

State of California  
AIR RESOURCES BOARD

**Final Statement of Reasons for Rulemaking,  
Including Summary of Comments and Agency Response**

PUBLIC HEARING TO CONSIDER AMENDMENTS TO REGULATIONS REGARDING CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1985 AND SUBSEQUENT MODEL HEAVY-DUTY DIESEL-ENGINES AND VEHICLES, TO SPECIFY STANDARDS FOR 1994 AND SUBSEQUENT URBAN BUS ENGINES.

Public Hearing Date: June 10, 1993  
Agenda Item No.: 93-7-4

I. GENERAL

The Staff Report: Initial Statement of Reasons for Rulemaking ("staff report"), "Public Hearing to Consider Amendments to Regulations Regarding California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy-Duty Diesel-Engines and Vehicles, to Specify Standards for 1994 and Subsequent Urban Bus Engines", released April 23, 1993, is incorporated by reference herein.

Following a public hearing on June 10, 1993, the Air Resources Board (the "Board" or "ARB") by Resolution 93-46 approved adoption of regulations to establish new, more stringent, exhaust emission standards for 1994 and subsequent urban bus engines, amendments to the emission control label specifications, and amendment of the useful life definition for heavy-duty engines and vehicles, specifically for urban buses. The Board approved, with some modifications, the regulations as originally proposed by staff. The regulations approved by the Board are contained in Title 13, California Code of Regulations (CCR), sections 1956.8, 1965, and 2112.

II. BACKGROUND

Senate Bill 135 (Stats. 1991, ch. 496) and Health and Safety Code section 43806 provide that the ARB shall adopt new emission standards and test procedures for transit buses to be implemented no later than January 1, 1996. This statute directs the ARB to set emission standards that would reflect the use of the best emission control technologies expected to be available at the time the standards and procedures become effective. In adopting the standards, the ARB shall consider the projected costs and availability of cleaner burning alternative fuels and low-emission vehicles compared with other air pollution control measures. The ARB has consulted with the engine manufacturers, transit agencies, utility companies, and other related industries in developing the regulations.

The proposed regulations would align California with the recently adopted federal Environmental Protection Agency's (EPA) regulations which require engines used in 1994 and 1995 model year urban buses to meet a 0.07 gram per brake horsepower-hour (g/bhp-hr) particulate matter (PM) standard and those used in 1996 and later model year urban buses to meet a 0.05 g/bhp-hr PM standard with a 0.07 g/bhp-hr PM in-use standard. Also, the proposed regulations would require all 1996 and later California urban bus engines to meet a mandatory oxides of nitrogen (NOx) standard of 4.0 g/bhp-hr.

Further, it was proposed that optional, more stringent, NOx emission standards be adopted, beginning with the 1994 model year. The optional NOx emission standards would range from 0.5 to 3.5 g/bhp-hr for the 1994 and 1995 model years and from 0.5 to 2.5 g/bhp-hr for the 1996 and later model years, at 0.5 g/bhp-hr increments. This would allow low-emitting urban bus engines to be certified to more stringent standards and purchased to create NOx emission credits that could be used in a mobile source emission credit program. The ARB recently published specific guidance for the generation and use of mobile source emission reduction credits to the air pollution control districts who might want to adopt and implement their own program. Such a program would provide flexibility to industry in meeting requirements for emission reductions needed to offset increases in emissions associated with economic growth, and to reduce emissions from certain mobile sources. The development of such programs may also encourage the advancement of technologies that increase the emission reductions possible from mobile sources, such as the advancement of electric-powered vehicles and fuel cell technology. The proposed optional emission standards, as part of this regulatory action, are supportive of these goals. Staff believes that the proposed mandatory and optional emission standards provide a balanced proposal that requires the further reduction of NOx and PM emissions from urban buses while encouraging the use of cleaner operating buses.

To help identify those engines that are certified to the proposed optional emission standards, it was proposed that information be added to the emission control label for each engine. This information would identify the engine by the optional NOx emission standard it is certified to, and would state that it meets all other applicable California emission standards for that particular engine model year. Supplemental emission control labels may be used as an option.

Other proposed changes included adoption of the new federal urban bus definition that would clarify that urban buses are passenger-carrying vehicles, normally powered by heavy heavy-duty engines, with load capacities of fifteen or more passengers and intended primarily for intra-city operation. Urban bus operation is also characterized by short rides and frequent stops and normally equipped with 2 sets of doors and a farebox. In addition, the proposed regulations would align California regulations with the recently adopted federal extended useful life requirement of 10 years/290,000 miles for heavy heavy-duty diesel engines used in urban buses, for the 1994 and later model year PM standards.

The staff has estimated the statewide emissions benefit of the proposed mandatory emission standards for urban buses as 4.4 tons per day of NOx and 1.5 tons per day of PM by the year 2010; the time when the maximum emissions benefit would be achieved. These reductions would account for 20 percent of the NOx and one-half of the PM emissions from urban buses statewide.

### III. MODIFICATIONS TO THE REGULATIONS

As approved on June 10, 1993, the original proposal was modified to include changes adopted by the Board to address low-aromatics diesel fuel used for certification and exemption provisions.

#### A. LOW-AROMATICS DIESEL FUEL FOR CERTIFICATION

The original proposal required the urban bus engine manufacturers to continue using only low-sulfur (0.05 percent) diesel fuel for certifying to the proposed emission standards. The proposal has been modified to allow the use of California diesel fuel, with 0.05 percent sulfur and 10 percent aromatic hydrocarbon content specifications, for certifying urban bus engines. Low-aromatics diesel fuel will only be allowed for the 1996 and 1997 model years to help the manufacturers meet the 1996 4.0 g/bhp-hr NOx standard adopted by the Board. The Board recognized that low-aromatics diesel fuel may help manufacturers in meeting the 4.0 NOx standard, and is consistent with the diesel fuel that will be commercially available in California. However, in 1998, the federal 4.0 g/bhp-hr NOx standard for all heavy-duty vehicles will become effective and will necessitate that federal diesel fuel specifications be used.

#### B. EXEMPTIONS

Also, the original proposal required that all 1996 and later urban bus engines meet the mandatory 4.0 g/bhp-hr NOx standard. The proposal was modified to allow an exemption from the 1996 4.0 NOx standard of up to 10 percent of the model-year sales for 1996 and 1997 model-year urban bus engines based on each manufacturer's urban bus engine sales in the three years preceding the model year. The Board recognized the need to provide some flexibility to the manufacturers for 1996 and 1997 for certifying small sales volume engines such as higher horsepower engines used in articulated buses. However, the exemptions will be based on the technical justification to be submitted to the ARB by the manufacturers.

### IV. FISCAL AND BUSINESS IMPACT ISSUES

#### A. LOCAL GOVERNMENT IMPACT

SB 135 requires that the ARB adopt emission standards and test procedures for transit buses. Public transit agencies that own or operate transit buses shall purchase transit buses that conform to the standards and test procedures adopted by the Board.

There are approximately 150 public transit agencies that are supported by local government in California. The incremental cost for a 4.0 g/bhp-hr NOx bus over a baseline diesel-trap bus, has been estimated to be \$5,000 with approximately 300 to 400 urban bus engines being sold each year in California. Also, it is estimated that there would be an additional \$417/bus/year in fuel cost that comes from a slight fuel penalty from the use of exhaust gas recirculation (EGR) on a diesel-trap bus. Staff

estimates that the maximum statewide incremental cost to purchase new urban buses (600-800 engines for 2 years) to meet the mandatory emission standards for 2 years is approximately \$3.3 to \$4.3 million (bus capital costs + fuel cost). This cost is based on the assumption that the same number of engines will be sold after the 1996 implementation of the urban bus standards and takes into account EPA's adoption of a 4.0 g/bhp-hr NOx standard for 1998 and later heavy-duty engines (including buses). However, the actual costs will be unique to each transit agency, dependent on the number of new buses that are purchased.

It is expected that there will be a small cost impact difference between small transit agencies and larger transit agencies. Staff has estimated the cost of a 4.0 g/bhp-hr NOx diesel-trap bus to be \$230,000. However, small transit agencies may incur an extra 5 to 10 percent cost increase in the bid price per bus due to smaller quantity bus orders. Thus, a small transit agency could pay as much as \$241,500 to \$253,000 per bus whereas a larger transit agency could be paying \$230,000 per bus. It is expected that prices will differ for each transit agency depending on the bid price agreement made with the bus supplier. This is a historical trend and is based on the cost of doing business. Therefore, any additional cost to smaller transit agencies is not expected to be a result of the proposed urban bus regulations. Furthermore, staff has endeavored to minimize the cost impact to small transit agencies as well as larger transit agencies while still obtaining emission benefits. As proposed, the applicability of the regulations would be limited to urban buses, which may exempt many of the small transit agencies which use smaller transit buses (less than 33,000 pounds gross vehicle weight rating). Also, staff has proposed a mandatory 4.0 g/bhp-hr NOx standard which is feasible for diesel urban buses, and optional NOx standards which would allow transit agencies the option of purchasing cleaner operating buses.

These local costs are not reimburseable state mandated local costs pursuant to Section 6 of Article XIII B of the California Constitution because the only costs which may be incurred by a local agency will be incurred because this act creates a new crime or infraction, changes the definition of a crime or infraction, changes the penalty for a crime or infraction, or eliminates a crime or infraction, as stated in SB 135.

## B. BUSINESS IMPACT

The transit bus regulations would apply to all manufacturers of urban bus engines that intend to certify urban bus engines for sale in the State of California. Manufacturers subject to the regulations would be required to comply with the emission standards, test procedures, and other requirements of the regulations.

Staff has determined that the maximum incremental cost to manufacturers for complying with the regulations is estimated to be \$5,000 per bus or \$1.5 to \$2 million for an average California sales projection of 300 to 400 urban buses per year (\$3 to \$4 million for 2 years).

The transit bus regulations may also impose compliance costs on manufacturers directly affected, if manufacturers choose to use the optional supplemental labeling requirement provided by the regulations.

The Board has further determined that no alternative considered by the agency would be more effective in carrying out the purpose for which the regulatory action was proposed or would be as effective and less burdensome to affected private persons than the action taken by the Board.

The incorporated test procedures have been incorporated because it would be cumbersome, unduly expensive, or otherwise impractical to publish the documents in the CCR.

## V. SUMMARY OF COMMENTS AND AGENCY RESPONSE

During the 45-day comment period, the Board received written comments from Long Beach Transit (LB Transit), Cummins Engine Company (Cummins), Detroit Diesel Corporation (DDC), Engine Manufacturers Association (EMA), Manufacturers of Emission Controls Association (MECA), and the California Natural Gas Vehicle Coalition (CA NGVC).

At the public hearing, oral testimony was given by Cummins, DDC, EMA, MECA, CA NGVC, South Coast Air Quality Management District (SCAQMD), Los Angeles County Metropolitan Transportation Authority (LACMTA), and Sacramento Regional Transit (RT).

No written comments were received during the 15-day comment period in response to modifications made to the originally proposed regulatory language.

The Board received written comments and oral testimony favorable to the original proposal from the SCAQMD, LACMTA, MECA, CA NGVC, and RT. These written and oral comments are not summarized nor responded to herein.

### A. IMPLEMENTATION/LEADTIME ISSUES

1. Comment: Delay the mandatory 4.0 g/bhp-hr NO<sub>x</sub> standard until 1998 when trucks and urban buses can be brought into compliance at the same time. (Cummins, DDC, LB Transit)

2. Comment: Engine manufacturers' human and capital resources are stretched to the breaking point. They will need to redevelop virtually their entire line of engines to meet several challenging new emission standards. In the next few years, manufacturers must meet new EPA and ARB rules for emissions from non-road engines, the new EPA urban bus rules, the stringent new ARB emission rules for medium-duty vehicles, the EPA rules for NO<sub>x</sub> emissions from all heavy-duty engines, as well as other regulatory requirements. Their ability to meet the proposed 1996 mandatory standards may be governed more by resource limitations and business priorities than technical feasibility. (Cummins, DDC, EMA)

Agency Response: Health and Safety Code section 43806 requires that the new emission standards adopted for transit buses must be implemented by January 1, 1996. The ARB staff believes the 4.0 g/bhp-hr NO<sub>x</sub> standard to be feasible and cost-effective for 1996 implementation, based on current and expected future emission control technology. There are alternative-fueled urban bus engines that are already certified to provide significant emission reductions. Furthermore, since the engine manufacturers did not feel that there was adequate leadtime to develop lower-emitting engines for the lighter buses, those generally less than

33,000 pounds, the ARB staff proposed that only the larger urban buses be included in the proposed regulations. The mandatory standards would, therefore, be limited to only about 5 or 6 engine families.

In this proposal, the ARB is already aligning with the new EPA urban bus rule for PM by adopting a 0.07 g/bhp-hr PM standard for the 1994 and 1995 model years and a 0.05 g/bhp-hr PM standard for the 1996 and later model years. Some manufacturers currently offer urban bus engines that already meet these standards and other urban bus engines may need only minor engine modifications or catalysts to meet these standards. As for EPA's 4.0 g/bhp-hr NOx standard for all 1998 and later heavy-duty engines, the ARB staff believes that since the manufacturers need to develop strategies for meeting this standard in 1998, it seems logical to concentrate the technology first on a smaller segment of the heavy-duty vehicle population, such as urban buses, which could then be expanded to all heavy-duty engines. The ARB has worked with the manufacturers to provide feasible emission standards while still meeting the requirements and intent of the Legislature. The manufacturers have not provided the ARB with any information or data to show that the proposed transit bus regulations would not be able to be met. Furthermore, the Board adopted modifications to allow the use of California clean diesel fuel (low sulfur/low aromatics) for the certification of 1996 and 1997 urban buses and a limited number of exemptions of up to 10 percent of the model-year sales for 1996 and 1997 model year urban bus engines. These provisions should ease the manufacturers' resource and technology concerns. At the Board hearing, DDC testified that these options would allow them to supply engines for 1996.

As to the other California emission standards mentioned by the commenters, but which are not part of this rulemaking action, the ARB has provided the manufacturers with technologically feasible emission standards while endeavoring to also provide some flexibility to achieve these standards. For heavy-duty off-road diesel cycle engine emission standards, the ARB changed its original proposal of a 1995 implementation date to 1996 to address the manufacturers' concerns even though the technology needed to control off-road engine emissions is known and has been proven on on-road engines. Also, the low-emission medium-duty vehicle standards, beginning in 1998, are being phased-in over 6 years to provide flexibility to the manufacturers.

3. Comment: The statutory requirements are being fulfilled by the proposal of lower PM standards and the optional NOx standards that are being recognized for emissions credit generation without having to bring ahead the 4.0 g/bhp-hr NOx rule two years early. (EMA)

Agency Response: The ARB is adopting lower PM emission standards for urban buses in order to align the regulations with federal requirements, rather than proposing more stringent PM standards for California urban buses. Lowering PM emission standards, by itself, would not meet the requirements of Health and Safety Code section 43806. The lower, more stringent, NOx standards are optional and are being adopted to generate emission credits whose sale (most likely to stationary sources for offset) would aid in the purchase of the buses meeting the optional lower-emissions standards. The Board has adopted the mandatory 4.0 g/bhp-hr NOx standard in 1996 as the regulatory proposal having the least adverse impact on the manufacturers and transit agencies while still complying with the mandates of Health and Safety Code section 43806.

4. Comment: The certification process is very demanding and there's been little consideration given to streamlining the certification process for new technologies leaving less than the 2-year leadtime for engine development. If the industry is required to develop unique engine hardware than what would normally be developed for a 1998 requirement, then we will have introduced into commerce non-standard parts which must be stocked and serviced. This adds expense and complexity to the customer. This additional requirement for a unique 2-year engine is not justified. (Cummins)

Agency Response: The ARB anticipates that very few unique parts will be needed for manufacturers to meet a 4.0 g/bhp-hr NOx standard, especially in light of the modifications to the regulations to allow for certification of engines with the clean diesel fuel and the 10 percent exemption provisions. Also, several transit agencies around the state voluntarily have operated and maintained alternative-fueled buses which necessitate stocking unique parts. The added complexity and expense of stocking unique parts for alternative-fueled buses, which are far more involved than for 4.0 g/bhp-hr NOx diesel buses, have evidently not been overly burdensome to transit agencies and have not deterred them from their alternative-fuel programs.

The current regulations provide for demonstration and experimental permit programs for new technologies. The ARB has encouraged alternative fuel usage and the development of advanced diesel technologies. However, all new technologies as well as current technologies must meet the applicable emission standards and test procedures to ensure that durability and in-use issues are addressed before certification can take place. The certification process also addresses warranty requirements and measures to discourage tampering.

The ARB staff believes that the manufacturers will likely develop similar strategies to meet both the California 1996 NOx standard for urban buses and the federal 1998 NOx standard for all heavy-duty engines, thereby minimizing the costs and the likelihood of non-standard parts. The ARB staff acknowledges that urban bus engines may increase in cost due to this earlier implementation of a 4.0 g/bhp-hr NOx standard. However, the conservative cost-effectiveness estimate of \$2.10 per pound of NOx reduced would place the 4.0 g/bhp-hr standard within the acceptable cost-effectiveness ranges of other regulations previously adopted by the Board.

5. Comment: Because of the long purchasing cycles for buses, California transit operators will need to make difficult decisions about their 1996 bus purchases in the very near future before it is known whether diesel buses will be available in 1996. (DDC)

Agency Response: Funding is available to transit agencies through federal, state, and local sources on an annual basis and each transit agency must determine for itself which combination of bus purchases would best serve its needs. The ARB staff's proposal of mandatory and optional standards allows diesel and alternative fuel engines to play a role in the urban bus market. The ARB staff has evaluated the current emission control technologies and the potential of future advanced technologies and believes that diesel urban bus engines will be available in 1996 that would meet the

proposed mandatory standards. Additionally, the clean diesel fuel and exemption provisions would further ensure that diesel-fueled buses are available to the transit agencies by 1996. DDC testified at the hearing that diesel-fueled urban buses would be available with the adopted provisions.

The ARB also proposed a range of optional lower NOx standards to encourage alternative-fueled buses to allow transit agencies to earn emission reduction credits, which can be marketed. The sale of these credits can then help offset the extra costs of switching to alternative fuels. The ARB believes that its proposal allows the transit agencies the flexibility that is needed to make their important bus purchasing decisions.

## B. FEASIBILITY OF THE PROPOSED MANDATORY EMISSION STANDARDS

6. Comment: Attempting to pull ahead diesel technology by two years to meet the proposed California standards in 1996 may not be feasible. The staff has been overly optimistic in forecasting the availability of the technologies needed to meet a 4.0 g/bhp-hr NOx level which will, in turn, create a high degree of uncertainty regarding the availability of diesel-fueled engines in 1996. Except for catalysts and exhaust gas recirculation (EGR), all the diesel technologies mentioned in the ARB staff report are already in use on current model year DDC engines. While some refinements of these technologies may yet be possible, it must be recognized that their emission reduction potential has, for the most part, already been exploited in reaching the low emission levels which we have today. (DDC, EMA, LB Transit)

Agency Response: The ARB believes that the proposed mandatory 4.0 g/bhp-hr NOx and 0.05 g/bhp-hr PM standards are feasible with diesel technology as well as alternative fuel technology for 1996 implementation. While it is true that diesel emission control technologies such as retarding injection timing, higher injection pressures, turbochargers and aftercoolers, and some combustion chamber modifications are being used on current diesel engines, the ARB believes that further improvements can be made to these technologies that would allow the proposed mandatory standards to be met. If needed, the addition of EGR would provide another means to comply with the proposed mandatory standards. Significantly, however, the federal EPA's technological assessment on their 4.0 g/bhp-hr NOx standard adopted for 1998 and later heavy-duty engines did not include EGR as a necessary technology for meeting 4.0 g/bhp-hr NOx.

Currently, there are two diesel particulate trap engines, two methanol engines, and one compressed natural gas (CNG) engine that have been certified for urban bus applications. DDC also has certified their Series 50 diesel engine with a NOx level of 4.6 g/bhp-hr and a PM level of 0.08 g/bhp-hr without any exhaust aftertreatment. The alternative-fueled engines already meet very low NOx and PM levels and the diesel engines meet or nearly meet the proposed 0.05 g/bhp-hr PM standard. Among the various technology options, it is expected that the manufacturers will be able to concentrate their efforts on reducing the NOx emissions down to the proposed standard by using aftertreatment devices to control the PM emissions.

In addition, the Board provided the manufacturers with increased flexibility in meeting the standards by allowing the use of California clean diesel fuel with a low aromatics content and a limited number of exemptions for small sales volume engines up to a 10 percent cap. For example, the use of low aromatics diesel fuel for certification amounts to a 0.5 g/bhp-hr reduction in NOx and should enable the DDC Series 50 urban bus engine, with other minor modifications, to easily meet the 4.0 g/bhp-hr NOx standard.

7. Comment: EGR has not been used on heavy-duty diesel engines because of the added cost, complexity, and uncertain reliability of the EGR plumbing and the sophisticated control system which would be required to regulate the EGR flow. Engine life may be significantly reduced because EGR can cause fouling of the engine intake air system and increase wear of cylinder components. Particulate emissions can also increase with the use of EGR and new challenges arise when attempting to use EGR in combination with the aftertreatment devices which will be required to meet the very stringent urban bus particulate standards. Given these concerns, it's not reasonable to assume this technology can be developed, proven, and made available for widespread commercial application by 1996. (DDC)

8. Comment: Cummins is in the early stages of developing EGR and it is our proposal to meet the EPA's 1998 4.0 g/bhp-hr NOx standard with an EGR system. However, we are not in production with such a system yet and Cummins is not aware of any EGR system in production that is a proven and available technology that we could just pick off the shelf and add on. (Cummins)

Agency Response: EGR is one of the most effective methods for reducing NOx emissions to low levels. By recirculating spent combustion gases back into the engine's intake system, the oxygen concentration is lowered while the heat capacity of the air/fuel charge is increased. These effects reduce the peak combustion temperature and the rate of combustion, thus reducing NOx emissions.

Navistar's experimental 7.3 DIT heavy-duty diesel engine utilizes EGR and has reported preliminary results of 2.9 g/bhp-hr NOx at 0.10 g/bhp-hr PM (with no aftertreatment devices). Although this is not an urban bus engine, it demonstrates the significant NOx reduction potential of EGR on diesel engines. In addition, with the very low PM levels in current diesel engines and low-sulfur diesel fuel, EGR systems would be expected to not be subject to plugging. Therefore, EGR is more durable and feasible for heavy-duty diesel engines than in the past. The ARB believes that EGR could be used to reduce NOx emissions to 4.0 g/bhp-hr and lower. Although PM emissions may increase slightly with EGR usage, particulate traps, catalytic traps, or oxidation catalysts could be used to control the excess PM emissions down to 0.05 g/bhp-hr.

The ARB believes that the use of EGR technology would be a worst case scenario for meeting a 4.0 NOx standard in 1996 and is not likely to be necessary for widespread commercial application. As mentioned in response to comment 6, the California clean diesel fuel should enable some diesel engine families to meet a 4.0 g/bhp-hr NOx standard without EGR. However, the ARB has determined that even with the incremental \$5,000 cost of using EGR combined with all the other emission control technologies mentioned, the proposal is still cost-effective and feasible.

9. Comment: Meeting the proposed PM standards for 1994 and 1996 will necessitate significant development work by the engine manufacturers. Combining a 4.0 g/bhp-hr NOx standard in 1996 would exacerbate the development effort further. (Cummins)

10. Comment: No combination of clean fuel and technology refinements, other than EGR, is going to get us to 4.0 g/bhp-hr NOx by 1996 with the quality we demand and that our customers demand. We think that we can achieve it by 1998 without low aromatics diesel fuel (only low sulfur), but not by 1996. (Cummins)

Agency Response: There is already emission control technology available to minimize PM emissions as shown by the DDC 6V-92TA diesel-trap urban bus engine certified at 0.06 g/bhp-hr PM and the Cummins L-10 diesel-trap urban bus engine certified at 0.05 g/bhp-hr PM. Both these engines meet the proposed 0.07 g/bhp-hr PM standard for 1994 and 1995 model year urban buses and meet or nearly meet the 0.05 g/bhp-hr PM standard for 1996. By combining a 4.0 g/bhp-hr NOx standard in 1996, the ARB realizes that the manufacturers will need to examine their emission control strategies more carefully. However, the ARB believes that the manufacturers will be able to achieve 4.0 NOx levels since the aftertreatment devices will control the PM emissions, thus the NOx emissions can be brought down through modifications to the combustion chamber, injection timing and pressures, and engine cooling. EGR could also be added, if necessary.

Low aromatics/low sulfur diesel fuel would provide an added emissions benefit of approximately 0.5 g/bhp-hr NOx. At the Board hearing, EMA and DDC testified that the allowance for the use of California clean diesel fuel for certification testing and for exemptions for smaller sales volume engines may provide enough assistance to meet the 4.0 g/bhp-hr NOx standard in 1996. The Board's adoption of these provisions addresses the manufacturers' concerns and further ensures diesel-fueled urban bus engine model availability.

11. Comment: EMA does not understand the ARB's proposal of not including the allowance of low aromatics diesel fuel for certification purposes. Since the buses will utilize the California specified fuel throughout its useful life, it would seem straightforward that the engine should be certified on that fuel which is expected to be used in the commercial marketplace. Low aromatics fuel for certification will provide some NOx reduction benefits. However, those benefits do not compensate for the difference between California's more stringent 4.0 g/bhp-hr NOx standard and EPA's 5.0 g/bhp-hr NOx standard for 1996 urban bus engines. (EMA)

12. Comment: Allow the use of low aromatics fuel or its equivalent for urban bus engine certification testing. (DDC, EMA)

Agency Response: The Board recognizes the benefits of low aromatics fuel and is allowing clean diesel fuel to be used for certification purposes for the 1996 and 1997 model years. In 1998 and thereafter, since the federal EPA does not allow low aromatics diesel fuel to be used for certification of 1998 and later heavy-duty engines to meet the federal 4.0 g/bhp-hr NOx standard, the ARB has adopted the federal fuel standard to be consistent with the federal requirement.

Additionally, even though California urban buses will be required to use California specified diesel fuel throughout their useful lives, the ARB believes that a 4.0 g/bhp-hr NOx standard can be achieved with just the current low sulfur certification diesel fuel. Also, because low aromatics diesel fuel will not be available for use to meet EPA's 1998 4.0 NOx standard, the manufacturers will need to develop engines for meeting a 4.0 g/bhp-hr standard nationwide without the help of low aromatics fuel.

As mentioned in the response to comments 9 and 10, low aromatics diesel fuel provides an emissions benefit of approximately 0.5 g/bhp-hr NOx. While this benefit does not completely compensate for the difference between a 4.0 and 5.0 g/bhp-hr NOx standard, Health and Safety Code section 43806 provides that the engine as well as the fuel technology should be considered when proposing the standards. The ARB believes that a 4.0 g/bhp-hr NOx standard is feasible without low aromatics diesel fuel, particularly in view of the DDC Series 50 certification at 4.6 g/bhp-hr NOx without low aromatics diesel fuel. DDC testified that the use of low aromatics diesel fuel would significantly increase the level of certainty that diesel-fueled engines can be certified to the 4.0 g/bhp-hr NOx standard in 1996. DDC testified that it would take some additional development time and some hardware changes, but at least for the lower horsepower category, DDC would be able to supply engines. The benefit of using low aromatics diesel fuel for certification in 1996 and 1997 should allow the manufacturers the opportunity for more flexibility in meeting the standard.

13. Comment: It is critical that some additional relief be provided to urban bus engine manufacturers for small volume engines, especially for higher horsepower engines that would have more difficulty in meeting the standards even with low aromatics diesel fuel. Such relief could include a limited number of exemptions from the 4.0 g/bhp-hr NOx standard per manufacturer to give them flexibility within their engine families to determine how then they can devote their resources to bringing the higher volume engines into compliance. (EMA)

14. Comment: Articulated buses require 300 to 330 hp, and therefore, cannot use the same 250 to 280 hp engines that are used in the standard 35 to 40 foot transit buses. Because the California sales volume of articulated buses is typically less than 50 per year, it is doubtful that engine manufacturers could amortize their cost to develop special engines for this small market in 1996. The ARB should consider exempting articulated buses from the proposed mandatory standards. (DDC)

Agency Response: The Board recognizes the need to provide some flexibility to the manufacturers for 1996 and 1997. The Board, therefore, adopted an exemption from the 1996 4.0 g/bhp-hr NOx standard of up to 10 percent of the model-year sales for 1996 and 1997 model year urban bus engines based on each manufacturer's urban bus engine sales in the three years preceding the model year. The exemptions will be based on the technical justification to be submitted to the ARB by the manufacturers.

15. Comment: Allow averaging of NO<sub>x</sub> emission credits between urban bus engines. A statewide version of the federal averaging program is suggested. Or allow transit agencies to average within their fleet to provide them with more flexibility of not only being able to sell credits generated under an emission credit program; but instead allow them to use those credits to allow them to purchase some diesel-fueled buses at a 5.0 g/bhp-hr NO<sub>x</sub> level in 1996 and 1997. (DDC, EMA)

Agency Response: If the ARB were to allow NO<sub>x</sub> averaging, there would be no financial incentive for the transit agencies to purchase alternative-fueled buses because the credits would have already been used by the manufacturer to average the cleaner buses against buses that would be meeting a less stringent standard. If the ARB allowed the transit agencies to average within their own fleet, there would be no financial incentive, again, since the higher cost of purchasing alternative-fueled buses would not be offset by the sale of credits to another source. By adopting the modifications for the use of low aromatics diesel fuel for the certification of 1996 and 1997 model year urban bus engines and for a small number of exemptions, the ARB has provided for the flexibility that averaging would achieve and hence, an averaging program would be duplicative and is not needed.

16. Comment: The proposal could be further strengthened by setting the particulate standard at a 0.05 g/bhp-hr level beginning in 1994 rather than waiting until 1996. (MECA)

Agency Response: The ARB did not propose to adopt a 0.05 g/bhp-hr PM standard until 1996 because of leadtime concerns and in order to be consistent with federal requirements. Although there currently is emission control technology available that would allow a 0.05 g/bhp-hr PM standard to be met, the additional leadtime would provide the manufacturers with more flexibility in meeting both the lower PM and NO<sub>x</sub> standards in 1996. The ARB standard for PM provides consistency with the federal regulations and allows a reasonable amount of leadtime for the manufacturers to comply.

17. Comment: The ARB staff report refers to heavier fuel tanks needed for gaseous fuels and that the transit buses require six large tanks weighing approximately 2,500 pounds. Although not currently available in transit bus sizes, two onboard natural gas fuel cylinder manufacturers recently began offering for sale full composite tanks that weigh 60 percent less than the composite aluminum tanks currently utilized on transit buses. (CA NGVC)

Agency Response: In the ARB staff report, the additional weight of the fuel tanks was discussed to address the concerns of the transit agencies if required to purchase CNG buses. The report also mentioned the ongoing research into lighter-weight materials for CNG fuel tanks which would address the weight issues.

18. Comment: The ARB staff report indicates the low price scenario for compressed natural gas is 30 cents per therm. Pacific Gas and Electric Company's current tariff for the volume of fuels that a transit district would use is now 28 cents per therm. So, the price of natural gas has, in fact, gone down in recent months. (CA NGVC)

Agency Response: To evaluate the impact on transit agencies of converting to an alternative-fueled fleet, staff estimated the cost associated with purchasing and operating alternative-fueled buses rather than diesel-fueled buses. In this analysis, it became apparent to staff that the final outcome was very sensitive to, and largely dependent on, the price of fuel. At the time that the staff report was written, the low price scenario for compressed natural gas was 30 cents per therm. However, the ARB staff chose to show a cost range of 30 to 35 cents per therm for compressed natural gas since the price of fuel will vary. While it is true that the price of natural gas may decrease, it is also true that the price may increase in the future. Recognizing this, the staff's intent is to use the fleet cost estimates only as indicators of feasibility, not as precise predictions of future costs.

### C. EMISSION BENEFITS/AIR QUALITY

19. Comment: The proposed PM standards and emission levels that would bring greater harmony with the federal regulations are sufficiently low. Attempts to differentiate the standards by requiring an earlier implementation of the 4.0 g/bhp-hr NOx standard within the relatively narrow range of technological feasibility will add expense by creating the need for multiple development programs and engine product lines, but will not produce meaningful differences in air quality. (DDC)

Agency Response: Compared to other vehicle categories, the NOx standard for heavy-duty vehicles has remained fairly constant for the past 10 years. As the NOx emissions contribution of the rest of the vehicle categories has decreased, the heavy-duty vehicle NOx contribution has increased. By the year 2010, heavy-duty vehicles will account for only 8 percent of the total on-road vehicle miles travelled, yet the projected heavy-duty vehicle contribution will be over 55 percent of the NOx emissions from all on-road vehicles. The benefit of reducing NOx emissions by 20 percent and PM emissions by 50 percent from buses operating in urban areas statewide in 2010 is meaningful and significant. Furthermore, with the allowance of low aromatics diesel fuel for certification and a limited number of exemptions, eliminates, in part, the need for multiple development programs.

20. Comment: The annual sales volume represented by other vehicle applications is significantly larger than the urban bus market and, consequently, the air quality benefits and NOx and PM reduction will be significantly larger than the benefit attributable to a 4.0 g/bhp-hr NOx level for buses for this 2-year period (1996 and 1997). (Cummins)

Agency Response: Health and Safety Code 43806 requires that new transit bus engines meet new emission standards, effective by January 1, 1996. The ARB must adopt transit bus standards to fulfill the statutory requirements. While, acknowledging that the annual sales volume represented by other vehicle applications is larger than the urban bus market, the proportional contribution of NOx and PM emissions from heavy-duty vehicles, including urban buses, is much larger. Heavy-duty vehicles only represent approximately 4 percent of the 1993 population of in-use vehicles in

California. Yet, the NOx and PM emissions from heavy-duty vehicles is over 40 percent and 80 percent, respectively, of the emissions inventory from all on-road vehicles. As mentioned in the response to comment 19, the ARB believes that the benefits of this proposal are significant in reducing emissions from the heavy-duty vehicle population.

21. Comment: Transit operators could decide to delay scheduled bus purchases for 1996 and 1997 which would disrupt normal bus funding and procurement patterns and delay the replacement of older, higher-emitting buses that would lead to a degradation rather than an improvement in urban air quality. (DDC)

Agency Response: It is true that transit operators could decide to delay scheduled bus purchases for 1996 and 1997. However, since funding is available each fiscal year, it is unlikely that the transit agencies would delay bus purchases entirely, solely on the basis of being required to buy buses that comply with a 4.0 g/bhp-hr NOx standard. Transit agencies would have the option of purchasing either diesel or alternative-fueled buses and the optional NOx standards and associated credits would provide further incentives for the purchase of lower-emitting buses. In addition, the exemptions being provided for the engine manufacturers should ensure engine model availability. The transit agencies would have nothing to gain by delaying their bus purchases since all new bus purchases in 1998 would need to meet the 4.0 g/bhp-hr NOx standard anyway. Furthermore, the ARB has received comment letters from transit agencies, such as the Orange County Transportation Authority and the Monterey-Salinas Transit Agency, which support the proposal of a 4.0 g/bhp-hr NOx standard in 1996. These transit agencies agree that the proposed mandatory standards for 1996 are realistic and achievable with diesel technology.

#### D. COSTS AND COST-EFFECTIVENESS

22. Comment: Bus operators shouldn't be forced to bear the costs associated with emission requirements and alternative fuel research alone. (LB Transit)

Agency Response: Bus operators are not being forced to bear the costs associated with emission requirements and alternative fuel research alone. Passenger cars and light and medium-duty vehicles are being required to meet very stringent standards under the low-emission vehicle program for which much research on alternative fuels was performed. The 4.0 g/bhp-hr NOx standard for 1996 and later model year urban buses would be able to be met by diesel engines, thus not requiring an investment in alternative fuels. In addition, many demonstration programs for alternative-fueled trucks and buses are ongoing. These programs are supported by mutual efforts made by the public and private industries, manufacturers, and government agencies where the responsibility of alternative fuel research is shared.

23. Comment: Mobile source emission reduction credit programs can help transit operators generate funding, which could partially offset alternate fuel conversion expenses. However, the uncertainties that exist regarding the availability of these programs and the quantity and value of the credits that might be generated make it difficult to accurately forecast the financial implications of a decision to convert to alternate fuels. Without firm financial support to convert to alternative fuels, transit agencies may decide to delay bus purchases until 1998 when diesel buses should be available to meet the federal 4.0 g/bhp-hr NOx standard. (DDC)

Agency Response: Participation in a mobile source emission reduction credit program is voluntary and is made successful through collaborative efforts. The transit agencies must be willing to work with the air quality districts and potential purchasers of the credits such as stationary sources in order to arrive at an agreement. Since this is optional, the transit agencies must make their own decisions about whether to participate in such a program. As mentioned in the response to comment 21, the ARB's proposal allows for some exemptions from the 1996 4.0 g/bhp-hr NOx standard which should ensure that diesel-fueled buses are available for transit agencies to purchase if they choose not to participate in a mobile source emission reduction credits program.

24. Comment: A severe economic burden will be placed on engine manufacturers by accelerating the 4.0 g/bhp-hr NOx standard from 1998 to 1996, and will potentially disrupt the urban bus marketplace. (EMA)

Agency Response: The ARB has endeavored to minimize the economic impact of this proposal and has shown that, even with a worst case scenario, the standards are still feasible and cost-effective. The ARB has limited the applicability of the proposal to only the larger urban buses. The Board allowed even more flexibility by adopting modifications allowing for the use of low aromatics diesel fuel and for a small number of exemptions for 1996 and 1997. The manufacturers have not provided any data to show that they could not meet the requirements nor have they presented figures which support their claim of a severe economic burden with this proposal. In fact, DDC testified that they would be able to comply with the standards with the adoption of the modifications considered by the Board.

25. Comment: There are only two engine manufacturers offering products for the urban bus market. One or the other, or both, may elect not to participate in this business in 1996 and 1997 with diesel engine offerings. Without market competition, the cost study and air quality benefit presented in the staff report is, needless to say, in jeopardy. (Cummins)

Agency Response: Even if only alternative-fueled engines were offered in 1996 and 1997, the proposal would still be cost-effective and there would be even more emission benefits. (Please see Staff Report, Air Quality and Cost Effectiveness Analysis, pages 23-24.) However, it is not likely that diesel engines would be excluded from the urban bus market with the technology options, low aromatics diesel fuel, and exemptions that are available to the manufacturers for meeting the proposed standards.

26. Comment: Attempting to implement the diesel technology necessary to bring urban bus engines into compliance with the 1996 model year standards (a unique NOx standard for California) will not be cost-effective nor a wise business decision given the very small California market for these engines, and may create problems in providing quality engines. (Cummins, EMA)

Agency Response: The ARB has shown the proposal to be cost-effective and feasible for 1996 implementation. In addition, the modifications adopted by the Board give the manufacturers the increased flexibility to meet the standards which should continue to allow them to produce quality engines. In fact, the development of urban bus engines that comply with a 4.0 g/bhp-hr NOx standard will help in the progression towards meeting the federal 4.0 g/bhp-hr NOx standard for all heavy-duty vehicles.