power measured during the sampling period shall be used in the calculation.

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(j) Emission testing caps. (1) The weighted average exhaust emissions, as determined under paragraph (e)(5) and (6) of this section pertaining to the supplemental steady-state test cycle, for each regulated pollutant shall not exceed 1.0 times the applicable emission standards specified in California Code of Regulations, title 13, §1956.8 (a)(~~1~~2) or §1956.8 (h)(2), or FELs specified in §86.007-11 (a)(1).

(2) For engines not having a NOx FEL less than1.5 g/bhp-hr, ~~G~~gaseous exhaust emissions shall not exceed the steady-state interpolated values determined by the

Maximum Allowable Emission Limits (for the corresponding speed and load), as determined under ~~paragraph~~ subdivision (g) of this section, when the engine is operated in the steady-state control area defined under ~~paragraph~~ subdivision (d) of this section, during steady-state engine operation.

(3) For engines with a NOx FEL less than1.5 g/bhp-hr, the Maximum Allowable Emission Limit requirements, as determined under Sec. 86.1360-2007(f), do not apply.

(4) The emission caps specified in this section shall be rounded to the same number of significant figures as the applicable standards in California Code of Regulations, Title 13, §1956.8 (a)(2) or §1956.8 (h)(2), using ASTM E29-93a.

* * * * *

Amend § 86.1370-2007, Title 40, Code of Federal Regulations, to read:

§ 86.1370-2007 Not-To-Exceed (NTE) test procedures. October 6, 2000.

(a) General. The purpose of this test procedure is to measure in-use emissions of 2005 and subsequent model year 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 paragraph (d)(1) of this section. The Not-To-Exceed Limits specified in paragraph (d)(1) of this section do not apply for engine starting conditions specified in subdivision (k) of this section.

(b) Not-to-exceed control area for heavy-duty diesel engines. The Not-To-Exceed Control Area for heavy-duty diesel engines consists of the following engine speed and load points:

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(5) For particulate matter only from 2005 and 2006 model year engines, speed and load points determined by one of the following methods, whichever is applicable, shall be excluded from the Not-To-Exceed Control Area. B and C engine speeds shall be determined according to the provisions of § 86.1360-2007(c):

(i) If the C speed is below 2400 rpm, the speed and load points to the right of or below the line formed by connecting the following two points:

(A) 30% of maximum torque or 30% of maximum power, whichever is greater, at the B speed;

(B) 70% of maximum power at 100% speed (n_{hi});

(ii) If the C speed is above 2400 rpm, the speed and load points to the right of the line formed by connecting the two points in ~~paragraphs~~ item (b)(5)(ii)(A) and (B) of this section and below the line formed by connecting the two points in ~~paragraphs~~ item (b)(5)(ii)(B) and (C) of this section:

(A) 30% of maximum torque or 30% of maximum power, whichever is greater, at the B speed;

(B) 50% of maximum power at 2400 rpm;

(C) 70% of maximum power at 100% speed (n_{hi}).

INSERT

(6)(i) For 2007 and subsequent model year petroleum-fueled diesel cycle engines, a manufacturer may identify particular engine-vehicle combinations and may petition the Executive Officer at certification to exclude operating points from the Not-to-Exceed Control Area defined in Sec. 86.1370-2007(b)(1) through (4) 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 2007 and subsequent model year diesel cycle engines that are not petroleum-fueled, a manufacturer may petition the Executive Officer at certification to exclude operating points from the Not-to-Exceed Control Area defined in Sec. 86.1370-2007(b)(1) through (4) if the manufacturer can demonstrate that the engine is not expected to operate at such points in normal vehicle operation and use.

(7) For 2007 and subsequent model year petroleum-fueled diesel cycle engines, a manufacturer may petition the Executive Officer 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 Executive Officer 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 ARB-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.

(c) [Reserved]

(d) Not-to-exceed control area caps. (1) (i)The emission caps specified in this section shall be rounded to the same number of significant figures as the applicable standards in California Code of Regulations, Title 13, §1956.8 (a) using ASTM E29-93a.

(~~1~~ ii) For 2005 and 2006 model year engines, ~~W~~when operated within the Not-To-Exceed Control Area defined in ~~paragraph~~ subdivision (b) of this section, diesel engine brake-specific exhaust emissions in grams/bhp-hr (as determined under ~~paragraphs~~ subdivisions (b) and (c) of this section), for each regulated pollutant, shall not exceed 1.25 times the applicable emission standards specified in California Code of Regulations, Title 13, §1956.8 (a)(~~1~~2) and (h)(2) during engine and vehicle operation specified in paragraph (e)(1) of this section, except as noted in paragraph (e)(2) of this section, 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.

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(iii) For 2007 and subsequent model year engines having a NOx FEL less than 1.50 g/bhp-hr, the brake-specific exhaust NMHC or NOx emissions in g/bhp-hr, as determined under Sec. 86.1370-2007 pertaining to the NTE test procedures, shall not exceed 1.5 times the applicable NMHC or NOx emission standards or FELs specified in California Code of Regulations, title 13, §1956.8 (a)(2) and (h)(2), during engine and vehicle operation specified in subdivisions (b), (e), (f), and (g) of this section 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.

(iv) For 2007 and subsequent model year engines not having a NOx FEL less than 1.50 g/bhp-hr, the brake-specific NOx and NMHC exhaust emissions in g/bhp-hr, as determined under Sec. 86.1370-2007 pertaining to the not-to-exceed test procedures, shall not exceed 1.25 times the applicable emission standards or FELs specified in California Code of Regulations, title 13, §1956.8 (a)(2) and (h)(2), during engine and vehicle operation specified in paragraphs (b), (e), (f), and (g) of this section 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.

(v) For 2007 and subsequent model year engines, the brake-specific exhaust PM emissions in g/bhp-hr, as determined under Sec. 86.1370-2007 pertaining to the not-to-exceed test procedures, shall not exceed 1.5 times the applicable PM emission standards or FEL (for FELs above the standard only) specified in California Code of Regulations, title 13, §1956.8 (a)(2) and (h)(2), during engine and vehicle operation specified in paragraphs (b), (e), (f), and (g) of this section 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) ~~[Reserved]~~ 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 (d)(2) only applies for engines that send an electronic signal indicating the start of the regeneration event.

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(f) NTE cold temperature operating exclusion. 2007 and subsequent model year engines equipped with exhaust gas recirculation (EGR) whose operation within the NTE control area specified in §86.1370(b) when operating during cold temperature conditions

as specified in paragraph (f)(1) of this section are not subject to the NTE emission caps during the specified cold temperature operation conditions.

(1) Cold temperature operation is defined as engine operating conditions meeting either of the following two criteria:

(i) Intake manifold temperature (IMT) less than or equal to the temperature defined by the following relationship between IMT and absolute intake manifold pressure (IMP) for the corresponding IMP.

$$P = 0.0875 \times IMT - 7.75 \qquad \text{Equation (1)}$$

Where;

P = absolute intake manifold pressure in bars
IMT = intake manifold temperature in degrees Fahrenheit

(ii) Engine coolant temperature (ECT) less than or equal to the temperature defined by the following relationship between ECT and absolute intake manifold pressure (IMP) for the corresponding IMP.

$$P = 0.0778 \times ECT - 9.8889 \qquad \text{Equation (2)}$$

Where;

P = absolute intake manifold pressure in bars
ECT = engine coolant temperature in degrees Fahrenheit

(2) [Reserved]

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(i) Deficiencies for NTE requirements. (1) For model years 2005 through ~~2007~~ 2009, upon application by the manufacturer, the Executive Officer may accept a HDDE as compliant with the NTE requirements even though specific requirements are not fully met. Such compliances without meeting specific requirements, or 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 and lead time and production cycles including phase-in or phase-out of engines or vehicle designs and programmed upgrades of computers. Deficiencies will be approved on a engine model and/or horsepower rating basis within an engine family, and each approval is applicable for a single model year. A manufacturer's application must include a description of the auxiliary emission control device(s) which will be used to maintain emissions to the lowest practical level, considering the deficiency being requested, if applicable. An application for a deficiency must be made during the certification process; no deficiency will be granted to retroactively cover engines already certified.

(2) Unmet requirements 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 Executive Officer. The NTE deficiency should only be seen as an allowance for minor deviations from the NTE requirements. The NTE deficiency provisions allow a manufacturer to apply for relief from the NTE emission requirements under limited conditions. ARB expects that manufacturers should have the necessary functioning emission control hardware in place to comply with the NTE.

(3) For model years 2010 through 2013, the Executive Officer may allow up to three deficiencies per engine family. The provisions of §86.007-11 (a)(4)(iv)(A) and §86.007-11 (B) apply for deficiencies allowed by §86.007-11 (a)(4)(iv)(C). In determining whether to allow the additional deficiencies, the Executive Officer may consider any relevant factors, including the factors identified in §86.007-11 (a)(4)(iv)(A). If additional deficiencies are approved, the Executive Officer may set any additional conditions that he/she determines to be appropriate.

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(k) NOx and NMHC aftertreatment warm-up. For 2007 and subsequent engines equipped with one or more aftertreatment devices that reduce NOx or NMHC emissions, the NTE NOx and NMHC emission caps do not apply when the exhaust gas temperature is measured within 12 inches of the outlet of the aftertreatment device and is less the 250 deg.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 caps apply.