



California

*Air Resources Board*

## PUBLIC MEETING AGENDA

March 21 - 22, 2002  
9:00 a.m. / 8:30 a.m.

02-1-1 Public Meeting to  
Consider a Health Update

02-1-2 Public Meeting to  
Consider Research Proposals

02-1-3 Public Meeting to  
Consider an Update on  
California-Mexico Border  
Activities

02-1-4 Public Meeting to  
Consider a Status Report  
on the Fleet Rule and  
Reporting Requirements for  
all Urban Bus Transit Agencies

02-1-5 Public Meeting to  
Consider a Status Report  
on the Carl Moyer Memorial  
Air Quality Standards Attain-  
ment Program: Incentives for  
Lower Emission Heavy-Duty  
Engines (The Carl Moyer  
Program)

Includes  
Acrobat™  
Reader™

PC and Mac  
Compatible

California Environmental Protection Agency 

ELECTRONIC BOARD BOOK

LOCATION:

San Diego County Administration Center  
Supervisors Chambers, Room 310  
1600 Pacific Highway  
San Diego, CA 92101

California Environmental Protection Agency



**PUBLIC MEETING AGENDA**

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March 21-22, 2002  
9:00 a.m. / 8:30 a.m.

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02-1-4	39	<b>Public Meeting to Consider a Status Report on the Fleet Rule and Reporting Requirements for all Urban Bus Transit Agencies</b>
02-1-5	103	<b>Public Meeting to Consider a Status Report on the Carl Moyer Memorial Air Quality Standards Attainment Program: Incentives for Lower Emission Heavy-Duty Engines (The Carl Moyer Program)</b>

The Board Book is comprised of a number of individual documents, many of which are individually numbered. The Board Book itself is numbered in the top right and left hand corners. These numbers are reflected in the Table of Contents above.

**CONTACT CLERK OF THE BOARD, 1001 I Street, 23<sup>rd</sup> Floor, Sacramento, CA 95814**

**(916) 322-5594**

**FAX: (916) 322-3928**

**ARB Homepage: [www.arb.ca.gov](http://www.arb.ca.gov)**

To submit written comments on an agenda item in advance of the meeting.

To request, in advance of the meeting, to be placed on the list to testify on an agenda item.

To request special accommodations for those persons with disabilities (at least 7 days prior to the meeting date please).

For persons with a hearing or speech impairment, please use our telephone device for the deaf

**TDD: (916) 324-9531 or (800) 700-8326.**

**SMOKING NOT PERMITTED AT MEETINGS OF THE CALIFORNIA AIR RESOURCES BOARD**

LOCATION:

San Diego County Administration Center  
Supervisors Chambers, Room 310  
1600 Pacific Highway  
San Diego, CA 92101

**PUBLIC MEETING AGENDA**

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March 21-22, 2002

9:00 a.m. / 8:30 a.m.

02-1-1 **Public Meeting to Consider a Health Update**

*Staff will provide the Board with a short update on the health impacts from exposures to particulate air pollution. This presentation will focus on recent studies that have shown that exposure to particulate matter can result in serious heart disease.*

02-1-2 **Public Meeting to Consider Research Proposals**

*Proposal No. 2512-224, entitled "A Post-Regulatory Evaluation of the Cost and Economic Impact Estimates of Air Pollution Control Regulations," submitted by the University of California, Riverside, for an amount not to exceed \$149,997.*

*Proposal No. 2510-224, entitled "Indoor Air Chemistry: Cleaning Agents, Ozone and Toxic Air Contaminants," submitted by the University of California, Berkeley, for an amount not to exceed \$446,509.*

*Proposal No. 2515-224, entitled "Gas-Phase Formation Rates of Nitric Acid and its Isomers under Urban Conditions," submitted by NASA/Jet Propulsion Laboratory/California Institute of Technology, for an amount not to exceed \$180,000.*

*Proposal No. 2514-224, entitled "Quantitative Analysis of Aerosol Time-of-Flight Mass Spectrometry Data Using YAADA," submitted by Arizona State University, for an amount not to exceed \$50,000.*

*Proposal No. 2516-224, entitled "Research in the Development of Biological Methods of Dust Suppression in the Antelope Valley," submitted by San Diego State University, for an amount not to exceed \$89,830.*

*Proposal No. 2507-223, entitled "Determination of the Asbestos Content of Current Automotive Dry Friction Materials, and the Potential Contribution of Asbestos to the Particulate Matter Derived from Brake Wear," submitted by the California Department of Health Services, for an amount not to exceed \$131,055.*

*Proposal No. 2505-223, entitled "Incidence of Malfunctions and Tampering in Heavy-Duty Vehicles," submitted by the University of California, Riverside, for an amount not to exceed \$199,103.*

**(Agenda continued on next page)**

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**SMOKING NOT PERMITTED AT MEETINGS OF THE CALIFORNIA AIR RESOURCES BOARD**

02-1-3 **Public Meeting to Consider an Update on California-Mexico Border Activities**



*Staff will report on recent activities to better understand and reduce air pollution in the California-Mexico border region. The Air Resources Board has been involved in several cross-border efforts that will assist in the development of air quality management strategies for border communities.*

02-1-4 **Public Meeting to Consider a Status Report on the Fleet Rule and Reporting Requirements for all Urban Bus Transit Agencies**

*Staff will provide the Board with an update on the transit agencies' progress in complying with the 4.8 grams per brake horsepower-hour (g/bhp-hr) as directed by the Board on September 21, 2001.*

02-1-5 **Public Meeting to Consider a Status Report on the Carl Moyer Memorial Air Quality Standards Attainment Program: Incentives for Lower Emission Heavy-Duty Engines (The Carl Moyer Program)**

*Staff will update the Board on the status of the statewide program for the first three years as required by Health and Safety Code section 44295. The report contains detailed information on local air district programs, including the status of state funds expended under the program. In addition, the report addresses how the Carl Moyer Program has reduced public exposure to toxic diesel exhaust.*

**CLOSED SESSION – LITIGATION**

*Coalition for Clean Air, Inc. v. South Coast Air Quality Management District (SCAQMD), et al., U.S. District Court for the Central District of California Case No. CV97-6916-HLH. The Board will hold a closed session as authorized by Government Code section 11126(e) to confer with, or receive advice from, its legal counsel regarding this litigation.*

*San Joaquin Valley Unified Air Pollution Control District v. State of California Air Resources Board, Sacramento County Superior Court Case No. 02CS00270. The Board will hold a closed session as authorized by Government Code section 11126(e) to confer with, or receive advice from, its legal counsel regarding this litigation*

**OPEN SESSION TO PROVIDE AN OPPORTUNITY FOR MEMBERS OF THE PUBLIC TO ADDRESS THE BOARD ON SUBJECT MATTERS WITHIN THE JURISDICTION OF THE BOARD**

Although no formal Board action may be taken, the Board is allowing an opportunity to interested members of the public to address the Board on items of interest that are within the Board's jurisdiction, but that do not specifically appear on the agenda. Each person will be allowed a maximum of five minutes to ensure that everyone has a chance to speak.

**THOSE ITEMS ABOVE WHICH ARE NOT COMPLETED ON MARCH 21 WILL BE HEARD BEGINNING AT 8:30 A.M. ON MARCH 22.**

**THE AGENDA ITEMS LISTED ABOVE MAY BE CONSIDERED IN A DIFFERENT ORDER AT THE BOARD MEETING.**

## SUMMARY OF BOARD ITEM

**ITEM # 02-2-1:** **BOARD UPDATE ON HEALTH EFFECTS OF AIR POLLUTION: EFFECTS OF PARTICULATE MATTER ON THE CARDIOVASCULAR SYSTEM**

**STAFF RECOMMENDATION:** Informational item.

**DISCUSSION:** The ARB staff are providing the Board with monthly updates on the health effects of air pollution. This month staff would like to focus on the short-term health impacts of particulate matter. Later this year staff will be recommending changes to the ambient air quality standards for particulate matter.

**SUMMARY AND IMPACTS:** Over the past decade a number of epidemiologic studies have reported a significant association between exposure to air-borne particulate matter (PM) and deaths and hospital admissions for cardiovascular causes. Staff will briefly discuss several recent studies on human subjects that have reported significant relationships between ambient PM exposure and several physiological responses that are known from previous clinical research to be risk factors for adverse cardiovascular outcomes, such as increased pulse rate, decreased heart rate variability, and elevated levels of protein indicators in the blood. Changes in these risk factors have been clinically linked to various heart pathologies, such as cardiac arrhythmia and myocardial infarction (heart attack) that lead to hospitalization and mortality for cardiovascular causes.

These findings come from epidemiologic studies. Further studies in both human subjects and animal models will provide more conclusive evidence that exposure to PM causes an increased risk for adverse cardiovascular effects. ARB is involved in funding several on-going research projects that will begin to provide the information that is needed to draw a causal link between PM exposure and adverse cardiovascular effects. Staff will discuss how future studies will provide better information on the adverse effects of particulate matter pollution.



State of California  
AIR RESOURCES BOARD

Research Resolutions

Research Division

March 21, 2002

## INTRODUCTION

Contained herein for Board review are seven resolutions and accompanying summaries from the Extramural Research Program recommended to the Board by the Research Screening Committee.

Item 1 is a research proposal from the University of California, Riverside, entitled "A Post-Regulatory Evaluation of the Cost and Economic Impact Estimates of Air Pollution Control Regulations." The principal investigator will be Dr. James M. Lents. Resolution No. 02-09

Item 2 is a research proposal from the University of California, Berkeley, entitled "Indoor Air Chemistry: Cleaning Agents, Ozone, and Toxic Air Contaminants." The principal investigator will be Dr. William W. Nazaroff. Resolution No. 02-10

Item 3 is a research proposal from NASA/Jet Propulsion Laboratory/California Institute of Technology, entitled "Gas-Phase Formation Rates of Nitric Acid and its Isomers under Urban Conditions." The principal investigator will be Dr. Stanley Sander. Resolution No. 02-11

Item 4 is a research proposal from Arizona State University, entitled "Quantitative Analysis of Aerosol Time-of-Flight Mass Spectrometry Data using YAADA." The principal investigator will be Dr. Jonathan O. Allen. Resolution No. 02-12

Item 5 is a research proposal from San Diego State University, entitled "Research into the Development of Biological Methods of Dust Suppression in the Antelope Valley." The principal investigator will be Dr. Thomas A. Zink. Resolution No. 02-13

Item 6 is a research proposal from the California Department of Health Services, entitled "Determination of the Asbestos Content of Current Automotive Dry Friction Materials, and the Potential Contribution of Asbestos to the Particulate Matter Derived from Brake Wear." The principal investigator will be Dr. Stephen Wall. Resolution No. 02-14

Item 7 is a research proposal from the University of California, Riverside, entitled, "Incidence of Malfunctioning and Tampering in Heavy-Duty Vehicles." The principal investigator will be Dr. J. Wayne Miller. Resolution No. 02-15

## PROPOSED

State of California  
AIR RESOURCES BOARD

## RESEARCH PROPOSAL

Resolution 02-9

March 21, 2002

Agenda Item No.: 02-2-2

WHEREAS, the Air Resources Board has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2512-224, entitled "A Post-Regulatory Evaluation of the Cost and Economic Impact Estimates of Air Pollution Control Regulations," has been submitted by the University of California, Riverside;

WHEREAS, the Research Division staff has reviewed and recommended this proposal for approval; and

WHEREAS, the Research Screening Committee has reviewed and recommends for funding:

Proposal Number 2512-224 entitled "A Post-Regulatory Evaluation of the Cost and Economic Impact Estimates of Air Pollution Control Regulations," submitted by the University of California, Riverside, for a total amount not to exceed \$149,997.

NOW, THEREFORE BE IT RESOLVED, that the Air Resources Board, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendation of the Research Screening Committee and approves the following:

Proposal Number 2512-224 entitled "A Post-Regulatory Evaluation of the Cost and Economic Impact Estimates of Air Pollution Control Regulations," submitted by the University of California, Riverside, for a total amount not to exceed \$149,997.

BE IT FURTHER RESOLVED, that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the

research effort proposed herein, and as described in Attachment A, in an amount not to exceed \$149,997.

## ATTACHMENT A

### “A Post-Regulatory Evaluation of the Cost and Economic Impact Estimates of Air Pollution Control Regulations”

#### **Background**

California has made great strides in improving the air quality over the past few decades. However, despite the dramatic air quality improvement, California has not been able to achieve the federal clean air standards. A majority of Californians still breathe unhealthy air on at least some days during the year. Additional regulations are needed to meet the federal requirements for attaining national air quality standards within this decade. New regulations may be more expensive if businesses must meet more stringent air quality standards. Yet there is numerous evidence showing that costs may not be as high as originally estimated. This may be due to the fact that the regulatory agencies, when estimating costs, usually assume that more stringent standards will be attained with current technologies. But, history shows that technology continues to improve and technological innovation tends to lower future compliance costs.

Although anecdotal evidence indicates that regulation stimulates innovation, there are no comprehensive studies to assess the impact of innovation on the actual costs of regulations. This study plans to collect and analyze data on actual regulatory costs and economic impacts of a selected number of ARB and South Coast Air Quality Management District (SCAQMD) regulations and rules, and then compare them to the original estimates. The study will also conduct a comparison of emission reduction data before and after a regulation if such data are available. The results may shed light on how innovation can lower compliance costs.

#### **Objective**

The objective of this study is to conduct a post-regulation engineering and economic evaluation of the accuracy of the costs, economic impacts, and emission reductions of air pollution control regulations in California. This study also intends to identify the primary causes of the differences between the original estimates and the actual results.

#### **Methods**

The contractor proposes to select a minimum of ten key ARB and SCAQMD rules and regulations that have affected a variety of industries and geographic areas and that have required different technologies to assess the accuracy of their cost, economic impact, and emission reduction estimates. The contractor will develop a profile of candidate regulations. The profiles include estimates of costs, economic impacts, and emission reductions, along with underlying assumptions made by various stakeholders and regulatory agencies to develop those estimates. Information will be obtained from the initial regulatory process, including staff reports, published reports and materials, stakeholder comments, and actual rule adoption records. Stakeholders will also be contacted to collect any historical information available.

The contractor will utilize a variety of sources to collect or develop actual data on costs, economic impacts and emission reductions for the candidate regulations. Such sources include the Internet, documents and reports, trade publications and surveys, interviews of affected industries, consumers, and equipment vendors, and emission reduction transaction costs from RECLAIM or offsets where appropriate. The main focus of this study will be to collect the actual data on control/process equipment costs, operating/maintenance costs, and indirect costs associated with the selected regulations. However, information will also be collected on the actual technologies used to comply with the candidate regulations. Special attention will be given to accounting for any productivity effects these technologies may have created.

**Expected Results**

This study will provide the Board with a report on the accuracy of the projected vis-à-vis actual costs, economic impacts, and emission reduction impacts for a number key of regulations. It will also provide an explanation of any significantly inaccurate estimates, and suggest specific recommendations on how to improve cost and emission reduction projections for future rulemaking efforts.

**Significance to the Board**

The insights gained from this study will assist the board and the districts to improve estimates of cost, economic impacts, and emission reductions of their proposed regulations and rules.

**Contractor:**

University of California, Riverside

**Contract Period:**

18 months

**Principal Investigator (PI):**

Dr. James M. Lents

**Contract Amount:**

\$149,997

**Cofunding:**

None

**Basis for Indirect Cost Rate:**

The 10 percent rate used is a negotiated rate between the ARB and University of California campuses.

**Past Experience with this Principal Investigator:**

Dr. James Lents, the principal investigator for this project, was the Executive Officer of the South Coast Air Quality Management District for 11 years. He has impeccable credentials in the fields of environmental science, technology, and policy.

**Prior Research Division Funding to the University of California, Riverside:**

Year	2001	2000	1999
Funding	\$79,884	\$654,788	\$659,987

## BUDGET SUMMARY

University of California, Riverside

A Post-Regulatory Evaluation of the Cost and Economic Impact Estimates of Air  
Pollution Control Regulations

### DIRECT COSTS AND BENEFITS

1.	Labor and Employee Fringe Benefits	\$99,475	
2.	Subcontractors	\$18,000	
3.	Equipment	\$ 0	
4.	Travel and Subsistence	\$ 2,133	
5.	Electronic Data Processing	\$ 0	
6.	Photocopying and Printing	\$ 0	
7.	Mail, Telephone and Fax	\$ 3,030	
8.	Materials and Supplies	\$ 0	
9.	Analyses	\$ 0	
10.	Miscellaneous	<u>\$15,600</u>	
	Total Direct Costs		\$138,238

### INDIRECT COSTS

1.	Overhead	\$11,759	
2.	General and Administrative Expenses	\$ 0	
3.	Other Indirect Costs	\$ 0	
4.	Fee or Profit	<u>\$ 0</u>	
	Total Indirect Costs		<u>\$11,759</u>

### TOTAL PROJECT COSTS

\$149,997

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## PROPOSED

State of California  
AIR RESOURCES BOARD

Resolution 02-10

March 21, 2002

Agenda Item No.: 02-2-2

WHEREAS, the Air Resources Board has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2510-224, entitled "Indoor Air Chemistry: Cleaning Agents, Ozone, and Toxic Air Contaminants," has been submitted by the University of California, Berkeley;

WHEREAS, the Research Division staff has reviewed and recommended this proposal for approval; and

WHEREAS, the Research Screening Committee has reviewed and recommends for funding:

Proposal Number 2510-224 entitled "Indoor Air Chemistry: Cleaning Agents, Ozone, and Toxic Air Contaminants," submitted by the University of California, Berkeley, for a total amount not to exceed \$446,865.

NOW, THEREFORE BE IT RESOLVED, that the Air Resources Board, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendation of the Research Screening Committee and approves the following:

Proposal Number 2510-224 entitled "Indoor Air Chemistry: Cleaning Agents, Ozone, and Toxic Air Contaminants," submitted by the University of California, Berkeley, for a total amount not to exceed \$446,865.

BE IT FURTHER RESOLVED, that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the research effort proposed herein, and as described in Attachment A, in an amount not to exceed \$446,865.

## ATTACHMENT A

### "Indoor Air Chemistry: Cleaning Agents, Ozone, and Toxic Air Contaminants"

#### **Background**

Household products such as cleaning agents, polishes, and air fresheners contain many volatile constituents that can contribute to indoor pollutant levels, including both directly emitted Toxic Air Contaminants (TACs) and pollutants formed by chemical reaction. Many volatile constituents of household cleaning agents have been identified as TACs, such as toluene, ethyl benzene, styrene, glycol ethers, formaldehyde, acetaldehyde, and methyl ethyl ketone. Therefore, the use of cleaning products in residences, schools, and commercial and institutional buildings can result in inhalation exposure to TACs. Additionally, ozone, a very reactive gas, has been found to react with some common cleaning agent constituents to form respiratory irritants and/or carcinogens such as formaldehyde, acrolein, and numerous carboxylic acids, among others.

Formulations of cleaning products have undergone considerable change in response to ARB's regulations limiting percent by weight of VOCs in consumer products, with regulations requiring further reductions for some products (to 4% VOC by weight) to be implemented in 2004. As a result, there is concern that many household cleaners are evolving to have a larger contribution to the total composition from unsaturated, lower volatility hydrocarbons (e.g., d-limonene, selected terpenes and glycol ethers), a class of compounds generally more available to participate in reactions with ozone. Additionally, accurate and realistic information on indoor exposure to TACs, both directly emitted and formed by chemical reaction, is crucial because of the importance of such exposures in determining health risks from these chemicals.

#### **Objective**

The objective of the proposed research is to identify and quantify primary emissions of TACs from cleaning products, as well as secondary emissions resulting from reactions between cleaning agent emissions and ozone under realistic indoor conditions. Tests will be conducted using realistic indoor use scenarios, so that the potential exposure of product users and room occupants can be assessed. In addition to obtaining product emissions and exposure information, the investigators will identify the conditions under which these processes contribute to elevated indoor levels of TACs.

#### **Methods**

The investigators propose to conduct a series of chamber tests at the Lawrence Berkeley National Laboratory (LBNL) to examine cleaning product emissions and associated indoor chemistry in realistic use scenarios. A set of screening tests will be performed in a small-scale chamber to identify cleaning products with a high potential either for primary TAC emissions or for formation of TACs as secondary emissions. These products will be further tested in a full-scale chamber under simulated indoor use conditions to better quantify emissions and user/occupant exposure during cleaning product application. A subset of these experiments will be conducted with and without the introduction of ozone into the chamber to assess reaction products. Analytes for all

chamber experiments will include a large number of VOCs, aldehydes, acids, glycol ethers, and terpenes and related compounds.

**Expected Results**

Results from the study will include semi-quantitative data on the primary emissions of TACs from approximately 20 cleaning products, and more specific, quantitative data on the primary emissions and exposure concentrations for approximately nine of these products. Also, the proposed study will provide quantitative data on the secondary (reaction) emissions of TACs (including formation and removal processes) resulting from cleaning agent-ozone reactions under realistic use scenarios for at least three of the cleaning products selected in screening tests as described above. In addition to obtaining product emissions and exposure information, the investigators will identify the conditions under which these processes contribute to elevated indoor levels of TACs.

**Significance to the Board**

Results from this study will be used by ARB to assess the need for further refinement of ARB's consumer products regulations to protect public health, and to provide guidance to the public on ways to reduce any potentially harmful exposure that may occur when using cleaning products.

**Contractor:**

University of California, Berkeley

**Contract Period:**

36 months

**Principal Investigator (PI):**

William W. Nazaroff, Ph.D.

**Contract Amount:**

\$446,865

**Cofunding:**

None

**Basis for Indirect Cost Rate:**

The indirect cost rate of 10 percent is a negotiated rate agreed to by the State and University of California campuses.

**Past Experience with this Principal Investigator:**

Dr. William Nazaroff is a Professor in the Department of Civil and Environmental Engineering at the University of California, Berkeley, and is a leader in the field of indoor air quality, aerosol physics, air pollution control, and contaminant transport processes. Dr. Nazaroff also serves as a member of ARB's Research Screening Committee. Dr. Nazaroff has completed one ARB-funded project in the past, entitled "Assessing Exposure to Air Toxicants From Environmental Tobacco Smoke" (ARB contract

#94-344). In that work, Dr. Nazaroff demonstrated his excellent analytical abilities and the ability to oversee the administration and management of research projects.

**Prior Research Division Funding to the University of California, Berkeley:**

Year	2001	2000	1999
Funding	\$0	\$0	\$392,027

## B U D G E T S U M M A R Y

University of California, Berkeley

Indoor Air Chemistry: Cleaning Agents, Ozone, and Toxic Air Contaminants

### DIRECT COSTS AND BENEFITS

1.	Labor and Employee Fringe Benefits	\$207,531
2.	Subcontractors	\$190,695
3.	Equipment	\$ -0-
4.	Travel and Subsistence	\$ 1,820
5.	Electronic Data Processing	\$ -0-
6.	Reproduction/Publication	\$ 1,400
7.	Mail, Phone, and FAX	\$ 1,100
8.	Materials and Supplies	\$ 15,620
9.	Analyses	\$ -0-
10.	Miscellaneous	<u>\$ 1,158</u>
Total Direct Costs		\$419,324

### INDIRECT COSTS

1.	Overhead	\$ 27,541
2.	General and Administrative Expenses	\$ -0-
3.	Other Indirect Costs	\$ -0-
4.	Fee or Profit	<u>\$ -0-</u>
Total Indirect Costs		<u>\$27,541</u>

### TOTAL PROJECT COSTS

\$446,865

Two subcontractors will be part of this project: Lawrence Berkeley Laboratory and a private consultant, Dr. Charles J. Weschler.

Labor	116,891	
Miscellaneous	<u>14,364</u>	
Total Direct Cost		\$131,255
Indirect Cost	<u>59,440</u>	
Subcontractors Total		\$190,695

PROPOSED

State of California  
AIR RESOURCES BOARD

Resolution 02-11

March 21, 2002

Agenda Item No.: 02-2-2

WHEREAS, the Air Resources Board has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2515-224, entitled "Gas-Phase Formation Rates of Nitric Acid and its Isomers under Urban Conditions," has been submitted by NASA/Jet Propulsion Laboratory/California Institute of Technology;

WHEREAS, the Research Division staff has reviewed and recommended this proposal for approval; and

WHEREAS, the Research Screening Committee has reviewed and recommends for funding:

Proposal Number 2515-224 entitled "Gas-Phase Formation Rates of Nitric Acid and its Isomers under Urban Conditions," submitted by NASA/Jet Propulsion Laboratory/California Institute of Technology, for a total amount not to exceed \$180,000.

NOW, THEREFORE BE IT RESOLVED, that the Air Resources Board, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendation of the Research Screening Committee and approves the following:

Proposal Number 2515-224 entitled Gas-Phase Formation Rates of Nitric Acid and its Isomers under Urban Conditions," submitted by NASA/Jet Propulsion Laboratory/California Institute of Technology, for a total amount not to exceed \$180,000.

BE IT FURTHER RESOLVED, that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the research effort proposed herein, and as described in Attachment A, in an amount not to exceed \$180,000.

## ATTACHMENT A

### “Gas-Phase Formation Rates of Nitric Acid and its Isomers under Urban Conditions”

#### Background

Urban airshed models are indispensable tools in the assessment of control strategies for  $\text{NO}_x$  and VOCs. The controlling processes for ozone formation in such models are fast free-radical reactions. These reactions involve the generation of free radicals (primarily through photolysis reactions), conversion and regeneration of radicals, and removal of radicals through termination reactions. An important process in this latter category is the formation of nitric acid from the hydroxyl radical OH and nitrogen dioxide  $\text{NO}_2$ :  $\text{OH} + \text{NO}_2 + \text{M} = \text{HNO}_3 + \text{M}$ , where M is an inert bath gas, such as  $\text{N}_2$ . This reaction removes two short-lived reactive intermediates, OH and  $\text{NO}_2$ , and produces a relatively long-lived product,  $\text{HNO}_3$ . The significance of the termination step to urban airshed models is reflected in the high sensitivities of the spatial and temporal distributions of ozone from models to the value of the rate constant. For example, propagation of the uncertainty in the OH+ $\text{NO}_2$  rate constant (~25 percent) in an urban airshed model produces an uncertainty of 35 ppbv in the calculated ozone concentration at a site downwind (i.e., ~25-50 percent uncertainty in the total ozone concentration). Also, this overall reaction is comprised of two reaction channels in which nitric acid  $\text{HNO}_3$  and peroxyxynitrous acid HOONO are produced; complications arising from these channels introduce an additional uncertainty of 10-20 percent in the rate constant.

#### Objective

This primary objectives of this research are: 1) determine kinetic data for the radical termination reaction  $\text{OH} + \text{NO}_2 + \text{M} \rightarrow \text{products}$ , and 2) measure the branching ratio for the formation of the isomers,  $\text{HNO}_3$  and HOONO, which are produced by this reaction.

#### Methods

A new laser photolysis/laser-induced fluorescence apparatus will be used to obtain kinetic data for the reaction  $\text{OH} + \text{NO}_2$ . The reaction will be studied over the temperature range 250-310 K and the pressure range 500-800 Torr. The Chemical Kinetics and Photochemistry Group will carry out this work at NASA Jet Propulsion Laboratories. The targeted uncertainty in the rate constant is 15 percent or less. The branching ratios for the formation of the products  $\text{HNO}_3$  and HOONO will also be measured. The groups of Prof. M. Okumura and Prof. P. Wennberg at the California Institute of Technology will carry out these studies using the techniques of infrared cavity ringdown spectroscopy and near-infrared photofragment (action) spectroscopy.

#### Expected Results

This project will determine kinetic and mechanistic information about a key radical termination process under urban conditions. This information is essential to improve the predictive capabilities of urban airshed models with respect to oxidant formation.

**Significance to the Board**

This project will improve our understanding of an important termination pathway for both OH and NO<sub>x</sub>. The kinetic information obtained about this process will further the predictive capabilities of urban airshed models, which in turn will help determine the relative effectiveness of NO<sub>x</sub> and VOC controls on oxidant formation in urban areas. In addition, since this termination step is the primary pathway for the production of gas-phase nitric acid, this project may also have implications for the control of particulate matter.

**Contractor:**

NASA/Jet Propulsion Laboratory/California Institute of Technology

**Contract Period:**

24 Months

**Principal Investigator (PI):**

Dr. Stanley Sander

**Contract Amount:**

\$180,000

**Basis for Indirect Cost Rate:**

The Jet Propulsion Laboratory is using a federally approved rate.

**Past Experience with this Principal Investigator:**

Dr. S. Sander is team leader of the Chemical Kinetics and Photochemistry Group at NASA JPL. This group is a recognized leader in research concerning elementary reaction kinetics and photochemical processes relevant to the earth. Dr. S. Sander is also the chairman of the NASA Panel for the Evaluation of Chemical Kinetic and Photochemical Data for Atmospheric Modeling, which provides a critical tabulation of the most recent kinetic and photochemical data for use by modelers in computer simulations of atmospheric chemistry.

**Prior Research Division Funding to NASA/Jet Propulsion Laboratory/California Institute of Technology:**

Year	2001	2000	1999
Funding	\$0	\$0	\$0

## B U D G E T S U M M A R Y

NASA/Jet Propulsion Laboratory/California Institute of Technology

“Gas-Phase Formation Rates of Nitric Acid and its Isomers under Urban Conditions”

### DIRECT COSTS AND BENEFITS

1.	Labor and Employee Fringe Benefits	\$44,700	
2.	Subcontractors	\$60,000 <sup>1</sup>	
3.	Equipment	\$ 7,000	
4.	Travel and Subsistence	\$ 700	
5.	Electronic Data Processing	\$ - 0 -	
6.	Reproduction/Publication	\$ - 0 -	
7.	Mail and Phone	\$ - 0 -	
8.	Supplies	\$ 4,000	
9.	Analyses	\$ - 0 -	
10.	Miscellaneous	<u>\$14,000</u>	
	Total Direct Costs		\$130,400

### INDIRECT COSTS

1.	Overhead	\$29,100	
2.	General and Administrative Expenses	\$10,300	
3.	Other Indirect Costs	\$10,200	
4.	Fee or Profit	<u>\$ -0-</u>	
	Total Indirect Costs		<u>\$49,600</u>

### TOTAL PROJECT COSTS

\$180,000

(notes)

<sup>1</sup> CalTech subcontractor	
Labor	\$34,600
Tuition	4,640
Indirect Cost	<u>\$20,760</u>
	\$60,000

PROPOSED

State of California  
AIR RESOURCES BOARD

Resolution 02-12

March 21, 2002

Agenda Item No.: 02-2-2

WHEREAS, the Air Resources Board has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2514-224, entitled "Quantitative Analysis of Aerosol Time-of-Flight Mass Spectrometry Data using YAADA," has been submitted by Arizona State University;

WHEREAS, the Research Division staff has reviewed and recommended this proposal for approval; and

WHEREAS, the Research Screening Committee has reviewed and recommends for funding:

Proposal Number 2514-224 entitled "Quantitative Analysis of Aerosol Time-of-Flight Mass Spectrometry Data using YAADA," submitted by Arizona State University, for a total amount not to exceed \$50,281.

NOW, THEREFORE BE IT RESOLVED, that the Air Resources Board, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendation of the Research Screening Committee and approves the following:

Proposal Number 2514-224 entitled "Quantitative Analysis of Aerosol Time-of-Flight Mass Spectrometry Data using YAADA," submitted by Arizona State University, for a total amount not to exceed \$50,281.

BE IT FURTHER RESOLVED, that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the research effort proposed herein, and as described in Attachment A, in an amount not to exceed \$50,281.

## ATTACHMENT A

### “Quantitative Analysis of Aerosol Time-of-Flight Mass Spectrometry Data using YAADA”

#### Background

Epidemiological studies have shown that the concentration of very small airborne particles (aerodynamic diameter less than 2.5  $\mu\text{m}$ ) is correlated with excess human mortality in cities across the United States. Further studies have shown that some airborne particles contain toxic substances such as carcinogens suggesting that health effects may be associated with a small subset of toxic particles within atmospheric aerosols. One approach taken to understand the cause of these observed health effects is to measure atmospheric aerosol composition in detail and relate this to observations of acute or chronic health effects.

Researchers are now able to measure the size and composition of single aerosol particles using instruments like the Aerosol Time-of-Flight Mass Spectrometry (ATOFMS) instruments developed by Prof. Kimberly Prather and others. Complete mass spectra are collected on individual particles at a rate of approximately one per second. Thus, very large data sets (approximately 200 MB/day) can be collected during a multi-day, multi-instrument experiment. These data sets are too large for *ad hoc* data analysis techniques. YAADA is a software package of data management and analysis that can be used to process these large data sets. YAADA includes functions to import, plot, and quantitatively analyze ATOFMS data. The import module rapidly converts data from the common ATOFMS data acquisition software and performs quality control checks on the data.

#### Objective

The objectives of this research project are to compare quantitatively ATOFMS data and collocated impactor measurements of aerosol mass to investigate particle detection efficiencies for the modified ATOFMS design, to determine chemical sensitivity of ATOFMS instruments for organic and elemental carbon in the Bakersfield Instrument Intercomparison and other studies, and to develop, test, and distribute the quantification package for YAADA so that other users can perform quantitative comparisons of ATOFMS and reference sampler data.

#### Methods

The proposed work is based on the hypothesis that ATOFMS data can be scaled to account for nonlinear particle and ion detection efficiencies to yield quantitative aerosol composition. The initial approach will be to develop scaling functions for particle transmission efficiency which have parameters fitted by nonlinear regression of scaled ATOFMS data with reference measurements. ATOFMS data to be used for in this research project are available from several recent field studies. The investigator will also develop scaling functions for carbonaceous species detection efficiency by comparison with quantitative size-segregated aerosol carbonaceous aerosol measurements. In order to perform the complex analyses proposed in this research

project, the investigator will use YAADA software toolkit. Several general functional modules will be written to improve the current proprietary codes. In addition to improved documentation and ease-of-use, the new functions will allow complex mass spectral responses to be compared with reference data.

**Expected Results**

The deliverables from the proposed research will include a final report summarizing the research methods, results, and conclusions, and the YAADA quantification module. The investigator will release to the public the programs used in this work. The programs will include those used to quantitatively compare ATOFMS data to reference sampler data and those used to scale up ATOFMS data collected to determine continuous aerosol mass, elemental carbon, and organic carbon concentrations.

**Significance to the Board**

The resulting software will allow for a much wider analysis of the ATOFMS data (very large data sets of approximately 200 MB/day) collected under other ARB contracts. Quantitative aerosol measurements are needed to better understand the sources, transformations, and fate of ambient particles in order to understand the effects of particulate matter on global climate, human health, and regional visibility.

**Contractor:**

Arizona State University (ASU)

**Contract Period:**

18 months

**Principal Investigator (PI):**

Dr. Jonathan O. Allen

**Contract Amount:**

\$50,281

**Cofunding:**

None

**Basis for Indirect Cost Rate:**

Indirect cost is calculated per ASU office of research and creative activities guidelines.

**Past Experience with this Principal Investigator:**

Dr. Allen's research work to analyze large aerosol data sets follows from his long-standing and mutually productive collaboration with other investigators. This collaboration began in 1996 when the PI was a postdoctoral with Prof. Glen Cass at the California Institute of Technology. Numerous peer-reviewed research papers and the YAADA software toolkit are the result of this collaboration.

**Prior Research Division Funding to Arizona State University:**

Year	2001	2000	1999
Funding	\$0	\$0	\$0

## BUDGET SUMMARY

Arizona State University  
Quantitative Analysis of Aerosol Time-of-Flight Mass Spectrometry  
Data using YAADA

### DIRECT COSTS AND BENEFITS

1.	Labor and Employee Fringe Benefits	\$28,054
2.	Subcontractors	\$ -0-
3.	Equipment	\$ 4,000 <sup>1</sup>
4.	Travel and Subsistence	\$ 1,800
5.	Electronic Data Processing	\$ -0-
6.	Reproduction/Publication	\$ 1,000
7.	Mail and Phone	\$ -0-
8.	Supplies	\$ -0-
9.	Analyses	\$ -0-
10.	Miscellaneous	<u>\$ -0-</u>
Total Direct Costs		<b>\$34,854</b>

### INDIRECT COSTS

1.	Overhead	\$ 15,427
2.	General and Administrative Expenses	\$ -0-
3.	Other Indirect Costs	\$ -0-
4.	Fee or Profit	<u>\$ -0-</u>
Total Indirect Costs		<b><u>\$15,427</u></b>

**TOTAL PROJECT COSTS** **\$50,281**

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(notes)

<sup>1</sup> Funding is requested for a data analysis workstation running Linux to be purchased for \$4,000. Based on a recent quote, a Dell Precision Workstation 340 computer purchased for this amount would be equipped with a 2 GHz Pentium 4 processor, 1 GB RAM, two 40 GB disks, and a DD3 tape drive.

## PROPOSED

State of California  
AIR RESOURCES BOARD

Resolution 02-13

March 21, 2002

Agenda Item No.: 02-2-2

WHEREAS, the Air Resources Board has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2516-224, entitled "Research into the Development of Biological Methods of Dust Suppression in the Antelope Valley," has been submitted by San Diego State University;

WHEREAS, the Research Division staff has reviewed and recommended this proposal for approval; and

WHEREAS, the Research Screening Committee has reviewed and recommends for funding:

Proposal Number 2516-224 entitled "Research into the Development of Biological Methods of Dust Suppression in the Antelope Valley," submitted by San Diego State University, for a total amount not to exceed \$89,830.

NOW, THEREFORE BE IT RESOLVED, that the Air Resources Board, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendation of the Research Screening Committee and approves the following:

Proposal Number 2516-224 entitled "Research into the Development of Biological Methods of Dust Suppression in the Antelope Valley," submitted by San Diego State University, for a total amount not to exceed \$89,830.

BE IT FURTHER RESOLVED, that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the research effort proposed herein, and as described in Attachment A, in an amount not to exceed \$89,830.

## ATTACHMENT A

### “Research into the Development of Biological Methods of Dust Suppression in the Antelope Valley”

#### **Background**

Due to their lack of vegetation, the deserts of the southwest experience frequent dust problems that often induce air quality problems in local and surrounding areas. One area with just such a problem is Antelope Valley, the westernmost arm of the Mojave Desert. Dust particles continue to become airborne there because of abandoned and fallow agricultural fields and other disturbances of the desert soil.

One method to curtail the problem of airborne dust is to reintroduce native plant life to the area. Vegetation helps to reduce airborne dust in two ways. First, the very shape of the native plants slows the wind, thus allowing airborne dust to settle at the base of the plant. Secondly, the roots of the plants essentially grab the dirt around it, helping to hold potentially airborne dust in place.

Direct seeding of native species, the current method of restoration of plant life, has proven to be inadequate in arid and semi-arid ecosystems. This failure of direct seeding in arid and semi-arid environments can be attributed to the fact that the necessary requirements of precipitation, humidity, temperature, and soil conditions occur only rarely and at very irregular intervals. Since current methods have proven ineffective, there is a need to develop more effective methods of reintroducing native plants.

#### **Objective**

The primary objective of this project is to develop cost efficient methods for controlling airborne dust, particularly PM10 and smaller sized particles, from disturbed desert soils.

#### **Methods**

The contractor will conduct research at two agricultural sites (one where soil has been fallow for several (3-5) years since being disturbed and another that has been abandoned for many (15-20) years since disturbed). The contractor will evaluate, over a 3-year period, three types of irrigation and three types of soil amendments to determine the most effective method of reintroducing native plants for reducing the amount of windblown dust.

#### **Expected Results**

The contractor will determine the most cost efficient method of reintroducing native plant growth to disturbed desert soils.

**Significance to the Board**

The development of cost efficient methods to control airborne dust, particularly PM10 and smaller particles, will not only limit the loss of valuable soil, but will also remove a serious health hazard for the residents of Antelope Valley.

**Contractor:**

San Diego State University

**Contract Period:**

48 months

**Principal Investigator (PI):**

Dr. Thomas A. Zink

**Contract Amount:**

\$89,830

**Cofunding:**

None for this project.

**Basis for Indirect Cost Rate:**

The State and UC System have agreed to a ten percent indirect cost rate.

**Past Experience with this Principal Investigator:**

ARB has not previously contracted with Dr. Zink, however he has been a member of the Dustbusters Cooperative for several years (using funding from a different source). Working with him in this setting we have observed Dr. Zink to be energetic, resourceful, and dedicated to the success of the Dustbusters program. We expect his diligent and efficient performance to continue under this contract.

**Prior Research Division Funding to San Diego State University**

Year	2001	2000	1999
Funding	\$0	\$0	\$284,080

## BUDGET SUMMARY

San Diego State University

Research into the Development of Biological Methods of Dust Suppression in the  
Antelope Valley

### DIRECT COSTS AND BENEFITS

1.	Labor and Employee Fringe Benefits	\$	56,812
2.	Subcontractors	\$	-0-
3.	Equipment	\$	-0-
4.	Travel and Subsistence	\$	6,429
5.	Electronic Data Processing	\$	-0-
6.	Reproduction/Publication	\$	550
7.	Mail and Phone	\$	270
8.	Supplies	\$	15,503 <sup>1</sup>
9.	Analyses	\$	2,100
10.	Miscellaneous	\$	-0-
	Total Direct Costs	\$	<u>81,664</u>

### INDIRECT COSTS

1.	Overhead	\$	8,166
2.	General and Administrative Expenses	\$	-0-
3.	Other Indirect Costs	\$	-0-
4.	Fee or Profit	\$	<u>-0-</u>
	Total Indirect Costs	\$	8,166

### TOTAL PROJECT COSTS

\$89,830

(notes)

<sup>1</sup> The materials and supplies for this project consist of native seeds and plants (\$7150), plant protectors (\$3390), irrigation materials (\$2597), tractor rental (\$1500), and soil amendments (\$866).

## PROPOSED

State of California  
AIR RESOURCES BOARD

Resolution 02-14

March 21, 2002

Agenda Item No.: 02-2-2

WHEREAS, the Air Resources Board has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2507-223, entitled "Determination of the Asbestos Content of Current Automotive Dry Friction Materials, and the Potential Contribution of Asbestos to the Particulate Matter Derived from Brake Wear," has been submitted by the California Department of Health Services;

WHEREAS, the Research Division staff has reviewed and recommended this proposal for approval; and

WHEREAS, the Research Screening Committee has reviewed and recommends for funding:

Proposal Number 2507-223 entitled "Determination of the Asbestos Content of Current Automotive Dry Friction Materials, and the Potential Contribution of Asbestos to the Particulate Matter Derived from Brake Wear," submitted by the California Department of Health Services, for a total amount not to exceed \$131,055.

NOW, THEREFORE BE IT RESOLVED, that the Air Resources Board, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendation of the Research Screening Committee and approves the following:

Proposal Number 2507-223 entitled "Determination of the Asbestos Content of Current Automotive Dry Friction Materials, and the Potential Contribution of Asbestos to the Particulate Matter Derived from Brake Wear," submitted by the California Department of Health Services, for a total amount not to exceed \$131,055.

BE IT FURTHER RESOLVED, that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the

research effort proposed herein, and as described in Attachment A, in an amount not to exceed \$131,055.

## ATTACHMENT A

### “Determination of the Asbestos Content of Current Automotive Dry Friction Materials, and the Potential Contribution of Asbestos to the Particulate Matter Derived from Brake Wear”

#### **Background**

The U.S. EPA instituted a ban on the production of most Automotive Dry Friction Materials (ADFM) products (such as brake pads and linings) containing asbestos (a known carcinogen) in 1989. However, ADFM products were exempted in 1991. Recent reports indicate that asbestos is widely used in after-market brakes. However, the proportion of vehicle brakes containing asbestos, as well as the compositional formulation of asbestos in the brake lining material, is unknown. Therefore, motor vehicle emission rates and inventories of asbestos are also unknown.

#### **Objective**

The objective of this study is to obtain information that can be used to estimate the extent of asbestos emissions due to brake-wear from vehicles used in California. The key elements include the identification and verification of asbestos in brakes, and the determination of the character and composition of asbestos in dust produced by vehicle brake-wear.

#### **Methods**

The first task is to survey the brake industry to assess the prevalence of asbestos in brakes of vehicles in California. Subsequently, samples of brakes and brake dust will be collected from brake repair shops, and from vehicles operated on a dynamometer. These samples will be subjected to detailed laboratory analysis. Finally, the contractor will characterize the form, size, and levels of asbestos present in brake dust.

#### **Expected Results**

This project will characterize the asbestos composition of the brakes and brake-wear generated dust collected from vehicles, including the asbestos fiber type, fiber size distribution, and concentration as a percent of total mass. The results will help clarify the relationship between the form of asbestos present in brakes, and the asbestos released in the brake dust by high temperature abrasion. The ARB staff will obtain useful information on the nature and use of current automotive brake lining products containing asbestos, as verified through direct laboratory analysis.

#### **Significance to the Board**

Recent reports show that asbestos is widely used in after-market brakes. To determine the need to control emissions of this carcinogen, ARB staff need to estimate the extent of asbestos emissions due to brake-wear from vehicles used in California. The results of this project should help the ARB to assess the potential health threat from public exposure to asbestos emissions generated from brake-wear.

**Contractor:**

California Department of Health Services (DHS)

**Contract Period:**

18 months

**Principal Investigator (PI):**

Dr. Stephen Wall

**Contract Amount:**

\$131,055

**Cofunding:**

None

**Basis for Indirect Cost Rate:**

The indirect cost rate specified is what DHS requires for all contracts. The ARB staff accepted their 19 percent rate, regarding it as relatively low compared to those required by non-State laboratories.

**Past Experience with this Principal Investigator:**

Dr. Stephen Wall successfully completed a research study for the ARB that involved the development of a sophisticated sampling technique of toxic chemicals from stationary sources (Contract No. A932-098, Final Report Date October, 1996).

**Prior Research Division Funding to California Department of Health Services:**

Year	2001	2000	1999
Funding	\$0	\$0	\$0

## B U D G E T S U M M A R Y

California Department of Health Services

Determination of the Asbestos Content of Current Automotive Dry Friction Materials,  
and the Potential Contribution of Asbestos to the Particulate Matter  
Derived from Brake Wear

### DIRECT COSTS AND BENEFITS

1.	Labor and Employee Fringe Benefits	\$ 59,652
2.	Subcontractors	\$ 20,816
3.	Equipment	\$
4.	Travel and Subsistence	\$ 2,243
5.	Electronic Data Processing	\$
6.	Reproduction/Publication	\$ 1,215
7.	Mail and Phone	\$ 1,215
8.	Supplies	\$ 25,375 <sup>1</sup>
9.	Analyses	\$
10.	Miscellaneous	<u>\$ 374</u>
Total Direct Costs		\$ 110,890

### INDIRECT COSTS

1.	Overhead	\$ 12,407
2.	General and Administrative Expenses	\$ 7,758
3.	Other Indirect Costs	\$
4.	Fee or Profit	<u>\$</u>
Total Indirect Costs		<u>\$ 20,165</u>

**TOTAL PROJECT COSTS** **\$ 131,055**

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<sup>1</sup>Supplies: \$25,375

General expenses for consumables, \$ 5,421

Calibration standards, sampling, and analysis consumables, \$14,954

Components for fabrication and assembly of sampling system, \$5,000

PROPOSED

State of California  
AIR RESOURCES BOARD

Resolution 02-15

March 21, 2002

Agenda Item No.: 02-2-2

WHEREAS, the Air Resources Board has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2505-223, entitled "Incidence of Malfunctioning and Tampering in Heavy-Duty Vehicles," has been submitted by the University of California, Riverside;

WHEREAS, the Research Division staff has reviewed and recommended this proposal for approval; and

WHEREAS, the Research Screening Committee has reviewed and recommends for funding:

Proposal Number 2505-223, entitled "Incidence of Malfunctioning and Tampering in Heavy-Duty Vehicles," submitted by the University of California, Riverside, for a total amount not to exceed \$199,103.

NOW, THEREFORE BE IT RESOLVED, that the Air Resources Board, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendation of the Research Screening Committee and approves the following:

Proposal Number 2505-223, entitled "Incidence of Malfunctioning and Tampering in Heavy-Duty Vehicles," submitted by the University of California, Riverside, for a total amount not to exceed \$199,103.

BE IT FURTHER RESOLVED, that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the research effort proposed herein, and as described in Attachment A, in an amount not to exceed \$199,103.

## ATTACHMENT A

### Incidence of Malfunctioning and Tampering in Heavy-Duty Vehicles

#### Background

The EMFAC2000 emission model estimates excess PM and NO<sub>x</sub> emissions due to 23 faults in diesel engines. For each fault and class of diesel vehicle, the calculation is:

$$I \times F \times E$$

where: I is an incidence estimate (fraction of all such vehicles operating with the fault).

F is an estimate of the fractional emission increase for the average occurrence of the fault.

E is the base (w/o fault) emission rate for the class.

Most of the estimates of incidence (I) are derived from a 1988 contract report. The scant empirical data on the incidence of faults available then were for trucks with engines whose controls were either mechanical-only or mechanical with rudimentary electronic controls. Much of the basis for the incidence estimates in the 1988 work was merely opinion expressed by fleet mechanics or engineering assumptions. Those opinions and assumptions applied to a situation before the ARB's current smoke inspection programs and before computerized electronic engine controls.

#### Objective

- To update estimates of the incidence (I) of 23 specified malfunctions and types of tampering ("faults") in on-road heavy-duty diesel vehicles. These faults have been identified as increasing NO<sub>x</sub> or PM emissions from diesel engines made before the advent of electronic controls on the engines.
- To assess the need to characterize types of faults to which electronically controlled engines may be susceptible. Such faults could be added to emission inventory calculations and included in an inspection-and-maintenance program.

#### Methods

CE-CERT will develop the new estimates by reviewing all the existing work on estimating fault incidence, reviewing data from past field work, obtaining new data by surveying several sources of information, and conducting roadside inspections.

Specific steps are:

##### 1. Review of Databases

- Open literature
- Data from ARB's roadside inspections and fleet inspections
- U.S. EPA data
- OEM supplier and manufacturer recalls
- Manufacturers' warranty data

## 2. Surveys to Obtain New Data

- Surveys of manufacturers, engine rebuilders, and parts wholesalers for repair information
- Surveys of repair and maintenance records of HDD fleets
- Surveys of commercial repair shop registries

## 3. Field Work

- Random roadside inspections (in concert with Enforcement Division) to count the occurrence of the faults that are visually detectable
- Retrieval with proprietary scanning tools of fault records from the memory chips of inspected vehicles that have electronic controls

Abbreviated versions of the tasks in 2 and 3, above, will be conducted first in a pilot project to assess the availability and quality of data from the various sources. The balance of the project will be conducted only if the Research Screening Committee agrees that the results of the pilot work indicate that further work will be worthwhile. The budget for the pilot work and its report is \$52,509.

### **Expected Results**

The project should provide more accurate estimates of the incidence of the 23 faults now recognized in the emission inventory calculations for heavy-duty vehicles. Also, it will provide a basis for identifying new faults specific to engines with electronic controls.

### **Significance to the Board**

Periodically, the ARB must update factors used in emission inventory calculations. Also, the ARB must analyze potential subjects for inclusion in a heavy-duty inspection-and-maintenance program.

### **Contractor**

College of Engineering - Center for Environmental Research and Technology,  
University of California, Riverside (CE-CERT)

**Contract Period:** 18 months

**Principal Investigator (PI):** Dr. J. Wayne Miller

**Contract Amount:** \$199,103

**Cofunding:** none

### **Basis for Indirect Cost Rate**

The State and the UC System have agreed to a ten percent indirect cost rate.

### **Past Experience with this Principal Investigator**

The principal investigator, J. Wayne Miller, has a Ph.D. in Chemical Engineering from Caltech. Because he joined CE-CERT only recently (December 2000), the Research Division has not previously engaged him for research. However, Dr. Miller is a key participant in the California Energy Commission's study "Methodology to Assess Air Quality Impacts of Distributed and Back-Up Generation", is a reviewer for SSD on fuels regulations, and heads the ARB-supported Mobile On-Road Heavy-Duty Emissions Laboratory. Prior to joining CE-CERT, Dr. Miller was Vice President of Technology and Development for Sun Oil. Previously, at Unocal, he led a large research program related to reformulated gasoline.

### **Prior Research Division Funding to the University of California, Riverside:**

Year	2001	2000	1999
Funding	\$ 79,884	\$654,788	\$659,987

## B U D G E T S U M M A R Y

College of Engineering - Center for Environmental Research  
and Technology, University of California, Riverside

Incidence of Malfunctioning and Tampering in Heavy-Duty Vehicles

### DIRECT COSTS AND BENEFITS

1.	Labor and Employee Fringe Benefits	\$133,461
2.	Subcontractors	\$ 0
3.	Equipment	\$ 12,966
4.	Travel and Subsistence	\$ 7,045
5.	Electronic Data Processing	\$ 0
6.	Reproduction/Publication	\$ 0
7.	Mail and Phone	\$ 1,000
8.	Supplies	\$ 0
9.	Analyses	\$ 0
10.	Miscellaneous	<u>\$ 30,480</u> <sup>(1)</sup>

Total Direct Costs \$184,952

### INDIRECT COSTS

1.	Overhead	\$ 14,151
2.	General and Administrative Expenses	\$ 0
3.	Other Indirect Costs	\$ 0
4.	Fee or Profit	<u>\$ 0</u>

Total Indirect Costs \$ 14,151

**TOTAL PROJECT COSTS** **\$199,103** <sup>(2)</sup>

<sup>(1)</sup> a charge to cover CE-CERT's off-campus rent

<sup>(2)</sup> The budget will be implemented in two severable phases. The first phase, \$52,509, is for pilot work consisting of partial completion of certain tasks. The second phase, \$146,594, is for completing the balance of all the project's tasks. It will be implemented only if the Research Screening Committee finds that the pilot work provides a reasonable expectation of a successful project.

**SUMMARY OF BOARD ITEM**

**ITEM # 02-2-4: PUBLIC MEETING TO CONSIDER A STATUS REPORT ON THE FLEET RULE AND REPORTING REQUIREMENTS FOR ALL URBAN BUS TRANSIT AGENCIES**

**STAFF RECOMMENDATION:** Informational meeting only: Recommend accepting the report.

**DISCUSSION:** In February 2000, the Air Resources Board (ARB or Board) adopted the public transit bus fleet regulation. At the September 21, 2001, Board meeting, staff updated the Board regarding: (1) the transit agencies' progress in implementing the regulations; (2) the status of the alternative oxides of nitrogen (NO<sub>x</sub>) exemption applications; (3) the status of advanced aftertreatment systems; and (4) the development of hybrid-electric bus test procedures. At the conclusion of the meeting, the Board asked staff to report back in six months on the transit agencies' progress in complying with the 4.8 grams per brake horsepower-hour (g/bhp-hr) NO<sub>x</sub> fleet average and on the implementation progress of the alternative NO<sub>x</sub> strategy exemption applications.

**SUMMARY AND IMPACTS:** At the September meeting, 14 transit agencies were projected to exceed the 4.8 g/bhp-hr NO<sub>x</sub> fleet average as of October 1, 2002. Since that time, a number of transit agencies have revised their bus fleet purchases and retirements and indicated they will comply with the fleet average by October. As of February 2002, five transit agencies still project they will exceed the NO<sub>x</sub> fleet average. Of the five transit agencies, two stated they will be in compliance by the end of 2002 because of their bus delivery schedules. Two other transit agencies stated they will be in compliance by December 2003 because budgetary constraints prevent them from purchasing new buses or engines in the timeframe necessary to comply. The fifth transit agency has informed staff that it will comply by December 2002 due to timing and budgetary issues.

In addition to instituting the NOx fleet average requirement, the rule prohibits engine manufacturers from selling new transit bus engines during 2004-2006 unless they meet a NOx standard of 0.5 g/bhp-hr. The engine manufacturers have indicated no complying buses are expected to be available for these model years. However, the rule includes an alternative NOx strategy exemption that would allow transit agencies to purchase buses with engines that do not meet the 2004-2006 MY engine emission standards if specified conditions are met.

To receive the exemption, transit agencies needed to apply to the Board by June 30, 2001, with a plan to achieve greater NOx emission benefits than would have been achieved through compliance with the engine emission standards. Of the 15 transit agencies that applied for the alternative NOx strategy exemption by the June 30, 2001 deadline, seven transit agencies received approval for their plans and are eligible for the exemption. Those remaining have either formally withdrawn in writing or failed to submit an approvable NOx reduction plan by December 31, 2001. As a practical matter, those that have not been approved for the exemption will not be able to purchase new buses during 2004-2006, since none are expected to be certified to comply.

Another requirement of the alternative NOx strategy exemption is the demonstration of advanced NOx aftertreatment technology. A promising technology appears to be selective catalytic reduction. All seven transit agencies have elected to do one joint demonstration project. Two transit agencies that have not applied for the alternative NOx strategy exemption have also committed to participating in the joint demonstration, and a third transit agency has informed staff that it is planning a separate NOx demonstration.

**CALIFORNIA AIR RESOURCES BOARD**

**NOTICE OF PUBLIC MEETING TO CONSIDER A STATUS REPORT ON THE FLEET RULE AND REPORTING REQUIREMENTS FOR ALL URBAN BUS TRANSIT AGENCIES**

The Air Resources Board (the Board or ARB) will conduct a public meeting at the time and place noted below to consider a status report on the public transit bus fleet rule.

DATE: March 21, 2002

TIME: 9:00 a.m.

PLACE: San Diego County Administration Center  
Supervisors Chambers, Room 310  
1600 Pacific Highway  
San Diego, CA 92101

This item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., March 21, 2002, and may continue at 8:30 a.m., March 22, 2002. This item may not be considered until March 22, 2002. Please consult the agenda for the meeting, which will be available at least 10 days before March 21, 2002, to determine the day on which this item will be considered.

This facility is accessible to persons with disabilities. If accommodation is needed, please contact ARB's Clerk of the Board by March 7, 2002, at (916) 322-5594, or Telephone Device for the Deaf (TDD) (916)324-9531, or (800) 700-8326 for TDD calls outside the Sacramento area.

In February 2000, the ARB adopted the public transit bus fleet regulation, set forth in title 13, California Code of Regulations (CCR), sections 1956.1-1956.4, 1956.8 and 1965, as amended on February 24, 2000. This regulation is designed to achieve significant reductions in emissions of oxides of nitrogen (NOx) and particulate matter (PM), through the implementation of a fleet rule and emission standards for new bus engines. Emission reductions will be achieved as transit agencies purchase new low-emission buses or repower older, higher-emitting buses to lower-emitting configurations. Reductions in diesel PM will also be achieved through the retrofit of engines with emission control systems and the use of low sulfur fuel.

The Board directed staff to work with transit agencies on the rule's implementation and to provide regular updates on the progress of implementation to the Board. In September 2001, staff presented the first status update to the Board on the following topics: (1) transit agency progress in complying with the NOx fleet average requirement; (2) implementation progress of the alternative NOx strategy exemption applications; (3) analysis of the first alternative NOx strategy exemption application; (4) status of

advanced aftertreatment systems; and (5) progress on development of hybrid-electric bus test procedures. Staff summarized the status of the transit agencies' implementation efforts and provided recommendations on the applications for NOx emission strategies as an alternative to purchasing new buses with engines meeting the 2004 engine standards. At the conclusion of the September meeting, staff was directed to provide a second update in March 2002 on the compliance progress of transit agencies that have not met the 4.8 g/bhp-hr NOx fleet average and on the implementation of the alternative NOx emission reduction strategies by the 15 transit agencies that applied by June 30, 2001.

This meeting is informational only and no regulatory action is being proposed at this time; however, the Board may recommend regulatory action for future consideration if necessary. The ARB staff will present an oral summary of the written status report at the meeting. Copies of the report may be obtained from the Board's Public Information Office, 1001 "I" Street, 1<sup>st</sup> Floor, Environmental Services Center, Sacramento, CA 95814, (916) 322-2990, at least 10 days prior to the meeting. The report may also be obtained from the ARB web site at <http://www.arb.ca.gov/msprog/bus/bus.htm> prior to the scheduled meeting. If you are a person with a disability and desire to obtain this document in an alternative format, please contact the Americans with Disabilities Act (ADA) Coordinator at (916) 323-4916, or TDD (916) 324-9531, or (800) 700-8326 for TDD calls from outside the Sacramento area.

Interested members of the public may present comments orally or in writing at the meeting, and in writing or by e-mail before the meeting. To be considered by the Board, written comments and submissions not physically submitted at the meeting must be received **no later than 12:00 noon, March 20, 2002**, and addressed to the following:

Postal mail is to be sent to:

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

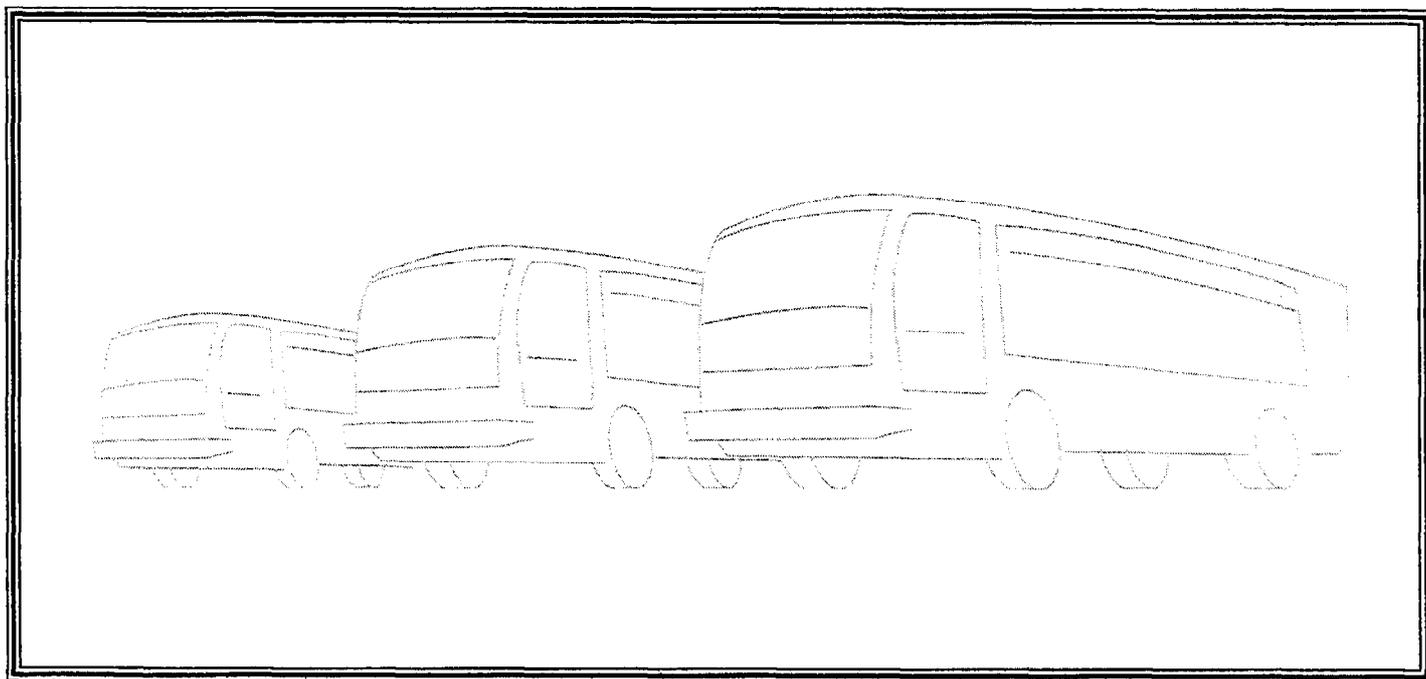
Electronic mail is to be sent to [bus02@listserv.arb.ca.gov](mailto:bus02@listserv.arb.ca.gov) and received at the ARB **no later than 12:00 noon, March 20, 2002**.

Facsimile submissions are to be transmitted to the Clerk of the Board at (916) 322-3928 and received at the ARB **no later than 12:00 noon March 20, 2002**.

California Environmental Protection Agency

 **Air Resources Board**

**STATUS REPORT  
PUBLIC TRANSIT BUS FLEET RULE**



**March 2002**

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## EXECUTIVE SUMMARY

### **Background**

In February 2000, the Air Resources Board (ARB or Board) adopted the public transit bus fleet regulation (title 13, California Code of Regulations (CCR), sections 1956.1-1956.4, 1956.8 and 1965, as amended on February 24, 2001). This regulation is designed to achieve significant reductions in particulate matter (PM) and oxides of nitrogen (NO<sub>x</sub>) emissions through the implementation of a fleet rule and emission standards for new transit bus engines. Emission reductions are achieved through purchasing new low-emission buses or repowering older, higher-emitting buses to lower-emitting configurations. Reductions in diesel PM are also achieved through the retrofit of engines with emission control systems and the use of low sulfur fuel. Long-term emission reductions are achieved through establishing increasingly more stringent new engine standards. Over time, ultra-low, near-zero, and zero emissions buses will replace older higher emitting engines.

The Board, through discussion at the February 24, 2000, public hearing and Resolution 00-2 (February 24, 2000), directed staff to provide regular updates on the progress of implementation of the regulation. At the September 21, 2001, Board meeting, staff updated the Board regarding: (1) transit agencies' progress in implementing the regulations; (2) implementation of NO<sub>x</sub> emission reduction strategies as an alternative to purchasing buses with complying model year (MY) 2006 engines including an analysis of the first exemption application; (3) status of advanced aftertreatment systems; and (4) development of hybrid-electric bus test procedures. At the September meeting, the Board expressed concern with the compliance progress of the transit agencies in meeting the NO<sub>x</sub> fleet average and the low participation of the transit agencies in the alternative NO<sub>x</sub> strategy exemption. At the conclusion of the meeting, the Board asked staff to report back in six months on the transit agencies' progress in complying with the 4.8 grams per brake horsepower-hour (g/bhp-hr) NO<sub>x</sub> fleet average and on the implementation progress of the alternative NO<sub>x</sub> strategy exemption applications.

### **NO<sub>x</sub> Emission Average Update**

As of the September meeting, 14 transit agencies had not demonstrated that they would meet the 4.8 g/bhp-hr NO<sub>x</sub> fleet average as of October 1, 2002. The reasons for the fleet average exceedances include using incorrect NO<sub>x</sub> emission values in the calculations and calculating the fleet average using NO<sub>x</sub> emission values of buses that do not meet the definition of an urban bus. Since that time, a number of transit agencies have revised their planned bus fleet purchases and retirements and indicate they will comply with the fleet average by October 2002.

As of February 2002, five transit agencies still project they will exceed the required NO<sub>x</sub> fleet average. Of the five transit agencies, Arcata/Mad River Transit System and Santa Rosa CityBus stated they will be in compliance by November 2002 and December 2002, respectively, because of their bus delivery schedules. San Luis Obispo Regional Transit and South County Transit have told staff that they will be in compliance by December 2003 because budgetary constraints prevent them from purchasing new buses or engines in the timeframe necessary to comply. The fifth, Fairfield/Suisun

Transit, will not be able to complete their repowering and diesel-to-alternative-fuel engine conversion projects until the end of 2002.

Staff is very concerned that these five transit agencies have not demonstrated that they will comply by October 1, 2002 with the NOx fleet average. While the reporting violation is a procedural violation only, staff views the potential violation of the NOx fleet average much more seriously and will therefore issue notices of violation to any transit agency that is not in compliance by October 1, 2002. However, staff is sensitive to the difficulties faced by smaller rural transit agencies in meeting the requirements and will take this into consideration when determining penalties.

### **Alternative NOx Strategy Update**

The new engine emission standards applicable to manufacturers are set forth in title 13, CCR, section 1956.1. The regulation prohibits engine manufacturers from selling new transit bus engines during MY 2004 through 2006 that exceed a NOx emission standard of 0.5 g/bhp-hr. However, the Board also adopted an alternative NOx strategy (title 13, CCR, sections 1956.2 (c)(8) and (d)(7)) that allows transit agencies to apply, by June 30, 2001, for an exemption that would allow the purchase of buses with engines that do not meet the 2004-2006 MY engine emission standards if specified criteria are met. Transit agencies that are approved for the exemption may purchase buses with diesel engines with NOx certified levels higher than 0.5 g/bhp-hr. The exemption is the only mechanism allowed by the regulation for transit agencies to purchase diesel buses with non-complying engines during those three years. Alternatively, there is no requirement that transit agencies must purchase buses during 2004-2006, so a transit agency could comply by not purchasing any diesel buses.

Of the 15 transit agencies that applied for the exemption by June 30, 2001, seven transit agencies subsequently received approval for their emission reduction plans and are eligible for the exemption. The remaining have either formally withdrawn in writing or failed to submit an approvable NOx reduction plan by December 31. Those that have failed to submit an approvable plan will not be able to purchase new buses during 2004-2006. These requirements were described in Resolution 01-31 (September 20, 2001).

All seven transit agencies with approved emission reduction plans have made written commitments to ARB to fund and conduct a joint demonstration of advanced NOx aftertreatment technology. Provided the demonstration is initiated by December 31, 2002, as stipulated in Resolution 01-31 (September 20, 2001), these transit agencies may purchase new transit bus engines during 2004-2006 that do not meet the 0.5 g bhp-hr NOx standard. Two transit agencies that have not applied for the alternative NOx strategy exemption have also committed to participating in the joint demonstration, and another transit agency has informed staff that it is planning a separate NOx demonstration.

### **PM Emission Control**

Along with reducing the NOx fleet averages, transit agencies are required to reduce PM emissions by a minimum of 85 percent through retrofitting their bus engines with

advanced aftertreatment technology. Staff has established a program to verify these aftertreatment devices, and as of February 2002, two devices applicable to MY 1994-2001 four-stroke engines have been verified. Currently there are no retrofit devices verified for engines older than 1994 MY, and no devices are verified for any two-stroke engine. The regulation requires transit agencies to retrofit 100 percent of their pre-1991 MY diesel engines, and differing percentages of their 1991 to 1995 MY diesel engines, depending on their fuel path, by January 1, 2003. Staff believes that the technology will not be available for pre-1994 MY engines in time to meet the January 2003, regulatory deadline.

Staff recommends that the regulation be revised to allow transit agencies to retrofit newer bus engines provided the same number of retrofits are completed by January 1, 2003, as would be required by the current regulation. This would be accomplished using the funds already earmarked by the transit agencies for the retrofit of the older engines. Staff plans to propose a revised implementation schedule for the Board's consideration in September 2002. If the Board approves this recommendation, staff will work with the transit agencies in the interim to begin the process towards retrofitting all the required engines.

## I. BACKGROUND

In February 2000, the Air Resources Board (ARB or Board) adopted the public transit bus fleet regulation (title 13, California Code of Regulations (CCR), sections 1956.1-1956.4, 1956.8 and 1965, as amended on February 24, 2001). This regulation was designed to achieve significant reductions in particulate matter (PM) and oxides of nitrogen (NOx) emissions, through the implementation of a fleet rule and new bus engine emission standards whereby transit agencies would purchase cleaner buses and install emission control equipment to existing engines.

### A. Regulation Summary & Board Directions (February 2000)

The public transit bus regulation achieves near-term emission reductions by requiring transit agencies to purchase new low-emission buses and retrofit or repower older, higher-emitting urban bus engines to lower-emitting configurations. Long-term emissions benefits are achieved through establishing increasingly more stringent new engine standards. Consequently, new bus engines with ultra-low, near-zero, and zero-emissions will replace the older higher emitting engines over time. Reporting requirements ensure compliance and progress in achieving the required reductions.

An urban bus is defined as a heavy heavy-duty diesel-powered<sup>1</sup> passenger-carrying vehicle with a load capacity of fifteen or more passengers intended primarily for intra-city operation, i.e., within the confines of a city or greater metropolitan area (title 13, CCR, section 1956.2). Typical features of urban buses include quick-opening exit and entrance doors and fare collection equipment. It must be noted that diesel hybrid-electric buses are considered to be urban buses although they are usually not powered by heavy heavy-duty engines.

The regulation does not apply to buses used in shuttle services, airport shuttle services, paratransit services, school transportation services and charter services unless urban buses are used to provide those services. The regulation also does not apply to military buses. Buses used to provide long-distance service, that are generally equipped with luggage compartments, rest rooms, and overhead storage, are also not included.

There are two major components to the regulation: (1) a transit bus fleet rule applicable to transit agencies; and (2) more stringent emission standards for new urban bus engines applicable to urban bus engine manufacturers. The transit bus fleet rule required fleet operators by January 31, 2001 to chose between operating a diesel bus fleet (the diesel path) or an alternative-fuel bus fleet (the alternative-fuel path). The rule contains different requirements for each path and is in effect from 2001 through 2015 (title 13, CCR, sections 1956.2). Table 1 shows the requirements for the two fuel paths.

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<sup>1</sup> A diesel-powered urban bus refers to a bus powered by a diesel-cycle engine, which by definition in the regulation includes alternative-fuel engines such as natural gas, propane, and methanol.

**TABLE 1: Comparison of Fuel Path Requirements**

Year	Diesel Path	Alternative-Fuel Path
July 2002	Require use of low sulfur fuel (15 ppm)	Require use of low sulfur fuel (15 ppm)
October 2002	4.8 g/bhp-hr NOx fleet average	4.8 g/bhp-hr NOx fleet average
January 2003 to January 2009	PM Retrofit Requirements	
	Tier 1 (pre-1991) 100% by January 1, 2003	Tier 1 (pre-1991) 100% by January 1, 2003
	Tier 2 (1991-1995) 50% by 1/1/03 100% by 1/1/04	Tier 2 (1991-1995) 20% by 1/1/03 75% by 1/1/04 100% by 1/1/05
	Tier 3 (1996- pre-Oct. 2002) 20% by 1/1/05 75% by 1/1/06 100% by 1/1/07	Tier 3 (1996-pre-Oct. 2002) 20% by 1/1/07 75% by 1/1/08 100% by 1/1/09
July 2003	3 bus demo of ZEBs for large fleets (>200)	Not applicable
January 2008	15% of new buses are ZEBs for large fleets (>200)	Not applicable
January 2010	Not applicable	15% of new buses are ZEBs for large fleets (>200)

For both paths, reductions from the older in-use fleet are achieved through a minimum NOx fleet average emission requirement achieved partly by purchasing cleaner diesel or alternative-fuel buses, and through requirements for retrofits to control diesel PM. The alternative-fuel path achieves equivalent NOx reductions and greater PM reductions through 2015 than the diesel path due to inherently low in-use PM emissions from alternative-fuel buses (ARB 1999b). Currently, PM emissions from alternative-fuel buses are on the order of 20 to 100 times lower than diesel buses. In the future, diesel buses will be equipped with emission control systems which will reduce the PM down to levels comparable to those of alternative-fuel buses.

The fleet rule also requires larger fleets on the diesel path to undertake a zero-emission bus demonstration project by July 1, 2003. If the project is judged to be successful by the ARB in 2006, larger fleets on both paths will be required to purchase zero-emission buses equal to 15 percent of the total bus purchases. This requirement takes effect in 2008 for those on the diesel path and 2010 for those on the alternative-fuel path.

The current NOx emission standard for diesel urban bus engines is 4.0 grams per brake horsepower-hr (g/bhp-hr). Manufacturers of alternative fuel engines can also certify their engines to an optional NOx emission standard between 0.5 g/bhp-hr and 2.5 g/bhp-hr (by 0.5 g/bhp-hr increments). Beginning with October 1, 2004, new diesel urban bus engines are required to certify to a NOx standard of 0.5 g/bhp-hr; beginning

with model year (MY) 2007, the NO<sub>x</sub> certification standard declines to 0.2 g/bhp-hr for all forms of bus engines. The rule provides an alternative approach to meeting this more stringent 2004-2006 NO<sub>x</sub> standard which allows transit agencies to purchase higher emitting buses provided they demonstrate and achieve greater overall NO<sub>x</sub> emission benefits through 2015.

The PM standard for diesel urban bus engines is currently 0.05 g/bhp-hr. The PM standard declines to 0.01 g/bhp-hr for new engines as of October 1, 2002. This standard can be met by using PM aftertreatment systems such as diesel particulate filters.

Low-sulfur diesel fuel is necessary for most aftertreatment technologies to function efficiently and reliably for diesel engines. With higher sulfur fuel, trap plugging and catalyst fouling can occur. Therefore, the transit fleet rule requires transit agencies using diesel fuel, regardless of fuel path, to purchase and use diesel fuel with a sulfur limit of 15 parts per million (ppm) beginning July 1, 2002, in order to be consistent with the PM retrofit requirements. Transit agencies that operate in federal ozone attainment areas and have fewer than 20 buses in their active fleets, however, would not be subject to this requirement until July 1, 2006. Because federal ozone attainment areas tend to be outlying rural areas that may experience difficulty in securing delivery of low sulfur diesel fuel before full statewide implementation of the low-sulfur requirements in 2006, these fleets will also be allowed a delay in the PM retrofit requirements until January 1, 2007.

The ARB expects that the transit bus regulation will reduce NO<sub>x</sub> emissions statewide by about seven tons per day (tpd) in 2020 (ARB 1999b). Furthermore, the regulation will reduce PM emissions from urban buses by requiring new buses to meet more stringent PM standards and by requiring retrofits to reduce PM from the existing diesel urban bus fleet. The estimated PM reduction in 2005, as a result of the PM retrofit requirements, is 300 pounds per day statewide. By 2020, the benefit from PM retrofits drops to 67 pounds per day due to the replacement of older dirtier engines with cleaner ones.

The following points summarize the regulation:

- A public transit fleet rule with two paths for compliance – a diesel path and an alternative-fuel path (see Table 1).
- A transit agency must have selected its fuel path by January 31, 2001.
- A 4.8 g/bhp-hr NO<sub>x</sub> fleet average requirement for transit agencies as of October 1, 2002.
- PM retrofit requirements apply on January 1, 2003 for pre-1991 MY engines. All other pre-October 2002 urban bus engines must be retrofitted following a phase-in schedule that depends on model year and fuel path.

- Zero-emission bus (ZEB) demonstration project requirements in 2003 for large transit agencies on the diesel path.
- ZEB purchase requirements beginning in 2007 for large transit agencies on the diesel path and in 2009 for large transit agencies on the alternative-fuel path.
- Requirements for transit agencies to use low-sulfur fuel (15 ppm or less) in all their diesel vehicles beginning July 1, 2002.
- Reporting requirements as a mechanism to determine a transit agency's compliance with the public transit fleet rule.
- More stringent emission standards for diesel and dual-fuel urban bus engines, including a 0.01 g/bhp-hr PM standard starting in October 1, 2002 and a 0.5 g/bhp-hr NOx standard for MY 2004-2006.
- More stringent emission standards, including a 0.2 g/bhp-hr NOx standard and a 0.01 g/bhp-hr PM standard, for all 2007 and subsequent model year engines.
- An alternative NOx strategy exemption with the following requirements:
  - (1) each transit agency that needs an exemption must apply by June 30, 2001.
  - (2) the transit agency must demonstrate to the Executive Officer that it will achieve NOx emissions benefits through 2015 greater than would have been achieved through compliance with the engine standard.
  - (3) before granting the exemption, the Executive Officer must make a finding that transit agencies, after consultation with the EMA, are demonstrating, or have contracted to demonstrate, advanced NOx aftertreatment technology.

At the conclusion of the February 2000 adoption Hearing, the Board approved the regulation and directed staff to provide regular updates on the implementation of the regulation. Specifically, directives to staff were (1) to report back regularly on transit agency progress in implementing regulations; (2) to report back to the Board on implementation of NOx emission reduction strategies as an alternative to compliance with the 2004 requirements and to analyze the first exemption application and present its recommendation before the Board as part of the first update; (3) to report on the status of advanced aftertreatment systems; and (4) to report on progress on the development of hybrid-electric bus test procedures.

## **B. September 2001 Public Meeting & Board Directions**

The ARB staff presented the first update to the Board on September 21, 2001. During the meeting, the Board members expressed a keen interest in the compliance progress of the transit agencies with regard to the 4.8 g/bhp-hr NOx fleet average and in the implementation progress of the alternative NOx strategy. As a result of the Board's discussions, staff was directed to implement the following tasks and to return in March 2002 (Appendix A) and report on the following items:

- 1) To work with transit agencies that have reported that they are unable to meet the required NOx fleet average of 4.8 g/bhp-hr by October 1, 2002, to assist them in achieving compliance, and to proceed with enforcement actions against those transit agencies that do not comply by October 1, 2002;
- 2) To make the necessary regulatory changes to allow transit agencies that applied for an exemption by June 30, 2001, additional time to demonstrate advanced NOx aftertreatment technology; to require transit agencies to commit resources to a demonstration project as of December 31, 2001; and to require those transit agencies to have initiated advanced NOx aftertreatment demonstrations by December 31, 2002; if the deadlines were not met, the Executive Officer was directed to rescind any conditional approvals granted previously;
- 3) To convene a delegation to meet with representatives of the Engine Manufacturers Association to assess and encourage efforts to advance the status of NOx emission control technology;
- 4) To continue development of a test procedure for the evaluation of hybrid electric bus emissions and to report back to the Board by late-2002 on progress in this effort;
- 5) To assist rural and smaller transit agencies in identifying, assessing, and implementing economies of scale and other strategies in infrastructure development to support alternative-fuel bus fleets; and
- 6) To be prepared to introduce a proposal to eliminate the diesel path option in the transit bus fleet rule if efforts towards clean diesel technology and compliance with low NOx emission standards do not improve considerably in the next six months.

## **II. Outreach to Transit Agencies (post-September 2001)**

As noted above, the Board directed staff to work with engine manufacturers and transit agencies to encourage efforts to advance the status of advanced NOx control technology and improve compliance with the transit bus regulation. Since the September meeting, staff has communicated frequently with transit operators through meetings, phone conversations, e-mails, and written letters. The public transit bus website ([www.arb.ca.gov/msprog/bus/bus.htm](http://www.arb.ca.gov/msprog/bus/bus.htm)) has been redesigned to allow easier access to the relevant transit bus information and updated frequently with new information. Communications that needed to be sent to all transit agencies have been mailed, e-mailed, and posted to the public transit bus website. The following information summarizes major meetings held with transit agencies and engine manufacturers since September 2001.

Transit agencies that had applied for the alternative NOx strategy exemption were invited to a meeting in El Monte on October 17, 2001, to discuss the remaining implementation issues related to the alternative NOx strategy. The points discussed included: (1) the December 31, 2001, deadline for submission of a complete plan to demonstrate greater NOx emission benefits through 2015; (2) the December 31, 2001,

deadline for submission of a commitment of resources for the demonstration of advanced NOx aftertreatment technology; and (3) the December 31, 2002 deadline for the initiation of the NOx demonstrations.

On October 30, staff held a teleconference with the representatives of the Engine Manufacturers Association (EMA), the Manufacturers of Emission Controls Association (MECA), and the transit agencies that had applied for the alternative NOx strategy. The cost and availability of NOx aftertreatment devices for the demonstration were discussed. A representative from Kleen Air Systems gave an estimate for a selective catalytic reduction (SCR) system they produce.

On November 8, 2001, staff made a presentation before transit agencies at the California Transit Association (Cal Transit) Fall Conference in San Jose. Staff summarized actions required of transit agencies in 2002 and answered questions about compliance with the regulation. Following the conference session, staff attended a transit agency meeting on the NOx demonstration. Also in November, representatives of Cal Transit met with ARB Chairman Alan Lloyd and the Executive Office to discuss efforts many transit properties are making to meet and exceed requirements of the regulation.

Additional meetings that focused on the protocol proposed by staff for the advanced NOx aftertreatment demonstration were held on December 14, 18, and 19. Staff continued to provide guidance and support to transit agencies through phone calls, e-mails, and letters, thereby resulting in six transit agencies completing the application process required by December 31, 2001. Staff met again with transit agencies regarding the advanced NOx aftertreatment demonstration on January 22, 2002.

In addition to these meetings with transit agencies, a delegation of the Board consisting of Chairman Alan Lloyd and Mr. Matthew McKinnon, along with the Executive Officer and Deputy Executive Officer, met with representatives of the EMA on November 7, 2001. The purpose of this meeting was to assess and encourage efforts to advance the status of advanced NOx emission control technology. The EMA's representatives reiterated their position that, while the engine manufacturers had made no commitment to a NOx aftertreatment demonstration in transit buses, they would cooperate with transit agencies and ARB on furthering the demonstration. They also restated their position that the 2007 standard for transit bus engines is infeasible and must be harmonized with the nationwide 2007 standard for heavy-duty diesel engines or no complying transit bus engines will be available in California in 2007.

Finally, staff met once with representatives of the environmental organizations Union of Concerned Scientists, Coalition for Clean Air, and American Lung Association on November 6, 2001, and spoke with representatives by phone on other occasions. The purpose of this meeting was to answer questions by the environmentalists on the progress of rule implementation. As a follow-up of the meeting, staff gave the Coalition for Clean Air a list of transit agencies that were not yet in compliance with the NOx fleet average as of that date.

Staff also personally contacted each transit agency that was not in compliance with the NOx fleet average as of the September Board meeting. Through telephone calls and e-mail, staff worked with each transit agency to obtain letters detailing how and when each would be in compliance.

To summarize, outreach by staff to transit agencies since the September 20, 2001, Board meeting has been intensive and focused on achieving reductions in NOx emissions, as required by the transit bus regulation. Over 200 phone calls and e-mails, along with eight meetings, have taken place during the last quarter of 2001 alone. The results of this work are the subject of this staff report.

### **III. IMPLEMENTATION PROGRESS**

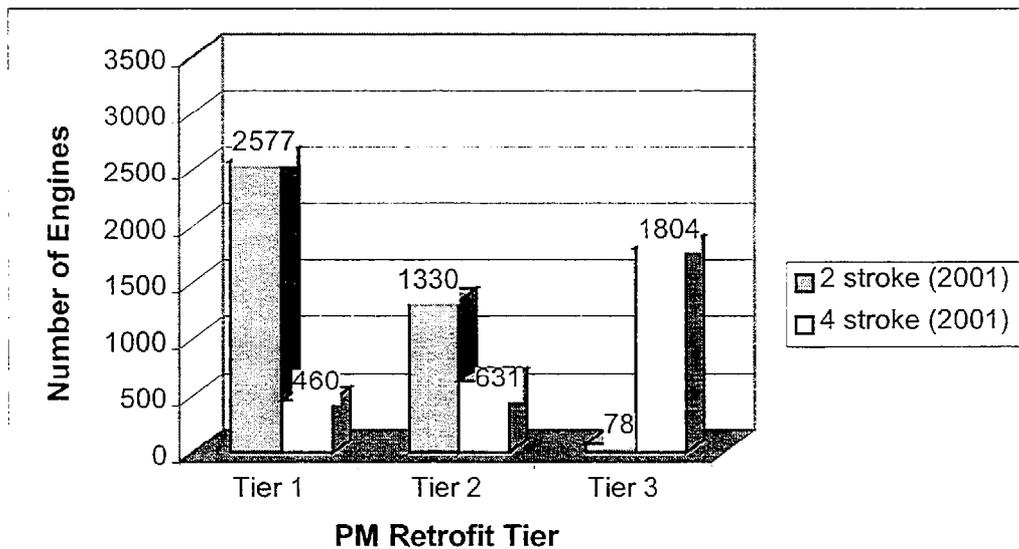
The reporting requirements of the public transit bus fleet rule are set forth in title 13, CCR, section 1956.4. A summary of the data provided in the September 2001 transit bus status report will be provided in this chapter. Please note that some data have been revised since the September publication.

#### **A. Fuel Path Selection (title 13, CCR, section 1956.2(c))**

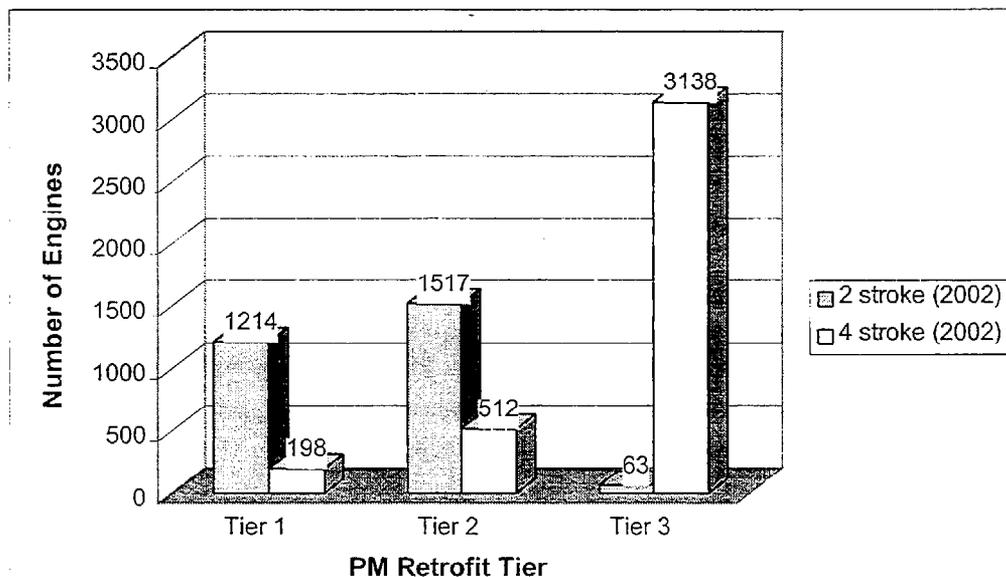
As stated in the September 2001 public transit bus fleet rule status report, 44 of the 71 transit agencies in California have selected the diesel path (Appendix B). A complete list of all the transit agencies with their fuel path selections is found in Appendix C. This list also shows the fleet size of the transit agencies for the years 2001 and 2002. Appendix D shows the number of buses categorized by fuel type in each air district as of January 1, 2001. The diesel buses operating in the Bay Area Air Quality Management District and the South Coast Air Quality Management District (SCAQMD) make up 82 percent of all diesel buses in California. In contrast, SCAQMD has the majority of the alternative fueled buses operating in California. Based on their submissions, transit agencies will increase the number of alternate fuel buses in their fleets by the year 2002 (Appendix E). Despite the decreasing number of diesel-fueled buses from year 2001 to 2002, diesel buses still outnumber alternative fuel buses by greater than two to one. Nevertheless, the public transit bus fleet regulation appears to be causing a gradual shift from diesel fuel to alternative fuels, even as the transit bus population increases.

Transit agencies are required to begin retrofitting diesel bus engines to reduce diesel PM by January 1, 2003. The PM retrofit schedule is divided into three tiers based on bus engine model year. As shown in Figures 1 and 2, a large number of buses with two-stroke engines fall within Tier 1 and 2 (pre-1991 and 1991-1995, respectively). In contrast, an overwhelming majority of the post-1995 engines (Tier 3) are four-stroke engines. As will be discussed later, there are technological challenges associated with retrofitting two-stroke and older engines; thus, it is useful to categorize engines into the retrofit tiers by age and whether they are two- or four-stroke.

**FIGURE 1: Two- and Four-Stroke Engines (2001)**



**FIGURE 2: Two- and Four-Stroke Engines (2002)**



## B. NOx Emission Average Update (title 13, CCR, section 1956.2(e))

The regulation required transit agencies to submit their NOx fleet averages, based on engine certification values, as of January 1, 2001. If the NOx fleet average was higher than 4.8 g/bhp-hr, transit agencies were required to submit a report by January 31, 2001, detailing actions planned to achieve that average by October 1, 2002.

As of the September 2001 Board meeting, 14 transit agencies had supplied insufficient information or miscalculated their NOx fleet averages. Prior to and following the September 2001 meeting, staff notified these agencies, both by phone and in writing, of the insufficiencies or miscalculations and requested revised bus fleet information. Staff has worked with these 14 transit operators to help resolve implementation issues.

Currently, of the 71 transit agencies, five transit agencies project they will exceed the October 1, 2002 required NOx fleet average (Table 2). Four of these five are very small transit agencies, with 25 or fewer urban transit buses in their fleets. Arcata/Mad River Transit System and Santa Rosa CityBus have stated they will be late in compliance because of their bus delivery schedules. San Luis Obispo Regional Transit and South County Transit have budgetary constraints that will prevent them from purchasing new buses or engines in the timeframe necessary to comply. The fifth, Fairfield/Suisun Transit, will not be able to complete their repowering and diesel-to-alternative-fuel engine conversion projects until the end of 2002.

Staff is very concerned that these five transit agencies have not demonstrated that they will comply by October 1, 2002 with the NOx fleet average. While the reporting violation is a procedural violation only, staff views the potential violation of the NOx fleet average much more seriously and will therefore issue notices of violation to any transit agency that is not in compliance by October 1, 2002. However, staff is sensitive to the difficulties faced by smaller rural transit agencies in meeting the requirements and will take this into consideration when determining penalties.

**Table 2: Reported Transit Agencies' NOx Fleet Averages (as of October 1, 2002)**

Transit Agency	Reported NOx Fleet Average	Fleet Size	Projected Compliance Date
Arcata/Mad River Transit System	5.63	4	November 2002
Fairfield/Suisun Transit	6.24	40	December 2002
San Luis Obispo Regional Transit Authority	5.83	18	December 2003
Santa Rosa CityBus	5.12	25	December 2002
South County Area Transit	8.13	4	December 2003

**C. Alternative NOx Strategy Update  
(title 13, CCR, sections 1956.2(c)(8) and (d)(7))**

**1. Background**

The new engine standards applicable to manufacturers are set forth in title 13, CCR, section 1956.1. The regulation prohibits engine manufacturers from selling transit bus engines during MY 2004 through 2006 that exceed a NOx emission standard of 0.5 g/bhp-hr. The two major bus engine manufacturers have indicated they will not be providing engines that meet the 0.5 g/bhp-hr NOx emission standard. However, the alternative NOx strategy set forth in title 13, CCR, sections 1956.2 (c)(8) and (d)(7) allows transit agencies to apply, by June 30, 2001, for an exemption that would allow the purchase of buses with engines that do not meet the 2004-2006 MY engine emission standards if specified criteria are met. Transit agencies that are exempted may purchase buses with diesel engines with NOx certified levels higher than 0.5 g/bhp-hr. The exemption is the only mechanism allowed by the regulation for transit agencies to purchase diesel buses with non-complying engines during those three years. Alternatively, there is no requirement that transit agencies must purchase buses during 2004-2006, so a transit agency could comply by not purchasing any diesel buses.

The rule has three parts. First, each transit agency that needs an exemption must have applied by June 30, 2001 (title 13, CCR, sections 1956.2(c)(8)(A) and (d)(7)(A)). Transit agencies that did apply will not be able to purchase new diesel engines during the three-year time period unless the engine meets the NOx and PM standards.

Second, the transit agency must have demonstrated to the Executive Officer that it will achieve NOx emissions benefits through 2015 greater than would have been achieved through compliance with the engine standards (title 13, CCR, sections 1956.2 (c)(8)(B) and (d)(7)(B)). Transit agencies can modernize their fleets through scrapping older engines and repowering with newer engines. Retirement of the oldest buses in their fleets is another method to achieve compliance.

Finally, before granting the exemption, the Executive Officer must make a finding that transit agencies, after consultation with the EMA, are demonstrating, or have contracted to demonstrate, advanced NOx aftertreatment technology (title 13, CCR, sections 1956.2 (c)(8)(C) and (d)(7)(C)).

During the September 2001 Board meeting, staff was given the following directives relating to the alternative NOx strategy (Resolution 01-31):

- 1) To make the necessary regulatory changes to allow transit agencies that applied for an exemption by June 30, 2001, additional time to demonstrate advanced NOx aftertreatment technology; to require transit agencies to commit resources to a demonstration project as of December 31, 2001; and to require those transit agencies to have initiated advanced NOx aftertreatment demonstrations by December 31, 2002. If these deadlines were not met, the Executive Officer shall rescind any conditional approvals granted previously; and

- 2) To convene a delegation to meet with representatives of the Engine Manufacturers Association to assess and encourage efforts to advance the status of NOx emission control technology.

## 2. Exemption Applications

Of the 15 transit agencies that originally applied as of June 30, 2001, only seven transit agencies received approval for their plans and are eligible for the exemption (Table 3). The remaining have either formally withdrawn in writing or failed to submit at least one approvable NOx reduction plan by December 31, 2001. Those that have failed to submit an approvable plan will not be able to purchase new, non-complying diesel bus engines during 2004-2006.

**TABLE 3: Transit Agencies with Approved Alternative NOx Strategy Plans**

AQMD: Air Quality Management District  
APCD: Air Pollution Control District

Agency	Fuel Path	Air District
Alameda/Contra Costa Transit District	D	Bay Area AQMD
Eastern Contra Costa Transit Authority	D	Bay Area AQMD
Golden Gate Bridge Highway and Transportation District	D	Bay Area AQMD
Santa Clara Valley Transportation Authority	D	Bay Area AQMD
El Dorado County Transit Authority	D	El Dorado County APCD
Merced County Transit	D	San Joaquin Valley APCD
Visalia City Coach	D	San Joaquin Valley APCD

The transit agencies that withdrew or did not complete their applications include Central Contra Costa Transit Authority, Livermore/Amador Valley Transit Authority, San Francisco Municipal Railway, Monterey-Salinas Transit, Long Beach Transit, City of Norwalk, San Joaquin Regional Transit, and Montebello Bus Lines (Table 4). Transit agencies that have withdrawn their applications indicated to staff that they have revised their bus purchase plans to include no diesel bus purchases between 2004-2006.

**TABLE 4: Withdrawn or Incomplete Alternative NOx Strategy Applications**

<b>Agency</b>	<b>Fuel Path</b>	<b>Air District</b>
Central Contra Costa Transit Authority	D	Bay Area AQMD
Livermore/Amador Valley Transit Authority	D	Bay Area AQMD
San Francisco Municipal Railway	D	Bay Area AQMD
Monterey-Salinas Transit	D	Monterey Bay Unified APCD
San Joaquin Regional Transit	D	San Joaquin Valley APCD
Long Beach Transit	D	South Coast AQMD
Montebello Bus Lines	D	South Coast AQMD
City of Norwalk	D	South Coast AQMD

### **3. NOx Aftertreatment Demonstration Status**

Another requirement of the alternative NOx reduction strategy application is the initiation of an advanced NOx aftertreatment demonstration by December 31, 2002. As stipulated by the Board at the September 2001 public meeting (Resolution 01-31, September 20, 2001), each transit agency that applied for an exemption has the option of performing a joint or individual demonstration. The guidelines for a joint demonstration are as follows: (1) may involve several or all transit agencies that applied for an exemption; (2) must include at least three buses operating in fare service; and (3) must demonstrate NOx aftertreatment technology that will offer commercial potential (i.e., reduce NOx emissions by 70 percent or more). If an individual demonstration is performed, then the transit agency is required to include at least one bus operating in fare service.

During the various meetings since the September Board meeting, transit operators and staff have worked with emission control equipment manufacturers on planning a joint advanced NOx aftertreatment demonstration. All seven transit agencies that must participate have committed to do a joint demonstration project. In addition to the seven transit agencies, San Mateo County Transit District and Central Contra Costa Transit Authority have also committed to participating in the joint NOx demonstration (Appendix F). Torrance Transit has told staff they plan to do a separate NOx demonstration.

Thus far, the most promising advanced NOx aftertreatment technology for the demonstration project appears to be selective catalytic reduction. Selective catalytic reduction (SCR) uses a reductant, usually urea or ammonia, to convert NOx to

harmless gases. The reducing agent is injected into the exhaust upstream of a catalyst bed. As the exhaust gases and the reductant pass over a catalyst applied to either a ceramic or metallic substrate, NO<sub>x</sub> emissions can be reduced to gaseous nitrogen and water vapor. Several studies in heavy-duty engines have estimated that SCR efficiencies can range from 50-80 percent or even higher (Tim Johnson, personal communication, 2001). In addition to reducing emissions of NO<sub>x</sub>, SCR simultaneously reduces emissions of HC by 50 to 90 percent and PM by 30 to 50 percent (MECA 2000a). In general, higher efficiencies, however, have been reported on steady-state cycles. Attaining high efficiencies from mobile engines operating on transient duty cycles is more challenging.

#### **D. Transit Agency Activities Beyond the Requirements**

Several of the transit agencies have informed staff that they are moving to reduce emissions from their fleets more aggressively than required by the transit bus fleet rule. Those transit agencies have submitted a letter detailing those activities (Appendix F). To summarize, they are: (1) aggressively repowering their older two-cycle engines; (2) switching to low sulfur (<15 ppm) diesel fuel earlier than the required July 1, 2002, date; (3) installing particulate filters earlier than required; and (4) testing various advanced technology engines and power systems that have lower NO<sub>x</sub> and PM emissions than currently certified engines. The potential benefits of these changes are discussed in a presentation made by the California Transit Association (Appendix G). This presentation also detailed the specific transit agencies that are incorporating these changes.

### **IV. OTHER ISSUES**

Beyond the issues discussed in the previous chapters, there are still a few outstanding issues related to the transit bus regulation that must be addressed.

#### **A. PM Emission Control**

Title 13, CCR, section 1956.2 (f) requires that older engines be retrofitted to reduce diesel PM earlier than newer engines. Specifically, 100 percent of pre-1991 MY (Tier 1) diesel engines must be retrofitted with technology that will reduce diesel PM by 85 percent by January 1, 2003. The same requirement applies to a lower percentage of MY 1991 through 1995 (Tier 2) engines by January 1, 2003, under a phase-in period. The deadline for full compliance for all 1995 and older models is January 1, 2004, for transit agencies on the diesel path and January 1, 2005, for transit agencies on the alternative-fuel path. Included in the retrofit requirements are the following exemptions:

- (1) MY 1990 and earlier engines that were originally certified to 0.6 g/bhp-hr PM and have been retrofitted to 0.1 g/bhp-hr PM with an ARB certified retrofit device are exempt from further retrofits;
- (2) Tier 2 and 3 buses, operated by transit agencies on the alternative fuel path, that are within two years of retirement are exempt from the retrofit requirements; and

- (3) Tier 2 and 3 buses, operated by transit agencies on the diesel path, that are within one year of retirement are exempt from the retrofit requirements.

Staff is currently evaluating reports submitted by transit agencies which detail retrofit plans for their diesel-fueled, dual-fueled, bi-fueled, or diesel hybrid buses. A summary of the analysis will be presented at the March Board meeting.

As of the publication of this report, two particulate control devices have been verified, and these have application only for 1994 and newer four-stroke engines. Both devices are passive diesel particulate filters that utilize exhaust gas heat and a catalyst to regenerate. In general, two-stroke bus engines are more technologically challenging to retrofit with a passive DPF because PM emissions tend to be higher than four-stroke engines. Furthermore, the exhaust gas temperature may not meet the minimum temperature required for spontaneous regeneration.

Appendix H provides the estimated timeframes for diesel emission control strategies verification for transit buses. These estimates are based primarily on information supplied by MECA. As noted above, Tier 1 two-stroke engines must be retrofitted by January 1, 2003, but the estimated verification timeframe for many pre-1991 two-stroke engines is sometime during 2003. Even if the estimates were accurate, the deadline for Tier 1 two-stroke engines would have passed by the time the verifications were to be performed.

Staff believes that the technology will not be available for pre-1994 MY engines in time to meet the January 2003, regulatory deadline. As a result, staff recommends the regulation be revised to allow transit agencies to retrofit newer bus engines provided the same number of retrofits are completed by January 1, 2003, as would be required by the current regulation. This would be accomplished using the funds already earmarked by the transit agencies for the retrofit of the Tier 1 and Tier 2 engines. Consequently, the retrofit implementation schedule in the regulation will require revision. Staff will present regulatory changes reflecting a revised implementation schedule for the Board's consideration in September 2002. If the Board approves this recommendation, staff will work with the transit agencies in the interim to begin the process towards retrofitting all the required engines.

## **B. Hybrid-Electric Bus**

As discussed in the September 2001 Board meeting, ARB continues to work with hybrid-electric bus manufacturers, hybrid drive train developers (e.g., BAE Systems and Allison), and transit bus fleet managers to further understand the operating characteristics and maintenance concerns of transit buses, both conventional and hybrid designs. Staff is working closely with key industry officials to facilitate the development of durability requirements, such as emission deterioration factors, in-use compliance measures, and onboard diagnostics requirements. The ARB staff plans to propose heavy-duty hybrid-electric vehicle test procedures for the Board's consideration and adoption in September 2002.

### C. Other Resolution Directives

The ARB staff was directed to assist rural and smaller transit agencies in identifying, assessing, and implementing economies of scale and other strategies in infrastructure development to support alternative-fuel bus fleets (Resolution 01-31, September 20, 2001). To date, staff has been unable to proceed with this directive due to limited resources. Staff will be meeting with small and/or rural transit agencies in April 2002 to begin accomplishing the goals set forth in the resolution.

The ARB staff was also asked to be prepared to introduce a proposal to eliminate the diesel path option in the transit bus fleet rule if efforts towards clean diesel technology and compliance with low NO<sub>x</sub> emission standards do not improve considerably in the next six months. Based on the information provided by the transit agencies, staff concludes that almost all the transit agencies are making good efforts towards meeting and exceeding the goals of the public transit bus fleet rule. Therefore, staff does not recommend a proposal to eliminate the diesel path option.

## REFERENCES

ARB 1999b. The Public Transit Bus Fleet Rule: Initial Statement of Reasons, December 1999.

MECA 2000a. Manufacturers of Emissions Controls Association (MECA), Emission Control Retrofit of Diesel-Fueled Vehicles, March 2000.

**APPENDIX A: Board Resolution 01-31**State of California  
AIR RESOURCES BOARD

Resolution 01-31

September 20, 2001

Agenda Item No.: 01-7-2

WHEREAS, sections 39600 and 39601 of the Health and Safety Code authorize the Air Resources Board (the "Board") to adopt standards, rules and regulations and to do such acts as may be necessary for the proper execution of the powers and duties granted to and imposed upon the Board by law;

WHEREAS, in section 43000 of the Health and Safety Code, the Legislature has declared that the emission of air pollutants from motor vehicles is the primary cause of air pollution in many parts of the state and, in sections 39002 and 39003 of the Health and Safety Code, has charged the Board with the responsibility of systematically addressing the serious air pollution problem caused by motor vehicles;

WHEREAS, sections 43013, 43101, and 43104 of the Health and Safety Code direct the Board to endeavor to achieve the maximum degree of emission reduction possible from motor vehicle sources to accomplish the attainment of state ambient air quality standards by the earliest practicable date;

WHEREAS, sections 43013, 43101, and 43104 of the Health and Safety Code authorize the Board to adopt motor vehicle emission standards, in-use performance standards, and test procedures, which it finds to be necessary, cost-effective, and technologically feasible;

WHEREAS, section 43806 of the Health and Safety Code directs the Board to adopt emission standards and procedures applicable to new engines used in publicly owned and privately owned public transit buses;

WHEREAS, the United States Environmental Protection Agency has promulgated emission standards and programs to reduce emissions from urban transit buses, and those standards and programs can be found in Title 40 of the Code of Federal Regulations, Part 86;

WHEREAS, section 43701(b) of the Health and Safety Code requires the Board to adopt regulations that require heavy-duty diesel vehicles to utilize emission control equipment and alternative fuels to reduce emissions to the greatest extent feasible;

WHEREAS, on August 27, 1998, following extensive scientific review and public hearings, and consistent with the conclusions of the Scientific Review Panel and the Office of Environmental Health Hazard Assessment, the Board formally identified particulate emissions from diesel-fueled engines as a toxic air contaminant and on September 28, 2000, approved a plan to reduce risk from diesel particulate pollution by reducing harmful particulate matter emissions from diesel engines;

WHEREAS, the Board, through the adoption of Resolution 98-49 on September 24, 1998, called on state, local, and federal agencies to join together to "clean the fleet," supported immediate and continuing efforts to replace diesel-fueled school and public urban transit buses with low-emission alternative-fuel buses, including the provision of necessary infrastructure and technical training, and directed the staff to distribute this resolution to multiple affected parties;

WHEREAS, section 39667 of the Health and Safety Code directs the Board to achieve the maximum possible reduction in public exposure to toxic air contaminants by establishing emission standards for vehicular sources, including new and in-use motor vehicles and fuels;

WHEREAS, on February 24, 2000, the Board adopted Resolution 00-2 to achieve near-term and long-term emission reductions from urban transit buses through a fleet rule designed to reduce emissions of oxides of nitrogen (NOx) and diesel particulate matter (PM) by mandating a lower fleet average of NOx emissions; by requiring engines be retrofitted with devices to reduce diesel PM emissions by at least 85 percent; by requiring engine manufacturers to significantly reduce the allowable emissions from certified bus engines; by requiring that transit agencies switch to a specified percentage of low sulfur (less than 15 parts per million) diesel fuel; and by requiring transit agencies to purchase specified percentages of zero emission buses when adding to their fleets;

WHEREAS, the Board, through Resolution 00-2, directed the Executive Officer to work with transit agencies during implementation of the regulations, including provisions of the fleet rule, and to report to the Board regularly on transit agencies' progress in implementing the regulations;

WHEREAS, the regulations allow both diesel and alternative fuel fleet operators to apply for an exemption from the Model Year 2004-2006 NOx standards if specified criteria are met;

WHEREAS, the Board, through discussion at the February 24, 2000, public hearing and Resolution 00-2, directed the Executive Officer to report to the Board on implementation of emission reduction strategies as an alternative to compliance with the 2004 standards, including presenting recommendations based on its analysis of the first exemption application received, and on the status of demonstrations of advanced aftertreatment systems;

WHEREAS, the Board, through Resolution 00-2, directed the Executive Officer report to the Board on the development a test procedure for the evaluation of hybrid electric bus emissions;

WHEREAS, based on the information in the public record, the Board finds that:

1. Seventy transit agencies operating 6,698 diesel buses and 1,864 alternative-fuel buses are subject to the regulation, of which 43, or 61 percent, chose the diesel path and 27, or 39 percent, chose the alternative-fuel path.
2. As of August 1, 2001, 68 of the 70 transit agencies had submitted their fleet averages of NOx as of January 1, 2001, and projected fleet averages as of October 1, 2002, as required by the regulation. Of these 68 transit agencies, approximately 80 percent either comply with the required NOx fleet average of 4.8 grams per brake horsepower-hour (g/bhp-hr) as of January 1, 2001, or report that they will as of October 1, 2002.
3. Fifteen transit agencies have applied as required by June 30, 2001, for an exemption from the requirement that model years 2004 through 2006 transit bus engines as purchased be certified to emit no more than 0.5 g/bhp-hr NOx, but of those 15 only one transit agency, Santa Clara Valley Transportation Authority, submitted complete plans detailing how it would achieve greater NOx emission benefits through 2015, and no transit agency has submitted a declaration that it is demonstrating or contracted to demonstrate advanced NOx aftertreatment technology.
4. Fourteen transit agencies that submitted applications for exemption have requested additional time and assistance from the Executive Officer to develop plans showing how each would achieve greater NOx emission benefits through 2015, as required in the regulation, and all 15 transit agencies have requested additional time to demonstrate advanced NOx aftertreatment technology.
5. The plan submitted by Santa Clara Valley Transportation Authority to achieve greater NOx emission benefits through 2015 provides a good framework that can be followed by other transit agencies.
6. As of August 2, 2001, the Executive Officer has verified that two devices manufactured by Engelhard Corporation and Johnson Matthey, respectively, reduce diesel particulate matter emissions by 85 percent or more and meet the additional requirements for verification, including durability and warranty, and that these devices may be installed and operated on certain Cummins and Detroit Diesel Corporation bus engines to meet the requirement of this regulation, but that thus far no retrofit devices have been certified for any bus engines older than model year 1995.

7. Advanced NOx aftertreatment systems that achieve significant reductions in NOx emissions require additional research and development, and that while the June 30, 2001, deadline for transit agencies to be demonstrating, or contracted to demonstrate, advanced NOx aftertreatment systems is a premature deadline that should be extended, the demonstration requirement should be retained because demonstration of the technology in transit buses will assist California in meeting its NOx emission reduction goals;
8. The Executive Officer is making progress in developing a test procedure for the evaluation of hybrid electric bus emissions; and
9. The Public Transit Bus Fleet Rule Status Report included as Attachment A to this resolution and incorporated by references herein adequately sets forth the status of implementation of the Public Transit Bus Fleet Rule, as required in Resolution 00-2.

NOW, THEREFORE, BE IT RESOLVED, that the Board hereby approves the Public Transit Bus Fleet Rule Status Report.

BE IT FURTHER RESOLVED, that the Board expresses extreme disappointment at the lack of progress by engine manufacturers and diesel-path transit agencies towards achieving advanced diesel bus engine technology and reiterates its resolve to implement and enforce the requirements of the urban transit bus regulations adopted by the Board February 24, 2000.

BE IT FURTHER RESOLVED, that the Board directs the Executive Officer to work with transit agencies that have reported that they will not meet the required NOx fleet average of 4.8 g/bhp-hr by October 1, 2002, to assist them in achieving compliance, and to proceed with enforcement actions against those transit agencies that do not comply by October 1, 2002.

BE IT FURTHER RESOLVED, that the Board directs the Executive Officer to assist rural and smaller transit agencies in identifying, assessing, and implementing economies of scale and other strategies in infrastructure development to support alternative-fuel bus fleets.

BE IT FURTHER RESOLVED, that the Board directs the Executive Officer to make the necessary regulatory changes to allow transit agencies that applied for an exemption by June 30, 2001, additional time to demonstrate advanced NOx aftertreatment technology; to require transit agencies to commit resources to a demonstration project as of December 31, 2001; and to require those transit agencies to have initiated advanced NOx aftertreatment demonstrations by December 31, 2002; or the Executive Officer shall rescind any conditional approvals granted previously.

BE IT FURTHER RESOLVED, that the Board directs the Executive Officer to allow each transit agency that applied for an exemption the option of performing a joint demonstration of advanced NOx aftertreatment as follows: a joint project may involve all or several transit agencies that applied for an exemption, include at least three buses

operating in fare service, and demonstrate NOx aftertreatment technology that will offer commercial potential (i.e., reduce NOx emissions by 70 percent or more). Any transit agency that elects not to participate in a joint project shall demonstrate advanced NOx aftertreatment technology that offers commercial potential in at least one bus operating in fare service.

BE IT FURTHER RESOLVED, that the Board directs the Executive Officer to convene a delegation to meet with representatives of the Engine Manufacturers Association to assess and encourage efforts to advance the status of NOx emission control technology and to report back to the Board by March, 2002, the results of these efforts.

BE IT FURTHER RESOLVED, that the Board directs the Executive Officer to continue development of a test procedure for the evaluation of hybrid electric bus emissions and to report back to the Board by late-2002 on progress in this effort.

BE IT FURTHER RESOLVED, that the Board directs the Executive Officer to be prepared to introduce a proposal to eliminate the diesel path option in the urban transit bus fleet rule if efforts towards clean diesel technology and compliance with low NOx emission standards do not improve considerably in the next six months.

I hereby certify that the above is a true and correct copy of Resolution 01-31, as adopted by the Air Resources Board.

---

Marie Kavan, Clerk of the Board

**APPENDIX B: Fuel Path Selection and Bus Fleet Total (2001)**

<b>Air Basin</b>	<b>Total Agencies</b>	<b>Diesel Path</b>	<b>Number of Buses</b>	<b>Alternative Fuel Path</b>	<b>Number of Buses</b>
Bay Area AQMD	15	13	2684	2	61
Sacramento Metro AQMD	2	1	13	1	214
San Diego County APCD	6	1	12	5	635
San Joaquin Valley APCD	8	4	151	4	204
South Coast AQMD	16	7	467	9	3798
All Others	24	18	327	6	200
<b>Total</b>	<b>71</b>	<b>44</b>	<b>3654</b>	<b>27</b>	<b>5112</b>

### APPENDIX C: Transit Agencies by Fuel Path and Fleet Size

\*(D): Diesel, (A): Alternative Fuel; AQMD: Air Quality Management District; APCD: Air Pollution Control District

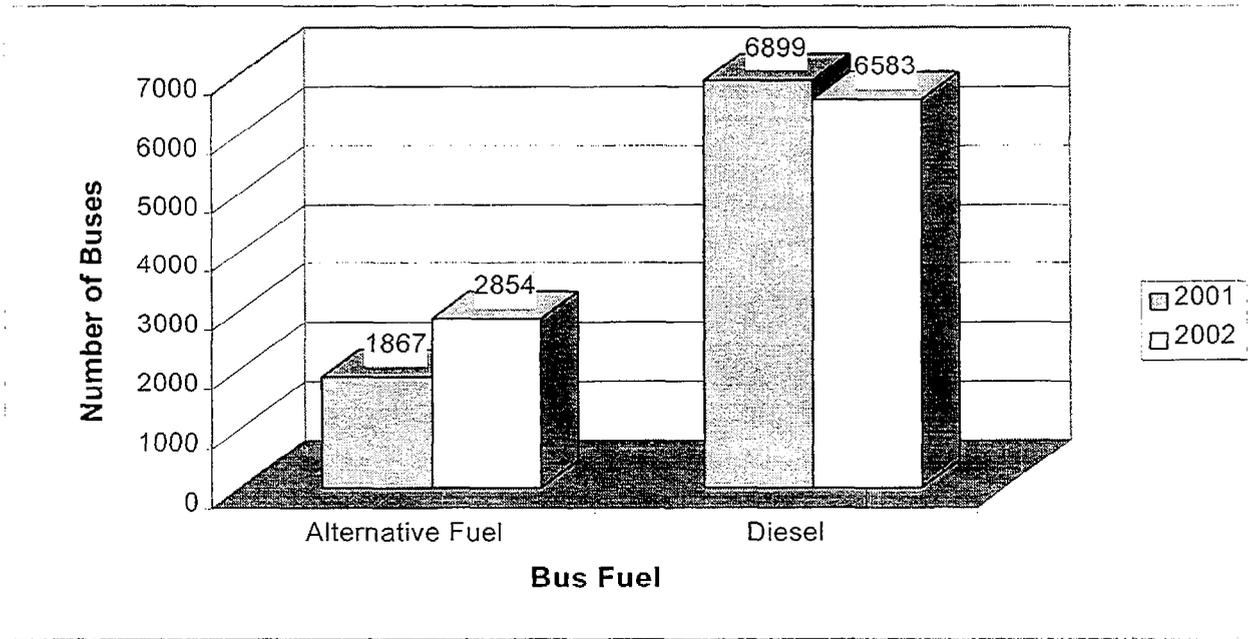
	Transit Agency	Fuel Path	Air District	Fleet Total (2001)	Fleet Total (2002)
1	Alameda/Contra Costa Transit District	D	Bay Area AQMD	741	751
2	Antelope Valley Transit Authority	D	Antelope Valley APCD	41	30
3	Arcata & Mad River Transit System	D	North Coast Unified AQMD	4	4
4	Central Contra Costa Transit Authority	D	Bay Area AQMD	132	128
5	Chico Area Transit System	D	Butte County AQMD	10	13
6	Chula Vista Transit	A	San Diego County APCD	25	35
7	Commerce Municipal Bus Lines	D	South Coast AQMD	13	13
8	Culver City, City of	A	South Coast AQMD	43	45
9	Eastern Contra Costa Transit Authority	D	Bay Area AQMD	45	52
10	El Dorado County Transit Authority	D	El Dorado County	4	8
11	Eureka Transit Service	D	North Coast Unified AQMD	8	9
12	Fairfield/Suisun Transit	D	Bay Area AQMD	26	40
13	Folsom Stage Lines	D	Sacramento Metro AQMD	13	15
14	Foothill Transit	A	South Coast AQMD	203	203
15	Fresno Area Express	A	San Joaquin Valley APCD	117	117
16	Gardena Municipal Bus Lines	D	South Coast AQMD	50	51
17	Golden Empire Transit District	A	San Joaquin Valley APCD	78	78
18	Golden Gate Bridge Highway and Transportation District	D	Bay Area AQMD	273	277
19	Humboldt Transit Authority	D	North Coast Unified AQMD	10	11
20	Livermore/Amador Valley Transit Authority	D	Bay Area AQMD	67	71
21	Lodi	A	San Joaquin Valley APCD	5	6
22	Lompoc	D	Santa Barbara County APCD	2	2
23	Long Beach Transit	D	South Coast AQMD	192	192
24	Los Angeles County Metropolitan Transportation Authority	A	South Coast AQMD	2448	2411
25	Los Angeles Department of Transportation	A	South Coast AQMD	109	109
26	Mendocino Transit Authority	D	Mendocino County AQMD	9	9
27	Merced County Transit	D	San Joaquin Valley APCD	19	21
28	Metropolitan Transit Development Board	A	San Diego County APCD	92	106
29	Modesto, City of	D	San Joaquin Valley APCD	40	52
30	Montebello Bus Lines	D	South Coast AQMD	78	78
31	Monterey-Salinas Transit	D	Monterey Bay Unified APCD	70	76
32	Napa VINE Transit Service	D	Bay Area AQMD	23	23
33	National City Transit	D	San Diego County APCD	12	16
34	North San Diego County Transit District	A	San Diego County APCD	149	149
35	Norwalk, City of	D	South Coast AQMD	24	28
36	Omnitrans	A	South Coast AQMD	189	209
37	Orange County Transportation Authority	A	South Coast AQMD	506	543
38	Redding Area Bus Authority	D	Shasta County AQMD	18	18

	Transit Agency	Fuel Path	Air District	Fleet Total (2001)	Fleet Total (2002)
39	Riverside Transit Agency	A	South Coast AQMD	83	94
40	Roseville, City of	D	Placer County APCD	7	19
41	Sacramento Regional Transit District	A	Sacramento Metro AQMD	214	214
42	San Diego County Transit System	A	San Diego County APCD	51	44
43	San Diego Transit	A	San Diego County APCD	318	321
44	San Francisco Municipal Railway	D	Bay Area AQMD	445	546
45	San Joaquin Regional Transit District	D	San Joaquin Valley APCD	71	83
46	San Luis Obispo Transit	D	San Luis Obispo County APCD	15	12
47	San Luis Obispo Regional Transit Authority	D	San Luis Obispo County APCD	18	18
48	San Mateo County Transit District	D	Bay Area AQMD	306	353
49	Santa Barbara Metropolitan Transit District	D	Santa Barbara County APCD	53	53
50	Santa Clara Valley Transportation Authority	D	Bay Area AQMD	528	574
51	Santa Clarita Transit	D	South Coast AQMD	60	60
52	Santa Cruz Metropolitan Transit District	A	Monterey Bay Unified APCD	99	110
53	Santa Maria Area Transit	D	Santa Barbara County APCD	8	8
54	Santa Monica's Big Blue Bus	A	South Coast AQMD	179	199
55	Santa Rosa CityBus	D	Bay Area AQMD	25	25
56	Simi Valley Transit	A	Ventura County APCD	9	11
57	Siskiyou County STAGE	D	Siskiyou County APCD	3	3
58	Sonoma County Transit	A	Bay Area AQMD	49	60
59	South Coast Area Transit	D	Ventura County APCD	43	43
60	South County Area Transit	D	San Luis Obispo County APCD	4	4
61	Stanislaus Regional Transit	A	San Joaquin Valley APCD	4	6
62	SunLine Transit Agency	A	South Coast AQMD	38	38
63	Thousand Oaks	A	Ventura County APCD	5	7
64	Torrance Transit System	D	South Coast AQMD	50	50
65	Union City Transit	A	Bay Area AQMD	12	14
66	Unitrans	A	Yolo-Solano AQMD	34	34
67	Vallejo Transit	D	Bay Area AQMD	54	27
68	Victor Valley Transit Authority	A	Mohave Desert AQMD	21	19
69	Visalia City Coach	D	San Joaquin Valley APCD	21	24
70	Western Contra Costa Transit Authority	D	Bay Area AQMD	19	19
71	Yolobus	A	Yolo-Solano AQMD	32	47
<b>TOTAL</b>				<b>8766</b>	<b>9137</b>

**APPENDIX D: Number of Diesel and Alternative Fuel Buses by Air District (2001)**

<b>Air District</b>	<b>Number of Diesel Buses</b>	<b>Percentage</b>	<b>Number of Alternative Fuel Buses</b>	<b>Percentage</b>
Bay Area AQMD	2718	39%	27	1%
Sacramento Metro AQMD	79	1%	148	8%
San Diego County APCD	458	7%	189	10%
San Joaquin Valley APCD	309	4%	46	3%
South Coast AQMD	2935	43%	1265	68%
All Others	400	6%	192	10%
<b>Total</b>	<b>6899</b>	<b>100%</b>	<b>1867</b>	<b>100%</b>

**APPENDIX E: Fleet Composition by Fuel Type (2001-2002)**



**APPENDIX F: Letter from Transit Agencies**

ADMINISTRATIVE OFFICES  
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# The County Connection

CUSTOMER SERVICE  
TRANSPORTATION CENTER  
At Walnut Creek BART  
220 Ygnacio Valley Rd  
Walnut Creek, CA 94596-3739  
(925) 676-7500  
Fax(925)932-1476

January 22, 2002

Nancy Steele  
Manager, Retrofit Implementation  
California Air Resources Board  
9480 Telstar Avenue, Suite 4  
El Monte, CA 91731

Dear Ms. Steele:

I am sending this letter on behalf of the transit agencies in the state of California to try to clarify issues with statements made by the CARB Executive Committee that the Bay Area and transit agencies in general are not in compliance with or are in some way attempting to circumvent the Urban Bus Transit Regulations. Transit agencies are not only in full compliance with the regulation, but are in many cases exceeding the requirements.

VTA, SamTrans, Golden Gate Transit, Fresno Montebello Bus Line, and others have been aggressively repowering existing buses in their fleets with new certified 4-cycle engines. While some of these repowers are being done to meet the 4.8 gram NOx fleet average, the majority are being done to get the older 2-cycle engines out of their fleets and making the repowered buses able to use the particulate filters that are called for in the particulate matter (PM) retrofit section of the rule, thereby reducing NOx and PM emissions in their fleet. As an example, SamTrans was required to complete twenty (20) repowers to meet the 4.8 gram average, but has committed funds to complete 137 buses. Each bus repower results in a reduction in NOx of 25%, in PM of 50%.

The Bay Area is set to bid as a region for ultra low sulfur diesel. Because of the volume of fuel being bought through this multi-year contract, ultra low sulfur diesel is now being produced in the Bay Area, resulting in a price premium of less than .5 cents per gallon. These savings make the fuel available to the private fleets at a cost competitive with other regions.

Ms. Nancy Steele  
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January 22, 2002

Most Bay Area properties made the transition to ultra low sulfur diesel on or before January 1, 2002, a full six months before the regulation calls for (and VTA/one Bay Area Transit Property transitioned to ultra low sulfur diesel fuel back in April 2001). Testing conducted by New York City Transit (NYCT) has demonstrated 23% reduction in PM just from the use of ultra low sulfur diesel. This assures that Bay Area properties are prepared to participate in NOx and PM reduction programs.

Eastern Contra Costa County has been running a test on Purinox fuel. They have seen a NOx reduction average of 19.45%.

Long Beach Transit has a contract in place to install particulate filters on 166 of its buses. Long Beach has been running its fleet on ultra low sulfur diesel since October 1, 2001.

The San Francisco Muni is looking to install particulate filters on 375 buses over the next two years.

Central Contra Costa Transit Authority (CCCTA) is waiting for approval from the Air Resources Board so that it can have the OEM install particulate filters on its new buses scheduled for delivery in 2002. SamTrans is also interested in receiving buses built in 2002 and 2003 with PM filters meeting the 0.01 gm/bhr standard.

AC Transit, VTA, San Francisco and Fresno are in the process of testing the Swedish Turbo Technology (STT) on its buses. This technology has demonstrated the ability to reduce NOx emissions on 4 gram engines up to 50%.

CCCTA is preparing to test a lean NOx catalyst technology that will reduce NOx by up to 40% and PM emissions by 85%. Even though these technologies fall short of the ARB goal of 70% NOx reduction, this equipment may provide a cost-effective (bolt of technology) to greatly reduce NOx and PM emission on heavy-duty vehicles in California.

Fresno, Orange County, Torrance Transit, and the San Francisco Muni are currently testing electric hybrid buses in revenue service and San Joaquin Transit has funding in place to purchase and test this technology.

Transit agencies are preparing for a joint program for an advanced NOx reduction demonstration in accordance with the regulations. These agencies include AC Transit, Golden Gate, Merced, El Dorado, Eastern Contra Costa County, Visalia, Tri-Delta, and VTA. SamTrans as well as CCCTA, although not required to do so, are committed to this program as well. Additionally, Torrance is pursuing a separate NOx reduction demonstration program with a potential 70% NOx reduction.

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Nancy, the transit agencies in California are proactively pursuing projects, equipment, and fuels beyond the scope of the CARB regulations. Our commitment to follow the regulation did not stop at mere compliance. The transit agencies are committed to working with the ARB staff for the duration of this regulation. Please make this information available to the Executive Committee. We look forward to a continued partnership between the ARB and the California public transit agencies.

Sincerely,



J. Scott Mitchell  
Director of Maintenance CCCTA  
Chairman CTA Maintenance Committee

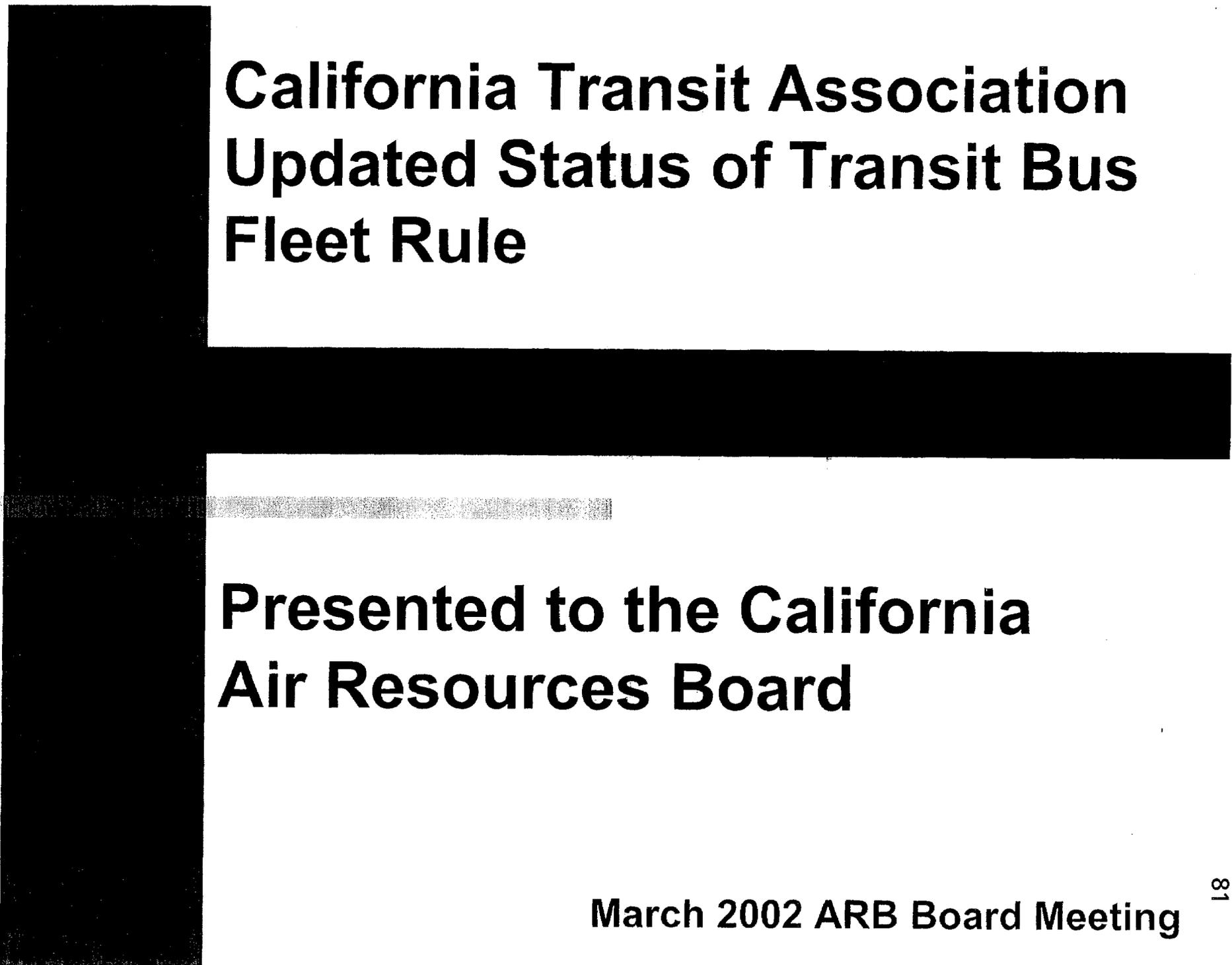
JSM/tr

C: Rick Ramacier, CCCTA  
Durand Rawl, Omni Trans  
Josh Shaw, CTA

**APPENDIX G: California Transit Association Presentation**

**APPENDIX H: Estimated Timeframes for Diesel Emission Control Strategies  
Verification**

<b>Year</b>	<b>Engines</b>	<b>Model Year</b>	<b>MECA Probability</b>	<b>Verified</b>
2001	Cummins L-10	>1994	9	x
2001	Cummins M-11	>1994	8-10	x
2001	DDC Series 50	>1994	10	x
2002	Cummins L-10	1991-1993	9	
2002	Cummins M-11	1991-1993	8-10	
2002	DDC Series 40	1991-1993	10	
2002	DDC Series 50	1991-1993	10	
2003	Cummins M-11	1988 - 1990	Not available	
2003	Cummins M-11	<1988	Not available	
2003	DDC 6V-92	>1991	5-7	
2003	DDC 6V-92	1988 - 1990	5-7	
2003	DDC Series 50	1988 - 1990	Not available	
2003	DDC Series 50	<1988	Not available	
2003	DDC 6L-71	>1991	2-3	
2003	DDC 6L-71	1988 - 1990	2-3	
2003	DDC 6L-71	<1988	2-3	
2003	DDC 6V-71	>1991	2-3	
2003	DDC 6V-71	1988 - 1990	2-3	
2003	DDC 6V-71	<1988	2-3	
2003	DDC 6V-92	<1988	Not available	



# **California Transit Association Updated Status of Transit Bus Fleet Rule**

**Presented to the California  
Air Resources Board**

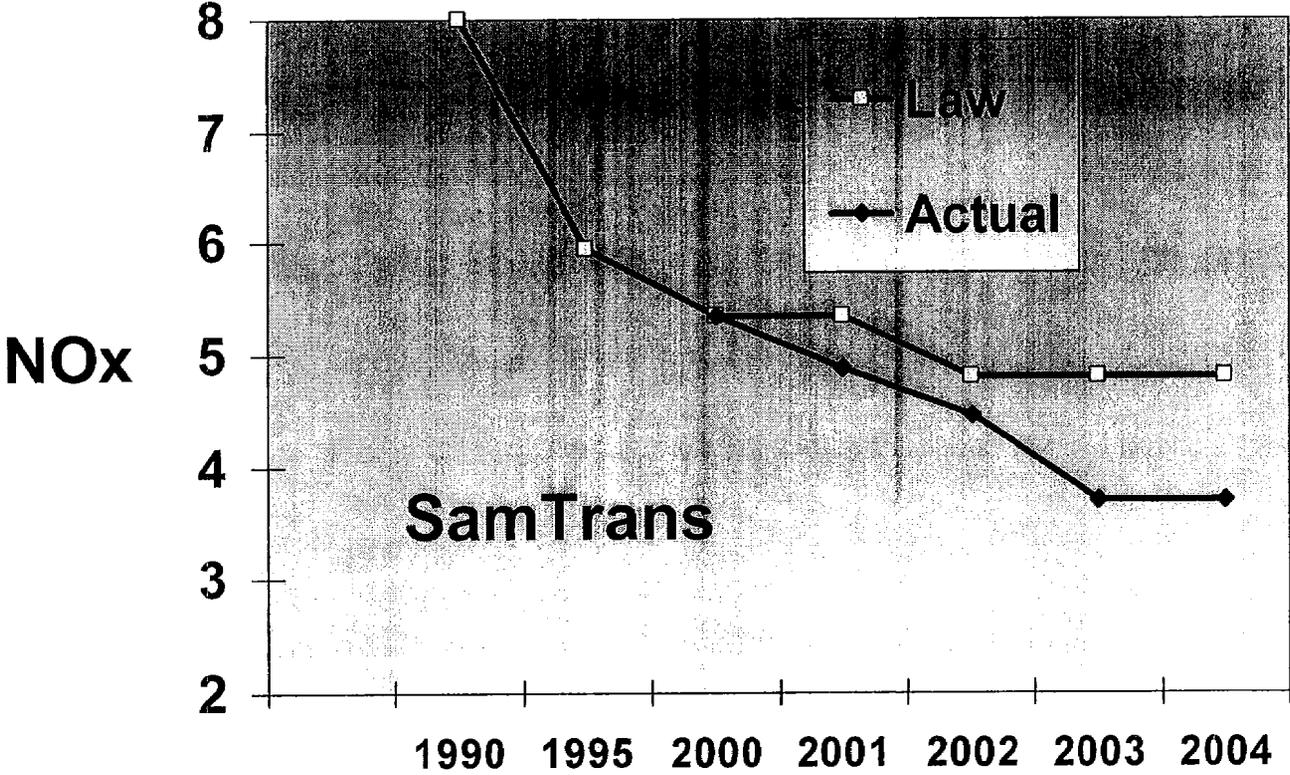
**March 2002 ARB Board Meeting**

- **Clarify any misunderstandings**
- **Show transit programs meet/exceed**
- **Advanced NOx tests: 2004-2006**
- **Hybrids and ZEBs**
- **Transit's commitment**
- **CTA - CARB partnership**

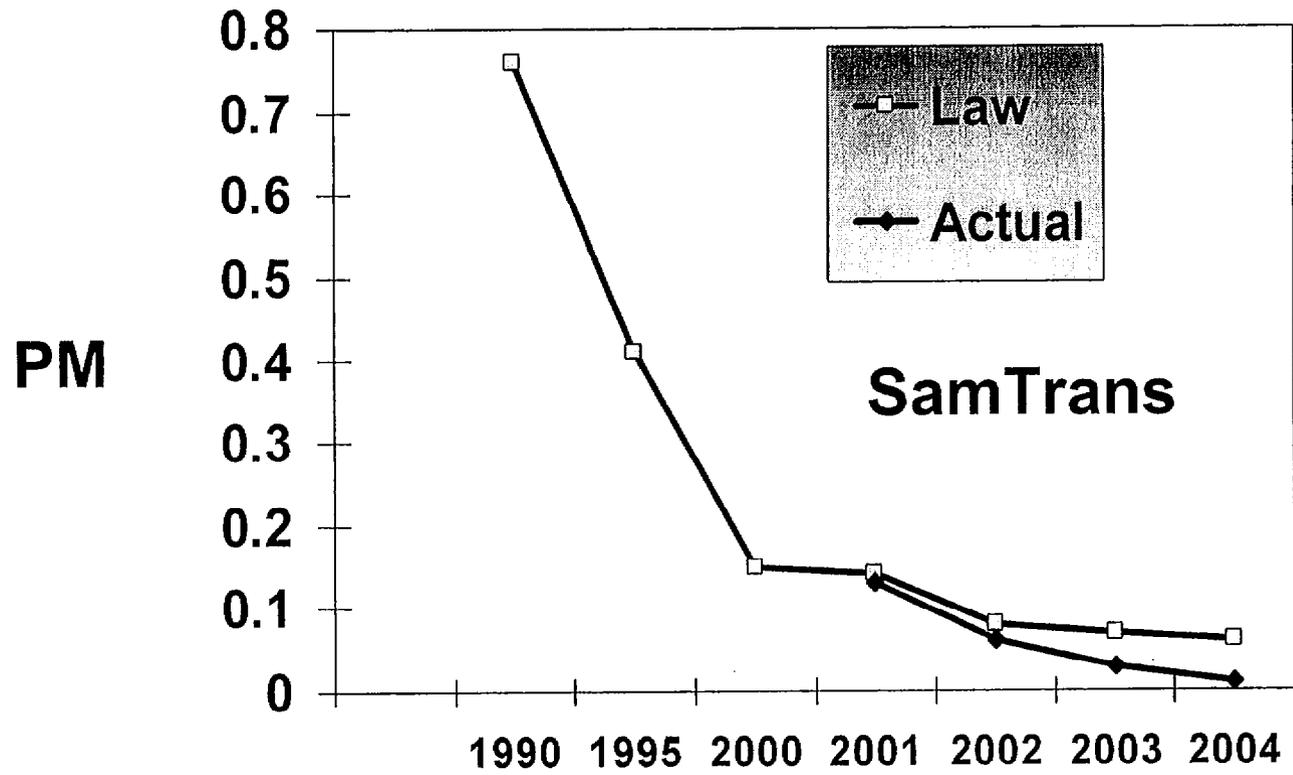
- **Transit is not standing still or planning to circumvent the regulation**
- **Transit funding cycles are unique and changing (2004-2006)**
- **Transit is committed to testing advanced NOx reduction technology**
- **Transit wants to partner with CARB**

- **Paths have been selected and documentation submitted (15 years)**
- **Programs are in place to meet 4.8 NOx fleet average**
- **Significant funding has been committed**
- **Bus emissions are going down**
- **Programs are exceeding the regulation**
- **Multiple technologies in testing**

# FLEET AVERAGE BY YEAR



### FLEET AVERAGE BY YEAR



PM

SamTrans

- **Replace/Retire model year 1984-1990 buses.**
  - Programmed prior to regulation
  - Funding from Federal/Local sources
  - New programs ex: Express Bus
- **Repower engines 2 cycle to 4 cycle**
  - Lower NOx, PM, Increase fuel economy
  - Allows older buses to use Traps
  - Properties repowering more than required to meet regulation

- **ULSF Diesel Fuel**

- Early conversion by properties
- Volume in Bay Area has reduced cost to 2-3 cents/gallon
- ULSF diesel fuel lowers emissions of all engines in inventory

- **PM Traps**

- Possible with 4 cycle engines and ULSF
- Properties are accelerating retrofits
- Significant PM fleet average reductions

- **NOx Technology testing**
  - EGR 2-2.5 gm engines
  - Purinox demo/tests
  - Cummins STT bolt on 50% reduction
  - EXT technology demo/tests
  - All these efforts are voluntary
- **Preparing for advanced NOx testing**
  - Discussions with SCR providers
  - Cooperating to map engines/certify

- **Minimum FTA use is 12 years**
  - Does not include bid/delivery time
  - Typical fleet today operates 14-15 years
- **Federal/State/Local sources**
  - MTC moving funding cycle to 14-16 years
  - Economy/competing projects (Rail)
- **Properties are currently replacing 1984-1990 model buses for delivery from 2000 - 2003**

- **Limited buses sold 1991-1992 due to methanol and PM regulations**
- **Extended replacement cycle moves 1993-1994 buses out to 2007-2010**
- **Many properties expanded mid-life rehab and repower projects to insure bus lives will match funding**
- **Many properties have built-in gaps in fleet buys from 3-8 years**

- **Properties are not planning to buy illegal engines in 2004-2006.**
  - **Properties with need submitted application for alternative plans**
  - **Properties can meet and exceed the regulation without purchases**
  - **Funding cycle changes and lack of clarity of best technology will impact some properties (small/rural location)**

- **Transit is prepared to demonstrate advanced NOx reduction technology**
  - **Regardless of path or 2004-2006 plans**
  - **Based on what is available and acceptable to CARB staff**
  - **SCR technology to meet 70% target**
  - **CTA properties have committed funding and plans to begin Advanced NOx Reduction Program in 2002**

- **Transit is prepared to demonstrate advanced NOx reduction technology**
  - **Northern California Test Consortium**  
**VTA      AC Transit      Golden Gate**  
**ECCTA      El Dorado      SamTrans**  
**Merced      Visalia**
  - **Southern California Test**  
**Torrance**

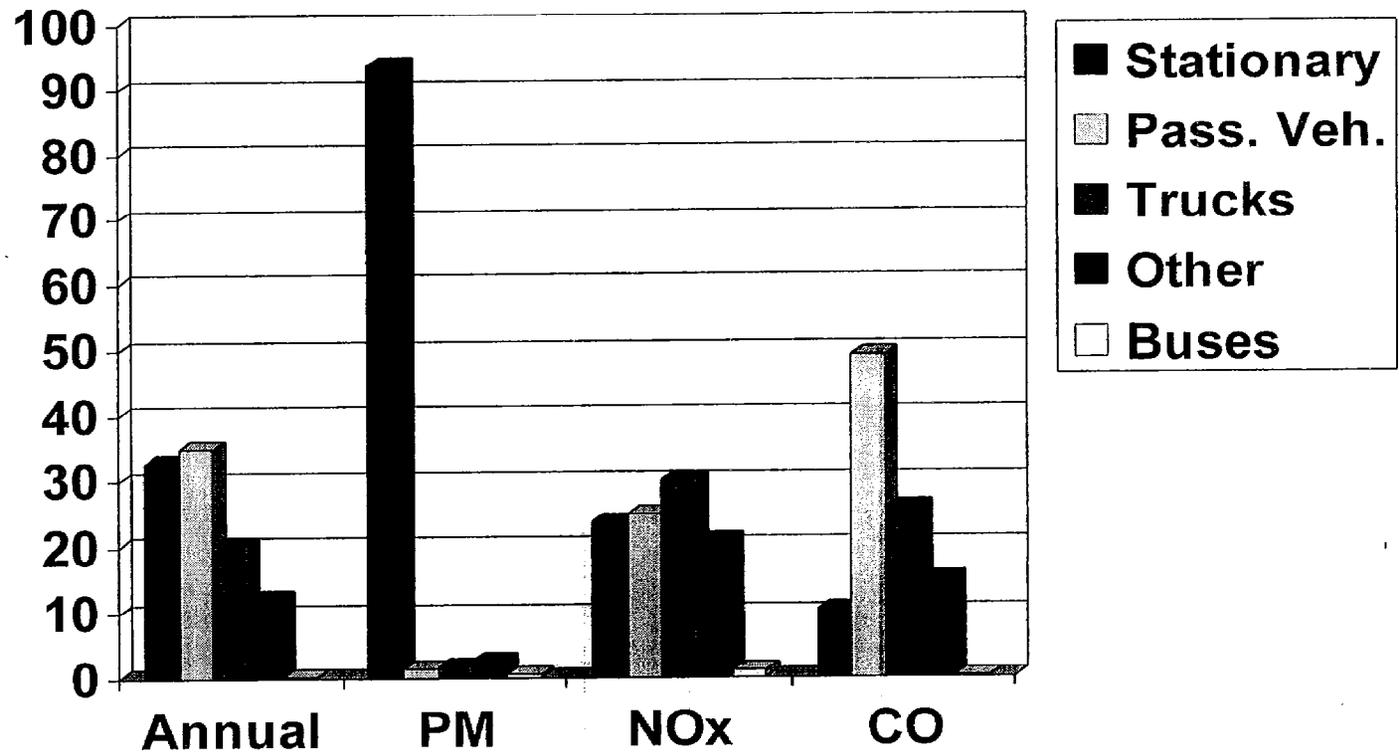
- **Hybrid drive technology**
  - Certification processes in design
  - Huge potential impact on fleet averages
  - Cost effectiveness compared to ZEB
  - Properties already buying/testing
- **CARB tests with OCTA diesel hybrid**
  - “Limited testing at ARB has demonstrated that similarly equally sized hybrid and CNG buses offer similar emission levels of NOx and PM.”

- **Zero Emissions Bus Demonstrations**
  - Funding committed by multiple agencies
  - Infrastructure investments in progress
  - Negotiating Bus/Fuel Cell availability
  - Changes to regulation may impact ZEB program commitments
  - Future application of ZEB and Hybrids to transit fleets requires extensive testing and measurement of emissions and cost effectiveness

- **Transit is committed to being CARB's partner to lower emissions**
- **Transit supports the technology forcing initiatives in the regulation**
- **Transit has committed funding and established programs in place**
- **Transit has selected paths and committed to 15 year programs**

- **Diesel path allows multiple emissions platforms to be developed**
- **Transit and the multiple technology in development is the gateway to Zero & Near Zero Emissions Vehicles**
- **Proving multiple technology paths will allow CARB to apply to vocations with greater potential to reduce overall emissions**

### Total Bay Area Emissions by Category (% of total)



1996 BAAQMD Rankings

- **Regardless of path we would like to continue our emissions reductions programs including programs that exceed CARB's regulations**
- **Transit is limited by the marketplace to what it can do to reduce emissions. Transit suggests an open market allowing multiple technology development to force reductions**
- **Transit is ready and eager to utilize ULSF fuel and test advanced NOx reduction devices**
- **Transit is prepared to move forward on PM trap technology, accelerating where possible**

- **Transit is eager to test Hybrid and ZEB technologies to develop options and cost effectiveness models for CARB**
- **Transit would like to work with CARB staff and the Board to provide any information that is needed to clarify our position and our commitment to the Transit Bus Fleet Rule**
- **The CTA would like to continue this open dialog with CARB to improve communications and foster a partnership that encourages innovation and demonstrates technology**



**SUMMARY OF BOARD ITEM****ITEM # 02-2-5: PUBLIC HEARING TO CONSIDER APPROVAL OF THE CARL MOYER MEMORIAL AIR QUALITY STANDARDS ATTAINMENT PROGRAM STATUS REPORT**

**STAFF RECOMMENDATION:** Staff recommends the Board approve the Carl Moyer Air Quality Standards Attainment Program (The Carl Moyer Program) Status Report for submittal to the Legislature as required by section 44245(a) of the Health and Safety Code.

**DISCUSSION:** The Carl Moyer Program provides grants for the incremental cost of cleaner on-road heavy-duty vehicles, off-road equipment, marine vessels, locomotives, agricultural pumps, auxiliary power units and other equipment to reduce emissions of oxides of nitrogen (NOx), a smog-forming pollutant, from mobile source diesel engines. The Carl Moyer Program also aims to reduce the fine particulate component of diesel exhaust, which contributes to particulate matter (PM) air pollution and is a toxic air contaminant. The program is in its fourth year of implementation. Initial program guidelines were approved in February 1999 and revised guidelines were approved in November 2000. The Carl Moyer Program has provided \$114 million in grants over the last four years, including \$16 million in this fiscal year. A portion of the program provides grants to support refueling infrastructure and engine technology development. The Infrastructure Demonstration and Advanced Technology sections are administered by the California Energy Commission (CEC). The NOx emission reductions achieved through this program are necessary to meet California's clean air commitments in the federally-required State Implementation Plan.

Section 44286 of the Health and Safety Code, establishes the ARB, the air pollution control districts, and the CEC as the administrators of

the Carl Moyer Program. Section 44245 (a) mandates that the Board submit an annual report on the status of the Carl Moyer Program to the Legislature.

Estimated emission reductions from the first three years are about 14 tons per day of NOx and 800 pounds per day of PM. The majority of the emission benefits occur in the first five years (the minimum project life), although some lower-emission engines may be in service 20 years or more. Overall, the program is extremely cost-effective – averaging approximately \$5,000 per ton of NOx. Reductions produced by the program will continue to benefit California for up to 20 years, depending on expected life of the engine.

Most of the engines funded include refuse haulers, urban transit buses, agricultural irrigation pumps and other farm equipment. These vehicles and equipment operate daily in residential neighborhoods and agricultural communities. These impacted areas will receive the benefits of the majority of the program's emission reductions.

This report is an update on the status of the statewide program for the first three years as required by the Health and Safety Code, including status of expenditures, types of projects, number of engines, and emission benefits. The report also addresses the role of the Carl Moyer Program in reducing public exposure to toxic diesel exhaust and the program's role in alleviating California's energy crisis. The significant emission benefits achieved the reduction in public health exposure to toxic PM emissions, and the overwhelming response to the program support the need for continued funding.

**CALIFORNIA AIR RESOURCES BOARD****NOTICE OF PUBLIC MEETING TO CONSIDER A STATUS REPORT ON THE CARL MOYER MEMORIAL AIR QUALITY STANDARDS ATTAINMENT PROGRAM: INCENTIVES FOR LOWER EMISSION HEAVY-DUTY ENGINES (THE CARL MOYER PROGRAM)**

The Air Resources Board (ARB or Board) will meet publicly at the time and place noted below to consider a status report on the Carl Moyer Program, as required by section 44295 of the Health & Safety Code. The Carl Moyer Program is currently operating in its fourth year. The Board approved the original program guidelines in February 1999 and revised the guidelines on November 16, 2000. Over the course of four fiscal years (1998/1999-2001/2002), the Carl Moyer Program has helped replace over 3,000 heavy-duty diesel engines with either cleaner burning diesel engines or alternative fueled engines. ARB estimates that emission reductions from the first four years are about 16 tons per day of oxides of nitrogen (NOx) and 1,000 pounds per day of particulate matter (PM).

The status report includes background on the Carl Moyer Program and the participating air pollution control and management districts' progress toward implementing this important program. The report also includes a discussion of the California Energy Commission's (CEC) activities in implementing the infrastructure demonstration and advanced technology portions of the Carl Moyer Program. A summary of the report will be presented to the Board at the meeting.

DATE: March 21, 2002  
TIME: 9:00 a.m.  
PLACE: San Diego County Administration Center  
Supervisor's Chambers, Room 310  
1600 Pacific Highway  
San Diego, California 92101

The item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., March 21, 2002, and will continue at 8:30 a.m., March 22, 2002. Please note that this item may not be considered until March 22, 2002. Please consult the agenda for the meeting, which will be available at least ten days before March 21, 2002, to determine the day on which this item will be considered.

This facility is accessible to persons with disabilities. If accommodation is needed, please contact Ms. Erin Dooley at (916) 323-8975, or for the Telecommunications for the Deaf (TDD), call (916) 324-9531 or (800) 700-8326 for TDD calls from outside the Sacramento area 14 days before March 21, 2002.

## BACKGROUND

Over 1.2 million diesel engines operate in California today. Diesel engines emit significant quantities of pollutants such as NO<sub>x</sub> that form smog and ambient PM, as well as carcinogenic compounds. Diesel engines account for less than five percent of California's total engine population, yet produce more than 40 percent of California's NO<sub>x</sub> emissions. Furthermore, many diesel engines tend to operate for 20 years or more. The long life of diesel engines makes fleet turnover alone an insufficient emission control strategy.

In 1998 the ARB identified PM exhaust from diesel-fueled engines as a toxic air contaminant. A prominent study cited over 70 percent of the cancer risk from identified toxic air contaminants in the South Coast Air Basin was due to diesel PM. In September of 2000, ARB approved the Diesel Risk Reduction Plan, which focuses on PM emission reductions for new and existing diesel-fueled engines and vehicles. In March 2000 the Carl Moyer Program Advisory Board, in a report to the Governor and the Legislature, recommended the Carl Moyer Program Guidelines include a provision to reduce PM emissions. In November 16, 2000, the Board revised the guidelines to introduce PM emission reductions targets.

The ARB's mission is to promote and protect public health, welfare, and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the state. The State Implementation Plan (SIP), a federally-required clean air plan, lays out California's control strategies to achieve clean air. Near-term emission reductions from heavy-duty diesel engines are critical to achieving air quality goals.

The Carl Moyer Program provides critical funding to achieve near-term emission reductions from heavy-duty diesel engines and help California meet its air quality commitments under the SIP. The Carl Moyer Program is a grant program that funds the extra capital cost of cleaner-than-required vehicles and equipment to produce NO<sub>x</sub> and PM emission benefits. The program has received a total of \$114 million in one-time appropriation allotments over the last four fiscal years (FY 1998/1999 – FY 2001/2002). The program also provides grants for alternative fuel infrastructure and grants for development of technology to reduce emissions beyond what is required by any state, federal, or local regulations. Hence, the program buys critical near-term emission benefits that California needs to meet impending federal air quality deadlines.

## DISTRICT PROGRESS

During the first three years, 23 air districts successfully implemented the Carl Moyer Program. In general, districts have seen a large demand for project funds. The types of funded projects include: purchase of new natural gas trucks, transit buses, and school buses; purchase of electric forklifts instead of internal combustion forklifts; and replacement of old diesel engines with newer diesel engines in marine vessels, agricultural pumps, and other off-road equipment. All the major air districts in the state are well into the process of awarding fourth year grants, which total \$16 million.

Emission benefits will be realized into the next decade because many lower-emission engines will remain in service for ten years or more. Overall, the program is extremely cost-effective – averaging below \$5,000 per ton of NOx.

### STATUS OF CEC INFRASTRUCTURE DEMONSTRATION AND TECHNOLOGY DEVELOPMENT PROJECTS

The CEC program criteria and guidelines for implementing the Carl Moyer Fueling Infrastructure Program were approved at a CEC Business Meeting in November 1999. Under the CEC program, funds are subvented to air districts which solicit applications and expend funds in accordance with the criteria. The CEC has awarded a total of \$4.5 million for infrastructure projects in local air districts.

The CEC allocated \$2 million from the 1999/2000 fiscal year budget and \$2.2 million from the 2000/2001 fiscal year budget for the Advanced Technology Development Section for the Carl Moyer Program. CEC allocated the majority of the 1999/2000 fiscal year funds to aftertreatment and advanced natural gas engine development. Fiscal year 2000/2001 funds were awarded to four projects: a turbine hybrid demonstration bus, a low NOx heavy-duty natural gas reliability augmentation project, a retrofit NOx filter demonstration, and a retrofit control technology demonstration project.

Like the ARB's portion of the Carl Moyer Program, the CEC's infrastructure demonstration and advanced technology development programs have been oversubscribed in both funding years. A full discussion of CEC's Carl Moyer programs is included in the report.

### AVAILABILITY OF DOCUMENTS AND CONTACT PERSON

The written report updating the Board on the progress of the Carl Moyer Program will be presented by ARB staff at the meeting. Copies of the written report prepared by staff may be obtained from the Board's Public Information Office, 1001 "I" Street, 1<sup>st</sup> Floor, Environmental Services Center, Sacramento, California 95814, (916) 322-2990, prior to the scheduled meeting. This report will also be available electronically on ARB's website at [www.arb.ca.gov/msprog/moyer/moyer.htm](http://www.arb.ca.gov/msprog/moyer/moyer.htm) prior to the scheduled meeting. Further inquiries regarding this matter should be directed to Ms. Cindy Sullivan, Manager, Alternative Strategies Section, at (916) 445-6015. If you are a person with a disability and desire to obtain this document in an alternative format, please contact the Americans with Disabilities Act (ADA) Coordinator at (916) 323-4916, or TDD (916) 324-9531, or (800) 700-8326 for TDD calls from outside the Sacramento area.

SUBMITTAL OF COMMENTS

The public may present comments relating to this matter orally or in writing at the meeting, and in writing or by e-mail before the meeting. To be considered by the Board, written comments and submissions not physically submitted at the meeting must be received **no later than 12:00 noon, March 20, 2002**, and addressed to the following:

Clerk of the Board  
Air Resources Board  
1001 "I" Street, 23<sup>rd</sup> Floor  
Sacramento, CA 95814

To be considered by the ARB, e-mail submissions must be addressed to [moyer02@listserv.arb.ca.gov](mailto:moyer02@listserv.arb.ca.gov) and received at the ARB **no later than 12:00 noon, March 20, 2002**.

To be considered by the ARB, facsimile submissions must be sent to (916) 322-3928 and received at the ARB **no later than 12:00 noon, March 20, 2002**.

The Board requests but does not require 30 copies of any written submission. Also, the ARB requests that written and e-mail statements be filed at least ten days prior to the meeting so that ARB staff and Board Members have time to fully consider each comment. The ARB encourages members of the public to bring any suggestions or comments to the attention of staff in advance of the meeting.

CALIFORNIA AIR RESOURCES BOARD



Michael P. Kenny  
Executive Officer

Date: March 4, 2002