CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS

PROPOSED MODIFICATIONS TO THE FLEET RULE FOR TRANSIT AGENCIES AND NEW REQUIREMENTS FOR TRANSIT FLEET VEHICLES

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PROPOSED MODIFICATIONS TO THE FLEET RULE FOR TRANSIT AGENCIES AND NEW REQUIREMENTS FOR TRANSIT FLEET VEHICLES

Staff Report

January 7, 2004

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LIST OF ACRONYMS

$/lb	Dollars per pound
ug/m3	Micrograms per cubic meter
ARB, or the Board	Air Resources Board
CalACT	California Association for Coordinated Transportation, Inc.
CCR	California Code of Regulations
CDC	Clean diesel combustion
CNG	Compressed natural gas
CO	Carbon monoxide
DECS	Diesel emission control system
DMV	California Department of Motor Vehicles
DOC	Diesel oxidation catalyst
DPF	Diesel particulate filter
EGR	Exhaust gas recirculation
EMFAC	ARB's on-road motor vehicle emissions estimation model
FBC	Fuel-borne catalyst
FTA	Federal Transit Administration
FTF	Flow-through filter
g/bhp-hr	Grams per brake horsepower-hour
GGT	Golden Gate Bridge Highway and Transportation District
GVWR	Gross vehicle weight rating
HC	Hydrocarbon
HCCI	Homogenous charge compression ignition
H&SC	Health and Safety Code
HEB	Hybrid-electric bus
lbs	Pounds
lbs/day	Pounds per day
LNG	Liquefied natural gas
Low sulfur diesel fuel	Diesel fuel with less than 15 ppmw sulfur content
LPG	Liquefied propane gas
MY	Model year
NMHC	Non-methane hydrocarbons
NOx	Oxides of nitrogen
NO_2	Nitrogen dioxide
OEHHA	Office of Environmental Health Hazard Assessment
PM	Particulate matter
ppd	Pounds per day
ppmw	Parts per million by weight
ROG	Reactive organic gases
SRP	Scientific Review Panel
TAC	Toxic air contaminant
tpd	Tons per day
tpy	Tons per year
U.S. EPA	United States Environmental Protection Agency
ZEB	Zero-emission bus

EXECUTIVE SUMMARY

The Air Resources Board (ARB or "the Board") seeks to provide clean, healthful air to all the citizens of California. California's commitment to providing clean public transportation is an important part of achieving this goal. Public transportation has important societal benefits, providing access to work and education, reducing traffic congestion, and meeting mobility needs of the public.

In February 2000 the Board took steps to reduce emissions from public transportation by establishing a new fleet rule for transit agencies and more stringent emission standards for new urban bus engines and vehicles. The regulations were designed to reduce oxides of nitrogen (NOx) and particulate matter (PM) emissions from urban buses. The rule also promoted advanced technologies by adopting a zero-emission bus (ZEB) demonstration and ZEB acquisition requirements for larger transit agencies.

Diversification in public transit services has led to the increased use of smaller and commuter service buses not subject to the existing fleet rule for transit agencies. Therefore, staff believes it is necessary and appropriate to add requirements for emission reductions from buses and trucks not covered under the current rule.

In this rulemaking, staff is proposing to expand the fleet rule to include smaller diesel and alternative-fuel buses, commuter buses, and heavy-duty trucks owned or operated by transit agencies. The affected vehicles are called transit fleet vehicles and would be subject to a fleet average NOx limit and PM reduction requirement, phased in between 2007 and 2010. As a part of this change, staff is proposing to add a definition for a commuter service bus, which is a subcategory of a transit fleet vehicles. A commuter service bus is a bus that would otherwise meet the definition of an urban bus except that its duty cycle includes very little of the stop-and-go operations of an urban bus. In this case, a commuter service bus will be classified as a transit fleet vehicle, not an urban bus. This definition codifies existing policy based on a guidance issued in 2001.

Staff is also proposing several new sections to address various issues not covered in prior amendments. The rule is currently silent on how new transit agencies established after adoption of the rule in 2000 are to comply, thus staff is including directions on compliance for new transit agencies. The current PM reduction requirement does not allow for fleet growth following the final emission reduction deadlines, thus staff is proposing to add a diesel fleet standard for urban buses and transit fleet vehicles to allow for fleet growth while maintaining emission reductions. The engine emission standard adopted for 2004 to 2006 model year diesel hybrid-electric urban buses in June 2004 is silent on engine exhaust emission standards for non-methane hydrocarbon, carbon monoxide, and formaldehyde, thus staff is proposing language for these standards. Finally, staff is proposing to move and renumber the existing Fleet Rules for Transit

Agencies (title 13, California Code of Regulations (CCR), sections 1956.2-1956.4), currently located with the new engine emission standards, to new sections set aside for controlling diesel particulate emissions from fleets.

The emission reductions obtained from this regulation will result in lower ambient PM levels and reductions of exposure to primary and secondary diesel PM. Lower ambient PM levels and reduced exposure, in turn, would result in a reduction of the prevalence of the diseases attributed to PM and diesel PM, including hospitalizations for cardio-respiratory disease, and premature deaths.

ARB staff estimates that in 2010 the proposed amendments would result in the reduction of 44 pounds per day (lbs/day) of diesel PM, 380 lbs/day of NOx, 80 lbs/day of hydrocarbons (HC), and 80 lbs/day of carbon monoxide (CO) emissions. In 2020, staff estimates reductions of 47 lbs/day of diesel PM, 620 lbs/day of NOx, 140 lbs/day of HC, and 100 lbs/day of CO emissions. The proposed amendments, along with the more stringent new engine emission standards identified in the *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB 2000), reduce transit fleet vehicle PM emissions by 43 percent and 81 percent in 2010 and 2020, respectively, from the 2000 baseline emissions. NOx is reduced 29 percent in 2010 and 83 percent in 2020 from the 2000 baseline emissions.

The estimated cost of the proposed regulatory amendments is $0.90 to $1.90 per pound of NOx and $42 to $88 per pound for PM. There are no associated costs for business, only for local public transit agencies. Staff expects there will be benefits to those businesses that produce or sell new vehicles or engines, and retrofit technology.

ARB staff estimates that approximately 11 premature deaths would be avoided by 2020 as a result of emission reductions obtained through this regulation. The U.S. EPA has established $6.3 million (in 2000 dollars) for a 1990 income level as the mean value of avoiding one death (U.S. EPA, 2003). Staff calculated the value of avoiding one premature death, arriving at a range from $4 million to $6 million (in 2004 dollars). For the proposed regulation, the estimated cost of control per premature death prevented is about $1.5 million to $2 million, which is about three times lower than the U.S. EPA's benchmark for value of avoided death. This rule is, therefore, a cost-effective mechanism to reduce premature deaths that would otherwise be caused by diesel emissions without this regulation.

The proposed modifications, as described herein, are consistent with the authority of the ARB to control emissions from mobile sources. To maintain current emission reduction goals set by the *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB 2000), as well as those set for urban buses in 2000, the ARB staff, therefore, recommends that the Board adopt the proposed modifications to title 13, CCR, sections 1956.1, 1956.2, 1956.3, 1956.4, and 2020, and proposed new sections 2023, 2023.1, 2023.2, 2023.3 and 2023.4, as set forth in the proposed Regulation Order in Appendix A.

I. INTRODUCTION AND BACKGROUND

The Air Resources Board (ARB or "the Board") seeks to provide clean, healthful air to the citizens of California. California's commitment to providing clean public transportation is an important part of achieving this goal. Public transportation has important societal benefits, including providing access to work and education, reducing traffic congestion, and meeting the mobility needs of the public, including the elderly and disabled.

California's transit agencies are responsible for providing basic transportation services for the public. Transit agencies provide both fixed-route service within urban places, such as traditional urban bus and neighborhood routes, and between urban places such as commuter routes, and non-fixed-route services such as paratransit, dial-a-ride and charter services.

Most types of public transportation, however, are also sources of polluting engine exhaust emissions. Oxides of nitrogen (NOx) and hydrocarbons (HC) contribute to the atmospheric formation of ozone and fine particles. Carbon monoxide (CO) is a colorless, odorless gas that reduces the ability of the body to transport oxygen to cells. Diesel particulate matter (PM) is a toxic air contaminant – a cancer-causing pollutant that also has significant short- and long-term negative cardiovascular impacts. These emissions often occur within California's most populated areas. It is, therefore, vital to all Californians that the ARB continues its efforts to reduce engine exhaust emissions from all sources.

In February 2000, the Board confirmed its established a new fleet rule for transit agencies and more stringent emission standards for new urban bus engines and vehicles: The *Public Transit Bus Fleet Rule and Emission Standards for New Urban Buses* (ARB 1999, ARB 2000b). The multi-faceted regulations went beyond the federal requirements for urban buses. The rules were designed to reduce NOx and PM by setting fleet emission reduction requirements that encouraged transit agencies to purchase cleaner buses and retrofit their existing buses; and promoted advanced technologies by adopting requirements for zero-emission bus (ZEB) demonstrations and acquisition that are applicable to larger transit agencies. New, more stringent mid- and long-term emission standards were adopted that apply to new urban bus engines.

As a result of these rules, many transit agencies have installed natural gas refueling infrastructure and purchased alternative-fuel urban buses; repowered old diesel engines to engines meeting cleaner exhaust emission standards; installed diesel particulate filters on diesel engines; and experimented with developing technologies, such as hybrid-electric buses, NOx aftertreatment systems and cleaner fuels. Many of California's transit agencies consider themselves to be innovators and incubators for advanced technologies.

Since the rules were adopted, however, diversification in public transit services has led to increased use of smaller local buses and larger commuter service buses that do not meet the definition of urban bus and thus are not subject to the existing Fleet Rule for Transit Agencies. In addition, the Board adopted the *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-fueled Engines and Vehicles* (ARB 2000a) and began an ambitious schedule of adopting and implementing rules to reduce diesel PM emissions from all California in-use vehicles and equipment. Staff therefore determined that it was appropriate to expand the scope of the Fleet Rule for Transit Agencies to reduce emissions from buses and trucks not within the current scope of the rule.

Staff's proposal to amend the rule has five elements. First, staff is proposing new NOx and PM fleet emission standards for buses and trucks owned and operated by public transit agencies that are not urban buses, which staff terms "transit fleet vehicles." Second, staff is proposing new sections to address the issue of a schedule for emission reductions for a new transit agency established after adoption of the regulations. Third, staff is proposing to add a diesel PM fleet standard applicable to urban buses to allow for fleet growth while maintaining emission reductions. Fourth, staff is proposing clarifying language for the adopted 2004 to 2006 model year diesel hybrid electric urban bus engine standard to address non-methane hydrocarbon (NMHC), carbon monoxide (CO), and formaldehyde emission standards. Finally, staff is proposing to move and renumber the existing Fleet Rule for Transit Agencies [title 13, California Code of Regulations (CCR), sections 1956.2-1956.4], currently located with engine emission standards, to new sections set aside for rules controlling diesel particulate emissions from fleets.

A. Urban Buses and Transit Fleet Vehicles

The Fleet Rule for Transit Agencies regulates urban buses that are owned or leased by public transit agencies. An "urban bus" is a bus that is powered by a heavy heavy-duty diesel engine, or of a type that would normally be powered by a heavy heavy-duty diesel engine. These buses are generally 35 feet in length or longer, although smaller chassis may have an urban bus engine installed if necessary, in which case a smaller bus could be an "urban bus." Urban buses usually operate on a fixed route consisting of stops and starts as passengers are routinely picked up and delivered to their destinations. Commuter bus operations within metropolitan areas (such as the Yolo-Sacramento metropolitan area) that consist of more than a few pick-up and drop-off stops are also considered to fall within the definition of urban bus operation (ARB 2001b).

Diversification in public transit services has led to the increased use of buses not subject to the current Fleet Rule for Transit Agencies. These vehicles typically are greater than 8,500 lbs. gross vehicle weight rating (GVWR) but are smaller than a typical urban bus and use a medium heavy-duty engine. In addition, buses using heavy heavy-duty engines or buses that are charters or commuter buses having a few pick-up and drop-off stops may not meet the definition of an urban bus. Traditional paratransit and dial-a ride services also utilize smaller buses that are not currently subject to the rule. Several transit agencies only operate buses and vehicles that do not meet the definition of urban bus. Staff has defined these vehicles as “transit fleet vehicles.” Today, transit fleet vehicles fueled by diesel and alternative fuel represent approximately one fourth of the vehicles operated by public transit agencies.

B. Engine Exhaust Emission Standards for Transit Fleet Vehicles and Urban Buses

ARB certifies new vehicles and engines to meet California's engine exhaust emission standards based on how the vehicle or engine is operated, categorized by service class. Types of service classes include passenger car, light-duty truck, medium-duty vehicle, heavy-duty vehicle or engine, and urban bus. To be certified, a vehicle must demonstrate that its emission control systems are durable and comply with the applicable emission standards for the vehicle's useful life. A vehicle or engine manufacturer determines under which emission standard a vehicle or engine is to be certified, and vehicles and engines are not legal for sale in California until certified by ARB. Certification is applied to either the complete vehicle, "chassis certification," or the engine alone, "engine certification," depending on the emission standard to which it is certified.

Heavy-duty engines used to power trucks and buses operated by transit agencies, other than urban buses, are required to certify to California engine exhaust emission standards (title 13, CCR, section 1956.8). As stated previously, staff has termed these vehicles, when owned or operated by a transit agency, as “transit fleet vehicles.” Transit fleet vehicles will continue to utilize engines certified to the heavy-duty truck engine standards and not be required to meet tighter urban bus engines that are found in title 13, CCR, section 1956.1.

Tables 1 and 2 provide a comparison of the California engine emission standards for urban buses and transit fleet vehicles. A more detailed summary of the California and federal heavy-duty truck and urban bus engine exhaust emission standards is provided in Appendix C.

Table 1. California Urban Bus and Heavy-Duty (HD)Truck New Engine Emission Standards for NOx

Emission Standards (grams per brake horsepower-hour, g/bhp-hr)		
Model Year	**Urban Bus**	**HD Truck**
1988	6.0	6.0
1990	6.0	6.0
1991	5.0	5.0
1996	4.0	5.0
1998	4.0	4.0
October 2002	2.2(1)	2.2(1)
2004	0.5(2), 2.2(3)	2.2(1)
2007	0.2	1.2(4)
2010	0.2(4)	0.2(4)

1. Nominal expected NOx level based on emission standards of 2.4 g/bhp-hr NOx plus non-methane hydrocarbons (NMHC) or 2.5 g/bhp-hr NOx plus NMHC with 0.5 g/bhp-hr NMHC cap to take effect in October 2002 for those engines subject to the Settlement Agreements between the heavy-duty engine manufacturers, the United States Environmental Protection Agency (U.S. EPA), and ARB. As part of the Settlement Agreements, the federal heavy-duty engine emission standards adopted for 2004 took effect in October 2002.

2. Standard applies to urban bus equipped with diesel-fuel, dual fuel, or bi-fuel, engines.

3. Standard applies to urban bus equipped with alternative-fueled engines. Nominal expected NOx level of 2.2 g/bhp-hr is based on ARB emission standards of 2.4 g/bhp-hr NOx plus NMHC or 2.5 g/bhp-hr NOx plus NMHC with 0.5 g/bhp-hr NMHC.

4. Between 2007 and 2009, U.S. EPA requires 50 percent of heavy duty diesel engine family certifications to meet the 0.2 g/bhp-hr NOx standard. Averaging is allowed, and it is expected that most engines will conform to the fleet NOx average of approximately 1.2 g/bhp-hr.

Table 2. California Urban Bus and Heavy-Duty (HD)Truck New Engine Emission Standards for PM

Emission Standards (g/bhp-hr)		
Model Year	**Urban Bus**	**HD Truck**
1988	0.6	0.6
1991	0.1	0.25
1993	0.1	0.25
1994	0.07	0.1
1996	0.05(1)	0.1
October 2002	0.01(2)	0.1
2007	0.01	0.01

1. In-use standard of 0.07 g/bhp-hr.

2. Standard applies to urban bus equipped with diesel-fuel, dual fuel, or bi-fuel, engines. Urban bus equipped with alternative fueled engines may certify to optional standard of 0.03, 0.02, or 0.01 g/bhp-hr.

C. Amendments to the Fleet Rule for Transit Agencies

In the Fleet Rule for Transit Agencies, the Board set fleet-wide requirements for urban buses applicable to each transit agency, requiring each transit agency to consider its urban bus fleet as a whole to meet emission reduction goals. Each transit agency was required to select a compliance path – either the “diesel” path or the “alternative-fuel” path – by January 1, 2001. Path selection set the fuel type for new urban bus purchases or leases through model year 2015. Transit agencies on either path were required to achieve a maximum fleet average of 4.8 g/bhp-hr NOxas of October 1, 2002. The requirement was typically met by retiring older buses or bus engines. The PM emission reduction requirement is being met by replacement of older buses and bus engines and retrofit of diesel engines with PM Filters. Future bus purchases must include 15 percent ZEBs for the larger transit agencies. Large diesel path agencies are also required to conduct a demonstration of ZEBs prior to implementation of the purchase requirement.

The October 24, 2002, rule amendments were primarily focused on changing the mechanism for PM reduction because of the unavailability of retrofit technology for the oldest engines, and adopting an interim certification procedure for hybrid-electric buses (HEBs) and vehicles (ARB 2002, ARB 2003). Further, any transit agency on the diesel path and located in the South Coast Air Basin was allowed to switch its fuel path to the alternative-fuel path, provided the transit agency was in compliance with the rule. Additional changes allowed diesel path agencies to purchase 2004 through 2006 MY alternative-fuel engines; provided a “financial hardship” delay request mechanism for small transit agencies; repealed the certification procedures for PM retrofit devices as duplicative of another recently adopted rule; and made other conforming and clarifying changes.

The purpose of the June 24, 2004, rule amendments was to provide a mechanism for manufacturers to certify diesel HEBs for the engine MY of 2004 through 2006 at 1.8 g/bhp-hr and allow diesel path transit agencies to purchase those diesel HEBs (ARB 2004). To ensure that emission reductions were maintained, transit agencies were required to prove they could offset the excess NOx emissions from the difference between the 2004 to 2006 diesel emission standard of 0.5 g/bhp-hr and the new allowed standard of 1.8 g/bhp-hr for HEBs. In addition, the Board modified the ZEB demonstration requirements in acknowledgment of the lag in technology compared to that projected in 2000 when the requirements were adopted.

II. NEED FOR REDUCTION OF DIESEL EXHAUST EMISSIONS

A. Diesel Particulate Matter

Particulate matter (PM) is the general term for tiny airborne particles. Diesel PM, emitted from engines that burn diesel fuel, is a complex mixture that consists of dry solid fragments, solid cores with liquid coatings and small droplets of liquid. These tiny particles vary greatly in shape, size and chemical composition and can be divided into several size fractions. Coarse particles are between 2.5 and ten microns in diameter, and arise primarily from natural processes, such as wind-blown dust or soil. Fine particles are less than 2.5 microns in diameter and are produced mostly from combustion, or burning activities and are termed $PM_{2.5}$. Particles with an aerodynamic diameter less than or equal to a nominal ten microns (about 1/7 the diameter of a single human hair) are termed PM_{10}; PM_{10} is a criteria air pollutant for which federal and state ambient air quality standards have been set. Diesel PM is a subset of PM_{10}.

B. Ambient Air Quality Standards for Particulate Matter

Both California and U.S. EPA have established standards for the amount of PM_{10} in the ambient air. These standards define the maximum amount of particles that can be present in outdoor air without threatening the public's health and welfare. California's current PM_{10} standard is more protective of human health than the corresponding national standard. Standards for $PM_{2.5}$ have also been established to further protect public health (Table 3).

Table 3. State and National Particulate Matter Standards.

California Standard		National Standard	
	PM_{10}		
Annual Arithmetic Mean	20 $\mu g/m^3$	Annual Arithmetic Mean	50 $\mu g/m^3$
24 Hour Average	50 $\mu g/m^3$	24 Hour Average	150 $\mu g/m^3$
	$PM_{2.5}$		
Annual Arithmetic Mean	12 $\mu g/m^3$	Annual Arithmetic Mean	15 $\mu g/m^3$
24 Hour Average	No separate State standard	24 Hour Average	65 $\mu g/m^3$

When the ARB sets California's ambient air quality standards, it designs them to protect the most sensitive subpopulations, such as children, the elderly, or people with pre-existing disease, such as cardiac patients or asthmatics.

C. Identification of Diesel Particulate Matter as a Toxic Air Contaminant

After ten years of extensive research and public outreach, ARB identified diesel PM as a toxic air contaminant (TAC) in August 1998 (CalEPA 1998). As part of the identification process, Office of Environmental Health Hazard Assessment (OEHHA) evaluated the potential for diesel exhaust to affect human health. OEHHA found that exposures to diesel PM resulted in an increased risk of cancer and an increase in chronic non-cancer health effects, including a greater incidence of cough, labored breathing, chest tightness, wheezing, and bronchitis (OEHHA 1998). OEHHA estimated, based on available studies, that the potential cancer risk for exposure to diesel PM in concentrations of one microgram per cubic meter ($\mu g/m^3$) ranged from 130 to 2400 excess cancers per million. The ARB's Scientific Review Panel (SRP) approved OEHHA's determinations concerning health effects and approved the range of risk for PM from diesel-fueled engines, concluding that a value of 300 excess cancers per million people, per $\mu g/m^3$ of diesel PM, was appropriate as a point estimate of unit risk for diesel PM.

OEHHA also concluded that exposure to diesel PM in concentrations exceeding five $\mu g/m^3$ can result in a number of long-term chronic health effects. The five $\mu g/m^3$ value is referred to as the chronic reference exposure value for diesel PM. The SRP supported OEHHA's conclusion and noted that the reference exposure value may need to be lowered further as more data emerge on potential adverse chronic effects of diesel PM.

D. Physical and Chemical Characteristics of Diesel Particulate Matter

Diesel PM is the non-gaseous portion of the exhaust from a diesel-fueled compression ignition engine. PM emissions result primarily from incomplete combustion of fuel in the cylinder and lubrication oil that has entered the cylinder incidentally. Secondarily produced diesel PM is formed as a result of atmospheric reactions with diesel NOx emissions. Diesel PM consists of several constituents, including an elemental carbon fraction, a soluble organic fraction, and a sulfate fraction. The majority of diesel PM, approximately 98 percent, is smaller than ten microns in diameter. Diesel PM is a mixture of materials containing over 450 different components, including vapors and fine particles coated with organic substances. More than 40 chemicals in diesel exhaust are considered TACs by the State of California (Table 4).

Table 4. Substances in Diesel Exhaust Listed by California as Toxic Air Contaminants.

Acetaldehyde	Manganese compounds
Acrolein	Mercury compounds
Aniline	Methanol
Antimony compounds	Methyl Ethyl Ketone
Arsenic	Naphthalene
Benzene	Nickel
Beryllium compounds	4-Nitrobiphenyl
Biphenyl	Phenol
Bis[2-ethylhexyl]phthalate	Phosphorus
1,3-Butadiene	Polycyclic organic matter,
Cadmium	including polycyclic aromatic
Chlorine	hydrocarbons (PAHs) and their
Chlorobenzene	derivatives
Chromium compounds	
Cobalt compounds	Propionaldehyde
Creosol isomers	Selenium compounds
Cyanide compounds	Styrene
Dibutylphthalate	Toluene
Dioxins and dibenzofurans	Xylene isomers and mixtures
Ethyl benzene	o-Xylenes
Formaldehyde	m-Xylenes
Inorganic lead	p-Xylenes

Note: California Health and Safety Code section 39655 defines a TAC as "an air pollutant which may cause or contribute to an increase in mortality or in serious illness, or which may pose a present or potential hazard to human health."

E. Sources and Ambient Concentrations Of Diesel Particulate Matter

PM emissions from diesel-fueled vehicles and engines totaled about 28,000 tons per year (tpy) in California as of 2000 (ARB 2000a). These emissions come from a wide variety of sources including more than one million on-road and off-road vehicles, about 16,000 stationary engines, and close to 50,000 portable engines. On-road engines account for about 27 percent of the emissions, off-road engines and portable engines about 71 percent, and the remaining two percent from stationary engines. With full implementation of the current vehicle standards and vehicle turnover, but not considering this control measure, diesel PM emissions will still total about 22,000 tpy in 2010 and about 19,000 tpy in 2020.

In the year 2000, outdoor diesel PM concentrations were 1.8 $\mu g/m^3$ and projected to be 1.5 $\mu g/m^3$ in 2010 after accounting for current regulations. After including indoor concentrations of diesel PM, total exposure was 1.26 $\mu g/m^3$ in 2000 and projected to be 1.05 $\mu g/m^3$ in 2010 (Table 5).

Table 5. Estimated Exposure of Californians to Diesel Particulate Matter for 2000, 2010 and 2020 (ARB 2000a).

Exposure Location	Estimated Average Air Exposure Concentration – 1990 (mg/m^3)	Estimated Average Air Exposure Concentration (mg/m^3) and Potential Risk (excess cancers/million)					
		2000		2010		2020	
		Conc.	Risk	Conc.	Risk	Conc.	Risk
Outdoor Ambient	3.0	1.8	540	1.5	450	1.2	360
Indoor	2.0	1.2	360	1.0	300	0.8	240
Total	2.1	1.26	380	1.05	315	0.84	252

F. Health Effects of Diesel Particulate Matter

Diesel PM has been linked to a wide range of serious health problems. Particles that are deposited deep in the lungs can result in lung cancer, increased hospital admissions; increased respiratory symptoms and disease; decreased lung function, particularly in children and individuals with asthma; alterations in lung tissue and respiratory tract defense mechanisms; and premature death. Increased PM exposure causes increased cardiopulmonary mortality risk as demonstrated in a validity and causality analysis of 57 epidemiological studies. (Dab, et al., 2001). Significant positive associations exist between lung cancer incidence and the number of days per year that respirable particulates (PM_{10}) exceeded several thresholds (Beeson, et al., 1998).

Long-term ambient concentrations of PM_{10} are associated with increased risks of all natural-cause mortality in males, mortality with any mention of nonmalignant respiratory causes in both sexes, and lung cancer mortality in males (Abbey, et al., 1999; McDonnell, et al., 2000). Initial findings indicate a clear correlation between reduced lung function and more intense air pollution and high levels of nitrogen dioxide (NO_2), PM_{10}, $PM_{2.5}$, and acid vapor appear to be associated with slower lung growth (Peters, et al., 1999).

G. Statewide Risk Reduction Goal of Diesel Risk Reduction Plan

As noted above, diesel PM is emitted from a variety of sources, including on- and off-road diesel-fueled vehicles and stationary engines. On a statewide basis, the average potential cancer risk associated with diesel PM emissions is 540 potential cases per million statewide, with the potential risk in the South Coast Air Basin estimated to be 1,000 per million people. Compared to other air toxics the Board has identified and controlled, diesel PM emissions are estimated to be responsible for about 70 percent of the total ambient air toxics risk. In addition to these general risks, diesel PM can also present elevated localized or near-source exposures. Depending on the activity and nearness to receptors, these potential risks can range from small to 1,500 per million or more.

The goal of the Board (ARB 2000) is to reduce diesel PM emissions and the associated cancer risk by 75 percent in 2010 and 85 percent in 2020. The Fleet Rule for Transit Agencies is one of a group of regulations being developed to achieve the emission reduction goals of the ARB of protecting the health of Californians by reducing the cancer risk from diesel PM and complying with legal requirements to control a TAC. Other benefits associated with reducing diesel PM emissions include increased visibility, less material damage from soiling of surfaces, and reduced incidence of non-cancer health effects, such as bronchitis, asthma, and allergy. The emission reductions obtained from this regulation will result in lower ambient PM levels and significant reductions of exposure to primary and secondary diesel PM. Lower ambient PM levels and reduced exposure, in turn, would result in a reduction of the prevalence of the diseases attributed to PM and diesel PM, including reduced incidences of hospitalizations for cardio-respiratory disease, and prevention of premature deaths.

H. Nitrogen Oxides and Reactive Organic Gas Emissions

Emissions of NOx and Reactive Organic Gases (ROG) are precursors to the formation of ozone in the lower atmosphere and secondary PM. Exhaust from diesel engines contributes a substantial fraction of ozone precursors in any metropolitan area. Secondary PM forms from the interaction of gases in the atmosphere, including nitrates that result from diesel engine exhaust. Therefore, reductions in NOx from diesel engines in urban areas would make a considerable contribution to reducing exposures to ambient ozone and secondary PM. Controlling emissions of ozone precursors would reduce the prevalence of the types of adverse respiratory effects associated with ozone exposure and would reduce hospital admissions and emergency visits for respiratory effects. ARB has long established the need for reduction of emissions of NOx and other ozone precursor chemicals from mobile sources.

III. NEED FOR MODIFICATIONS

This discussion will focus specifically on the need for the regulatory modifications proposed in this initial statement of reasons.

A. Transit Fleet Vehicles: Addition to Scope

Diversification in public transit services has led to the increased use of buses that are not subject to the current Fleet Rule for Transit Agencies. Transit agencies have added long-distance routes to bring passengers from far-flung suburbs into cities or to transit hubs. From cities or transit hubs, riders transfer to shorter, local routes that use small buses and trolleys. California public transit agencies today operate approximately 10,100 urban buses that are subject to the fleet rule. In addition, in 2003 transit agencies operated approximately 5,400 buses and trucks not subject to the fleet rule. These vehicles are fueled by gasoline, diesel and alternative fuels. Of the 5,400 buses and trucks not subject to the fleet rule, 4,100 are fueled by diesel fuel or alternative-fuels. These numbers are expected to increase as California's population and density increase, thus requiring both smaller and larger heavy-duty buses to meet both neighborhood and commuter service needs.

The current Fleet Rule for Transit Agencies requires that transit agencies reduce diesel PM and NOx emissions from their diesel and alternative-fueled urban buses. Staff is proposing in this rule to add on emission reduction requirements applicable to heavy-duty transit fleet vehicles fueled by diesel and alternative-fuels. Staff is not proposing to include gasoline engines in this rule as they produce no diesel PM and have lower NOx emissions as new certified engines than diesel engines. Staff is proposing to include alternative-fuel engines as required in the existing fleet rule.

As staff began implementing the newly finalized Fleet Rule for Transit Agencies in 2001, we addressed the question of the definition of an urban bus. Some transit agencies told ARB that they preferred or needed to use a large bus configured more like a charter bus on commuter service routes and they felt that these buses should not be classified as urban buses. Staff researched the issue and responded with a letter dated December 20, 2001, that set forth guidance to transit agencies. Staff determined that a bus used for commuter service is an urban bus when its duty cycle is similar to that of a typical urban bus for at least that part of its travel within a city or metropolitan area. In other words, if a bus operates with more than a small number of drop-offs and pick-ups in a city or metropolitan area for part of its route, then ARB determined that the bus would be classified as an urban bus.

Staff is now proposing to codify existing guidance by adding a definition of commuter service bus, which is not classified as an urban bus but would instead be classified as a transit fleet vehicle. Staff's proposed definition does not expand the scope of what ARB has previously classified as a commuter service bus and thus maintains the integrity of previously adopted emission reductions from urban buses.

B. Newly Formed Transit Agencies

Staff has been asked by newly formed transit agencies, which are either successors under new ownership of existing transit agencies or new agencies providing new services in new areas, to clarify how they are to comply with the adopted rule. The current rule does not provide these new transit agencies with direction on how to comply. Thus, staff is proposing regulations that establish deadlines and set criteria for compliance with the fuel path and emission reduction requirements for a new transit agency formed after 2001, which is when the Fleet Rule For Transit Agencies was finalized.

C. Urban Bus Requirements for PM Reduction

At its October 2002 hearing, the Board modified the mechanism used by transit agencies to reduce diesel PM emissions from urban buses in recognition of the lack of available retrofit technology originally projected to be available for PM reduction from certain diesel urban buses. After working with the transit agencies, staff recognized that the new PM reduction requirements adopted in 2002 did not allow for fleet growth after 2007 (diesel path agencies) or 2009 (alternative-fuel path agencies) when the transit agencies were to have reduced total fleet PM emissions to 15 percent of their January 1, 2002, baseline PM emissions. With increases in demand for transit service, staff is proposing that the final particulate emissions reduction requirement be based on the lowest achievable particulate emission standard multiplied by the number of urban buses in a transit agency's urban bus fleet.

D. 2004 to 2006 Diesel Hybrid-Electric Urban Bus Engine Exhaust Emission Standards

In the June 24, 2004, rule amendments, the Board provided a mechanism for manufacturers to certify diesel HEBs for 2004 through 2006 model years and a transit agency on the diesel path to purchase those diesel HEBs, provided the transit agency offsets the excess NOx emissions between the adopted exhaust emission standard of 0.5 g/bhp-hr for diesel engines and the new standard for diesel HEBs of 1.8 g/bhp-hr NOx. The adopted standards also included a requirement that the diesel HEBs be certified at the existing exhaust emission particulate standard of 0.01 g/bhp-hr (ARB 2004). Staff inadvertently, however, neglected to specify any other engine exhaust emission standards in the adopted section and was informed recently that, as written, manufacturers would be required to meet the 2004 diesel urban bus exhaust emission standards for nonmethane hydrocarbons (NMHC), carbon monoxide (CO), and formaldehyde found in title 13, CCR, section 1956.1 (a)(11). Manufacturers have further informed staff that they could not meet the NMHC, CO, and formaldehyde standards in section 1956.1(a)(11), which is not surprising as those standards were crafted to match the expected engine technology to meet a NOx standard of 0.5 g/bhp-hr. To correct its error, staff is therefore proposing to add language to clarify the specific engine exhaust emission standards. For non-methane hydrocarbon (NMHC) the proposed standard is 0.5 g/bhp-hr; for carbon monoxide (CO) the proposed standard is 15.5 g/bhp-hr; and for formaldehyde staff proposes to remove the requirement.

E. Renumbering Sections for the Fleet Rule for Transit Agencies

The existing Fleet Rule for Transit Agencies is located with engine emission standards in title 13, CCR, sections 1956.2-1956.4. The engine emission standard regulations are directed to new engine and vehicle manufacturers.

Recently, ARB set aside title 13, CCR, sections 2020-2027 for regulations that control diesel emissions from existing in-use engines or fleets. Staff believes that moving existing sections for the Fleet Rules for Transit Agencies to the new sections for rules controlling diesel emissions from existing in-use engines or fleets best serves the regulated transit community by co-locating all of the regulations that focus on in-use engine exhaust emission reductions.

IV. SUMMARY OF PROPOSED REGULATIONS

Staff recommends that the Board adopt proposed amendments to title 13, CCR, sections 1956.1, 1956.2, 1956.3, 1956.4, and 2020, and add sections 2023, 2023.1, 2023.2, 2023.3 and 2023.4, as set forth in Appendix A:

- Add transit fleet vehicles to the scope of the Fleet Rule for Transit Agencies and require new NOx and PM fleet emission reduction standards for these buses and trucks owned and operated by public transit agencies.
- Provide explicit guidance in the rule for newly formed transit agencies, established after adoption of the Fleet Rule for Transit Agencies.
- Modify the urban bus PM fleet reduction standard to allow for fleet growth once transit agencies have met the mandated final PM reduction deadline.
- Modify the urban bus diesel HEB engine emission standard to clarify the emission standards for non-methane hydrocarbon, carbon monoxide, and formaldehyde.
- Move existing Fleet Rules for Transit Agencies (title 13, CCR, sections 1956.2-1956.4), currently housed with the engine emission standards, to new sections set aside for controlling diesel particulate emissions from fleets.

The proposed changes are summarized below. A detailed description of the all the components is located in Appendix B.

A. Transit Fleet Vehicle Requirements

Staff proposes to add transit fleet vehicles to the scope of the Fleet Rule for Transit Agencies and require new NOx and PM fleet emission reduction standards for these buses and trucks owned and operated by public transit agencies.

1. Applicability

Staff is proposing to define a transit fleet vehicle as an on-road vehicle greater than 8,500 pounds gross vehicle weight rating (GVWR) powered by a heavy-duty engine fueled by diesel or alternative fuel, owned or operated by a transit agency, and which is not an urban bus. Transit agencies operating only gasoline powered vehicles are not subject to this proposal.

In addition, staff is also proposing to add a new definition of a commuter service bus, which is a bus that would otherwise meet the definition of an urban bus except that its operations include very little of the stop-and-go operations of an urban bus. The proposed definition is:

> "Commuter Service Bus" means a passenger-carrying vehicle powered by a heavy heavy-duty diesel engine, or of a type normally powered by a heavy heavy-duty diesel engine, that is not otherwise an urban bus and that operates on a fixed route primarily during peak commute hours and has no more than ten stops per day excluding park-and-ride lots. A commuter service bus is a transit fleet vehicle."

2. Fleet Requirements

The proposal establishes a fleet average NOx standard and PM emission reduction requirement for transit fleet vehicles, phased-in between 2007 and 2010 (Tables 6 and 7). Staff is not requiring transit agencies to select a fuel path for transit fleet vehicles. Transit fleet vehicles would not be required to use ultra-low sulfur diesel fuel until it becomes the only type of diesel fuel available in mid-2006. New transit fleet vehicles would be subject to the heavy-duty diesel engine emission standards, and not be subject to the new, more stringent urban bus engine exhaust emission standards.

a. Fleet NOx Average

The proposal requires that a transit agency meet fleet NOx emission averages of 3.2 g/bhp-hr by December 31, 2007 and 2.5 g/bhp-hr by December 31, 2010 for its transit fleet vehicles (Table 6). A transit agency calculates this value by summing the NOx portion of the engine emission standard of each TFV and dividing by the total number of transit fleet vehicles in its fleet. Staff expects transit agencies to achieve this fleet standard through fleet turnover, repowering older trucks, or retrofitting with a verified diesel emission control strategy (DECS) that reduces NOx.

Table 6. Fleet NOx Average Requirements for Transit Agencies (g/bhp-hr)

Fleet Type	Compliance Date		
	October 1, 2002	December 31, 2007	December 31, 2010
Urban Bus	4.8[1]		
Transit Fleet Vehicles		3.2[2]	2.5[2]

[1]Currently required in the Fleet Rule for Transit Agencies
[2]Proposed

b. Fleet PM Reductions

The proposal requires that a transit agency reduce diesel PM emissions of its transit fleet vehicles by 40 percent as of December 31, 2007 and 80 percent as of December 31, 2010, compared to emissions as of January 1, 2005 (Table 7). A transit agency calculates its diesel PM emission total by summing the PM portion of the engine exhaust emission standard of each diesel-fueled transit fleet vehicle. Staff expects that some reduction will occur with fleet turnover, but a majority of the reductions will be achieved through retrofitting with a DECS or repowering with a cleaner engine.

Table 7. Fleet Diesel PM Reduction Requirements for Transit Agencies (g/bhp-hr)

Fleet Type	Baseline Year	Percent Reduction From Baseline				
		2004	**2005**	**2007**	**2009**	**2010**
Urban Bus[1]						
Alternative Path	2002	20	40	60	85[3]	
Diesel Path	2002	40	60	85[3]		
TFV[2]	2005			40		80[3]

[1]Currently required in the Fleet Rule for Transit Agencies
[2]Proposed
[3]In the final year of compliance and beyond the transit agency can meet a fleet average of 0.01 g/bhp-hr times the number of vehicles in the fleet.

B. Urban Bus Fleet Diesel PM Requirement

The current fleet diesel PM reduction requirements require transit agencies to have reduced their total diesel PM emissions from their urban buses to 15 percent of their 2002 baselines as of 2007 (diesel path agencies) or 2009 (alternative-fuel path agencies), but are silent as to total diesel PM emissions following those deadlines. In addition, the rule does not consider the situation of a transit agency that meets the lowest possible diesel PM total without achieving an 85 percent reduction from baseline. Staff proposes, as an option, that a transit agency be able to meet a fleet average of 0.01 g/bhp-hr, in lieu of achieving the value of 15 percent of the January 1, 2002, diesel PM emission total. This new value would be calculated by a transit agency by multiplying the value equal to the lowest achievable particulate emission standard of 0.01 g/bhp-hr by the number of urban buses.

C. 2004-2006 Urban Bus Diesel Hybrid-Electric Engine Emission Standard

Staff proposes to modify the adopted 2004 to 2006 diesel HEB engine exhaust emission standards to enable manufacturers to certify diesel HEBs for 2004 through 2006. Staff is proposing to add engine exhaust emission standards of

0.5 g/bhp-hr NMHC and15.5 g/bhp-hr CO and delete the formaldehyde standard from title 13, CCR, section 1956.1(a)(11)(B).

In order to certify a diesel HEB, some manufactures plan to utilize engines already certified to the heavy-duty truck engine exhaust emission standards found in title 13, CCR, section 1956.8. As there is no formaldehyde standard required of heavy-duty truck engines, staff is proposing not to require a formaldehyde standard for certification of diesel HEBs. Requiring such a standard would add time and cost to the diesel HEB certification process and would serve no useful purpose. The formaldehyde standard was adopted for an engine that was expected to use selective catalytic reduction to meet the NOx standard of 0.5 g/bhp-hr, which will not be used for these diesel HEBs. Manufacturers are prohibited from using diesel urban bus engines, including HEB engines, in the averaging, banking and trading program for PM.

D. "Newly Formed" Transit Agency Requirements

Staff proposes that a transit agency formed after the adoption of the Fleet Rule for Transit Agencies be required to notify the Executive Officer in writing of its existence and submit certain required reports to the Executive Officer. The new transit agency would be required to choose a compliance path for its active fleet and notify the Executive Officer within 120 days of formation of its intent to follow either the diesel path or alternative path. A new transit agency that is a successor to an existing transit agency would be required to follow the compliance path of the transit agency out of which it has been formed.

The new transit agency would also be required to meet a specific NOx fleet average and a diesel PM emission total reduction goal, which are specified in the proposed rule. The emission reduction targets are set based on the date of formation of the new transit agency and assume that the new transit agency should be as clean as existing transit agencies. If, however, the new transit agency was formed out of an already existing transit agency, then it must meet the NOx fleet average and the diesel PM emission total of the urban buses and transit fleet vehicles used in the transit operations of the existing transit agency out of which the new transit agency was formed.

E. Extensions and Additional Definitions

Staff is proposing to allow the use of the compliance deadline extensions in the existing urban bus rule for transit fleet vehicles. Applicable extensions include:

- an extension of the diesel PM emission requirements for one year due to the unavailability of technology. A transit agency can apply annually;
- an extension for transit agencies in one hour ozone attainment areas from the intermediate PM compliance deadlines; and,

- an extension for transit agencies with fewer than 30 vehicles (urban bus and TFV) in their fleet for financial hardship. The fleet size was increased to accommodate transit agencies with urban bus and transit fleet vehicles.

Staff is adding the following extension and exemption for transit fleet vehicles:

- an extension for a transit agency that is operating transit fleet vehicles under contract (turnkey operations) for one year. Transit agencies may apply annually; and,
- an exemption for low usage vehicle for transit fleet vehicles.

Staff is adding the following definitions:

- Commuter Service Bus is added as explained earlier to clarify when a bus is an urban bus and when it is a transit fleet vehicle;
- Diesel PM Emission Total is defined and the used in the corresponding sections;
- Low Usage Vehicle has been added to define transit fleet vehicles that get little use. The corresponding category for urban buses is an emergency contingency bus.
- New Transit Agency is defined to clarify the requirements for these transit agencies;
- NOx Fleet Average is defined and used in corresponding sections;
- Retirement or Retire provides that ARB consider a vehicle or engine retired only when it is sold out of state, the engine scrapped, or converted to use as a low usage vehicle;
- Transit Fleet Vehicle is defined to provide the basis for the scope of the rule.

In addition, other definitions are moved from one section to another as part of the movement of the Fleet Rule for Transit Agencies from sections 1956.2 to 1956.4 to sections 2023 to 2023.4.

V. PUBLIC OUTREACH AND ENVIRONMENTAL JUSTICE

The ARB is committed to ensuring that all California communities have clean, healthful air by addressing not only the regional smog that hangs over our cities but also the more localized toxic pollution that is generated within our communities. The ARB works to ensure that all individuals in California, especially children and the elderly, can live, work and play in a healthful environment that is free from harmful exposure to air pollution.

A. Environmental Justice

On December 13, 2001, the Board approved Environmental Justice Policies and Actions,[1] which formally established a framework for incorporating environmental justice into the ARB's programs, consistent with the directives of State law and policy (ARB 2001a). "Environmental justice" is defined as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. These policies apply to all communities in California, but environmental justice issues have been raised more in the context of low-income and minority communities because of past land use policies and the cumulative impact of a concentration of emitting facilities in some neighborhoods.

To achieve this ambitious goal, the ARB has established a Community Health Program and emphasized community health issues in our existing programs. To provide people with the basic tools and information needed to understand and participate in air pollution policy planning, permitting, and regulatory decision-making processes, ARB has published "The Public Participation Guide to Air Quality Decision Making in California."[2]

The Environmental Justice Policies are intended to promote the fair treatment of all Californians and cover the full spectrum of ARB activities. Underlying these Policies is a recognition that we need to engage community members in a meaningful way as we carry out our activities. People should have the best possible information about the air they breathe and what is being done to reduce unhealthful air pollution in their communities. The ARB recognizes its obligation to work closely with all stakeholders; communities, environmental and public health organizations, industry, business owners, other agencies, and all other interested parties to successfully implement these Policies. Our outreach efforts, described below, facilitate this objective.

1. Regulatory Proposal

Staff's proposal reduces diesel particulate matter, identified as a toxic air contaminant, from transit buses. Transit services are predominantly located in urbanized areas. Individuals from low income communities, along with elderly and disabled people, are more likely to rely on transit services, and therefore may be disproportionately exposed to diesel exhaust emissions from transit buses.

By lowering the diesel PM emissions from transit buses, the exposure to toxic air contaminants is reduced, therefore reducing cancer risk and exposure for

[1] Complete information for these programs can be found at http://www.arb.ca.gov/ch/ej.htm.
[2] Complete information on this program can be found at http://www.arb.ca.gov/ch/public_participation.htm

individuals who use transit services and for those who reside in urbanized areas. The staff's proposal (Section X) benefits these individuals and supports the Air Resources Board's Environmental Justice goals.

B. Outreach Efforts

The ARB strives to involve the widest number of affected persons in the development of its regulations. To this end, staff held informal public workshops and meetings prior to publishing the notice and the staff report. For this rule, staff conducted four sets of public workshops (Table 8) and additional focused meetings. Notices for the workshops were mailed to more than 3,700 individuals and companies and were posted to ARB's Public Transit Agencies web site and e-mailed to subscribers of ARB's electronic listserves. Those workshops held in Sacramento were webcast for individuals who could not travel to the meeting locations. To generate additional public participation and to enhance the information flow between ARB and interested persons, staff made all documents, including workshop presentations, available via the Public Transit Agencies web site.[3] In addition, the web site provides background information and serves as a portal to other web sites with related information.

Table 8. Workshop Locations and Times

Date	Location	Time
April 3, 2003	El Monte	2:00 – 5:00 PM
December 2, 2003	El Monte	1:30 – 3:00 PM
December 3, 2003	Sacramento	1:30 – 3:00 PM
May 17, 2004	Sacramento	1:30 – 3:00 PM
May 18, 2004	El Monte	1:30 – 3:00 PM
October 7, 2004	El Monte	1:30 – 3:00 PM
October 8, 2004	Sacramento	1:30 – 3:00 PM

Participants in the workshops included representatives from environmental organizations, transit agencies, engine manufacturers, bus manufacturers, air pollution control districts, cities and counties, the California Association for Coordinated Transportation, California Transit Association, Regional Council of Rural Counties, Manufacturers of Emission Controls Association, Engine Manufacturers Association, California Department of Transportation, California Natural Gas Vehicle Coalition, California Energy Commission, consultants, and other parties interested in transit bus emissions.

Staff met with a number of the same stakeholders in focused meetings throughout the rulemaking process to get feedback on staff's proposed regulatory

[3] http://www.arb.ca.gov/msprog/bus/bus.htm

modifications. These stakeholders represented transit agencies, manufacturers of buses and environmental organizations. Staff attended or made presentations at the California Transit Association conference in November 2003 and November 2004, the California Association for Coordinated Transportation (Cal/ACT) conference in April 2004 and September 2004, and Rural County Task Force Meetings. Staff also worked closely with small transit agencies, including Amador County, Lake County, Mariposa County, Tehama County and many other rural transit agencies. Alternatives were suggested to the proposed regulation and explored by staff.

VI. ENGINE AND EMISSION INVENTORY

An improved engine and emission inventory was developed for this rule proposal, including a new survey of transit fleet vehicles in California (Appendix C). Staff undertook a detailed survey to determine the engine make, model, model year, and vehicle type of the transit fleet vehicles in California.

A. Engine Inventory

From April through December 2003, staff conducted a survey of both those transit agencies subject to the Fleet Rule for Transit Agencies (reporting), as well as transit agencies that are not subject to the rule because they operate no urban buses (non-reporting). The survey was included in the annual reporting forms for each reporting agency and distributed to the 250 Cal/ACT members, which consist predominantly of small, rural, and paratransit agencies, the majority of which were not subject to the existing Fleet Rule for Transit Agencies. Other surveys were distributed as contacts were developed. Approximately 81 percent of reporting transit agencies and 15 percent of the estimated non-reporting transit agencies completed the survey. ARB staff gathered engine and fleet data from 2,187 vehicles and 91 transit agencies. Approximately 74 percent of the transit fleet vehicles surveyed were operated by transit agencies currently subject to the Fleet Rule for Transit Agencies.

ARB staff conducted a data extraction of the 2002 Department of Motor Vehicles (DMV) database in January 2004 to further refine the estimate of the total population of transit fleet vehicles. Using DMV data and survey information, staff compared the fleet characteristics and determined the population of transit fleet vehicles (non-urban buses and trucks) as approximately 5,410, of which approximately 4,070 vehicles are fueled by diesel or alternative fuel; the rest are gasoline or electric vehicles (Table 9). About ninety-nine percent (98.8 percent) of the vehicle population was in revenue service (passenger carrying vehicles). The truck population was 1.2 percent of the total population of transit fleet vehicles. Details regarding the methodology and results are presented in Appendix C.

Table 9. California Transit Fleet Vehicle Survey Population by Percent[1]

Gross Vehicle Weight (GVW) (lbs)	Diesel percent	Gasoline percent	Alternative Fuel percent	Electric percent	Total percent
8,500-14,000	15.6	7.5	2.9	0	**26**
14,001-33,000	47	17.4	7.1	0.2	**71.7**
>33,000	2.2	0	0	0	**2.2**
Total	**64.8**	**24.9**	**10.0**	**0.2**	**99.9[2]**

1.These values represent transit fleet vehicles and do not include urban buses.

2.The total does not add up to 100 percent due to rounding

B. Emission Inventory

The California on-road vehicle emission inventory data consists of two elements: emissions-related and activity-related. The emissions-related data reflect new vehicle testing information and the latest vehicle registration data from the DMV. The activity-related data are updated by the regional transportation agencies that estimate of the daily vehicle miles of travel, the distribution of travel by speed, and the number of starts per vehicle per day by year. The on-road emission inventory is then derived using a mathematical model named EMFAC.

ARB staff calculated the transit fleet vehicle emission inventory using a model developed from EMFAC specifically incorporating the turnover rates for the various types of transit fleet vehicles and emission factors for light, medium and heavy heavy-duty truck engines. Gasoline vehicles were not included in the emissions analysis (Appendix C).

The baseline emissions for the transit fleet vehicles (Table 10) gradually decline over time naturally with the introduction of cleaner engines in the 2007 and 2010 model years.

Table 10. Transit Fleet Vehicle Estimated Baseline Emissions

Calendar Year	NOX (tpd)	PM (lbs/day)	HC (tpd)	CO[a] (tpd)
2000	4.48	158	0.99	0.78
2005	4.07	149	0.86	0.67
2010	3.47	133	0.70	0.57
2015	1.87	80	0.37	0.35
2020	0.81	77	0.14	0.22

[a] No emission factors are available for carbon monoxide (CO) from alternative fuel, and therefore values are lower than expected.

VII. TECHNOLOGICAL FEASIBILITY OF CONTROL MEASURE

Reducing emissions from diesel engines is an area of active research and development. Engine manufacturers are close to deploying engines that meet the California and federal 2007 engine standards for demonstration in fleets, and they are developing technologies to further reduce NOx emissions for the 2010 standards. In addition to technologies to reduce emissions in new engines, the fields of exhaust aftertreatment and engine retrofitting are growing rapidly, spurred both by the research and development ongoing to new engines and by California's diesel emission reduction regulations. Based on its evaluation of the technology available today and an assessment of technology likely to be available in the near future, staff is confident that the proposed control measure is technologically feasible. The following sections describe the availability and feasibility of various exhaust emission control technologies.

A. Availability of Ultra-low Sulfur Diesel Fuel

Most diesel emission control technologies are adversely affected by sulfur in the fuel. Ultra-low sulfur (15 ppmw or less sulfur content) diesel fuel is therefore required for effective functioning of many, although not all, diesel emission control strategies (DECS). New 2007 engines will require ultra-low sulfur diesel fuel to enable proper functioning of the catalyzed diesel particulate filter (DPF) that manufacturers will use to reduce diesel PM emissions to 0.01 g/bhp-hr.

The U.S. EPA and California adopted regulations that mandate the sale of ultra-low sulfur diesel fuel beginning July 1, 2006. One refiner, BP, has been making and selling ultra-low sulfur fuel in California since 2002, and California transit agencies subject to the Fleet Rule for Transit Agencies have been required to use the fuel since July 1, 2002. Some cities have also been using ultra-low sulfur diesel fuel since it became widely available in 2002 when BP certified fuel resellers to handle the ultra-low sulfur diesel fuel, thus making the product available by truck. BP is also selling ultra-low sulfur diesel fuel through its ARCO stations that carry diesel fuel. Ultra-low sulfur diesel fuel will likely not be made available through the pipeline distribution system until July 2006.

B. Verification of Diesel Emission Control Strategies

The Board adopted a procedure to verify diesel emission control strategies in 2003, codified in title 13, CCR, sections 2700 et seq.. The purpose of the procedure is to verify strategies and systems that reduce diesel PM emissions from in-use engines. Verification is an approval from ARB, which tells end users that the verified device achieves advertised emission reductions and is durable. The device manufacturer is required to provide a warranty for product useful life and against engine damage caused by the DECS. To protect the end user, only ARB-verified DECSs can be used in all of ARB's mandated programs and most of its voluntary programs.

ARB's verification procedure is a multi-level verification system consisting of three PM reduction levels and optional NOx reduction levels (Table 11). Reductions in NOx are not required for verification, but ARB's procedure recognizes and verifies NOx reductions that are greater than or equal to 15 percent in five percent increments. This system has broadened both the spectrum of control technologies available to participate in California's diesel emission control effort and the number and types of vehicles and engines that can be controlled. This multi-level approach to verification is consistent with the goal of achieving the maximum reductions in diesel PM emissions that are economically and technologically feasible.

Table 11. Diesel Emission Control Strategy Verification Levels

Category	**PM Reduction**
Level 1	≥ 25 percent
Level 2	≥ 50 percent
Level 3	≥ 85 percent, or 0.01 g/bhp-hr
Category	**NOx Reduction**
Not verified	<15 percent
Optional	≥ 15 percent; in 5 percent increments

The verification procedure requires considerable data to prove emission reductions and durability, and any DECS that uses a fuel additive must demonstrate that it is non-toxic in all media by going through a multimedia assessment. ARB has received over 100 applications for verification, but not all of those applications are actively moving forward for approval. As of November 1, 2004, ARB has verified four DPFs at Level 3, a fuel strategy and flow-through-filter at Level 2, and three DOCs at Level 1 (Table 12). Not all of these DECSs are applicable to transit fleet vehicles.

Table 12. Verified DECSs That May be Applicable to Transit Fleet Vehicles

E.O.	Manufacturer & Product	Date
Level 3		
EO DE-04-001, EO DE-04-002	Lubrizol Purifilter™	January 12, 2004
DE-04-005/DE-04-005	Donaldson DPM	February 27, 2004/September 30, 2004
DE-04-006	Johnson Matthey CRT™	May 21, 2004
DE-03-001-03 DE-04-004-02	Cleaire Longview™[1]	July 26, 2004
Level 2		
DE-04-008	Lubrizol's PuriNOx™[1]	August 5, 2004
DE-04-011	Environmental Solutions Worldwide	September 13, 2004
Level 1		
Verification Letter	Donaldson DCM	November 7, 2002
DE-04-009	Donaldson DCM	September 8, 2004
DE-04-010	Donaldson DCM	September 8, 2004

[1.] Also verified for NOx reductions

The verification of a DECS specifies which engine family and vehicle operating requirements the DECS be used for. The Executive Order or Verification Letter, lists the engines by engine family and other conditions of verification, such as minimum engine exhaust temperature. Additional evaluations by the manufacturer may then be needed prior to installation of the DECS on a vehicle, such as use of a datalogger that records engine exhaust temperatures over a typical duty cycle.

This list is subject to change as additional systems are verified. The most current list of verified DECSs, applicable engine families, as well as the verification letters, may be found on our web site at:

http://www.arb.ca.gov/diesel/verdev/verdev.htm

C. Diesel Emission Control Strategies for In-use Transit Fleet Vehicles

A variety of retrofit strategies can be used for controlling emissions from in-use diesel engines. The two main types of technologies discussed here are hardware, add-on technologies such as diesel particulate filters (DPF) or oxidation catalysts (DOC), and fuels or fuel additives. As discussed above, ARB requires that a product be verified in order to claim PM or NOx emission reductions. Devices certified under Vehicle Code 27156(h) for aftermarket parts can be used on a vehicle but emission reductions cannot be claimed.

1. Hardware Diesel Emission Control Strategies

Currently, hardware DECSs consist of the DPF, including both passive and active regenerated versions, and the DOC. Each of these types of technology has been used in both on- and off-road vehicles and equipment for many years. More recently, another device, a catalyzed wire mesh filter, also known as a flow-through-filter (FTF), was verified.

a. Passive (Catalyzed) Diesel Particulate Filter

A passive DPF reduces PM, CO and HC emissions through catalytic oxidation and filtration. Most of the DPFs sold in the United States use substrates consisting either of a ceramic wall-flow monolith or a silicon carbide substrate. These substrates are either coated with a catalyst material, typically a platinum group metal, or a separate catalyst is installed upstream of the particulate filter. The filter is positioned in the exhaust stream to trap or collect a significant fraction of the particulate emissions while allowing the exhaust gases to pass through the system.

Effective operation of a DPF requires a balance between PM collection and PM oxidation, or regeneration. The volume of PM generated by a diesel engine will fill up and plug a DPF over time, thus the trapped PM must be burned off or "regenerated" periodically. Regeneration is accomplished by either raising the exhaust gas temperature or by lowering the PM ignition temperature through the use of a catalyst. The type of filter technology that uses a catalyst to lower the PM ignition temperature is termed a passive DPF, because no outside source of energy is required for regeneration.

Verified passive DPFs have demonstrated reductions in excess of 90 percent for PM, although the ARB verification Level 3 lists 85 percent PM reduction as its minimum level. A passive DPF also reduces CO and HC by approximately the same amount as the PM reduction. A passive DPF is a very attractive means of reducing diesel PM emissions because of the combination of high reductions in PM emissions and minimal operation and maintenance requirements.

Four passive DPF systems have been verified in California for use on a variety of diesel applications including the most popular engine series of the major engine manufacturers. One, the Cleaire Longview™**,** is also verified for NOx reductions.

b. Active Diesel Particulate Filter

An active DPF system uses an external source of heat to oxidize the PM. The most common methods of generating additional heat for oxidation involve electrical regeneration by passing a current through the filter medium, injecting fuel to provide additional heat for particle oxidation, or adding a fuel-borne catalyst or other reagent to initiate regeneration. Some active DPFs induce regeneration automatically on-board the vehicle or equipment when a specified backpressure is reached. Others use an indicator, such as a warning light, to alert the operator that regeneration is needed, and require the operator to initiate the regeneration process. Some active systems collect and store diesel PM over the course of a full shift and are regenerated at the end of the shift with the vehicle or equipment shut off. A number of the filters are removed and regenerated externally at a regeneration station.

For applications in which the engine-out PM is relatively high, and the exhaust temperature is relatively cool, actively regenerating systems may be more effective than a passive DPF. Because active DPFs are not dependent on the heat carried in the exhaust for regeneration, they potentially have a broader range of application than passive DPFs. Currently no active DPF systems have been verified.

c. Catalyzed Wire Mesh Flow Through Filter

Flow-through filters (FTF) employ a catalyzed wire mesh substrate that has an intermix of flow channels creating turbulent flow conditions. Unlike a DPF, in which only gases can pass through the substrate, the FTF does not physically trap and accumulate PM. Instead, it acts like a DOC (diesel oxidation catalyst) but achieves a greater PM reduction due to enhanced contact of PM with catalytic surfaces and longer residency times. Any particles that are not oxidized within the FTF flow out with the rest of the exhaust and do not accumulate. Consequently, the filtration efficiency of an FTF is lower than that of a DPF, but the FTF is much less susceptible to plugging from high PM emissions and low exhaust temperatures. Therefore, this type of filter may be suitable for specific duty cycles where a typical DPF would not be applicable.

d. Diesel Oxidation Catalyst

A DOC reduces emissions of CO, HC, and the soluble organic fraction of diesel PM through catalytic oxidation alone. Exhaust gases are not filtered in DOCs. In the presence of catalytic material and oxygen, CO, HC, and the soluble organic fraction of the PM undergo a chemical reaction and are converted into carbon dioxide and water. Some manufacturers integrate HC traps (zeolites) and sulfate suppressants into their oxidation catalysts. HC traps enhance HC reduction efficiency at lower exhaust temperatures and sulfate suppressants minimize the generation of sulfates at higher exhaust temperatures. A DOC may reduce total PM emissions by up to 30 percent.

e. Selective Catalytic Reduction (SCR)

ARB has not verified any selective catalytic reduction DECS as of November 1, 2004. SCR catalysts that use ammonia as a NOx reductant have been used for stationary source NOx control for a number of years. Urea may also used as the source of ammonia for SCR catalysts, and such systems are commonly referred to as Urea SCR systems. In recent years, considerable effort has been invested in developing urea SCR systems that could be applied to heavy-duty diesel vehicles with low sulfur diesel fuel. Urea SCR systems will be introduced in 2004 or 2005 in Europe to comply with the EURO IV heavy-duty diesel emission standards. The actual introduction dates in some countries will be earlier than the EURO IV implementation requirements because of tax incentives in those countries to promote early technology introduction (U.S. EPA 2004a).

Although no SCR system is verified by ARB, transit agencies that received an alternative NOx strategy exemption under title 13, CCR, section 1956.2(c)(8) or (d)(9) were required to conduct a demonstration of an advanced NOx aftertreatment system that could reduce NOx emissions by 70 percent or more on buses operating in urban bus revenue service. Staff is monitoring the demonstration of an ammonia SCR system on urban buses being conducted by the seven transit agencies that received the exemption, led by the Santa Clara Valley Transit Authority.

Three SCR NOx aftertreatment devices were selected, produced and installed by Extengine, for demonstration on three urban buses. Initiated in October 2002, VTA conducted baseline and emissions testing prior to placing the buses into revenue service. Preliminary data submitted in January 2004 are favorable and buses are operating in revenue service (VTA 2004).

2. Fuel-based Diesel Emission Control Strategies

Fuel-based DECSs utilize the fueling system and fuel for emission reductions. All fuel-based DECSs must undergo an assessment of multimedia toxicity effects by the California Environmental Policy Council as required by Health and Safety Code 43830.8 prior to ARB verification.

a. Fuel-Water Emulsion

A demonstrated alternative to diesel fuel that reduces both PM and NO_x emissions is an emulsion of diesel fuel and water. The process blends water into diesel fuel along with an additive to keep the mixture from separating. The water is suspended in droplets within the fuel, creating a cooling effect on the fuel that decreases NO_x emissions. A fuel-water emulsion creates a leaner fuel environment in the engine, thus lowering PM emissions also (U.S. EPA 2002B); Lubrizol has verified a fuel-water emulsion under the name PuriNOx™.

b. Fuel Additives

A fuel additive is a substance designed to be added to fuel or fuel systems so that it is present in-cylinder during combustion and its addition causes a reduction in exhaust emissions. Fuel additives must be used with a Level 3 filter unless proven safe when used without one. Additives can reduce the total mass of PM, with variable effects on CO, NO_x and gaseous HC production. In published studies, PM reductions from fuel additives range from 15 to 50 percent reduction in mass. Most additives are fairly insensitive to fuel sulfur content and will work with a range of sulfur concentrations as well as different fuels and other fuel additives (DieselNet 2002).

A fuel-borne catalyst (FBC) can be used in conjunction with both passive and active filter systems to aid system performance and decrease mass PM emissions. FBC/DPF systems are in widespread use in Europe in both on-road and off-road, mobile and stationary applications and typically achieve a minimum of 85 percent reduction in PM emissions. No fuel additive is currently verified by ARB.

c. Biodiesel

Biodiesel is a mono-alkyl ester-based oxygenated fuel made from vegetable oils, such as oilseed plants or used vegetable oil, or animal fats. It has similar properties to petroleum-based diesel fuel, and can be blended into petroleum-based diesel fuel at any ratio. B20 is a biodiesel blend into petroleum-based diesel fuel at 20 percent (ARB 2000a). Pure biodiesel is called B100.

Using publicly available data, the U.S. EPA analyzed the impacts of biodiesel on exhaust emissions from heavy-duty on-road engines (U.S. EPA 2002a). While biodiesel and biodiesel blends decrease PM, HC, and CO emissions, NO_x emissions increases proportionally with the increase of biodiesel fraction. For B20, the NO_x increase is reported to be two percent, with reductions of ten percent PM, 21 percent HC, and 11 percent CO. In addition, the U.S. EPA states a B20 blend is predicted to reduce fuel economy by one to two percent. The data were qualified with conclusions that the impact of biodiesel on emissions varied depending on the type of biodiesel (soybean, rapeseed, or animal fats) and the quality of the diesel fuel used in biodiesel blends.

Based on published studies, B20, which is a common concentration used in California, is unlikely to reduce PM emissions enough to reach the Level 1 threshold of a minimum of 25 percent PM reduction. Although B20 meets the definition of California diesel fuel, no biodiesel blend or B100 has been verified to reduce emissions under the California program. In addition, in order to be verified as a DECS, biodiesel fuel must also undergo a multimedia assessment, just like any other alternative diesel fuel. At the time of this report, no biodiesel blend or B100 has been verified in California as a DECS.

3. Combination Systems

Systems combining a hardware and fuel strategy are under development and in-use, although none have yet received verification from ARB. The U.S. EPA has verified two combination systems under its voluntary program (U.S. EPA 2004b). The U.S. EPA, however, does not assign a level for PM reduction as California does, but describes the fuel-borne catalyst plus DOC as achieving 25 to 50 percent PM reduction and the fuel-borne catalyst plus wire mesh filter as achieving 55 to 76 percent PM reduction. ARB is currently evaluating these systems under California's program. Because these systems use a fuel additive, they must to under go a multimedia assessment.

4. In-Use Experience

Around the world, public agencies have long required the reduction of in-use and new diesel engine emissions, with a focus on reducing diesel PM. Retrofitting offroad diesel engines with DOCs has been taking place for more than 20 years; particulate filters have been in use for over ten years. In Europe and Asia, mandates have been in place and are working to clean up the air.

a. Diesel Oxidation Catalysts

In the past 20 years, over 250,000 DOCs have been installed primarily on undergound mining and materials handling equipment, and more than 40,000 DOCs have been installed on urban buses and on-road trucks in the U.S. and Europe. The U.S. EPA’s urban bus retrofit/rebuild program required that urban buses with engines older than 1994 MY (1995 MY in California) be retrofitted with DOCs, resulting in more than 15,000 retrofits. In addition, over 3,000 trucks have been retrofitted in Mexico and in Hong Kong about 40,000 heavy-duty vehicles are beginning to be retrofitted (MECA 2002, 2004).

b. Diesel Particulate Filters

The use of DPFs is not as widespread as DOCs in part because of the requirement for very low fuel sulfur content for effective operation of a DPF. Nevertheless, MECA estimated that more than150,000 DPFs have been retrofitted on heavy-duty vehicles worldwide (Kubsh, pers. comm.). One notable program is Sweden’s Environmental Zone Program, which requires on- and off-road vehicles operating in specified urban areas to be retrofitted. In the U.S., California and New York have taken the lead in aggressive programs to reduce diesel PM through the use of DPFs.

In addition, the City of Los Angeles adopted a policy in 2000 to require the retrofit of all city-owned diesel trucks with DPFs by February 2004. By January 2003, 339 vehicles had been retrofitted with DPFs. To determine if the DPF worked correctly, data loggers were installed on a subset of the retrofitted trucks and exhaust temperatures were recorded. After 966,000 miles of in-use experience, only a few DPF units demonstrated problems.

Los Angeles City's sanitation department originally determined that 429 trucks would be retrofitted with DPFs. However, many of these vehicles were retired or in other ways removed from the fleet bringing the total number of trucks retrofitted closer to 350. By 2004 the City has met its commitment to retrofit all solid waste collection vehicles.

The City has been satisfied with the operation of the DPFs and is in the process of retrofitting the remainder of the diesel fleet. The City of Los Angles has more than 500 medium and heavy-duty diesel vehicles used for road maintenance and other city activities. These included road maintenance vehicles such as asphalt haulers, dump trucks, and tractors. All of these vehicles are scheduled to be outfitted with DPFs. Scheduling issues prevented the City from retrofitting all vehicles by 2004 as originally envisioned, however, progress has made toward meeting the goal. As of October 2004, fewer than 200 trucks remained to be retrofitted. The City expects these to be retrofitted with the appropriate retrofit technology by June 2005 (Wilson, pers. comm.).

VIII. REGULATORY ALTERNATIVES

No alternative considered by the ARB would be more effective in carrying out the purpose for which the regulation is proposed nor would be both as effective and less burdensome to affected transit agencies than the proposed regulation. A comparison of emission reductions from each regulatory alternative considered can be found at the end of this section (Tables 13 and 14).

A. Make No Change To Existing Regulations

If the proposed regulations are not adopted, the emissions from transit fleet vehicles, i.e., those buses and trucks not currently subject to the Fleet Rule for Transit Agencies, will not be significantly reduced until 2020. With full implementation of the proposed amendments, staff's proposal reduces NOx emissions by 0.04 tpd in 2010 and 0.31 tpd in 2020 and diesel PM emissions by 44 lbs/day in 2010 and 47 lbs/day in 2020 when compared to not adopting this regulation (Tables 13 and 14). This proposed regulation will result in additional benefits associated with reducing diesel PM emissions, such as reducing ambient fine PM levels, increasing visibility, reducing material damage due to soiling of surfaces, and reducing incidences of non-cancer health effects, such as bronchitis and asthma.

In not adopting this regulation ARB would be disregarding the real health risks caused by diesel PM. In consideration of the adverse health impacts and ARB's mandate to protect the public health of all Californians, therefore, this alternative is not considered a reasonable option. Approximately 11 premature deaths would not be prevented by 2020 if the proposed regulation is not adopted. ARB staff does not recommend this alternative because it would result in greater PM emissions and NOx emissions over the next few decades than the proposed plan, thus adversely impacting the health of Californians.

B. Require Transit Agencies to Purchase Only Alternative-Fuel Vehicles when Replacing or Adding to their Fleets

Staff evaluated the emission reductions and costs of requiring all new purchases as of January 1, 2007, to be of alternative-fuel vehicles, as an alternative to cleaning up the existing fleet. In this analysis, staff limited the useful life of existing vehicles to ten years for vehicles less than 14,000 lbs GVWR, 15 years for vehicles 14,000 to 33,000 lbs GVWR, and 22 years for vehicles greater than 33,000 lbs GVWR. At the end of the useful life, a diesel vehicle would need to be replaced by an alternative-fueled vehicle. For the cost analysis, staff determined the number of vehicles that would be replaced between 2008 and 2020 and added up the incremental cost of purchasing alternative-fuel vehicle. Infrastructure and fuel cost differentials were not added to the cost analysis.

The alternative-fuel replacement scenario emission reductions are estimated at 0.94. tpd of NOx in 2010 and 0.31 tpd in 2020 and diesel PM emissions at 15 lbs/day in 2010 and 7 lbs/day in 2020 (Table 13 and 14). This alternative provides fewer emission reductions in 2010 and 2020 than staff's proposal provides. Although this option provides more NOx emission reductions than staff's proposal, the cost over the life of the rule is about $190 to $200 million, or approximately 11 times higher than staff's proposal. In addition, many of the transit agencies that will be newly subject to the Fleet Rule for Transit Agencies because of the proposed expansion of scope are in rural areas where alternative fuel is not available or the cost of infrastructure for alternative fuel is cost prohibitive. This alternative is not as cost effective or as health protective as staff’s proposal therefore staff does not recommend this alternative.

C. Adopt Alternative Fuel Purchase Requirement and PM 2005 baseline reduction

Staff evaluated the emission reductions and costs of requiring all new purchases as of January 1, 2007, to be of alternative-fuel vehicles as in Alternative B above. In addition, staff included the diesel PM reduction requirements as in the proposed regulation. The alternative fuel replacement plus PM reduction scenario emission reductions are estimated at 0.94 tpd of NOx in 2010 and 0.31 tpd in 2020 and diesel PM emissions by 44 lbs/day in 2010 and 47 lbs/day in 2020 (Table 13 and 14).

Although this analysis showed the same PM reductions and more NOx reductions as staff’s proposal, the cost is approximately 12 times higher than staff's proposal. The estimated cost of this alternative ranges from $202 to $222 million over the life of the rule. As stated before, many of the transit agencies newly subject to the Fleet Rule for Transit Agencies are in rural areas where alternative fuel is not available or the cost of infrastructure for alternative fuel is cost prohibitive. Staff does not recommend this alternative because it is not as cost effective as staff's proposal.

D. Include Transit Fleet Vehicles in a Rule for Public Agencies

Staff considered leaving the scope of the Fleet Rule for Transit Agencies unchanged and including transit fleet vehicles in the scope of an upcoming rule for public agencies. The Fleet Rule for Transit Agencies, however, uses a fleet-based reduction mechanism, which provides transit agencies with flexibility to consider all of their vehicles when making decisions on how to comply. The proposed rule for public agencies, on the other hand, will likely require owners to apply best available control technology to each vehicle. Thus, staff decided that it would make more sense for transit agencies to have only one type of compliance mechanism for all of their vehicles and did not further analyze this alternative. Staff therefore does not recommend this alternative, although it could be crafted to be neutral with regards to emission reductions.

E. Comparison of Emission Reductions from Alternatives

Tables 13 and 14 summarize staff's analysis of estimated emission reductions from each of the alternatives discussed above and compared to staff's proposal.

Table 13. Diesel PM Emissions for Baseline and Proposed Scenarios

Calendar Year	Diesel PM Emissions (lbs/day)			
	Staff's Proposal	No Change (Baseline)	Alt-Fuel Purchase Requirement	Alt-Fuel Purchase plus PM Reduction
2000	158	158	158	158
2005	149	149	149	149
2010	90	133	118	90
2015	30	80	54	30
2020	30	77	77	30

Table 14. NOx Emissions for Baseline and Proposed Scenarios

Calendar Year	NOx Emissions (tpd)			
	Staff's Proposal	No Change (Baseline)	Alt-Fuel Purchase Requirement	Alt-Fuel Purchase plus PM Reduction
2000	4.48	4.48	4.48	4.48
2005	4.07	4.07	4.07	4.07
2010	3.28	3.47	2.53	2.53
2015	1.52	1.87	1.21	1.21
2020	0.81	0.81	0.50	0.50

IX. ECONOMIC IMPACT

The proposed amendments require that transit agencies reduce fleet emissions of NOx and diesel PM from their trucks and buses that are not otherwise considered to be urban buses. Some transit agencies that do not own or operate urban buses have not previously been subject to such requirements and they will be subject to this rule for the first time. Staff believes that the proposed regulation would cause no noticeable adverse impacts in California employment, business status, or competitiveness.

A. Legal Requirement

Sections 11346.3 and 11346.5 of the Government Code require state agencies proposing to adopt or amend any administrative regulation to assess the potential for adverse economic impact on California business enterprises and individuals. The assessment shall include consideration of the impact of the proposed regulation on California jobs; on business expansion, elimination, or creation; and on the ability of California businesses to compete in other states.

State agencies are also required to estimate the cost or savings to any state or local agency or school district in accordance with instructions adopted by the Department of Finance. This estimate is to include nondiscretionary costs or savings to local agencies, and the costs or savings in federal funding to the state.

B. Affected Businesses

Companies affected would include manufacturers, distributors and installers of buses, trucks, heavy-duty engines, engine retrofit kits, and emission control systems. Most manufacturers of buses, trucks, and engines are located outside of California. Many manufacturers of engine retrofit kits and emission control systems are located in California, but staff did not do a comprehensive survey of these companies because we believe they will experience only positive impacts. There is at least one company in California that specializes in conversions of standard diesel buses to alternative-fuel buses.

C. Potential Impact on Businesses

These proposed amendments create no direct costs for private sector businesses. Staff discussed with transit agencies the use of private contractors and determined that no private contractors will be directly impacted by this rule.

Staff expects that any impacts on businesses will be positive because the regulation will result in a more rapid turnover of the newly regulated transit fleet vehicles and in the installation of emission control systems.

D. Potential Impact on Business Competitiveness

The proposed amendments have no direct cost impact on businesses and thus will have no negative impact on business competitiveness.

E. Potential Impact on Employment

Manufacturers, distributors and installers of exhaust after-treatment devices, and fuel-conversion businesses located in California may increase their production and sales volume, and thus create new jobs.

F. Potential Impact on Business Creation, Elimination, or Expansion

The proposed amendments could impact any of the companies involved in the manufacture, production, distribution and installation of alternative fuel engines and emission control systems that are sold in California. Many, but not all, of the manufacturers that could benefit from the potential increase in business created by requiring cleaner engines and buses are located outside of California. To the extent that those businesses are located in California, the amendments could lead to the creation or expansion of businesses in California. Businesses that distribute or install alternative-fuel engines or emission control systems in California are likely to expand their sales volumes.

G. Potential Cost to Local and State Agencies

The proposed regulation would impose fiscal impacts on local public transit agencies and on the ARB. The transit agencies can all be expected to experience relatively minor impacts due to additional record-keeping and auditing requirements.

1. Implementation Scenarios

To determine implementation scenarios for costs, staff first evaluated existing funding available for transit agencies. Transit agencies use Federal Transit Administration (FTA) moneys and state and local matching funds to replace their buses. A vehicle's service life determines when a transit agency can apply for FTA funding, and the local transportation agency prioritizes which transportation projects in its area obtain funding first (or in a fiscal year). Turnaround time for funding in a rural area for an equivalent project (or bus) is longer than in an urbanized area, due to competition for funds. A detailed description of the cost analysis is found in Appendix D.

Staff evaluated fleet turnover supported by existing funding for buses using its 2003 survey data. The NOx fleet average was then calculated based on the predicted fleet make up on December 31, 2007 and 2010. Because trucks do not receive federal transportation funding, staff assumed that trucks do not turn over and were still present in each implementation year. Staff estimated approximately 6 buses and 44 trucks would require to be repowered to meet the NOx requirements (Table 1, Appendix D).

Next, staff determined the fleet makeup for December 31, 2007 and 2010 to determine the number of repowers or Level 3 DECS installations required to meet the PM emission reductions. Although transit agencies have the flexibility to use any DECS to reduce their fleet emissions, staff assumed a transit agency would either repower a pre-1994 MY engine to a 1994 to 2002 MY engine plus a DPF or would retrofit a vehicle with a 1994 to 2002 MY engine with a DPF, because of the final 80 percent reduction requirement in 2010. Trucks and buses in each implementation year were treated separately. Staff estimated that 1543 buses and 59 trucks would require retrofitting with a DPF, and 8 trucks would require repowering, to meet the PM reduction requirement (Table 1, Appendix D).

2. Implementation Costs

All direct costs that will be required to comply with staff's proposal and achieve emissions reductions will only impact public transit agencies. Staff estimates that the proposed regulation will cost $12.8 million to $26.7 million overall, with an average estimate of just under $19 million (in 2005 dollars) over the lifetime of the regulation (Table 15).

Table 15. Total Costs for Staff's Proposal (In 2005 Dollars)

Total Costs for PM & NOx			
	Low	**Medium**	**High**
Buses	$11,873,233	$17,501,617	$25,120,541
Trucks	$972,261	$1,232,940	$1,621,797
Total	$12,845,494	$18,734,557	$26,742,339

Staff estimates that 95 percent of the costs are capital costs attributed to retrofitting buses and a few trucks with DPFs and replacing a few bus and truck engines with new or newer engines through engine repower or purchase of a new or newer vehicle, to meet PM reduction requirements. Of the costs of the DPFs, approximately 80 percent are capital costs with the rest attributed to maintenance and filter cleaning. All of the estimated NOx implementation costs are capital expenditures.

The first phase of the proposed regulation will be the most expensive at slightly less than 80 percent of total estimated costs. Staff assumes that transit agencies would not spend any money until the second half of 2007, since fleet operators are not expected to have to pay for vehicles ordered, or engine conversions, or other installations, until they are delivered or completed shortly before the December 31, 2007 deadline. The same assumption applies to the 2010 compliance deadline.

The overall range of cost estimates above is equivalent to an annualized amount ranging from $1.13 to $2.37 million, with a average annual amount of $1.66 million, over the 16 years from January 1, 2005 to December 31, 2020. These values are in 2005 dollars.

The overall costs of this scenario can also be presented on an actual annual basis. The values below represent 2005 dollars. The averages of the cost estimates were used in Table 16.

Table 16. Annual Average Costs

Year	Cost for PM	Cost for NOx	Total
2007	$11,364,611	$546,921	$11,911,533
2008	$333,469		$333,469
2009	$317,589		$317,589
2010	$3,461,223	$219,174	$3,680,397
2011	$379,504		$379,504
2012	$361,432		$361,432
2013	$344,221		$344,221
2014	$327,830		$327,830
2015	$312,219		$312,219
2016	$297,351		$297,351
2017	$283,192		$283,192
2018	$64,985		$64,985
2019	$61,891		$61,891
2020	$58,944		$58,944
Total	**$17,968,460**	**$766,097**	**$18,734,557**

3. Cost Estimates for Replacing or Repowering Transit Fleet Vehicles

The used-bus market is relatively small, thus staff expects transit agencies will opt to have new or newer engines installed in existing buses. The cost of repowering a bus with a newer engine that was not designed to fit in its engine compartment is highly variable. The relevant factors include the actual physical configuration and the number of other systems (such as transmission, radiator, or electronic control systems) which must be changed for a functional conversion. Also, the required number of identical conversions can play a very significant role in the cost estimate, as economies of scale and practice can reduce per-vehicle engine replacement costs dramatically. The estimated costs for bus engine replacements range from a low of $16,500 to a high of $70,000, depending on such factors as whether the replacement is mechanical to mechanical, electronic to electronic, or mechanical to electronic (the most expensive option).

In contrast, the used-truck market is extensive, and most of the trucks that are designated for replacement are relatively unspecialized. Thus, staff's economic analysis assumes that trucks with older engines will be sold and replaced by a newer truck. Staff interviewed truck sales staff who are familiar with the market and determined that the residual value of a pre-1994 model year truck is about $10,000, whereas the value of a 1994 to 2002 model year truck is about $25,000 to $30,000. Thus, the net cost of replacing a pre-1994 model year truck with a 1994 to 2002 model year truck is $15,000 to $20,000. Appendix D contains additional details regarding the cost estimates for replacing or repowering a transit fleet vehicle.

4. Cost Estimates for Diesel Particulate Filters (DPFs)

In this cost analysis, staff included only capital costs and annual filter cleaning costs. Passive DPFs have been readily available for several years, and currently prices are relatively stable. Estimates typically range from $7,000 to $8,000 installed, but could conceivably be as little as $6000 or as much as $11,000. A number of the higher-emitting engines targeted by this regulation have EGR valves, which means that active DPFs could be required; however, no product for an EGR engine is verified yet. Staff expects that an active DPF will be successfully verified in the near future, and well before the end of 2007. The expected cost range of such prospective technology is less certain; the cost analysis assumed a range of $8,500 to $20,000.

In addition, a DPF requires annual cleaning. Typically, this procedure is outsourced, and ranges from $250 to $500 per year. Fleet operators may elect to purchase a cleaning machine and take care of this themselves; the break-even point for making this approach cost-effective is about 17 vehicles. Staff did not analyze the cost of purchasing a cleaning machine, although it could be less expensive for a larger agency than outsourcing the cleaning. Thus staff expects that its cost estimate for DPF maintenance is high. See Appendix D for additional details on the cost estimates for a DPF.

H. Costs to Individuals

Raising fares is one of the few ways transit operators can unilaterally raise revenues. However, farebox revenues represent a minority of operating expenses, and staff believes, based on discussions with transit operators, that they are rarely used for capital expenditures. Of California transit agencies operating 100 or more buses, the percentage of operating revenue from fares ranges from 14.6 to 51.8 percent, with an average 31.75 percent. While riders tend to be price-sensitive to fare increases, many agencies offer monthly passes or discounts on purchases of set numbers of tickets or tokens that can reduce rider costs. Staff was unable to provide a reasonable estimate of potential costs to individuals because we can not predict if or how transit agencies would raise fares.

X. ENVIRONMENTAL IMPACT AND COST EFFECTIVENESS

A. Statewide Emission Benefits

ARB staff estimates that in 2010 the proposed amendments would result in the reduction of 44 pounds per day (lbs/day) of diesel PM, 380 lbs/day of NOx, 80 lbs/day of hydrocarbons (HC), and 80 lbs/day of carbon monoxide (CO) emissions. In 2020, staff estimates reductions of 47 lbs/day of diesel PM, 620 lbs/day of NOx, 140 lbs/day of HC, and 100 lbs/day of CO emissions.

The proposed amendments, along with the more stringent engine emission standards identified in the 2000 Diesel Risk Reduction Plan, reduce PM emissions by 43 percent and 81 percent reduction in 2010 and 2020, respectively, from the 2000 baseline emissions. NOx is reduced 29 percent in 2010 and 83 percent in 2020 from the 2000 baseline emissions (Tables 17 to 20).

Table 17. Proposed Regulation PM Emission Reductions

Calendar Year	Diesel PM Emissions (lbs/day)		
	Baseline	Proposal	Reductions from Baseline
2000	158	158	0
2005	149	149	0
2010	133	90	43
2015	81	30	51
2020	77	30	47

Table 18. Proposed Regulation NOx Emission Reductions

Calendar Year	NOx Emissions (tpd)		
	Baseline	Proposal	Reductions from Baseline
2000	4.48	4.48	0
2005	4.07	4.07	0
2010	3.47	3.28	0.19
2015	1.87	1.52	0.35
2020	0.81	0.50	0.31

Table 19. Proposed Regulation HC Emission Reductions

Calendar Year	HC Emissions (tpd)		
	Baseline	Proposal	Reductions from Baseline
2000	0.99	0.99	0
2005	0.86	0.86	0
2010	0.70	0.66	0.04
2015	0.37	0.26	0.11
2020	0.14	0.07	0.07

Table 20. Proposed Regulation CO Emission Reductions

Calendar Year	CO Emissions (tpd)		
	Baseline	Proposal	Reductions from Baseline
2000	0.78	0.78	0
2005	0.67	0.67	0
2010	0.57	0.53	0.04
2015	0.35	0.30	0.05
2020	0.22	0.17	0.05

B. Impacts on the State Implementation Plan

Currently several air basins are classified as nonattainment for the federal PM_{10} ambient air standard and have developed plans to meet this goal. This proposed rule will assist those air basins in achieving and maintaining the standard. The PM reductions will also serve as a down payment on future plans to achieve the federal $PM_{2.5}$ standards and California's more stringent standards. Most of the air basins are in non-attainment for the state PM standards.

C. Health Benefits of Reductions of Diesel PM Emissions

Staff estimates that approximately 11 premature deaths will be avoided from the implementation of this proposal. The proposed regulation is expected to reduce PM emissions by a cumulative amount of 140 tons by the end of year 2020, and therefore prevent an estimated 10 premature deaths (5 to 15, 95 percent confidence interval (95% CI)) by year 2020. In addition, staff estimates that the proposed regulation is expected to accrue a cumulative reduction of 620 tons of NOx by the end of 2020, therefore avoiding an estimated 1 premature death (0 to 1, 95% CI).

1. Primary Diesel PM

Lloyd and Cackette estimated that, based on the Krewski *et al.* study[4], a statewide population-weighted average diesel $PM_{2.5}$ exposure of 1.8 $\mu g/m^3$ resulted in a mean estimate of 1,985 premature deaths per year in California (Lloyd/Cackette, 2001). The diesel $PM_{2.5}$ emissions corresponding to that $PM_{2.5}$ concentration of 1.8 $\mu g/m^3$ is 28,000 tpy (ARB, 2000b). Based on this information, we estimate that reducing 14.11 tpy of diesel $PM_{2.5}$ emissions would result in one fewer premature death (28,000 tons/1,985 deaths). Comparing the PM emissions before and after this regulation, the proposed regulation is expected to reduce PM emissions by a cumulative amount of 140 tons by the end of year 2020, and therefore prevent an estimated 10 premature deaths (5 to 15, 95% CI) by year 2020.

2. Secondary Diesel PM

Lloyd and Cackette also estimated that indirect diesel $PM_{2.5}$ exposures at a level of 0.81 $\mu g/m^3$ resulted in a mean estimate of 895 additional premature deaths per year in California, above those caused by directly emitted formed diesel PM. The NOx emission levels corresponding to that $PM_{2.5}$ concentration of 0.81 $\mu g/m^3$ is 1,641 tpd (598,965 tpy). Following the same approach as above, we estimate that reducing 669 tons of NOx emissions would result in one fewer premature death (598,965 tons/895 deaths). Therefore, with a cumulative NOx reduction of 620 tons by the end of 2020, an estimated 1 premature death (0 to 1, 95% CI) would be avoided.

D. Cost-Effectiveness of Proposed Regulation

Staff determined that this rule is a cost-effective method of reducing PM and NOx emissions when compared to other similar, recently adopted measures. Staff developed low-cost and high-cost scenarios for calculating cost-effectiveness for this proposal. For PM, the cost-effectiveness ratio is $85,000 per ton ($42 per pound) for the low-cost estimate, and $176,000 per ton ($88 per pound) for the high-cost estimate. For NOx, the cost-effectiveness ratio is $1,800 per ton ($0.90 per pound) for the low-cost estimate and $3,700 per ton ($1.90 per pound)

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[4] Although there are two mortality estimates in the report by Lloyd and Cackette – one based on work by Pope *et al.* and the other based on Krewski *et al.*, we selected the estimate based on the Krewski's work. For Krewski *et al.,* an independent team of scientific experts commissioned by the Health Effects Institute conducted an extensive reexamination and reanalysis of the health effect data and studies, including Pope *et al*. The reanalysis resulted in the relative risk being based on changes in mean levels of $PM_{2.5}$, as opposed to the median levels from the original Pope *et al.* study. The Krewski *et al*. reanalysis includes broader geographic areas than the original study (63 cities vs. 50 cities). Further, the U.S. EPA has been using Krewski's study for its regulatory impact analyses since 2000. (Krewski et al., 2000) (Pope et al., 1995)

for the high-cost estimate. The cost effectiveness values are similar to the cost effectiveness of other recently adopted emission reduction measures.

In order to determine cost-effectiveness, ARB followed the following steps:

- For each year, note the annualized cost and the annual emission reductions.
- Allocate a portion of the costs to PM and the rest to NOx, in proportion to the premature deaths prevented by the regulation. Since 91 percent of the estimated deaths prevented by this regulation would be attributed to PM emission reduction, we allocate 91 percent of these costs to PM emission reductions and 9 percent to NOx reductions.
- Discount the cost in each year to 2004, using a 5 percent discount rate.
- Calculate the cost-effectiveness ratio in each year.
- Calculate a weighted average of these values, using the weights proportional to the annual emission reductions.

E. Benefit-Cost Analysis

The benefit-cost analysis, as discussed below, is based on the estimated value of avoiding one premature death, as well as the cost of control to prevent a premature death.

1. Value of Premature Deaths Avoided

The U.S. EPA has established $6.3 million (in 2000 dollars) for a 1990 income level as the mean value of avoiding one death (U.S. EPA, 2003). As real income increases, people may be willing to pay more to prevent premature death. The U.S. EPA further adjusted the $6.3 million value to $8 million (in 2000 dollars) for a 2020 income level. Assuming that real income grew at a constant rate from 1990 and will continue at the same rate until 2020, we adjusted the value of avoiding one death for income growth. We then updated the value to 2004 dollars and discounted values of avoiding a premature death in the future back to the year 2004. The U.S. EPA's guidance on social discounting recommends using both three and seven percent discount rates (U.S. EPA, 2000). Based on these rates, and the annual avoided deaths as weights, the weighted average value of reducing a future premature death, discounted back to the year 2004, is around $4 million at the seven percent discount rate, and $6 million at three percent.

2. Cost of Avoiding Premature Deaths

The average cost per premature death avoided is about $2 million using a 3 percent discount rate or about $1.5 million using a 7 percent discount rate.[5]

This calculation is similar to the one described above, except that we took a weighted average of the cost of control, rather than the benefit of avoided premature death. We allocated 91 percent of these costs to PM and the rest to NOx, since 91 percent of the estimated deaths prevented by this regulation would be attributed to PM emission reduction, and 9 percent to NOx reductions. Using the same discount rates (3% and 7%) recommended by the U.S. EPA, we discounted the cost in each year to 2004. The weighted average cost per premature death avoided is then derived by using the annual premature deaths avoided as weight.

3. Comparison

The social benefits of this regulation exceed the cost by a factor of about three.[6]

- *Results using a 3 percent discount rate.* The value of a premature death avoided is about $6 million. The average cost per premature death avoided is about $2 million.
- *Results using a 7 percent discount rate.* The value of a premature death avoided is about $4 million. The average cost per premature death avoided is about $1.5 million.

This rule is, therefore, a cost-effective mechanism to reduce premature deaths that would otherwise be caused by diesel emissions without this regulation.

F. Potential Negative Impacts

Staff identified three potential negative impacts from this proposed rule.

1. NO_2 Emissions from Diesel Particulate Filters

To the extent that transit agencies install diesel particulate filters on engines to reduce diesel PM, there will be some impact from an increase in nitrogen dioxide (NO_2) emissions relative to the total NOx emissions from the tailpipe. NO_2 is a component of NOx and its presence in the atmosphere can be correlated with emissions of NOx. There has been a steady decline in NO_2 values over the years due primarily to the implementation of more stringent controls on both mobile and stationary sources. However, statewide emission trends still predict NOx levels of 761 tons/day per year from on-road diesel vehicles by year 2010.

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[5] The value is the same whether the premature deaths avoided result from reductions of PM or reductions of NOx. That is because the costs allocated to each pollutant are proportional to the number of premature deaths avoided. Thus, the ratio of cost to deaths comes out the same for both pollutants.

[6] The results presented here are point estimates. Their values are actually uncertain. Not all of the uncertainties have been quantified, so it would be misleading to calculate and report a confidence interval for the results.

At higher concentrations than are normally found in the atmosphere, NO_2 is an acute irritant. Health effects from prolonged exposure to NO_2 include upper respiratory problems, bronchitis, and pulmonary edema, and NO_2 has been linked to causes of severe asthma and bronchial infections in children.

Measurements of NO_X emissions (NO and NO_2) from heavy-duty diesel vehicles equipped with passive catalyzed filters have shown an increase in the NO_2 fraction, though total NO_X emissions remain approximately the same. Passive catalyzed filters oxidize NO to NO_2, which helps to burn soot captured in the filter. More NO_2 is created than is actually used in the regeneration process and the excess is emitted. The NO_2 to NO_X ratios could range from 20 to 70 percent, depending on factors such as the diesel particulate filter system, sulfur level in diesel fuel, and the duty cycle.

In 2002, as part of the work to establish verification procedures, ARB conducted an atmospheric modeling study that found that an NO_2 to NO_X emission ratio of about 20 percent would nearly eliminate any impact of increased NO_2 emissions. The simulations were based on an assumed 90 percent market penetration of diesel particulate filters with varying NO_2/NOx ratios of 15, 20, 25, 30 and 50 percent (Table 21).

Table 21. Summary of Relative Percent Impacts from Simulated NO_2/NOx

Diesel NO_2/NOx		15%	20%	25%	30%	50%
Summer	24-hour O_3 Exposure > 90 ppb (%)	-3	-2	0	+2	+5
	Peak 24-Hour $PM_{2.5}$	-3	N/A*	N/A*	-2	-1
Fall	Peak 24-Hour $PM_{2.5}$	-6	N/A	N/A	-5	-3
Winter	Winter Peak 1-hr Exposure NO_2 (%)	+1	+6	+12	+18	+41

* N/A means the results were not available. However, the results can be estimated through interpolation of NO_2/NOx ratios between 15 and 30 percent.

The results of the study suggest that at a NO_2/NOx ratio of 20 percent (twice the baseline NO_2/NOx ratio of a diesel engine without a passive catalyzed filter, used in the simulation), population exposure to ozone levels above the 1-hour State ozone standard would be reduced slightly. Simulated winter peak NO_2 would increase, but remain well below the state ambient air quality standard, and both summer and fall $PM_{2.5}$ concentrations would decrease. The decrease in $PM_{2.5}$ occurs because the filter reduces carbon particles and hydrocarbon emissions. These reductions more than offset the increase in nitrates which are formed in the atmosphere because of the higher NO_2 emissions.

Based on this study, staff proposed a cap of 20 percent of NO_2 to NOx emission ratio be established for all verified diesel emission control technologies. To ensure that the cap does not penalize retrofit strategies that reduce total NOx emissions, the 20 percent cap is determined from the baseline (pre-control) emissions.

In December 2003, the Board delayed the effective date of the 20 percent NO_2 limit, which was to go into effect on January 1, 2004. This was necessary because no Level 3 DECSs had been verified that met the NO_2 limit, and the implementation of upcoming retrofit regulations required the installation of a verified system on certain vehicle fleets. Furthermore, questions had arisen surrounding the accuracy of the assumptions that led to selection of the 20 percent limit and the nature of engine-out NO_2 emissions. Therefore, the effective date of the NO_2 limit was delayed until January 1, 2007. This three-year delay gives staff time to gather additional data and to develop an understanding of the various aspects of the NO_2 issue and gives manufacturers time for additional research and development.

To address these issues the ARB created an NO_2 working group committee composed of scientists, health professionals, and manufacturers from around the world. This group provided input to ARB on how to control emissions of NO_2 from diesel retrofits. Their focus was on studying near-field NO_2 exposure scenarios, reevaluating the existing 20 percent NO_2 limit in the verification procedure, sharing emissions data, exploring technological issues, identifying information needs, and evaluating regulatory alternatives.

The results of this work were presented at the International Diesel Retrofit Advisory Committee meeting on October 5, 2004. Screening analyses have indicated that the 20 percent NO_2 limit would be sufficiently protective in near-field exposure scenarios, as well as in regional ambient air quality scenarios. Staff is now working on the rulemaking effort to refine the specific requirements for verification to take into account these results while still allowing greater application of retrofit PM reduction technologies to engines whose baseline NO_2 exceeds 20 percent of their baseline NOx.

2. Diesel Oxidation Catalyst Emissions and Disposal

Two potential adverse environmental impacts of the use and disposal of diesel oxidation catalysts have been identified. First, as is the case with most processes that incorporate catalytic oxidation, the formation of sulfates increases at higher temperatures. Depending on the exhaust temperature and sulfur content of the fuel, the increase in sulfate particles may offset the reductions in soluble organic fraction emissions. Using low sulfur diesel fuel can minimize this effect. Second, a diesel oxidation catalyst could be considered a “hazardous waste” at the end of its useful life depending on the materials used in the catalytic coating. Diesel oxidation catalysts are usually recycled, however, for their precious metal content and thus are not managed as hazardous wastes in practice. Recycling also reduces any potential impact on landfill capacity.

3. Ash Management

Diesel particulate filter technology may generate a new hazardous waste stream. The carbonaceous component of the PM captured by the filter is burned off when the filter regenerates. Any inorganic components left behind after regeneration as ash in the filter must eventually be cleaned from the filter. Based on preliminary data from two samples, the ash may be classified as hazardous waste because of its zinc content.

Ash collected from a diesel engine using a typical lubrication oil and no fuel additives has been analyzed and is primarily composed of oxides of the following elements: calcium, zinc, phosphorus, silicon, sulfur, and iron. Zinc is the element of primary concern because, if present in high enough concentration, it can make a waste a hazardous waste. Title 22, CCR, section 66261.24 establishes two limits for zinc in a waste: 250 milligrams per liter for the Soluble Threshold Limit Concentration and 5,000 milligrams per kilogram for the Total Threshold Limit Concentration. The presence of zinc at or above these levels would cause a sample of ash to be characterized as a hazardous waste.

Under California law, it is the generator's responsibility to determine whether their waste is hazardous or not. Applicable hazardous waste laws are found in the Health and Safety Code, division 20; title 22, CCR, division 4.5; and title 40 of the Code of Federal Regulations. Staff recommends owners who install a diesel particulate filter on a vehicle contact both the manufacturer of the DECS and the California Department of Toxic Substances Control (DTSC) for advice on waste management.

ARB staff has consulted with personnel of the DTSC regarding management of the ash from diesel particulate filters. DTSC personnel have advised ARB that it has a list of facilities that accept waste from businesses that qualify as a conditionally exempt small quantity generator. Such a business can dispose of a specific quantify of hazardous waste at certain Household Hazardous Waste events, usually for a small fee. An owner who does not know whether or not he qualifies or who needs specific information regarding the identification and acceptable disposal methods for this waste should contact the California DTSC.[7]

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[7] Information can be obtained from local duty officers and from the website: http://www.dtsc.ca.gov.

XI. ISSUES

Over the course of development of this proposal, staff has met many times with various stakeholders and received written and verbal comments. Although staff has considered each comment, not all issues could be resolved. Following is a discussion of major outstanding issues.

A. Cost is too high for agencies in low population counties

Staff has received comments during workshops stating that in low population counties, or rural areas, funding is not as available for bus purchases as in urban areas. These transit agencies state that they cannot obtain funding from their general county funds because the proposed regulations exceed general fund capacities or contingencies. In addition, funding for the current vehicle replacement program comes from the State Transportation Improvement Program (STIP) and due to the state budget crisis, the 2004 STIP provides no new programming capacity. As a result, some commenters contend that there are no future capital funds to purchase transit vehicles.

Federal funds typically pay for most of the cost of a new transit bus - the Federal Transit Administration (FTA) pays 80-83 percent of the purchase cost of a new bus. The remaining cost is made up from local and state transportation funds such as operational revenues, local sales tax, state fuel tax and state transportation accounts. The transportation planning agencies prioritize project categories and assign funding to each category. Transportation projects can include planning projects, streets and highways, bridges, public transit, rail projects, ferry operations, pedestrian and bicycle facilities, and other services and projects.

To address the funding issue, staff worked with the California Association for Coordinated Transportation, the Regional Council of Rural Counties, and rural transportation agencies. Staff evaluated approximately 20 transit agencies that were located in communities with a population of less than 50,000, and that are not subject to the current fleet rule for transit agencies (see Appendix C for the list). The fleet size of these transit agencies ranges from one to thirteen transit fleet vehicles, with an average of six. These transit agencies primarily own and operate buses that are eligible for FTA and state and local matching funds. Some of the local transit agencies rely on private contracts or "turnkey operations" for their fleets. Staff evaluated existing extensions and added extensions to provide a sufficient safety net for rural counties. The following discussion details how the regulation supports small transit fleets.

1. PM Emission Reductions

A small transit agency located in a 1-hour ozone attainment area is eligible for an extension on the PM reduction requirement. The transit agency may delay compliance with the intermediate 2007 PM requirement, extending their compliance to the final compliance date on December 31, 2010. This extension provides the opportunity for the a transit agency to delay or forego the installation of a diesel emission control strategy on a TFV or urban bus and take advantage of the purchase of a 2007 or newer vehicle that is certified to the most stringent particulate engine exhaust emission standard.

2. Contract Operations

It was brought to staff's attention that a few smaller communities do not own their fleets but contract for "turnkey" operations. Staff has added a new extension for transit agencies operating transit fleet vehicles through contract. The transit agency may apply annually to extend their compliance deadlines to allow for the termination of a vehicle lease, maintenance/lease, turnkey, or service contract operations of transit fleet vehicles.

3. Financial Hardship

An extension is provided for transit agencies with fewer than 30 vehicles (urban bus and TFV) that can not meet the compliance deadlines as a result of financial hardship. A transit agency can apply for an extension of a compliance deadline based on financial hardship. Financial hardship must be documented, including an analysis of the cost of compliance, the sources of available funds, and the shortfall between funds available and the cost of compliance. The transit agency must also specify the date and means by which compliance will be achieved in the request for a delay. This information provides for a case-by-case analysis of each transit agency's situation.

In summary, staff believes that modifications made to the proposed requirements provide for a sufficient safety net for rural counties.

B. Commuter Service Bus Definition

Transit agencies requested that staff develop a new definition that would exclude over-the-road coaches in commuter service from the definition of an urban bus. After meeting with transit agency, staff proposed a definition based on the engine type (heavy-heavy duty engine) and the duty cycle (number of stops). Staff has received comments that the definition of "Commuter Service Bus" should instead focus more on the style of the vehicle, such as a motor coach with features such as only one door, reading lights, reclining seats, and luggage racks.

ARB focused on urban bus emissions for the development of the original fleet rule for transit agencies in 2000 because the duty cycle of an urban bus generates high levels of emissions. When an over-the-road coach is operated like an urban bus it emits the same or more emissions, especially as a 45 ft. motor coach is typically not equipped with an engine certified to the urban bus engine emission standard. Staff's definition of "Commuter Service Bus" focuses on the duty cycle of the bus not on how the bus looks. Therefore, staff believes the proposed definition is appropriate for this type of vehicle. Staff also is concerned that changing the definition to focus more on the features of a motor coach than its duty cycle would potentially expand the number of buses that are not treated as urban buses and thus could result in excess emissions.

XII. STAFF RECOMMENDATION

ARB staff recommends that the Board adopt the proposed modifications to title 13, CCR, sections 1956.1, 1956.2, 1956.3, 1956.4, and 2020, and proposed new sections 2023, 2023.1, 2023.2, 2023.3 and 2023.4, set forth in the proposed Regulation Order in Appendix A. These new requirements will reduce NOx and PM emissions and are consistent with the Board's *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB 2000).

XIII. REFERENCES

Abbey et al. 1999. Abbey, David E., Nishino, Naomi, McDonnell, William F., Burchette, Raoul J., Knutsen, Synnove F., Beeson, W. Lawrence, Yang, Jie X. Long-term Inhalable Particles and Other Air Pollutants Related to Mortality in Nonsmokers. Am J Respir Crit Care Med. 159:373-382.

ARB 1999. Air Resources Board. December 10, 1999. Staff Report: Initial Statement of Reasons, Proposed Regulation for a Public Transit Bus Fleet Rule and Emission Standards for New Urban Buses.
http://www.arb.ca.gov/regact/bus/bus.htm

ARB 2000a. Air Resources Board. October 2000. Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles.
http://www.arb.ca.gov/diesel/documents/rrpapp.htm

ARB 2000b. Air Resources Board. December 8, 2000. Final Statement of Reasons for Rulemaking, including Summary of Comments and Agency Responses, Public Hearing to Consider Adoption of a Public Transit Bus Fleet Rule and Emission Standards for New Urban Buses.
http://www.arb.ca.gov/regact/bus/bus.htm

ARB 2001a. Air Resources Board. December 13, 2001. Policies and Actions for Environmental Justice.
http://www.arb.ca.gov/ch/ejpolicies_121301.pdf

ARB 2001b. Air Resources Board. December 20, 2001. Letter to Transit Agencies on Clarification of the "Urban Bus" Definition.
http://www.arb.ca.gov/msprog/bus/TransitbusAdvisoryltr.pdf

ARB 2002. Air Resources Board. September 6, 2002. Initial Statement of Reasons: Public Hearing To Consider Amendments To The Public Transit Bus Fleet Rule And Emission Standards For New Urban Buses.
http://www.arb.ca.gov/regact/bus02/bus02.htm

ARB 2003. Air Resources Board. October 16, 2003. Final Statement of Reasons for Rulemaking, including Summary of Comments and Agency Responses, Public Hearing to Consider Adoption of a Public Transit Bus Fleet Rule and Emission Standards for New Urban Buses.
http://www.arb.ca.gov/regact/bus02/bus02.htm.

ARB 2004. Air Resources Board. June 24, 2004. Initial Statement of Reasons: Public Hearing To Consider Amendments To Exhaust Emissions Standards and Test Procedures 1985 and Subsequent Model Year Heavy-Duty Urban Bus

Engines and Vehicles, the Fleet Rule for Transit Agencies, and Zero-Emission Bus Requirements
http://www.arb.ca.gov/regact/bus03/bus03.htm

Beeson et al. 1998. Beeson, W. Lawrence, Abbey, David E., Knutsen, Synnove F. Long-term Concentrations of Ambient Air Pollutants and Incident Lung Cancer in California Adults: Results from the AHSMOG Study. Environmental Health Perspectives. 106: 813-822.

Dab et al. 2001. Dab, William, Segala, Claire, Dor, Frederic, Festy, Bernard, Lameloise, Phillipe, Le Moullec, Yvon, Le Tertre, Alain, Medina, Sylvia, Quenel, Phillipe, Wallaert, Benoit, Zmirou, Denis. Air Pollution and Health: Correlation or Causality? The Case of the Relationship between Exposure to Particles and Cardiopulmonary Mortality. Journal of the Air and Waste Management Association. 51: 220-235.

CalEPA 1998. California Environmental Protection Agency, Air Resources Board and Office of Environmental Health Hazard Assessment. April 22, 1998. Executive Summary for the "Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant. Sacramento, CA.
http://www.arb.ca.gov/toxics/dieseltac/finexsum.pdf

DieselNet 2002. DieselNet. March 2002. Technical Guide: Diesel Filter Systems, Traps with Fuel Additives. Revision 2000.02b.
www.dieselnet.com.

DieselNet 2004. DieselNet. October 2004. October Update. Westport secures NREL funding for HPDI truck program.
http://www.dieselnet.com/

Krewski et al. 2000. Krewski D.; Burnett R.; Goldberg M.; Hoover K.; Stemiatychi J.; Jerrett M.; Abrahamovicz M.; White W. Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality, Health Effects Institute, Cambridge, Massachusetts; 2000.
http://es.epa.gov/ncer/science/pm/hei/Rean-ExecSumm.pdf

Kubsh, Joe. November 8, 2004. Personal Communication. E-mail from Joe Kubsh, Manufacturers Of Emission Controls Association to Kathleen Mead.

Lloyd and Cackette. 2001. Lloyd, A.C.; Cackette, T.A.; Diesel Engines: Environmental Impact and Control; J Air Waste Manage. Assoc. 2001, 51: 809-847.
http://www.arb.ca.gov/research/seminars/lloyd/AWMA2001/JAWMADieselCriticalReview.pdf

McDonnell et. al. 2000. McDonnell, William F., Nishino-Ishikawa, Naomi, Petersen, Floyd F., Chen, Lie Hong, Abbey, David E. Relationships of mortality with the fine and coarse fractions of long-term ambient PM_{10} concentrations in nonsmokers. Journal of Exposure Analysis and Environmental. Epidemiology. 10: 427-436.

MECA 2002. Manufacturers of Emission Controls Association. March 2002. Retrofiting Emission Controls on Diesel Powered Vehicles. Manufacturers of Emission Controls Association. 1660 L Street, NW, Suite 1100, Washington, DC 20036
http://www.meca.org

MECA 2004. Manufacturers of Emission Controls Association. October 31, 2004. Clean Air Facts: Emission Control Retrofit of Existing Diesel Engines; undated fact sheet; viewed October 31, 2004 at http://www.meca.org/jahia/Jahia/pid/229

OEHHA 1998. Office of Environmental Health Hazard Assessment. May 1998. Health Risk Assessment for Diesel Exhaust (Public and Scientific Review Panel Review Draft). Office of Environmental Health Hazard Assessment, California Environmental Protection Agency.
http://www.arb.ca.gov/regact/diesltac/diesltac.htm

Peters et al. 1999. Peters, J.M., Avol, E., Gauderman, W.J., Linn, W.S., Navidi, W., London, S.J., Margolis, H., Rappaport, E., Vora, H., Gong, H., Thomas, D.C. A study of Twelve Southern California Communities with Differing Levels and Types of Air Pollution. Am J Respir Crit Care Med 159:768-775

Pope et al, 1995. Pope, C.A.; Thun, M.J.; Namboodiri, M.M.; Dockery, D.W.; Evans, J.S.; Speizer, F.E.; Heath, C.W. Particulate Air Pollution as a Predictor of Mortality in Prospective Study of U.S. Adults, Am. J. Respir. Crit. Care Med.; 1995.

U.S. EPA 2000. United States Environmental Protection Agency. September 2000, *Guidelines for Preparing Economic Analyses.* EPA240-R-00-003
http://www.epa.gov/opei/pubsinfo.htm

U.S. EPA 2002a. United States Environmental Protection Agency. October 2002. A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions – Draft Technical Report. EPA420-P-02-001.
http://www.epa.gov/otaq/models/biodsl.htm

U.S. EPA 2002b. United States Environmental Protection Agency. December 2002. Impacts of Lubrizol's PuriNOx Water/Diesel Emulsion on Exhaust Emissions from Heavy-Duty Engines – Draft Technical Report. EPA420-P-02-007.
http://www.epa.gov/otaq/models/p02007.pdf

U.S. EPA 2003. United States Environmental Protection Agency. April 2003. United States Environmental Protection Agency, Assessment and Standards Division, Office of Transportation and Air Quality, Draft Regulatory Impact Analysis: Control of Emissions of Air Pollution from Nonroad Diesel Engines and Fuel. EPA420-R-03-008. CD-ROM. Research Triangle Park, North Carolina. http://www.epa.gov/otaq/cleaner-nonroad/r03008.pdf

U.S. EPA 2004a. United States Environmental Protection Agency. March 2004. Highway Diesel Progress Review Report 2. EPA420-R-04-004. http://www.epa.gov/otaq/diesel.htm#progreport2

U.S. EPA 2004b. United States Environmental Protection Agency. October 31, 2004. Voluntary Diesel Retrofit Program. Verified Products. Verified Technology List. Viewed on October 31, 2004 at http://www.epa.gov/otaq/retrofit/retroverifiedlist.htm

VTA 2004. Santa Clara Valley Transit Authority. February 5, 2004. California Transit Agencies Advanced NOx Reduction Demonstration Program. Update 04-01-21.

Wilson, Dave. October 29, 2004. Personal Communication by phone with Dave Wilson, General Automotive Supervisor, City of Los Angeles and Ron Nunes staff of the Air Resources Board.