California Environmental Protection Agency

Air Resources Board

PUBLIC MEETING AGENDA

October 21, 2010

LOCATION:
Air Resources Board
Byron Sher Auditorium, Second Floor
1001 I Street
Sacramento, California 95814

This facility is accessible by public transit. For transit information, call (916) 321-BUSS, website: http://www.sacrt.com
(This facility is accessible to persons with disabilities.)

TO SUBMIT WRITTEN COMMENTS ON AN AGENDA ITEM IN ADVANCE OF THE MEETING GO TO: http://www.arb.ca.gov/lispub/comm/bclist.php

October 21, 2010
9:00 a.m.

DISCUSSION ITEMS:
Note: The following agenda items may be heard in a different order at the Board meeting.

Agenda Item #

10-9-1: Public Meeting to Hear a Staff Presentation on the Draft Planned Air Pollution Research, Fiscal Year 2010-2011

Staff will present the portfolio of proposed research projects for FY 2010-2011. Research has been selected to support the Board's decision-making, support effective implementation of our regulatory programs, and address knowledge gaps critical to the Board's mission.

10-9-4: Public Meeting to Hear the 2010 Legislative Update

ARB Legislative Director and staff will present a review of legislation from the recently concluded 2009-2010 legislative session.

10-8-3: Public Meeting to Update the Board on the Implementation of the AB 32 Scoping Plan

Staff will update the Board on implementation of the Scoping Plan measures and other climate change program activities.

10-9-5: Public Meeting to Hear an Informational Update on Recent Federal and ARB Activities to Support Development of More Stringent Greenhouse Gas Emission Standards for Model Year 2017-2025 Passenger Vehicles

Staff will report on the recent publication of a Technical Assessment Report, jointly prepared by ARB, U.S. EPA, and U.S. DOT, on greenhouse gas emission reduction standards for model year 2017-2025 passenger vehicles and the related federal Notice of Intent to conduct a rulemaking.

10-9-2: Public Hearing to Consider Proposed Amendments to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines

Staff will propose amendments to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines (ATCM) to more closely align the requirements in the ATCM with those in the federal Standards of Performance for Stationary Compression-Ignition Internal Combustion Engines that was promulgated on July 11, 2006, help clarify provisions in the ATCM, address new information, and remove provisions no longer needed.

10-9-3: Public Hearing to Consider Minor Amendments to the Periodic Smoke Inspection Program in Response to the Inclusion of Diesel Vehicles in Smog Check (Assembly Bill 1488, Mendoza 2007)

Staff will present to the Board minor amendments to the Periodic Smoke Inspection Program (PSIP) to mitigate the duplicative testing requirements resulting from the implementation of the statutory requirements of AB 1488 and the existing testing requirements of PSIP. This action will eliminate duplicative emissions tests thereby lowering administrative costs to affected California fleets with diesel vehicles.

CLOSED SESSION – LITIGATION

The Board will hold a closed session, as authorized by Government Code section 11126(e), to confer with, and receive advice from, its legal counsel regarding the following pending or potential litigation:

Pacific Merchant Shipping Association v. Goldstene, U.S. District Court (E.D. Cal Fresno), Case No. 2:09-CV-01151-MCE-EFB.

American Trucking Associations, et al. v. U.S. Environmental Protection Agency, et al., U.S. Court of Appeals, District of Columbia Circuit, Case No. 09-1090.

POET, LLC, et al. v. Goldstene, et al., Superior Court of California (Fresno County), Case No. 09CECG04850.

Rocky Mountain Farmers Union, et al. v. Goldstene, U.S. District Court (E.D. Cal. Fresno), Case No. 1:09-cv-02234-LJO-DLB.

National Petrochemical & Refiners Association, et al. v. Goldstene, et al., U.S. District Court (E.D. Cal. Fresno) Case No. 1:10-cv-00163-AWI-GSA.

OPPORTUNITY FOR MEMBERS OF THE BOARD TO COMMENT ON MATTERS OF INTEREST

Board members may identify matters they would like to have noticed for consideration at future meetings and comment on topics of interest; no formal action on these topics will be taken without further notice.

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 do not specifically appear on the agenda. Each person will be allowed a maximum of three minutes to ensure that everyone has a chance to speak.

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IF YOU HAVE ANY QUESTIONS, PLEASE CONTACT THE CLERK OF THE BOARD:
OFFICE: (916) 322-5594
1001 I Street, Floor 23, Sacramento, California 95814
ARB Homepage: www.arb.ca.gov

SPECIAL ACCOMMODATION REQUEST

Special accommodation or language needs can be provided for any of the following:

- An interpreter to be available at the hearing;
- Documents made available in an alternate format (i.e., Braille, large print, etc.) or another language;
- A disability-related reasonable accommodation.

To request these special accommodations or language needs, please contact the Clerk of the Board at (916) 322-5594 or by facsimile at (916) 322-3928 as soon as possible, but no later than 10 business days before the scheduled Board hearing. TTY/TDD/Speech to Speech users may dial 711 for the California Relay Service.

Comodidad especial o necesidad de otro idioma puede ser proveído para alguna de las siguientes:

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

California Environmental Protection Agency
Air Resources Board

LOCATION:
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Sacramento, California 95814

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CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC MEETING TO CONSIDER THE APPROVAL OF A DRAFT REPORT: PLANNED AIR POLLUTION RESEARCH, FISCAL YEAR 2010-2011

The Air Resources Board (ARB or Board) will conduct a public meeting at the time and place noted below to consider a draft report, titled "Planned Air Pollution Research, Fiscal Year 2010-2011."

DATE: October 21, 2010

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Air Resources Board
Byron Sher Auditorium
1001 I Street
Sacramento, California 95814

This item may be considered at a one-day meeting of the Board, which will commence at 9:00 a.m., October 21, 2010. Please consult the agenda for the meeting, which will be available at least 10 days before October 21, 2010.

The California Health and Safety Code (HSC), Sections 39700 and 39703, established the Air Resources Board's research program. It directed the Board to coordinate and administer all air pollution research that is funded, to any extent, with State funds. To facilitate this process, HSC Section 39705 directs the Board to appoint a Research Screening Committee (RSC) to give advice and recommendations on all air pollution research projects proposed for funding.

The proposed research projects were selected from more than 150 research ideas that were submitted by the general public, business and academic communities, and ARB staff in response to ARB's public solicitation. All research ideas and technical evaluations were provided to the RSC for review and comment. The RSC met on September 9, 2010 to review and approve the final list of projects.

ARB staff will present a written draft report, Planned Air Pollution Research, Fiscal Year 2010-2011, at the meeting. The report describes projected funding allocations and proposed research projects, some recommended for funding and others recommended if funding becomes available. After the staff presentation and public testimony, the Board will vote on the draft plan.

Copies of the report may be obtained from ARB's Public Information Office, 1001 I Street, First Floor, Environmental Services Center, Sacramento, California, 95814, (916) 322-2990, on September 21, 2010. The report may also be obtained from ARB's website at http://www.arb.ca.gov/research/apr/apr.htm.

Interested members of the public may also present comments orally or in writing at the meeting and may be submitted by postal mail or by electronic submittal before the meeting. To be considered by the Board, written comments submissions not physically submitted at the meeting must be received **no later than 12:00 noon, October 20, 2010,** and addressed to the following:

Postal mail: Clerk of the Board, Air Resources Board
1001 I Street, Sacramento, California 95814

Electronic submittal: http://www.arb.ca.gov/lispub/comm/bclist.php

Please note that under the California Public Records Act (Government Code section 6250 et seq.), your written and oral comments, attachments, and associated contact information (e.g., your address, phone, email, etc.) become part of the public record and can be released to the public upon request. Additionally, this information may become available via Google, Yahoo, and any other search engines.

The Board requests, but does not require 20 copies of any written submission. Also, ARB requests that written and e-mail statements be filed at least 10 days prior to the meeting so that ARB staff and Board members have time to fully consider each comment. Further inquiries regarding this matter should be directed to Susan Fischer, Air Resources Engineer, (916) 324-0627, or Annmarie Rodgers, Manager of the Climate Action & Research Planning Section (916) 323-1517.

SPECIAL ACCOMMODATION REQUEST

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CALIFORNIA AIR RESOURCES BOARD

James N. Goldstene
Executive Officer

Date: Sept 15, 2010

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

California Environmental Protection Agency

Air Resources Board

PLANNED AIR POLLUTION RESEARCH

Fiscal Year 2010-2011

July 2010

Acknowledgments

This report was prepared with the assistance and support of managers and staff from the Research Division, Mobile Source Control Division, Monitoring and Laboratory Division, Planning and Technical Support Division, Office of Climate Change, and Stationary Source Division of the Air Resources Board. We would also like to acknowledge the members of the academic community, government agencies, private businesses, and the public who submitted research ideas.

Reviewed By:

Research Screening Committee
Harold Cota, Ph.D. (Chairman)
Dan Costa, Ph.D.
Irva Hertz-Picciotto, Ph.D.
Steven Japar, Ph.D.
Matthew Kahn, Ph.D.
Charles Kolstad, Ph.D.
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Rachel Morello-Frosch, Ph.D.
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Forman Williams, Ph.D.

External Reviewers and Collaborators
Bay Area Air Quality Management District
California Department of Resources Recycling and Recovery
California Department of Transportation
California Energy Commission
California Public Utilities Commission
Coordinating Research Council
Health Effects Institute
National Oceanic and Atmospheric Administration
New York State Energy Research and Development Authority
Office of Environmental Health Hazard Assessment
South Coast Air Quality Management District
United States Environmental Protection Agency

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SUMMARY

This report presents the Air Resources Board's planned air pollution research for the fiscal year 2010-2011. Twenty-five projects that support the Air Resources Board's programs are recommended for funding. An additional four projects are offered for consideration, should additional resources become available. This research portfolio is organized by key policy and regulatory drivers: Health Effects and Exposure; Emissions Reductions; Climate Change, Energy Efficiency, and Conservation; Economic Analysis; and Technology Research and Development. Issues related to agriculture and environmental justices are integrated into several of these primary categories.

This annual plan proposes research in the areas listed above, with a significant effort to further inform health impacts of air pollution, develop technologies and behavioral change strategies to reduce emissions of greenhouse gases, improve emission inventories, characterize and assess the behavior of pollutants in the atmosphere, and reduce emissions of conventional air pollutants and their precursors. The total budget for projects recommended for funding is approximately $6.5 million.

INTRODUCTION

The Air Resources Board (ARB or Board) sponsors a comprehensive program of research addressing the causes, effects, and possible solutions to air pollution problems in California. This research program also provides support for establishing ambient air quality standards. The Board's research program was established by the Legislature in 1971 (Health and Safety Code Sections 39700 et seq.) to develop a better understanding of air pollution in California, including air pollution's effects on health and the environment, atmospheric chemistry and transport of pollutants, and inventory and control of emissions. Several legislative mandates have expanded and further defined the scope of the program in recent years. For example, ARB's growing research interest in climate change issues is reflected by Assembly Bill 2991 (Nuñez, 2008), which expanded membership of ARB's Research Screening Committee to include two experts on climate change.

ARB's research portfolio comprises collaborative studies involving a variety of scientific disciplines and approaches. Some of these studies are long-term and build on unique data sets, while others address specific implementation or knowledge gaps as single modules. ARB funds niche projects that provide crucial input to California's air quality regulatory programs and may be unlikely to receive support from other funding agencies. In many cases, ARB technical staff play an active role in the research that extends far beyond contract management.

Objective of the Research Program. The goal of the research program is to provide timely scientific and technical information that will help the Board and local air pollution control districts to make sound policy decisions and effectively implement air pollution control programs in California. Specifically, this plan supports ARB's mission to protect public health based on a sound scientific understanding of health effects and exposures; continue developing and implementing strategies to reduce greenhouse gas emissions and energy consumption; develop effective strategies to safeguard health and welfare against adverse impacts of ambient air pollution; and support development of technologies and non-technological strategies that address multiple priorities related to air quality.

Process for Developing this Research Plan. Every year the Board sends out a public solicitation inviting and encouraging the public to contribute ideas for project consideration. Members of the public, the academic community, and ARB staff submit research ideas. To aid in the evaluation, the Board's Executive Officer has established interagency committees, led by ARB staff, to review research ideas. These interagency review teams comprised, in addition to ARB staff, experts from state agencies with related research priorities and responsibilities as well as experts from other state, air district, federal, and non-profit institutions with scientific research or regulatory authority in areas of policy relevance to ARB. In response to this year's solicitation, approximately 150 research ideas were submitted. Proposed projects were examined for relevance to regulatory questions facing the Board, scientific and technical merit, and opportunities to leverage State resources through co-funding. Proposals were modified as necessary to support ARB's goals. Reviewers then prioritized candidate projects with regard to urgency, cost-effectiveness, and likelihood to succeed. The Board's scientific external review committee, the Research Screening Committee (RSC), which was established by Health and Safety Code Section 39705, reviews candidate projects. A list of projects recommended for funding, as well as projects to consider pending availability of resources is compiled based on discussions between interagency review committees, feedback from ARB's divisions, and comments from the RSC as well as an agricultural stakeholder outreach working group. This list of recommended projects is submitted to the Executive Research Review Committee, whose members are the Executive Officer, his three deputies, and the Chief of the Research Division. The Executive Research Review Committee reviews all of the proposed projects and modifies the draft list of projects recommended for funding based on ARB's most pressing policy and regulatory needs. Finally, the RSC reviews the selected projects and recommends the Plan to the Board.

Implementation of the Plan. The next step for research concepts approved in the plan is their development into full research projects. The submission and selection of an idea does not guarantee a resulting contract for the submitter. Rather, ARB is required to consider public California universities for expertise to execute these projects. If the universities do not possess the expertise, then a public solicitation is issued or a sole source contract is awarded. A list serve distributes updates on research activities. To subscribe to the list serve, please visit:
http://www.arb.ca.gov/listserv/listserv_ind.php?listname=research.

Research Budget. The twenty-five recommended projects total approximately $6.5 million. An additional four projects totaling approximately $1.3 million may be considered if additional resources become available. Allocations for the projects recommended for funding are distributed among key research areas as follows:

RESEARCH CATEGORY	BUDGET
Health Effects and Exposure	$1,519,439
Emissions Reductions	$2,853,000
Climate Change, Energy Efficiency & Conservation	$1,315,000
Economic Analysis	$480,000
Technology Research & Development	$376,000
TOTAL	**$6,543,439**

Interagency Coordination. The Research Division works with other California government agencies to ensure that projects are non-duplicative, to identify opportunities to leverage resources, and to maximize the utility of research results. To foster coordination, staff at different agencies share information and solicit input from other agencies at all stages of the research process, including proposal review, updates on research progress, and final reports. Furthermore, the Climate Action Team has established a Research Subgroup to coordinate the State's climate change research. Starting in fall 2010, this Subgroup will hold annual meetings where State Agency research staff will display the products of research projects, summarize their on-going and planned research activities, and identify opportunities for collaboration. The CAT Research Working Group also maintains a database of State-funded climate change research. ARB, in collaboration with the California Council of Science and Technology, is compiling a database of climate change research in California's public and private universities, national laboratories, and State agencies. This publicly available tool is designed to help the State identify intellectual resources, in the form of principal investigators, ongoing or complete research, and databases, that can facilitate cost-effective attainment of climate change goals.

Project Co-Sponsorships. ARB is continually seeking co-funding opportunities and other ways to leverage the State's research dollars. This effort allows the ARB to be part of projects and studies that may otherwise lie beyond the state's fiscal reach. ARB has successfully worked with other research organizations and has participated in multi-million-dollar collaborations.

Summaries of Past Research. Projects completed since the beginning of 1989 are summarized in the Research Division's publication, *Air Pollution Research*, available at www.arb.ca.gov/research/apr/past/past.htm. Research Division's final reports are available at the same web site.

Organization of the Research Plan.
This research plan is organized according to key research categories that support the Board's mission: Health Effects and Exposure; Emissions Reductions; Climate Change, Energy Efficiency, and Conservation; Economic Analysis; and Technology Research and Development; with issues related to agriculture and environmental justice integrated into several of these primary categories. For each research area, an overview indicates primary policy drivers, links to ARB's mission, ongoing research efforts in the area, and research and knowledge gaps that need to be addressed. These contextual overviews are followed by the projects recommended for funding as well as those that may be considered if additional funds become available.

The proposed research projects are not intended to be exhaustive or exclusive. Unanticipated opportunities, unique or innovative study approaches, or urgency may lead to consideration of other projects.

OVERVIEWS OF RESEARCH AREAS

Health Effects and Exposure

Context

The health impacts of particulate matter (PM) air pollution have been confirmed by extensive studies conducted at many universities and institutions world-wide. The United States Environmental Protection Agency (U.S. EPA) recently released a comprehensive review of the scientific literature on the health and welfare impacts of particulate matter. That review included consideration of hundreds of epidemiological, toxicological and human exposure studies, and it concluded that there is a causal relationship between long-term PM2.5 exposure and mortality and for cardiovascular effects. The U.S. EPA further concluded that there is a likely causal relationship between long-term PM2.5 exposure and respiratory effects. Although the ARB has made considerable progress in reducing PM emissions from motor vehicles and other sources, and consequently reducing the level of adverse health effects of PM, the burden of PM exposure remains particularly acute, in part because California is home to two of the worst non-attainment areas in the U.S. with regard to federal 2006 PM2.5 standards.

Substantial progress has been made in understanding the mechanisms of PM toxicity, as well as the magnitude of the associated mortality risk. However, ARB must continue to improve its understanding of the specific components and sources of PM that are responsible for health burdens, as well as illuminate the mechanisms that cause adverse health impacts, particularly in vulnerable populations. This improved understanding will foster development of increasingly targeted and cost-effective regulations.

ARB's health and exposure research also targets indoor air quality because the indoor concentration of many air pollutants exceeds that of the outdoor levels, often elevating Californians' exposures to unhealthful levels of those pollutants. Previously, ARB's indoor air quality research focused on gaining a better understanding of indoor sources and exposures (especially for toxic air contaminants), the relationship between indoor and outdoor air pollution, and how building factors affect indoor pollutant concentrations and exposures. Current and planned research is focused on improved indoor source emission measurement techniques and the effectiveness of various mitigation approaches for reducing indoor concentrations and exposures. ARB's 2005 *Report to the Legislature: Indoor Air Quality in California* identified high priority indoor source categories requiring mitigation, including indoor air cleaning devices that emit large quantities of ozone, and building materials that produce high levels of formaldehyde and other volatile organic compounds (VOCs) indoors. ARB's pioneering research provided the key information that identified the need for recent regulation of these sources, but additional information is needed. For example, new technologies in indoor air cleaning devices require more sophisticated emissions measurement and mitigation techniques. Thus, a top priority is measuring pollutant emissions from indoor sources and investigating strategies for reducing individuals' levels of exposure to those pollutants.

Policy Drivers

- The Children's Environmental Health Protection Act (SB 25, Escutia, 1999)

- Reviewing and evaluating Ambient Air Quality Standards (Title 17 of the California Health & Safety Code, Section 39606)
- Diesel Risk Reduction Plan
- Regulation of Ozone Emissions from Indoor Air Cleaning Devices (California Health & Safety Code, Sections 41985 et seq.)

Research Themes

- *Particulate matter toxicity.* Public health risk from air pollution is dominated by exposure to PM. Much progress has been made over the last decade documenting the serious nature of the health risk from exposure to particles; now, research is needed to determine the relative toxicity of the components of the mixture of ambient particles. Furthermore, the biological mechanism of toxicity, which is just now coming to light, needs to be investigated. Research on the characteristics of particles, such as size, chemical composition, and interaction with other pollutants, are crucial in designing smarter, more targeted regulations, while providing adequate protection of public health and the environment.
- *Vulnerable populations.* As part of its mission, ARB investigates the health effects of air pollution in support of ambient air quality standards that are adopted to protect the health of all Californians, including sensitive sub-groups and those living in disadvantaged communities. Sensitive sub-groups of interest include children, the elderly, and those with chronic health conditions, such as asthma, cardiovascular and pulmonary disease.
- *Indoor air quality.* A top priority is measuring pollutant emissions from indoor sources and investigating strategies for reducing individuals' levels of exposure to those pollutants.

Recommended for Funding

Particulate Matter Toxicity

Season- and location-specific systemic health effects of ambient PM

Problem: A diverse and increasingly sophisticated body of epidemiologic evidence associates environmental particulate matter with asthma as well as cardiovascular morbidity and mortality, but less is known regarding the biological mechanisms as well as the specific PM components that are responsible for ill health. Most studies focus on urban particle sources and do not distinguish between regional differences in particle composition and potential pulmonary or systemic health outcomes. Stronger support for source-apportioned regulation depends on correlating source specific composition with health effects.

Objective: This project will use a mouse model to correlate PM composition, season, and location (urban versus rural) with biologic markers relevant to cardiovascular disease. Results will provide a biological link between epidemiologic studies and a principal health outcome of PM exposure, and will provide critical information on toxicity of PM from different sources that will help to inform future source-specific regulations.

Proposed funding level: $266,298

Biological activity of near-freeway particulate and gases

Problem: Epidemiological studies have shown associations between exposure to near roadway air pollutants and mortality and other adverse health outcomes, and a large number of in vitro and animal studies have shown that particulate matter has pro-oxidant activity relevant to the pathogenesis of these conditions. However, no study has examined how changes in the proximity to major roadways may impact the biological activity of particles. This project addresses that missing link and is an opportunity to identify the components of traffic-related pollutants potentially responsible for adverse health effects.

Objective: This proposed roadway gradient study will evaluate the seasonal and spatial variation in both gas and particle phase air pollutants. To link the physical/chemical characteristics of pollutants to biological activity, investigators will use state-of-the-art cellular assays to examine the role of chemical composition in determining the pro-oxidant, electrophilic, allergic, and inflammatory activity of ambient aerosols. Findings will promote our understanding of the causal relationship between exposure and health outcomes as well as clarify the spatial pattern of risk, and may guide development of regulatory and public health policy.

Proposed funding level: $300,000

Vulnerable Populations

Risk of pediatric asthma morbidity from multipollutant exposures

Problem: Asthma morbidity has been associated with fluctuations in daily concentrations of ambient air pollution, most strikingly with traffic-related air pollutants. However, the combined importance of local exposure to traffic-related ultrafine particles and regional exposure to ozone, as well as organic components of PM2.5, is largely unknown. This lack of information is due to the difficulty in estimating the exposure profiles of individuals at risk.

Objective: Investigators will use PM concentrations predicted by regional air quality models to study the relationship of asthma morbidity in over 7,500 children to exposure to primary organic aerosol (POA), which is directly emitted from sources, and secondary organic aerosol (SOA), which forms in the atmosphere from precursor emissions. The findings from this research will clarify the roles that components of complex urban air pollution play in producing adverse asthma outcomes in children.

Proposed funding level: $285,000

Investigation of persistent immune effects of acute PM exposure during early life and development of a biomarker for lung function decline

Problem: Although epidemiological studies suggest that there are life-long impacts of childhood air pollution exposures, the biologic mechanisms that mediate reduced lung function growth are not fully understood, and the phenomenon is difficult to study due to a lack of minimally invasive biomarkers. In addition to compromising lung development, preliminary data suggest that childhood exposures to air pollution may alter immune system development. The relationship between lung function growth and immune system development may offer a minimally invasive means of monitoring impacts of childhood air pollution exposures.

Objective: The proposed study will investigate the impact of environmental air pollutant exposure on immune system development and lung function growth in a cohort of rhesus monkeys that were born at the California National Primate Research Center, just prior to significant PM exposure from the Trinity and Humboldt County wildfires in July 2008. These fires led to air pollution levels significantly above ambient air quality standards that lasted for several weeks, which coincided with a period of rapid lung

growth in the exposed animals. The similarities between humans and rhesus monkeys in lung and immune system growth and development coupled with the cohort's inadvertent exposure to high levels of air pollution during a critical developmental period provides a unique opportunity to probe the mechanisms by which air pollution influences lung and immune system growth and development in children. The endpoints to be studied require minimally invasive procedures, and include lung function tests and blood draws that will provide the information needed while not harming the subject animals.
Proposed funding level: $268,141

Indoor Air Quality

Evaluation of secondary pollutant emissions from portable air cleaners
Problem: Although ARB is implementing a regulation to limit ozone emissions from portable indoor air cleaners such as electrostatic precipitators (ESPs), ionizers and ozone generators (OGs), some of these devices, including newer technology air cleaners designed to produce less ozone, may also cause the production of formaldehyde and other pollutants through their operation or from reaction of their emissions with other constituents of indoor air. Thus, the current regulation to limit ozone emissions from portable indoor air cleaners may not suffice to safeguard indoor air quality.
Objective: This research will evaluate the emission of indoor pollutants by devices commercialized as portable air cleaners in California, with emphasis on a new generation of equipment integrating several technologies that include photocatalytic oxidation. Both primary emissions and those formed by reaction in the indoor environment will be determined in realistic indoor conditions, to assess the potential for exposure and possible health risks. Results will help the State assist the public in making informed decisions when purchasing and using these devices, and may help determine whether such emissions require regulation.
Proposed funding level: $400,000

Recommended if Additional Funding Available

Particulate Matter Toxicity

Toxicity of fresh and aged semi-volatile PM
Problem: Many Californians live in nonattainment areas for PM2.5, and the contribution of aged pollution emissions from sources such as motor vehicles is significant to PM concentrations. However, less is known about the toxicity of aged emissions than is known for fresh tailpipe emissions. Within seconds of leaving the tailpipe, there are dramatic changes in gas-particle partitioning of semivolatile organic materials. These changes transform aerosol mass and chemical composition, but more importantly, they considerably alter the toxicity of the emissions.
Objective: The proposed two-phase research study will investigate the toxicity of fresh and aged motor vehicle emissions. This project will provide needed information on the atmospheric evolution of fresh vehicular emissions and their physico-chemical characteristics, transformation, and resulting toxicity. This knowledge will be vital in the development of cost-effective strategies to protect the public from toxic sources.
Proposed funding level: $300,000

Vulnerable Populations

Traffic-related pollution, DNA methylation and asthma in children living near sea ports

Problem: Asthma has a strong genetic basis, and genetic variants contribute to increase asthma susceptibility to exposures from traffic-related pollution. A growing body of evidence also suggests an epigenetic component in asthma susceptibility: air pollution may alter gene expression through effects on DNA methylation.

Objective: The proposed study will use a novel approach to generate new data that will improve understanding of the linkages among traffic-related pollution, DNA methylation and asthma progression in children. Results will also shed light on the impact of reductions in traffic-related pollution in the vicinity of the part of Long Beach due to ARB's implementation of the Goods Movement Emission Reduction Program on asthma progression and important epigenetic influences on asthma progression.

Proposed funding level: $550,000

Indoor Air Quality

Zero-energy air purification materials to reduce the exposure of Californians to harmful air pollutants

Problem: Ozone is both a health-damaging air pollutant and a driver of indoor chemistry that leads to the formation of oxidized reaction products, some of which are toxic or irritating. Indoor exposures are also responsible for 70% of cumulative exposure to a wide range of organic hazardous air pollutants (typically volatile organic compounds or VOCs). Indoor controls are a potential, but largely unexplored, strategy to reduce population exposures to ozone and its reaction products, as well as to organic hazardous air pollutants.

Objective: This study will explore the use of zero energy air purification building materials (e.g., wall materials) for substantially reducing population exposures to ozone, ozone reaction products, and organic hazardous air pollutants. If successful, this novel approach to exposure reduction could substantially reduce people's exposures from both indoor and outdoor emissions, when source controls do not exist or are insufficient to reduce pollutant levels below levels of health concern.

Proposed funding level: $254,205

Emissions Reductions

Context

Over the past four decades, ARB's emissions reductions strategies have yielded many improvements in air quality. For example, since the 1970's, aggregate tailpipe emissions of CO from on-road vehicles have been reduced by nearly 90%, and emissions of NO_X have been reduced by nearly one-half, despite substantial population growth and a more than doubling of vehicle-miles-travelled. However, California's topography and meteorology, compounded by continued population growth and a warming climate, render it vulnerable to poor air quality. Much of the State still struggles to meet air quality standards for ozone and particular matter (PM). Attaining air quality standards that protect public health rests on the best possible science to guide effective planning and implementation of emissions reductions strategies. In particular, meeting the U.S. EPA's current PM2.5 standards will require that the State's planning and implementation strategies are informed by accurate emissions inventories and partitioning models of primary PM as well as improved models of secondary aerosol formation processes and transport dynamics.

Policy Drivers

- Development of emission targets and State Implementation Plans for ozone.
- Development of emission targets and State Implementation Plans for PM.
- Improved inventory estimates of conventional air pollutants and greenhouse gases (GHG).

Research Themes

- *Agriculture*: Criteria pollutant and GHG emissions from several agricultural sources, such as VOC emissions from dairy silages and nitrous oxide from manure management, need to be developed or refined to support decision-making by the Board. Research projects will be crafted to support improvements to the inventory as well as identification and development of best practices for reducing emissions.
- *Vehicular emissions reductions*: Near-term emissions reductions with the current vehicle fleet are possible through improved operations and management. These strategies will complement existing rules requiring progressively cleaner heavy-duty diesel engines for the California fleet, and will reduce emissions of greenhouse gases as well as conserve energy.
- *Atmospheric chemistry*: Continued progress in reducing Californians' exposures to air pollution requires resolving the chemical and physical mechanisms responsible for transformation of emissions to ambient concentrations. Priority research gaps include investigation of atmospheric chemistry of particles, including mechanisms for formation of reactive oxygen species, aerosol partitioning and implications for PM concentrations, and quantifying the ammonia slip and eventual by-products associated with selective catalytic reduction for NO_X control;
- *Emissions inventory*: To optimize the development of cost-effective strategies for protecting public health, emissions inventories must be complete, up-to-date, and accurate. Current research needs include refinement of the emissions inventory associated with vehicular sulfate emissions, in-use tailpipe PM emissions, and organic aerosols; as well as improving ARB's source apportionment of the methane

emissions inventory. Due to its relatively short atmospheric lifetime coupled with strong climate forcing properties, ARB recognizes the potential for cost-effective, near-term, substantial climate benefits from reducing methane emissions.

- *CalNex*: In the summer of 2010, a large-scale multi-agency field study was conducted in California to better understand the emissions, transport, and transformation of conventional and climate change air pollutants. To leverage the results of this field work for maximum policy benefit requires a timely analysis and synthesis of the very large dataset collected.

Recommended for Funding

Agriculture

Characterization and mitigation of volatile organic compound emissions from dairy silage sources

Problem: Dairies are a major source of volatile organic compound (VOC) emissions in California and published studies suggest dairy cow feed or silage is an important factor in these emissions. However, the impact of silage on the magnitude and nature of VOC emissions is not well understood.

Objectives: This project will: (1) characterize silage production and management practices in California dairies; (2) evaluate effects of different ensilage practices on VOC emissions; (3) determine the potential for producing VOC's (in particular alcohol and aldehydes) emissions from different silages; and (4) delineate "best practices" for reducing or preventing the generation of alcohols and aldehydes during the ensiling process and consequently reducing their emissions.

Proposed funding level: $300,000

Developing, validating and implementing a process modeling system for California agriculture greenhouse gas inventories

Problem: Despite their significant contribution to livestock GHG emissions, nitrous oxide (N_2O) emissions were excluded from the California Climate Action Registry's (CCAR's) livestock project reporting protocol, which was developed to support manure management, one of ARB's AB32 Early Action measures. CCAR anticipates expanding the protocol to include GHG reductions beyond methane capture and destruction from biogas systems.

Objectives: Project objectives include: (1) expansion of existing field measurements of N_2O emissions from major sources in California's dairies, (2) further testing of UCD's Manure-DNDC model to quantify model uncertainties, (3) assessment using full process model versus detailed, regional/soil specific emission factors for estimating both baseline and project N_2O emissions from manure management, and (4) work with CCAR, ARB, Western United Dairymen, Sustainable Conservation, the San Joaquin Valley Air Pollution Control District, and an advisory panel to deliver an updated livestock reporting protocol.

Proposed funding level: $300,000

Vehicular Emissions Reductions

Investigation of Combined Aerodynamic Modifications to Reduce Emissions from the Current Heavy Duty Fleet

Problem: ARB's recently adopted tractor-trailer GHG rule requires that new and existing long-haul box-type trailers, as well as the tractors that pull them, be equipped with U.S. EPA Smartway-approved aerodynamic technology. However, little work has been done to investigate and quantify the benefits from combinations of multiple devices used simultaneously..

Objective: The proposed research will develop an evaluation protocol as well as test aerodynamic devices in multiple combinations on multiple platforms for increased reductions of greenhouse gases from on-highway trucks. Research results research will support innovative GHG emissions reductions and fuel-saving strategies that could be implemented with California's current heavy duty fleet.

Proposed funding level: $300,000

Atmospheric Chemistry

Probing the intrinsic ability of particles to generate reactive oxygen species

Problem: Oxidative stress caused by reactive oxygen species (ROS) is a leading hypothesis for the mechanism by which particulate pollution contributes to a range of illnesses, including asthma and cardiovascular mortality. ROS are generated within the body in response to inhalation of PM, but the "exogenous" ability of the particles themselves to generate ROS may also be important.

Objectives: This research will: (1) determine the strength of reactive oxygen species (ROS) production intrinsic in ambient particles, (2) probe sources and relative strengths of ROS production via (speciated) transition metals and quinones, (3) probe the balance between H_2O_2 and OH and the underlying mechanism(s) of ROS generation, and (4) clarify the sources of quinones in particles.

Proposed funding level: $260,000

Understanding primary organic aerosol volatility at atmospherically realistic concentrations for SIP analysis

Problem: Details of primary organic aerosol partitioning must be understood to predict the benefits of emissions control programs contained in the SIP as well as the impact of climate change on atmospheric organic aerosol pollution. Recent emissions tests have determined that primary organic aerosol generated from combustion sources behaves like a series of semi-volatile compounds when particulate phase concentrations range between 100 $\mu g/m^3$ and 10,000 $\mu g/m^3$.

Objective: The study will identify the dominant partitioning mechanism for primary organic aerosol emitted from diesel-powered and gasoline-powered vehicles at atmospherically realistic concentrations in the ranging from 5 to 30 $\mu g/m^3$. Results will provide input for regional airshed models that seek to predict changes to ambient organic aerosol concentrations in the presence of emissions control programs and/or climate change.

Proposed funding level: $300,000

Quantification of ammonia slip from SCR-equipped vehicles and estimation of secondary aerosol formation potential

Problem: As technologies such as Selective Catalytic Reduction (SCR) are developed to control conventional air pollutant emissions, care must be taken that operation of the new technologies does not produce new emissions that exacerbate air quality. SCR is becoming common for controlling oxides of nitrogen (NO_X) emissions from diesel vehicles. Excess ammonia that does not react with NO_X, called "ammonia slip", is emitted in the atmosphere. Atmospheric ammonia is very reactive, causing the formation of ammonium sulfate ($(NH_4)_2SO_4$) and ammonium bisulfate (NH_4HSO_4), two of the most significant types of PM in California. Ammonia slip can also react with NO_X to form ammonium nitrate if the SCR catalyst efficiency decreases after prolonged usage. In addition, ammonia in other forms such as free ammonia, ammonia salt, PM generated from ammonia salt, and secondary organic aerosol in the atmosphere are serious health and environmental hazards.

Objective: This investigation will quantify ammonia slip emitted from two SCR-equipped light duty vehicles operating at high, low, and transient modes; and investigate the correlation between ammonia slip and its effect on PM formation as well as PM mass emissions.

Proposed funding level: $140,000

Development of innovative instrumentation to enable investigation of the relationship between SO_2 and sulfate

Problem: Sulfur is an important component of combustion and lubricant-derived particles. Sulfate levels in vehicle exhaust particulates can be readily measured, but it is important to understand the relative contribution between combustion and oil-derived particles and conversion rates of sulfur dioxide (SO_2) to sulfate (SO_4). Current instruments are not capable of measuring the very low sulfate concentrations typical of new vehicles. Detection limits in the parts per billion range are needed to measure the SO_2 contribution from current and future model year vehicles.

Objective: The objective of this research is to construct, test and provide to ARB a differential optical absorption spectrometer (DOAS) that can measure down to 10 ppbV in real time and determine a mass balance between SO_2 and sulfate. Training for ARB's technical staff will also be provided as part of this program so they can run this state-of-the-art instrument independently.

Proposed funding level: $90,000

Development of a high quality proportional gravimetric PM system for in-use emissions measurements at low emissions levels

Problem: As vehicular PM emissions continue to be reduced, it is increasingly difficult to reliably measure in-use PM emissions, and protocols based on particle number or portable emissions measurement systems (PEMS) have not been satisfactory for gauging PM mass emissions rates. For example, comparisons of PEMS-based PM measurements to gravimetric reference methods reveal significant disparities, with deviations on the order of 100%. This poor correlation does not indicate faulty real-time instruments, but is the result of different measurement principles.

Objective: This research will develop and evaluate a new gravimetric-based system designed specifically for in-use conditions including on-highway, marine, and non-road

applications. The system will satisfy ARB's need for in-use PM measurements that are collected with PEMS but comparable to gravimetric reference methods.
Proposed funding level: $300,000

Extended analysis of the CARES aerosol chemistry data to characterize the sources and processes of organic fine particulate matter
Problem: Although organic aerosol represents a major mass fraction of fine particles in California, the ability of current air quality models to simulate ambient organic aerosol concentrations is limited by poor characterization of organic aerosol sources, formation mechanisms, and evolution processes. In particular, mechanisms by which organic aerosol is formed in the atmosphere requires clarification to improve model performance.
Objective: ARB funding will leverage a Department of Energy-funded project (aerosol characterization during CARES) to allow for advanced analyses to characterize the sources, formation, and atmospheric evolution of organic aerosol based on field data from the Sacramento and foothills region.
Proposed funding level: $155,000

Emissions Inventory

Methane source apportionment with stable isotope tracing
Problem: Methane is a powerful greenhouse gas with a global warming potential roughly 25 times that of CO_2 but a substantially shorter atmospheric lifetime, on the order of decades. Reducing methane emissions in a cost-effective way requires understanding how much is produced by different sources such as petroleum production, landfills, wastewater treatment, and agricultural fields and livestock.
Objective: This project will enhance ARB's methane monitoring network by using stable isotopes of methane to differentiate emission sources, thereby facilitating source apportionment. Research results will help prioritize, achieve, and verify methane emissions reductions. *Proposed funding level: $128,000*

Improving California's GHG emission inventory through ground-referenced remote sensing of fossil fuel industry emissions, and biological methane and carbon dioxide emissions
Problem: Methane's radiative properties and relatively short atmospheric residence time suggest that climate benefits of methane emissions reductions can be more cost-effective than CO_2 emissions reductions. However, effective regulation is hampered by discrepancies between top-down (or atmospheric inversion) and bottom-up (inventory) approaches for methane budget estimation; these discrepancies suggest emission inventory underestimation. Uncertainties in industrial emissions of methane from the fossil fuel industry, as well as substantial seasonal, spatial, and diurnal variability in biological methane emissions, warrant further investigation.
Objective: The study will leverage a successful NASA-funded satellite-based effort using a ground-based sensor to derive an improved estimate for emissions from terrestrial and marine fossil fuel production facilities, refineries, and biological sources using a combination of remote sensing and ground reference measurements.
Proposed funding level: $330,000

Synthesis of policy-relevant findings from the CalNex 2010 field study

Problem: The field phase of the joint ARB-NOAA CalNex 2010 field study, which leveraged vast scientific and intellectual resources to gather hitherto unavailable data that illuminate atmospheric processes and emissions relevant to air quality and climate change, was completed during the summer of 2010. It is important to now ensure that the results of that study are made fully available to California policy makers who must deal with air quality and climate change issues. The fieldwork was planned to address a number of scientific questions that were formulated to guide the study planning. The questions address many specific and general science needs that are required to improve policy responses to air quality and climate change issues.

Objective: The goal of the proposed work is to synthesize the results of ongoing, multi-agency, highly leveraged CalNex 2010 analyses to answer an array of science questions that directly support air quality policy, planning, and implementation. Results will be delivered in a timely fashion and in a form most useful to policy makers.

Proposed funding level: $250,000

Climate Change, Energy Efficiency and Conservation

Context

California's legislative policy and executive orders have established significant energy and environmental initiatives related to climate change. The state is widely recognized for innovations in the utility sector and building efficiency. For example, Executive Order S-20-04 related to state building energy efficiency requires 20% reductions in grid-based electricity purchases for state-owned buildings by 2015. More recently, SB 1368 (Perata, 2006) mandated a greenhouse gas (GHG) emissions portfolio standard for baseload electricity generation.

California has led the nation with respect to tailpipe emissions reductions of criteria pollutants for four decades, and with the passage of AB 1493 (Pavley) in 2002 the state expanded its successful emissions reduction programs to include vehicular emissions of GHGs. The Low Carbon Fuel Standard introduced by Executive Order S-1-07 and adopted by the Air Resources Board as an AB 32 Discrete Early Action in June 2007 represents another approach to reducing vehicular tailpipe GHG emissions by reducing the carbon content of fuels.

Legislative efforts to support scientific, administrative, legal, and technical dimensions of climate policy date back to 1988, when the California Energy Commission (CEC) was charged with the task of studying the effects of climate change on California. Since year 2000, when SB 1771 (Sher) established the California Climate Action Registry as a nonprofit that records and registers voluntary emissions reductions, SB 527 (Sher, 2001) and SB 812 (Sher, 2002) have broadened the technical scope and refined administrative aspects of emissions reporting and reduction protocols. More recently, AB 32 tasked ARB with the duty of reducing the state's GHG emissions to 1990 levels, and E-S-05 set a goal of 80% emissions reductions of GHG pollutants by 2050.

California's continued leadership in building energy efficiency, reducing transportation-related emissions, and conserving as well as greening its electricity resources require continued research to aid development and evaluation of voluntary strategies in the residential and building sectors.

Policy Drivers

- SB 375 (Steinberg), Sustainable Communities Strategy (2008). *Requires regional planning to incorporate land-use and related strategies to reduce GHG emissions from automobiles and light trucks.*
- SB 97 (Dutton), CEQA: Greenhouse gas emissions (2007). *Incorporate guidelines for GHG emissions impacts into CEQA.*
- AB 32 (Nuñez), California Global Warming Solutions Act of 2006. *Reduce greenhouse gas emissions to 1990 baseline by 2020.*
- SB 1368 (Perata), Electricity: emissions of greenhouse gases (2006). *Establish greenhouse gas emission performance standard for baseload generation.*
- AB 1925 (Blakeslee), Carbon sequestration (2006). *Identify technical readiness and barriers to geologic carbon sequestration.*

- AB 1493 (Pavley), Vehicular emissions: greenhouse gases (2002). *Regulate greenhouse gas emissions from cars and light trucks, incentivizing earlier actions through the California Climate Action Registry.*
- Executive Order S-3-05 establishing greenhouse gas emissions reductions targets.
- S-20-04, State building energy conservation. *Requires reductions in electricity purchases for state-owned buildings.*
- SB 1771 (Sher), Greenhouse gas emission reductions: climate change (2000). *Establishes the California Climate Action Registry as a nonprofit that records and registers voluntary emissions reductions*
- AB 1440 (Sher), Statewide emissions inventory and climate study (1988). *Directed CEC to assess global warming impacts on California's energy supply and demand, economy, environment, agriculture, and water supplies; to recommend measures for avoiding, reducing, and addressing impacts; and to develop a statewide GHG inventory.*

Research Themes

- *Built Environment*: A large portion of the State's energy consumption is associated with the built environment, for example, electricity and natural gas usage in buildings as well as transportation patterns incurred by land-use decisions. Forward-thinking research investigating this sector will help ARB lighten the energy demand and the carbon footprint of California's built environment, where decisions made today will impact emissions for decades to come.
- *Voluntary Emissions Reductions Strategies*: As articulated in the AB 32 Scoping Plan, the State's success in meeting its climate goals will depend in part on voluntary emissions reductions. Identification and characterization of potential GHG emission reduction strategies will help provide Californians with the resources they need to reduce their GHG emissions through cost-effective and substantive voluntary efforts.

<u>Recommended for Funding</u>

Built Environment

Developing databases to estimate California-specific climate forcing benefits of cool roofs

<u>Problem</u>: Solar-reflective cool roofs decrease air conditioning load, thereby saving electricity and reducing CO_2 emissions. By reflecting sunlight back into space, cool roofs can have an additional cooling effect. However, limited information on the spatial resolution of albedo and lack of site-specific urban attributes limit our ability to assess the benefits of widespread deployment of cool roofs and pavements and the extent to which roofs and pavements can be made more reflective.

<u>Objectives</u>: To support an accurate assessment of the climate benefits of cool roofs and cool pavements in California, this research will provide a database of spatially resolved urban attributes coupled to satellite data portraying irradiance and albedo. Results from this effort will support quantification of climate impacts of cool surfaces as well as life cycle cost analyses used to guide California building energy efficiency standards (Title 24) as well as criteria used by the California Department of Transportation, county, and local municipalities to select paving materials.

Proposed funding level: $250,000

The role of land use planning in reducing residential energy consumption and GHG emissions
Problem: Approximately 20% of California's household GHG emissions are related to heating and cooling needs, which are partly a function of house size and orientation, and are therefore strongly tied to land use planning decisions. The few academic studies that have examined residential energy use as a function of urban form indicate that residents living in high density urban centers emit 20 to 50 percent fewer greenhouse gases from heating and electricity usage than residents of low density suburbs. However, these studies have relied upon data sets created by national energy agencies, rather than more disaggregated state- or local-scale data that more accurately reflects local climatic conditions in California.
Objective: This research will: 1) investigate the relationship between land use planning factors and residential energy use in California's various climate zones, while controlling for other factors; and 2) develop a spreadsheet modeling tool that analyzes residential energy use within California climate zones as a function of land use planning factors. Findings will directly support achievement of AB 32's Green Building Strategy as well as complement an existing ARB-funded project to delineate the relationship of land use planning variables to vehicle miles traveled (VMT) and transportation energy consumption, ultimately supporting a variety of local and regional planning processes.
Proposed funding level: $100,000

Development and evaluation of energy-efficient approaches to keeping building occupants cool using room air motion
Problem: A significant portion of California's residential and commercial energy demand is devoted to keeping building occupants comfortable in warmer areas of the state, and the demand for thermal comfort will increase as climate change gains momentum. Moving air through low-power fans or using natural ventilation are strategies for achieving thermal comfort without increasing compressor-based cooling. Former heating and air conditioning standards, which were changed based on findings that large majorities of office occupants prefer increased air movement, discouraged exploration of these cost-saving strategies that address the need to adapt to, as well as mitigate, climate change.
Objective: The project will enable strategies to reduce compressor-based cooling in office buildings through the use of fan-powered air movement by: 1) testing combinations of nozzles and propeller fans mounted on or in office furniture, partitions, and ceiling panels; 2) characterizing the physiological cooling effect for these combinations and quantifying how much the ambient indoor temperature range can be expanded; 3) testing human subjects to quantify their comfort and satisfaction under long-term and short-term transient exposures; and 4) preparing a report for designers, owners, and manufacturers of interiors and furniture systems.
Proposed funding level: $150,000

Using feedback from commercial buildings to support energy-conserving behavior at work and at home
Problem: In 2006, energy use in California's residential buildings resulted in 34 million metric tons (MMT) of greenhouse gas emissions, while energy use in commercial buildings resulted in 14 MMT of GHG emissions. Occupant behavior is an important determinant of energy use, but little information is available to help the State leverage

occupant behavior for GHG reductions in the commercial realm. This research will look at a single method involving feedback to reduce both residential and commercial GHG emissions.
Objective: The project will foster reduced energy consumption in the building sector by: 1) identifying the kinds of energy conservation-related information most likely to influence different segments of the workforce; 2) quantifying the degree to which this information affects energy-conserving beliefs and behaviors at work and at home; and 3) quantifying the GHG reduction potential associated with the stated behaviors. Deliverables include a tool to support reduced energy use and GHG emissions mitigation in the commercial building sector.
Proposed funding level: $185,000

Voluntary Emissions Reductions

Reducing energy use through optimized communication of real-time residential energy usage information

Problem: Although recent studies estimate that behavioral changes can reduce residential energy consumption in California by between 22 and 30 percent over the next 5 to 8 years, it remains unclear how consumers respond to different presentations of information intended to prompt them to voluntarily reduce their electricity consumption. Most previous studies involve small samples of homes in Europe; some studies have even shown that providing consumers with more information results in an increase in electricity usage.
Objective: This project will investigate how to encourage energy conservation through strategic presentation of electricity usage information to residential consumers. Several interventions based on increased feedback (information) to customers will be investigated to explore the roles of private and public information, social norms, social status effects, and existing preconceptions about electricity usage. This research is particularly timely, as a number of California's utilities are installing Smart Grid systems with possible real time consumer feedback.
Proposed funding level: $330,000

Monitoring and evaluating behavioral change strategies that incorporate the CoolCalifornia.org resource developed by ARB

Problem: Social psychologists suggest that information alone does not suffice to prompt behavioral change. Rather, it is critical to tailor messages to appeal to the values, habits, abilities, worldviews, and social and economic constraints of target audiences; and to leverage social motivations for behavioral change. For example, encouraging individuals to make public commitments, fostering group identification and developing competitions have all been shown to be effective strategies to enable behavioral change.
Objective: This investigation will provide the State with empirical evidence from a California-based study to help identify ways to encourage the public to adopt climate-friendly behaviors. Specifically, this work will: 1) assess total greenhouse gas emissions reduced via the CoolCalifornia and CoolClimate projects; 2) illuminate how new information tools can be most effectively used by the State to encourage more sustainable behavior; and 3) compare the behavioral changes induced by different community-based greenhouse gas reduction programs in California.
Proposed funding level: $300,000

Economic Analysis

Direction of Proposed Research
Economic impact assessments of air pollution control on California business enterprises and individuals are a key component of ARB's decision-making process, which seeks cost-effective regulatory and non-regulatory measures to attain its goals and protect public health. A number of modeling tools have been developed for economic analysis on statewide climate change and air pollution control policies. Continued evolution of economic modeling and assessment tools will help illuminate bottom-line costs associated with the abatement of air pollution, the ability of small and large firms to pay those costs as well as any penalties that might be involved in noncompliance, and the most cost-effective strategies for simultaneously achieving environmental goals and protecting California's economy.

During FY 2010-2011, ARB will invite an economics fellow to help advance the State's capacity to model impacts of air quality regulations on California's economy and welfare. In collaboration with expert economics modelers and economists familiar with California's regulatory landscape, the fellow will delineate critical research gaps and priorities that need to be addressed to advance our ability to forecast near- and long-term impacts of environmental regulatory and non-regulatory strategies on California's economy. Based on the outcome of this collaboration, ARB will solicit research proposals to address the most critical research gaps.
Research funding allocation: $480,000

Policy Drivers
- California's Global Warming Solutions Act of 2006 (AB 32)
- AB 32 Scoping Plan
- Early Action regulatory measures
- EO S-3-05 establishing GHG reduction targets for 2020 and 2050
- Diesel Risk Reduction Plan
- Toxic and criteria pollutant reductions

Research Themes
- *Forecasting Models.* Evaluate economic forecasting models and methods that can help establish business-as-usual future baselines and corresponding GHG, toxic, and criteria pollutant emission levels.
- *Macroeconomic Impacts.* Identify and characterize macroeconomic impacts on multiple industries and sectors within California.
- *Assessment of Long-term Economic Impacts.* Assist in evaluating GHG economic impacts in California using new modeling techniques beyond the 2020 timeframe.

Technology Research and Development

Context

ARB's technology-forcing regulations, particularly those related to tailpipe and crankcase emissions from motor vehicles, have resulted in innovative technology development, and ARB continues to fund research to investigate and promote the understanding, advancement, development, and improvement of technology-based solutions for achieving zero or near-zero emissions from all manmade sources of air pollution in California. ARB also supports research to improve air pollutant and/or greenhouse gas monitoring and emission measurements. These research activities are designed to support regulatory strategies that reduce source-specific emissions as a means of mitigating exposures to air pollution, particularly among sensitive groups or communities that may bear a disproportionate share of air pollution exposure.

Policy Drivers

- Mobile source control
- Mobile source emissions monitoring

Research Themes

- *Small Off-Road Engines:* Development and dissemination of zero-emission small (less than 25 hp) off-road equipment will help the State reduce emissions from such applications as landscape maintenance, which accounts for significant criteria pollutant as well as GHG emissions.
- *Improved Monitoring Tools*: Enhance. ARB's ability to cost-effectively monitor ambient concentrations of and exposures to health-damaging air pollutants.

Recommended for Funding

Small Off-Road Engines

Zero on-site pollution for portable power applications including generators and lawnmowers

Problem: The vast majority of California's professional landscapers use exclusively gasoline fueled lawnmowers, which are a significant source of pollution and exposures. Even the most advanced battery technology is not capable of providing a reasonable solution for professional landscape crews and the bulk of small gasoline engine users. Small gasoline engines are a strong contender for early fuel cell adoption as they are highly polluting, have poor energy efficiency, and may potentially be serviced with existing distribution channels.

Objective: The proposed research will research the necessary components and control systems to support a sodium silicide fueled lawnmower. A prototype will be developed to look and feel like a professional product, suitable to serve as the template for larger-scale production. Research will focus on successful reaction control, thermal management, and fuel cell systems integration.

Proposed funding level: $376,000

Recommended if Additional Funds Available

Improved Monitoring Tools

An improved particle concentrator for inhalation studies

Problem: Numerous epidemiological studies associate high particle concentration with a range of pulmonary, cardiovascular and systemic health effects, yet toxicological support for these findings requires further animal studies. Exposing laboratory animals to concentrated ambient particles to elicit health effects requires a particle concentrator, but currently available concentrators are insufficiently steady with time and overly sensitive to ambient temperature, relative humidity, and particle concentration.

Objective: The objective is to develop a particle concentrator that, in terms of its concentration factor, is nearly insensitive to ambient conditions and can operate for long periods of time with minimal or no attendance. This reliable, stable particle concentrator will enable improved particle toxicity studies to support establishment of PM standards.

Proposed funding level: $150,000

APPENDIX A: Concepts Recommended for Health Effects and Exposure

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TITLE: Season- and location-specific systemic health effects of ambient particulate matter

PROBLEM: A diverse and increasingly sophisticated body of epidemiologic evidence associates environmental particulate matter (PM) with both asthma and cardiovascular morbidity and mortality in exposed populations. Most studies focus on the source of urban particles rather than regional differences in particle composition and their potential pulmonary or systemic health effects. Plausible biologic associations between PM exposure and systemic cardiovascular effects remain unclear. An ongoing problem for regulatory agencies is determining what source or component(s) of particulate matter is responsible for health effects. California's San Joaquin Valley is a unique geographic location with high particulate matter burdens that combine both urban, traffic corridor, and agricultural sources. While regulatory action levels for PM are currently based on mass concentrations, there is interest at both the State and federal level regarding the relative toxicity of PM from different sources. The information obtained from this project should help elucidate the relative contribution of particles of different composition in the health effects associated with PM exposure.

PREVIOUS WORK: Ongoing ARB funded work by the investigators demonstrates that platelet activation is a sensitive marker in mice exposed to concentrated ambient PM in the San Joaquin Valley. They found a seasonal effect on systemic cytokines, as winter rural Concentrated Ambient Air Particular Matter (CAPs) exposures result in significantly greater systemic pro-inflammatory responses. Laser capture mRNA analysis of pulmonary airways, blood vessels, and parenchyma demonstrates that there are no changes in expression in any of those tissues in summer urban CAPs exposures, yet winter urban CAPs exposures show clear patterns of mRNA upregulation, indicative of a general increase in xenobiotic metabolism as well as a pro-inflammatory and pro-coagulant response. These data, in combination with in vitro laboratory studies suggest that PM inhalation activates monocytes and platelets in the pulmonary microvasculature, laying the foundation for a systemic cardiovascular response. Theories advanced to explain the mechanism of particle-induced disease emphasize ROS generation catalyzed by transition metals, yet research by these investigators and others suggests that bacterial derived endotoxin may also drive inflammatory responses. The investigators' in vitro data shows that selective portions of these responses can be abrogated by endotoxin binding, antioxidant supplementation, metal chelation, or inhibition of the PAH induced Aryl Hydrocarbon Response Element (ARE). Responses differ based on location; rural site responses appear more endotoxin driven while urban responses are uniquely inhibited by pretreatment with transition metal chelators. Finally, they have demonstrated that intratracheal instillation of collected ambient particles to mice results in a systemic platelet activation response similar to that characterized in field exposures.

OBJECTIVE: The following hypothesis will be tested: Regional and seasonal differences in composition of environmental particulate matter from the San Joaquin Valley influence the nature and extent of systemic pro-inflammatory and pro-coagulant responses.

Specific Aim 1: Compare the influence of location-specific ambient particle composition on pro-inflammatory cytokine secretion patterns and platelet activation in mice given intratracheal instillations of collected particles.
Specific Aim 2: Determine the relative contributions of transition metal related ROS generation, PAH compounds and endotoxin on the generation of systemic pro-coagulant and inflammatory responses in mice given intra-tracheal instillations of collected particles.

DISCUSSION: The investigators propose to compare in vivo responses of mice to site and season specific samples in context of their elemental and organic chemical analysis. They will use intra-tracheal instillations of PM to compare airway, pulmonary vascular and alveolar expression of genes associated with endothelial, platelet and monocyte activation, expression of proinflammatory cytokines and pro-coagulant molecules in the systemic circulation and systemic platelet activation.
Approach: Each experiment will compare 6 mice given intratracheal instillations of collected ambient PM at a total dose equal to the calculated cumulative dose in a representative 2 week CAPs exposure. Previous studies have shown that groups of 6 mice are sufficient to detect significant differences between group responses. Control mice receive saline extracts from clean collection filters. Endpoints to be evaluated are 1) gene expression of Reactive Organic Species (ROS), PAH and inflammatory response elements in airways, vessels and parenchyma, 2) Expression of a panel of 36 inflammatory mediators in the lung and plasma, and 3) Markers of platelet activation including the presence of microaggregates, microvesicle formation, alterations in integrin expression, and secretion of alpha and lysosomal granule components. Plasma fibrininogen levels, an acute phase protein and pro-coagulant protein will also be determined.

From the results of studies comparing summer and winter PM collected from urban and rural Fresno, the investigators propose to select two samples, based on the most divergent composition and inflammatory responses, to evaluate the relative contribution of particle components to systemic responses. They will pre-incubate PM with the endotoxin binding antibiotic polymixin B or the metal chelator desferoxamine maleate to determine the relative biologic importance of each in induction of inflammatory responses. To evaluate the relative importance of PAH components, they will compare responses to whole PM with responses to PM previously extracted with hexane.

Results of animal studies will be correlated with summary compositional analysis data. They will use a multiple regression approach to develop correlation coefficients for the percentage change in each biologic endpoint with the percentage of elemental carbon, percentage of organic carbon, mass concentration of transition metals and mass concentration of PAH in samples from each source.

BENEFITS: Regulation of environmental PM is currently based on size and mass. Stronger support for source-apportioned regulation depends on correlating source specific composition with health effects. While not directly apportioning composition to sources, this project will correlate composition, season, and location with biologic markers relevant to cardiovascular disease. Results will provide a biological link between epidemiologic studies and a principal health outcome of PM exposure. It is entirely possible that rural source PM acts through different mechanisms than PM from urban sources. If true, this would have great significance for regulatory and health monitoring activities.

CO-FUNDING: This project would be a logical extension of the investigators' currently funded work. It is only possible because they have a well-characterized collection of season and location specific ambient particles from the San Joaquin Valley (in collaboration with the Kleeman Lab) and have previously established that their results with intra-tracheal instillations recapitulate those with CAPs exposures. This project will complement human exposure and CAPs exposures proposed in the SAHRC EPA program renewal.

COST: $266,298

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TITLE: Biological activity associated with near-freeway particles and gases

PROBLEM: Epidemiological studies have shown associations between residential exposure to near roadway air pollutants and mortality and exacerbation of diseases, including wheeze and asthma, reduced lung function, and chronic obstructive pulmonary disease. A large number of in vitro and animal studies have shown that diesel and ambient particulate matter have pro-oxidant activity relevant to the pathogenesis of these conditions. In addition, the pattern of near roadway exposures to ultrafine particulate matter and other traffic-related pollutants has been shown to correspond to the near-roadway residential distance gradient in the prevalence of asthma in southern California.[1-4] It is therefore surprising that there has been no previous study examining biologically-relevant activity associated with long-term collections of ambient air at multiple locations in the impact zone downwind of major roadways. Such roadway gradient studies would provide an opportunity to elucidate the biologic mechanisms causing the health effects and to identify the components of ambient traffic-related pollution potentially responsible for these effects.

The investigators propose to examine the spatial gradient in the biological activity of chronic exposure to particle and vapor phase pollutants relevant to asthma pathogenesis upwind and downwind from a major truck and automobile corridor in Los Angeles, and to correlate these findings to relevant composition of the aerosol. Pro-oxidant, electrophilic, inflammatory, and allergic properties of particles and/or vapors will be measured in vitro, using standard and novel assays. In addition, they will examine adaptive (protective) cellular responses. Relevant size-distributed chemical composition and vapors will also be measured.

PREVIOUS WORK: The University of Southern California (USC) and the University of California, Los Angeles (UCLA) investigators have recently adapted instrumentation to collect size-resolved PM (coarse, fine, quasi-ultrafine) at low flow rates to allow multiple 2-week integrated samples that can be composited to estimate seasonal average exposures. They have also adapted standard assays for measuring pro-oxidant, inflammatory, electrophilic and allergic properties in these particles. In addition, they have developed assays to evaluate a common susceptibility (present in 40 percent of the population) associated with knocking down the protective enzyme GSTM1 using small inhibitory RNA.

In previous studies of Los Angeles Basin air samples, the investigators demonstrated that vapor-phase pollutants are responsible for most of the electrophilic activity (which inactivated proteins by forming irreversible covalent bonds) while the particle phase that exhibits far greater redox activity.[5] Therefore, both gas and particle phase pollutants need to be collected to evaluate the full complement of health impacts of air pollution. Furthermore, electrophiles in the vapors have been shown to activate the Nrf2-based antioxidant response element to increase expression of protective downstream proteins.[6] Concurrently, an inflammatory response, mediated by the MAP kinase pathway, occurs at comparable exposure concentrations. Thus, the investigators' results show that both vapor and particulate phase pollutants play important roles in the health effects of air pollutants and that protective effects at ambient levels may be offsetting some or sometimes all of the inflammatory and oxidative stress reactions.

Therefore, the ratio of adaptive-to-inflammatory responses to a given concentration of pollutants may determine the extent of adverse health effects.

OBJECTIVE: The study's objective is to evaluate the seasonal and spatial variation in pollutants and in ambient air biological activity upwind and at 5 locations downwind from the I-5 freeway. Investigators will examine the distance decay in PM0.2, PM2.5 and PM10-2.5 mass and composition, including model pro-oxidant and electrophilic species, which they expect will vary in the vapor and particle phase and by particle size and composition. They also will examine the role of chemical composition in determining the pro-oxidant, electrophilic, allergic, and inflammatory activity of ambient aerosols. Spatial variation in the protective antioxidant responses is unknown, but they hypothesize that vapor electrophilic activity will induce greater protective antioxidant response. They also hypothesize that reduction in cellular GSTM1 activity will result in greater oxidative stress.

DISCUSSION: PM will be collected at logarithmically-spaced distances downwind from the freeway for two, two-week periods (a total of four weeks in the summer and four in the winter) and will be composited by season. PM mass in each size fraction will be determined gravimetrically. Metals, elemental carbon and organic carbon (as described above) in each PM size cut will be measured using standard methods.

The concentration of pro-oxidants and electrophiles in each sample will be determined by the dithiothreitol (DTT)-based redox assay and the glyceraldehyde-3-phosphate dehydrogenase (GAPDH) assay, respectively. The actions of the samples on the inflammatory and adaptive transcription factors will be determined in a mouse macrophage cell line (Raw 246.7) using immunoblot procedures to estimate levels of AP-1, NFkappaB and Nrf2 following exposure.

Pro-inflammatory effects will be assessed by measuring cytokine response (IL-8 ;GM-CSF;IL-1β) and phase II enzyme expression (GSTM1, GSTP1, HO-1 and NQO1) in primary human airway epithelial cells that are GSTM1 positive. These assays will be repeated after inhibiting GSTM1 with siRNA. TNFα; IL-6; MIP-2; and nitric oxide response will be measured in mouse alveolar macrophage cell line MH-S, because it is not possible to obtain sufficient cells from humans. Allergic effects will be assessed by measurement of IgE release in human peripheral blood mononuclear cells and of hexosaminidase in the rat basophil cell line RBL-SX38.

Correlations of freeway distance, particle and vapor composition with various biological activity indicators will be examined. Metals will be grouped based on their source specificity, e.g., Cu, Sb in coarse and fine particulate suggestive of brake wear. The relationship of pro-oxidant and electrophilic species with inflammatory and allergic responses and with assays of oxidative stress will be examined. The relationship of electrophilic species to adaptive response and the modulating effect of these responses on harmful responses will also be assessed.

BENEFITS: This project is an opportunity to develop and test a new approach for studying near roadway air pollution effects, to examine mechanisms of the health effects of traffic emissions, and to identify the components of traffic-related pollutants potentially responsible for these effects. Demonstrable gradients that the investigators hypothesize will exist would provide strong biological plausibility to the epidemiological findings and reduce the uncertainty both in the causal relationship and in the spatial pattern of risk. Together, these findings could provide important information to guide the development of better regulatory and public health policy. Scientific uncertainty to the causal relationship expressed in a recent influential review of the literature[7] is a limitation to development of policy, such as the California requirement that schools be located 500 feet from freeways. Greater precision of the gradient of biological effects would help develop more precise buffers. These methods also offer possible alternative approaches to exposure assessment in population studies of chronic health effects of air pollution.

CO-FUNDING: USC and UCLA own all equipment necessary to perform this study. Co-funding with the SCAQMD and NIH will be pursued.

COST: $300,000 (*original concept requested $453,000*)

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TITLE: Risk of pediatric asthma morbidity from multipollutant exposures

PROBLEM: Asthma morbidity (including hospital admissions) has been associated with daily concentrations of ambient air pollution (PM2.5 and Ozone in particular)[1] and with traffic-related air pollutants near the home.[2] However, there is a lack of data on the importance of local exposure to traffic-related ultrafine particles (UFP, <0.1 µm) and its relationship to regional exposure to PM2.5 and Ozone organic components. In particular, little is known about the health effects of two important classes of particles in California, namely:

1) Primary organic aerosols (POA) directly emitted from combustion sources; and
2) Secondary organic aerosols (SOA), which are largely photochemically-produced.

These particle types have different spatial and temporal variability and they are thus minimally correlated in California.[3,4] The organic component mix and size distribution differs as well, with POA being the predominant mass fraction in near-roadway UFP and SOA comprising a large part of accumulation mode particles (0.1-2.5 µm). Furthermore, POA components are more hydrophobic, and SOA components are more hydrophilic. These characteristics will likely determine their toxicity and differential effects in the airways. Furthermore, unregulated UFP may be more toxic than other size fractions because of number concentrations and surface area are magnitudes higher than larger particles, which dominate PM mass. Finally, studies reporting associations of ambient PM2.5 mass with asthma outcomes have been important to the regulatory protection of susceptible populations of children, but effect magnitudes may have been underestimated or obscured since a large fraction of the PM mass is biologically inactive while a variable and often small fraction has the potential to induce oxidative stress and inflammation.[5]

PREVIOUS WORK: Dr. Delfino and colleagues recently reported positive associations of recurrent episodes of asthma requiring hospital care with chronic exposure to traffic-related air pollution exposures (NO_X and CO) near 2,768 subject residences in Orange County.[2] Exposures were estimated with CALINE4 dispersion models. Associations were stronger for females and infants but not significantly. The investigators concluded that traffic-related air pollution adversely affects asthma severity.

The proposed study greatly advances this previous research by: 1) assessing acute exposure-response relationships for each hospital encounter; 2) adding estimated residential exposure to POA, SOA and UFP; and 3) nearly tripling the sample size. The proposed study will leverage co-funded efforts to predict size-resolved PM exposures with high temporal-spatial resolution, and to establish a dataset of subjects with addresses linked to all asthma hospital encounters (>10,000 emergency department visits and hospital admissions).

In another study,[6] Dr. Delfino and colleagues followed 60 elderly subjects with weekly repeated measures of airway inflammation estimated from the fractional concentration of nitric oxide (NO) in exhaled air. Particulate air pollutants were measured daily in the outdoor home environment of the subjects' retirement communities. The investigators collected PM<0.25 µm (PM0.25), made aqueous extracts of the PM0.25 filters, and assayed extracts for chemical tracers of POA and SOA. They also estimated primary and secondary organic carbon fractions of PM2.5.[7] Exhaled NO was positively associated with SOA markers and Ozone but not with POA markers. Data in a larger sample of subjects with asthma (proposed here) are needed to fully address the relative importance of POA and SOA to respiratory health.

OBJECTIVE: The investigators will use PM predictions generated by regional air quality models (Michael Kleeman, UC Davis) to study the relation of asthma morbidity in over 7,500 children to exposure to POA and SOA. They will evaluate whether variations in this important characteristic of PM2.5 affects the relation of PM2.5 mass concentrations to asthma morbidity (emergency department visits and hospital admissions). The investigators hypothesize that traffic-related number concentrations of UFP near subject homes and related estimates of exposure to POA will show associations with asthma morbidity that are additive with estimates of exposure to SOA and Ozone. This addresses the multipollutant nature of human exposure, which includes both ambient and microenvironmental particle and gas components. Finally, they will evaluate air pollution susceptibility, including asthma recurrence and socioeconomic status.

DISCUSSION:

Task 1. *Estimate exposures for children with asthma to primary and secondary organic aerosols.*

The UCD/CIT Source-Oriented Chemical Transport Model (Kleeman) will be modified to output daily POA and SOA at 5x5 km resolution from 2000-2008 for 7,500 children in North Orange County. The POA and SOA model output will include size-resolved mass, speciation, and source apportionment. SOA and POA model estimations will be validated using particle composition data from the study of 60 elderly subjects (discussed above).

Task 2. *Assess the risk of emergency department visits and hospital admissions for asthma in children from exposure to both traffic-related particles near their homes and local ambient primary and secondary organic aerosols and Ozone.*

The new POA-SOA exposure data from Task 1 will be combined with traffic-related air pollutant exposures (ultrafine PM, PM2.5, NO_2, NO_x, and CO) and Ozone near geocoded subject residences that will have been estimated under separate funding.

Task 3. *Stratify subjects based on recurrence of hospital encounters in order to assess whether children with multiple encounters show the strongest associations with air pollutants.*

Task 4. *Assess effect modification of associations by subject demographic and socioeconomic characteristics.*

The study will evaluate associations using a case-crossover design and conditional logistic regression.[8] Each person acts as their own control. The investigators will test regression estimates for lag 0-6 exposure days, and weekly cumulative averages.

The strength of this design is that it generates a complete PM dataset (resolved by space, time, speciation, and source apportionment), it involves individual-level data rather than aggregate administrative data normally employed in time series studies, and it enables assessments of the risk of hospital utilization from both spatial and temporal differences in air pollutant exposures, which has only once been evaluated in a case-crossover study of asthma and air pollution (in France).[9]

BENEFITS: Because asthma requiring medical care at a hospital represents a diagnosed severe exacerbation of asthma, the findings of this study will have implications regarding important clinical and economic impacts of air pollution. Subjects will also be stratified based on recurrence of hospital encounters to asses whether the most severely affected children show the strongest associations with air pollutants. In addition, one of the most pervasive determinants of air pollution exposure by children living in California is residence near freeways and major surface streets. Children in low income communities may be more likely to live near high density traffic.[10] Therefore, results regarding differences between socioeconomic groups in this study are of particular importance.

Finally, findings using $PM_{2.5}$ organic fractions and UFP could have importance to the Federal and State regulation of particles based on total $PM_{2.5}$ mass concentration. This is because the mass fraction of toxic components with oxidative or pro-inflammatory potential may be small and highly variable. Of particular benefit is the ability of this study to compare modeled air pollutant exposures that are spatially variable at the residential level (UFP and POA) to estimates of exposures such as SOA and O_3 representing more homogenous background air pollutants.

COST: $285,000

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TITLE: Investigation of persistent immune effects of acute PM exposure during early life and development of a biomarker for lung function decline

PROBLEM: Epidemiologic studies support a link between air pollutant exposures during early life and development of lung function decrements.[1-4] Although these findings provide important correlative data in human subjects, the biologic mechanisms for these effects are not understood. Evaluation of children is restricted due to limitations in experimental assessment and methodology. As with adults, it is clear that inflammation is a consistent effect of air pollutant exposure in children.[5] Yet, early life exposures in children are distinguished by the establishment of a persistent effect on lung function that is retained at maturity. It has been speculated that the contemporaneous maturation of lung and immune systems during infancy provides a critical window of susceptibility for epigenetic changes.

Immunological markers of environmental challenge have been evaluated in children (reviewed in Duramad et al[6]), but there are few valid biomarkers for air pollution exposure. There is currently no data available on the impact of air pollutant exposures on the functional status of immunity in infants and school-age children. Importantly, there are no early life biomarkers (immune or otherwise) that are predictive of lung function decrements at maturity. To address this problem, the investigators propose to study the impact of air pollutant exposure on immune and lung function by evaluating a cohort of rhesus monkeys that were born and raised in an outdoor environment at the California National Primate Research Center during the spring of 2008, just prior to significant PM exposure from the Trinity and Humboldt County wildfires in July 2008.

PREVIOUS WORK: To determine if early life exposure to air pollution has a persistent effect on the immune system, the investigators, affiliated with the University of California, Davis (UCD), have recently completed studies using the rhesus monkey as an animal model of childhood development. They hypothesized that the functional status of the immune system could be measured by challenge with ligands for toll-like receptors. In brief, toll-like receptors are a family of ten (TLR1-10) constitutively expressed immune receptors that serve as critical mediators of inflammation in response to a variety of pathogens. To test this hypothesis, monkeys were exposed to cyclic ozone (1 cycle = 9 days filtered air + 5 days 8 hrs/d 0.5 ppm ozone) starting at 30 days of age for 5 cycles or 11 cycles, followed by filtered air housing. At one year of age, immune function status was evaluated by (a) in vivo challenge with lipopolysaccharide, a TLR4 ligand and (b) in vitro challenge of peripheral blood cells with lipopolysaccharide, poly I:C, or flagellin, which are ligands for TLR4, TLR3, and TLR5, respectively. Following inhalation of lipopolysaccharide, animals that had a history of ozone exposure generated a reduced airways inflammatory response relative to control animals. Similarly, peripheral blood from ozone-exposed animals exhibited a reduced response to toll-like receptor ligand stimulation. These data show that early life exposure can persistently modulate the immune system, such that the immediate response to pathogens is attenuated. This proposal will expand on this previous work by investigating ambient exposure with an emphasis on peripheral blood analysis and lung function measurements.

OBJECTIVE: The objective of this proposal is to assess the early life impact of wildfire PM exposure on immune and lung function parameters, and to develop an immune biomarker of lung function decline. To complete this objective, the investigators will evaluate a cohort of rhesus monkeys that were born in an outdoor environment within three months prior to the summer wildfires of July 2008 in northern California. The rationale for this approach is that the immune system and lung architecture of the rhesus monkey is most similar to that of humans, as compared with other animal models. As such, these animals serve as excellent biological sentinels for the health effects of Sacramento and Yolo county air pollution. Importantly, this approach can be translated into larger human population studies to determine the impact of this exposure in school-age children.

DISCUSSION: In the research proposed here, the investigators will evaluate a cohort of rhesus monkeys that were born within three months prior to the July 2008 Trinity and Humboldt County fires (n=40). Because these animals were housed in an outdoor colony, they were also exposed to ambient ozone. As such, the study will also evaluate age-matched monkeys were born in the outdoor colony in the subsequent year (2009), as a control group (n=40). The investigators will collect peripheral blood samples from animals and culture with the following toll-like receptor ligands in a dose dependent fashion:

1. Lipopolysaccharide (LPS)-a cell wall component of gram negative bacteria
2. Poly I:C - a mimic for RNA viruses (i.e. respiratory syncitial virus)
3. Flagellin- a component of flagellated bacteria (i.e. Pseudomonas)

Output parameters for these cultures is measurement of interleukin-8 and interleukin-6 protein secretion by standard ELISA methods. If the functional status of the immune system is affected by PM 2.5 exposure, it is expected that animals born in 2008 will have a significant reduction in the ability to respond to toll-like receptor ligand stimulation, relative to animals born in 2009. Because an ARB air sampling site is located within two miles of the California Primate Research Center that houses the cohort of rhesus monkeys, the investigators will also be able to correlate exposure level with immune response.

In addition to measurement of peripheral blood immune responses, the investigators will also complete lung function measures for each animal enrolled in the study. Physiologic measures will include tidal volume, forced expiratory volume, and airways hyperresponsiveness to a non-specific stimuli (methacholine). If a link exists between immune function and lung function, they would expect to observe a significant correlation between reduced responsiveness to toll-like receptor stimulation and lung function deficits.

Because an important goal of this study to assess a potential biomarker for the human population, it should be emphasized that these studies will not be terminal. Rather, investigators will use physiologic measures and samples that are minimally invasive to acquire. With additional funding support this offers the opportunity to periodically evaluate this cohort of exposed animals in a longitudinal fashion.

BENEFITS: Upon completion of the studies outlined in this proposal, investigators expect that these findings will provide valuable reference data for the health impacts of wildfire PM exposure during early life. Importantly, because of the minimally invasive nature of the study, this approach can be immediately translated into studies designed to investigate identical parameters in human subjects. Although the focus of this proposal is to obtain an immune biomarker for lung function decline, it should be emphasized that this is also indicative of immune system decline that could have important implications with regards to susceptibility to infectious disease.

CO-FUNDING: A subgroup of the animals proposed for this study (n=24) are currently enrolled in NHLBI R21HL089148 "Temperament as a Risk Factor in a Monkey Model of Asthma Susceptibility" (John Capitanio, P.I.), which is a minimally-invasive, non-terminal project that will investigate the link between behavior and lung function. The UCD investigators will be able to utilize the lung function data collected from Dr. Capitanio's study in conjunction with evaluation of peripheral blood samples, thereby providing a substantial savings in time and resources.

COST: $268,141

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TITLE: Evaluation of secondary pollutant emissions from portable "air cleaners"

PROBLEM: In a recent survey, 14 percent of California households reported ownership or use of portable air cleaner during the past five years[1]. A majority of portable air cleaners are electrostatic precipitators (ESPs), ionizers and ozone generators (OGs), all of which may negatively impact indoor air quality (IAQ) through emissions of ozone (O_3).[2,3] Hence, nearly one million Californians may be exposed to potentially harmful pollutants emitted by poorly engineered air cleaning devices. Increasing public awareness of the deleterious effects of indoor ozone is likely driving consumers to seek alternative products available in a dynamic multi-million dollar market. Several new products combine new technology such as TiO_2 photocatalytic oxidation with established technologies in an integrated device. While ozone emissions remain a concern, formaldehyde and other partially oxidized VOCs may be generated as undesired byproducts of chemical processes taking place inside the air cleaner unit. These new integrated devices are capturing a growing market share, but research is needed to evaluate potential IAQ and public health impacts of these new generation devices.

PREVIOUS WORK: Characterization of ozone emissions by OGs, ESPs and ionizers has been carried out by ARB staff and other investigators[2-4]. Several other studies on portable air cleaners evaluated their effectiveness at removing aerosol particles[5-8], microbes[9] and VOCs[10, 11]. However, little attention has been paid to the generation of secondary organic pollutants formed during the operation of portable air cleaning devices. Recent work investigated the performance of a prototype in-duct whole-building photocatalytic oxidation (PCO) air cleaner through observations and quantification of the formation of volatile aldehydes and carboxylic acids as partial oxidation byproducts upon challenging the device with realistic indoor VOC mixtures,[12,13]. Those results, together with more recent bench-scale studies performed in the principal investigator's laboratory,[14] suggest that PCO air cleaners, when operated under certain conditions and in the absence of secondary treatment, may constitute a significant source of harmful byproducts such as formaldehyde. Similar results have also been described by other authors,[15, 16] further illustrating that the yield of secondary pollutants is highly dependent on experimental conditions, including the composition of the VOC mixture and the concentration of key constituents. In recent ARB-funded projects, the principal investigator's group has characterized secondary pollutants from ozone-initiated indoor chemistry[17, 18] and emissions from office electronic equipment under idle and active cycles,[19] gaining valuable insight on the key physical-chemical phenomena involved and the experimental and analytical tools required to perform the proposed study.

OBJECTIVE: The objective of this project is to evaluate the emission of indoor pollutants by devices commercialized as portable air cleaners in California, with emphasis on a new generation of equipment integrating several technologies that include PCO. Emissions will be determined in realistic indoor conditions, to assess the risks associated with exposure to those secondary pollutants.

DISCUSSION: Given the large number and diversity of portable air cleaners, ***Task 1*** will involve performing a survey of equipment and technologies available in California through chain-store retailers and online vendors. This initial screening will allow the investigators to identify devices with a likely significant presence in the state. A representative subset will be selected, in consultation with ARB staff, to perform this study. ***Task 2*** will involve the development of a test protocol for portable air cleaners. Devices will be operated inside a stainless steel, 20-m^3 chamber under a controlled atmosphere generated by continuous infusion of a challenge VOC mixture, at air exchanges typical of buildings (in the range 0.2 – 1.5 h^{-1}). Key parameters to be optimized include the composition of the chamber atmosphere and concentration of VOCs introduced in the chamber (which will include formaldehyde precursors such as alcohols and terpenes). Also, the study should be applicable to test equipment of different dimensions and different airflow throughput under comparable experimental conditions. ***Task 3*** will comprise the characterization of emissions of secondary pollutants by each of the air cleaners selected during Task 1, following the protocol developed under Task 2 for several air exchange conditions. This third task will be carried out with brand-new units, following manufacturers' operation procedures. In ***Task 4***, the air cleaners will be removed from the chamber and operated continuously in real indoor environments to age the test units. The investigators will also determine emissions in these real-world settings. Subsequently, ***Task 5*** will involve a repetition of the tests performed under Task 3 using the aged equipment, to evaluate possible changes of emissions of secondary pollutants. Finally, in ***Task 6*** the data obtained in Tasks 3-5 will be used to estimate the expected IAQ impact of each of the studied devices using a mass balance model.

BENEFITS: Ineffective portable air cleaners may lead to poor IAQ and associated adverse health effects for a significant number of Californians. The proposed research will help the State assist the public in making informed decisions when purchasing and using these devices. Information generated in this work would contribute to the broader effort that the ARB has been carrying out in this field over the past years.

CO-FUNDING: Over the past 3 years, the proposing investigators carried out the characterization of whole-building PCO systems in a DOE-funded project. In a related "seed" project, the proposing investigators developed tools to better understand the effects of key parameters in PCO efficacy and byproduct formation, as well as the performance of integrated air cleaner systems. These, together with other smaller PCO projects currently underway, provide synergistic support, experimental infrastructure and methods for the proposed research. This project will provide opportunities for UC students to carry out experimental work as part of their graduate research.

COST: $400,000 (*original submission requested ~$350k/year, for 3 years*)

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TITLE: Toxicity of fresh and aged semi-volatile and non-volatile PM

PROBLEM: Many Californians live in nonattainment areas for fine particulate matter (PM). In all of these areas, organic material contributes a large fraction of the fine PM. Motor vehicles are important sources of organic PM. Organic PM is comprised of primary organic aerosol (POA, particle mass directly emitted from sources such as motor vehicles) and secondary organic aerosol (SOA, particle mass formed in the atmosphere from oxidation of gas-phase precursors). Upon their release from their sources, particularly anthropogenic sources such as motor vehicles that are abundant in Southern California, the multi-pollutant mixtures of vehicular exhaust, consisting of PM, semivolatile and volatile vapors and gases, undergo atmospheric processing and their physical, chemical and toxicological properties also evolve with the changing ambient conditions. Field measurements indicate SOA dominance, even in heavily urbanized areas; for example, the recent SOAR-1 campaign estimated that around 75% of the organic PM in Riverside is SOA. Previous studies have examined the toxicity of the fresh primary PM emissions from motor vehicles; however, fresh emissions may only dominate exposure in near roadway environments. Little is known about the toxicity of aged vehicle emissions.

PREVIOUS WORK: Recent research has demonstrated the dynamic nature of organic aerosol emissions from motor vehicles. Within seconds of leaving the tailpipe, there are dramatic changes in gas-particle partitioning of semivolatile organic (SVOC) materials. For example, research from the Southern California Particle Center (SCPC) has shown that in close proximity to traffic sources (i.e. freeways and busy roadways), rapid cooling and mixing of hot exhaust emissions with the real world mixture of pollutants in the urban atmosphere, causes particle formation by nucleation and condensation onto pre-existing seed particles. This process forms the majority of PM in the exhaust as measured by particle number and, in newer vehicles, even by mass; further atmospheric dilution of the exhaust causes evaporation of these species from the particles. Upon entering the atmosphere these freshly emitted species are exposed to atmospheric oxidants (e.g. O_3, OH radicals, and NO_3 radicals), which chemically alter emissions creating substantial secondary organic aerosol. These changes transform aerosol mass and chemical composition, but more importantly, alter the toxicity of the emissions. Recent studies by Carnegie Mellon University have also suggested that gas-phase SVOCs participate in photochemical reactions that contribute to secondary organic aerosols (SOA) after further aging and oxidation.[1] Additionally, the SCPC has shown that in the time scales of atmospheric transport within the LA Basin, atmospheric metals undergo redox cycling and are likely to be important in changing the toxicity of PM during atmospheric aging.[2] A recent study from the University of Southern California (USC) showed that aged ultrafine particles in the Los Angeles basin display greater dithiothreitol (DTT) activity and increased levels of endogenous reactive oxygen species (ROS) as compared to freshly emitted ultrafine particles.[3]

OBJECTIVE: The objective of this project is to measure the toxicity of fresh and aged aerosol emissions from motor vehicles.

DISCUSSION: The proposed two-phase research study will investigate the toxicity of fresh and aged motor vehicle emissions. Phase 1 will investigate toxicity of fresh and aged emissions from individual vehicles operated over a standard test cycle on a chassis dynamometer. Phase 2 will investigate the toxicity of fresh and aged roadside emissions from a large vehicle fleet in field studies conducted in the vicinity of freeways in the Los Angeles area.

Task 1. The goal of this task will be to characterize the toxicity of fresh and aged emissions collected from individual vehicles. As part of an ongoing CARB/EPA/CRC supported project, Carnegie Mellon University will be quantifying the secondary organic aerosol production from vehicle exhaust. The experiments involve filling a smog chamber with exhaust from vehicles operated over standard test cycles using a chassis dynamometer. The emissions are then aged by exposing the chamber to either sunlight or artificial UV light. As part of the proposed project, Carnegie Mellon University will collect fresh and aged samples for toxicity analysis by USC. The research will characterize the toxicity of emissions from different classes of motor vehicle emissions (gasoline, diesel, smoker, low-emitter, etc).

Task 2. The goal of this task will be to characterize the toxicity of fresh and aged emissions from a large fleet of in-use vehicles at two roadway side sites. These sites will be in proximity of the CA-110 freeway, which is impacted almost 100% by light duty gasoline traffic, and the I-710, which has the highest ratio (up to 25%) of heavy-duty diesel vehicles in the Los Angeles highway network At each site the investigators will simultaneously collect fresh and aged emissions. Fresh emissions will be directly sampled. Aged emissions will be collected using an aerosol flow reactor that exposes the ambient aerosols to hydroxyl radicals. The integrated exposure will be equivalent to about one day of aging at typical atmospheric conditions. Particle collections will be conducted by means of state-of the–art techniques developed by the USC and Carnegie Mellon University groups. The collected PM samples will be used in a battery of in vitro tests, using assays developed by the SCPC such as DTT and ROS assays, which will determine their prooxidant and electrophile content and thus their overall redox activity.

BENEFITS: This project will provide important new knowledge and data for exposure and health effect assessments to fine particle mass. The linkage between the atmospheric evolution of fresh vehicular emissions, their physico-chemical characteristics, transformation, and resulting toxicity will be vital in the formulation of targeted regulatory efforts to reduce the human health impact of their emissions on human health. This research will therefore provide a strong scientific basis to develop cost-effective strategies to protect the public from toxic sources.

CO-FUNDING: This project will complement ongoing projects at SCPC, which are currently funded by U.S.EPA and ARB and will help evaluate toxicity using an array of in vitro assays. The SCPC studies characterize size distributions and composition of specific ambient particles related to specific sources in the laboratory. Substantial leveraging of costs will be realized with respect to site identification and access, provision of detailed chemical and physical analytical data, and direct comparisons to in vitro toxicology studies conducted through the SCPC. Also, the proposed study will be leveraged with an ongoing CARB/EPA/CRC supported project granted to Carnegie Mellon University to quantify SOA production from vehicle exhaust.

COST: $300,000 (*original submission requested $450,000*)

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TITLE: Traffic-related pollution, DNA methylation and asthma in children living near sea ports

PROBLEM: Asthma is the most common chronic disease among children in the United States affecting 1 in 12 children.[1] Asthma is a heterogeneous disease such that different asthma phenotypes have been defined based on disease severity, allergic predisposition, and response to treatment with anti-inflammatory medications. The disease disproportionately affects inner-city children from low socioeconomic background.[1] The economic burden of childhood asthma on healthcare is high with over $1000 spent annually for each child with asthma in 2004.[2]

Children with asthma are the most vulnerable population to changes in traffic-related pollution (TRP), as *in vitro*, animal and epidemiologic studies have provided strong support that TRP affects asthma occurrence and exacerbations.[3] However, problems with translating findings from *in vitro* and animal studies to humans and less than optimal characterization of asthma phenotypes in epidemiologic studies make it difficult to fully understand the biological mechanisms of air pollution effects in asthma.

Asthma has a strong genetic basis and genetic variants contribute to increase asthma susceptibility from exposures to TRP.[4, 5] A growing body of evidence also indicates that air pollution could affect DNA methylation[6, 7] and thereby can alter gene expression. Thus, a study among children with asthma that accounts for genetic variability within subjects provides an excellent opportunity to evaluate the impact of changes in TRP in Long Beach areas (near seaports) due to ARB's implementation of the Goods Movement Emission Reduction Program on asthma progression and epigenetic changes in key genes in the oxidative/ nitrosative stress.

PREVIOUS WORK: The Breathmobile program at the Los Angeles County+University of Southern California Medical Center provides regular asthma care in accordance with national standards. Each Breathmobile is a mobile clinic that is staffed by a four-member team of asthma care specialists. For the proposed project, the investigators, affiliated with the University of Southern California (USC), will utilize one Breathmobile that covers Long Beach. An electronic database routinely tracks sociodemographic information, clinical data on asthma phenotypes, and other relevant outcome measures (e.g., lung function, skin prick tests for allergy). The investigators found that residential proximity to freeways is associated with difficult-to-control asthma in children.[8]

For the southern California Children's Health Study (CHS), the investigators have already conducted intensive TRP assessment in Long Beach (a CHS community). In 2009, samplers were used to collect and characterize fine (PM2.5), quasi-ultrafine (PM0.2) and coarse (PM10-2.5) PM mass and components (e.g., elemental carbon, total organic carbon, metals) at 34 locations in Long Beach (homes, schools and central sites) over a 4-week period and in two seasons. These data will enable estimating baseline residential exposures to these TRP using GIS-based land-use regression models that accounts for traffic proximity, meteorology, local elevation, population density, and other land use categories. An active research group of statisticians at USC are involved in developing statistical methods to evaluate single pollutant effects in multi-pollutant exposure setting and in understanding the synergism of such pollutants.

OBJECTIVE: The three main objectives of the project are: (1) to characterize the spatiotemporal concentration patterns of traffic-related PM mass and components to record the changes in TRP in the study community; (2) to examine the effects of changes in TRP on asthma progression (symptoms, lung function growth) and gene-specific DNA methylation in buccal and blood samples in asthmatic children; and (3) to further test whether change in TRP results in differential gene-specific methylations in children with various asthma phenotypes (i.e., mild vs. persistent, allergic vs. non-allergic, well-controlled vs. difficult-to-control asthma). This novel approach will facilitate understanding of the TRP effects on asthma progression and provide new insights into the TRP-mediated epigenetic influences on asthma progression.

DISCUSSION: Using the Breathmobile that provides asthma care to children living in Long Beach, the investigators plan to enroll 3 to18-year-old children with asthma and routinely follow these children over a two-year period. They will collect both buccal and blood samples at each visit to determine global and promoter-specific methylation in these biological samples. Because gene expression due to tobacco smoke in buccal epithelium has been shown to reflect expression in airway epithelium[9], non-invasively collecting buccal epithelium for DNA methylation is reasonable.

Clinical data (e.g., body mass index, allergy test results, lung function, asthma symptoms, and anti-inflammatory medication use) will be routinely documented in Asma-Trax electronic database. The investigators will also collect additional information on each child's time-activity pattern, indoor home characteristics (exposures to tobacco smoke, pets, molds; level of parental stress) at each visit using a questionnaire. They will characterize the spatiotemporal concentration patterns of traffic-related PM mass and components to record the changes in residential TRP using a mobile monitoring platform in the second year of the study.[10] Data already collected as part of the CHS will provide baseline TRP exposures at homes. Pollen exposure data will available from another funded project.

For gene-specific methylation, they will use the Illumina HumanMethylation27 BeadChip assay, which provides high throughput, genome-wide, quantitative measurements of DNA methylation at 27,578 CpG dinucleotides spanning 14,495 genes. They will conduct methylation assays on 200 asthmatic children. The selection of subjects will be optimized to represent different clinical asthma phenotypes (allergy, severity, response to treatment). For each subject, samples collected at study entry and end will be used in methylation assays to determine changes in DNA methylation. Blood samples from a subset of children will be utilized to compare TRP effects on DNA methylation in different cells (buccal and blood cells) and to compare DNA methylation between cells.

BENEFITS: The proposed study uses novel approaches to generate new data that will improve understanding of the linkages among TRP, DNA methylation and asthma progression in children. Evaluation of changes in DNA methylation at each specific CpG (methylation) site within subjects will control for genetic variations and will allow the investigators to evaluate the independent impact of TRP on gene-specific DNA methylation. Comparison of DNA methylation in buccal and blood cell DNA will allow us to compare methylation across tissues which are vulnerable to TRP mediated oxidative/nitrosative stress. They will also be well-positioned to evaluate whether different size-cuts and components in PM have different effects on asthma progression and DNA methylation. As the proposed project will provide information on the health effects of PM on a sensitive population of children, the ARB will be able to assess the health impacts of the air quality standards. Finally, the study will provide data to assess whether changes in TRP due to regulatory improvements in air quality resulted in reduction of asthma-related morbidity in children living near seaports.

CO-FUNDING: Operational costs for the Breathmobile Program are provided by the LAC+USC Medical Center. As part of the southern California Children's Health Study, data on different PM size-cuts and components in Long Beach is currently being analyzed ($485,116, NIEHS). Another funded project ($900,000, EPA) will measure pollens in Long Beach during 2010-2011 and could help predict pollen exposure in future using CMAQ and MEGAN modeling systems. The proposed project will leverage substantial exposure and clinical data from these funded projects.

COST: $550,000

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TITLE: Zero-energy air purification materials to reduce the exposure of Californians to harmful air pollutants

PROBLEM: Ozone (O_3) is associated with numerous adverse effects on the human respiratory system, and with premature mortality.[1-5] Efforts to reduce population exposures to ozone have focused on outdoor air, even though a major fraction of total exposure to O_3 occurs indoors.[5-8] In studies involving 2,500 residences in seven cities, indoor exposure accounted for 43% to 76% of total daily exposure to O_3, with a mean of 60%.[5] Although indoor O_3 concentrations are typically 20% to 70% of outdoor levels, the high indoor contribution to exposure stems from the fact that Californians spend an average of 18 hours indoors for every hour spent outdoors.[9] At risk populations, e.g., infants and the elderly, spend an even greater amount of time indoors.

O_3 is also a driver of indoor chemistry and leads to the formation of oxidized reaction products which can be toxic, such as formaldehyde.[6] Cumulative molar intake of these products can be as much as twice the intake of O_3.[5]

Indoor exposures are also responsible for 70% of cumulative exposure to a wide range of organic hazardous air pollutants (OHAPs).[10] The proposing investigator's team has estimated cumulative cancer risks associated with exposures to just 12 OHAPs in Houston of nearly 10^{-3}, with risks dominated by indoor exposures.[11] Thus, *indoor controls are a potential, but largely unexplored, strategy to reduce population exposures to O_3 and its reaction products, as well as to OHAPs.*

PREVIOUS WORK: Activated carbon (AC) has been used extensively to control OHAPs, and has also been observed to remove O_3 from air.[12-16] Although field data are sparse, O_3 removals of 50% to 95% have been observed 1 to 3 years into AC bed operation for several large buildings.[15, 16] Recent experiments at the University of Texas (UT) have also shown that low-cost and less energy-intensive activated carbon fiber mats can be strategically placed on walls to passively remove O_3 from indoor air.[17] Ongoing studies at UT also indicate that substantial O_3 removal can be achieved with more acceptable materials, such as clay wall coverings, without concomitant formation of O_3 reaction products. Through the use of selective materials placed in areas with relatively high but natural air flows (no additional energy needed) the investigators have shown experimentally and through modeling that occupant exposures to O_3 in homes can be reduced by over 50%, with up to 30% reduction in total O_3 exposure. The proposing investigator's team has further shown no net changes in material performance over six months in actual field conditions. Finally, their ongoing research also suggest that some OHAPs are effectively removed from some indoor materials, although more work is needed to ascertain long-term desorption.

OBJECTIVE: It should be possible to use aesthetically acceptable materials as zero energy air purification (ZEAP) materials (hereafter referred to as ZEAPs) to reduce population exposures to O_3, O_3 reaction products, and OHAPs. The *objective of this study* is to explore the use of ZEAPs for substantially reducing population exposures to O_3, O_3 reaction products, and OHAPs. This effort will serve as an expansion of current research (additional ZEAPs and inclusion of OHAPs) being completed at the University of Texas at Austin.

DISCUSSION:

Task 1. Testing will include both small (48-L electro-polished stainless steel) and large (70,000-L stainless steel) chambers. Small chamber experiments will follow protocols described by Poppendieck *et al.*[18] for O_3 deposition and Won *et al.*[20-21] for OHAP sorption. Each of six ZEAPs will be tested to ascertain reactivity with O_3, degree and nature of reaction products, and sorptive uptake and release of OHAPs. Three promising ZEAPs will be selected for large chamber testing of O_3 and OHAP removal. Three OHAPs will be studied: benzene, *p*-dichlorobenzene, formaldehyde. A semi-factorial experimental plan will explore effects of variations in RH and mixing intensity.

Task 2. Chamber results will be evaluated in a house (UTest House). Experiments will be completed during the O_3 season with four one-month conditions (no ZEAP + each of three ZEAPs in series). Two complete walls in the living area will be equipped with a ZEAP. Air exchange rate will be measured using CO_2 releases and decay on an intermittent basis. Indoor (near HVAC return grill) and outdoor O_3 concentrations will be measured on a continuous basis. These data will allow determination of O_3 decay rates due to reactions with materials in the house and, by differencing from background, increases in reaction-based decay rates due to each ZEAP. On three occasions during each condition a release of OHAPs will be made with analysis of decay rates to determine sorption parameters.

Task 3. Information regarding spatial variations in residential building stock, outdoor O_3 concentrations, and indoor OHAP concentrations will be coupled with data collected for this study to complete a novel assessment of ZEAP materials for population O_3 and OHAP exposure reductions. The assessment will include net benefits, costs, and continued engineering challenges. The Sacramento metropolitan area will be considered, but protocols will be applicable to other cities.

BENEFITS: This study has direct relevance to the health of Californians, the majority of which live in O_3 nonattainment areas. The health benefits derived from reduced O_3 exposure will have substantial and positive economic implications in California. Applying monetary health benefit data for incremental O_3 reductions[1], a very rough estimate of benefits approaching $10 billion/year is possible by retrofitting every home and school/classroom in California nonattainment areas with ZEAPs that reduce indoor O_3 levels by 50%, achievable with at least two ZEAPs that the investigators have tested (activated carbon (AC) and clay wall coverings). The estimated cost using AC is $100 to $200 million/year (benefit/cost ratio of between 50:1 to 100:1). Similar economic analyses are more difficult for OHAPs because of uncertainties in the health effects of low-level long-term exposures. However, given that indoor environments dominate the exposure of Americans to OHAPs and that cumulative cancer risks are relatively high, it is reasonable to assume that substantial long-term health benefits would be gained by effective application of ZEAPs for OHAP removal.

CO-FUNDING: This study will benefit from infrastructure developed for past research at UT. The principal investigator has extensively researched O_3 and OHAP interactions with indoor materials, with funding from the American Chemistry Council, British Petroleum, the U.S. Department of Defense, U.S. EPA, and others.[18-21] Two current projects funded through the State of Texas Advanced Research Program and the US

Green Building Council will end in several months. The proposed study would allow continuation of those studies and future leveraging from others, e.g., the National Science Foundation.

COST: $254,205

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APPENDIX B: Concepts Recommended for Emissions Reductions

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TITLE: Characterization and mitigation of volatile organic compound emissions from dairy silage sources

PROBLEM: Silages have been known to be a major source on dairies for the emissions of volatile organic compounds (VOCs). Alcohols and aldehydes, including methanol, ethanol, iso-propanol and acetyl-aldehyde, are the major components of the VOCs emitted from silages. Alcohols account for 70-80% of VOCs emitted from the silages. They are bacterial fermentation products during ensilage fermentation processes. The types and contents of alcohols and aldehydes in the silage directly influence the emission rates and total emissions of these compounds. In order to estimate or predict the VOC emissions from various silage sources, the contents of alcohols and aldehydes in the silage must be known. However, very few data are available showing the types of alcohols and aldehydes and their contents in the silages used on California dairies, which are largely influenced by silage crop, crop maturity, moisture content, bulk density and bacterial inocculum addition. Research is urgently needed to characterize the various silages used on California dairies to determine the alcohols and aldehydes and their contents and compare the different silage crops, storage and management practices used on dairies so that recommendations can be developed for the dairy industry to make silages with reduced alcohol and aldehydes contents and emissions.

PREVIOUS WORK: An ARB-funded project on the development of a process-based VOCs emission model for dairy farms was recently completed.[1] A computer model was developed for predicting the emissions of alcohols from corn and alfalfa silages. More modeling work is being conducted with a research grant from National Milk Producers Federation to develop an emission model for predicting the emission of acetyl-adehyde from silages as our research results indicated that besides alcohols, acetyl-aldehyde is another major compound emitted from the silages and has high reactivity for ozone formation. The contents of alcohols and aldehydes in silage are an important input parameter for the emission models. However, there is no database available on the characteristics and alcohol and aldehydes contents of various silages that are used on California dairies and it is difficult to apply the emission models for estimating the emissions from dairies. Previous research demonstrated that corn and alfalfa silages have quite different types and contents of alcohols and aldehydes. A literature review revealed that the control and modification of the silage production processes could lead to an effective strategy for reducing or preventing the alcohol and aldehydes production in silages and consequently reducing their emissions. To support emissions estimates and reductions, investigators need to develop a database for the characteristics of various silages used on commercial dairies in California and apply emissions models to estimate the alcohol and aldehydes emissions from dairies of different locations and climatic conditions. Investigators also need to develop recommendations for reducing or preventing the alcohol generation in the silages.

OBJECTIVE: The main objectives of this project are to: (1) collect information and data on the silage production and management practices and characterize various silages produced on California dairies; (2) evaluate effects of different ensilage practices (e.g., inoculated versus not inoculated) on silage characteristics and alcohols and aldehydes produced; (3) determine the potential of alcohol and aldehydes emissions from different silages; and (4) develop strategies for reducing or preventing the generation of alcohols and aldehydes during the ensiling process and consequently reducing their emissions.

DISCUSSION: In order to assess the silage crops and ensilage practices used on commercial dairies, investigators will first conduct a survey for the dairies located in different parts of the State. Based on the survey results, investigators will select 30-40 dairies that will cover a range of different silages and climatic conditions. Then researchers will work closely with these dairies to collect information and data when their silages are made and collect samples from the silages using scientific protocols. The silage samples will be analyzed for alcohol and aldehydes species as well as moisture content, pH, volatile solids, lactic acid and volatile fatty acids. For each dairy, the silage samples will be taken at different times of the year so that the changes in silage over time can be quantified. Based on the chemical analysis results and the physical configurations of silages, potential emissions of alcohols and aldehydes from these silages will be calculated using our recently developed emission models. To investigate the effects of silage crop characteristics and ensilage process parameters, controlled experiments will be performed with different silage crops (e.g. corn, alfalfa and ryegrass) with different bulk densities, temperatures and moisture contents. Both laboratory and field experiments will be conducted. The characteristics of the experimentally produced silages will be compared with those produced on the dairies. In all experiments, bulk densities will be applied in the ranges commonly applied on commercial farms. Different moisture contents will be chosen based on different maturity stages of crop. The effect of using different doses of *Lactobacillus* and *Enterococcus faecium* strains on the characteristics of silages will also be studied. Recommendations for best silage making practices to reduce the generation of alcohols and aldehydes will be developed for the dairy industry. Investigators will collaborate with the dairy producers and silage production companies so that the results of this research are relevant to the dairy practices and the developed recommendations for best silage making practices can be both scientifically sound and practically useful.

BENEFITS: This work addresses the critical need to estimate and predict the VOC emissions from commercial dairies and develop effective strategies for reducing the VOC emissions from silage sources and consequently improving the air quality of the State. The expected outcome of this research will include the new scientific knowledge and database for the silage production and management practices currently used on commercial dairies and the types and contents of alcohols and aldehydes present in various silages and recommendations for best methods and practices for producing and managing silages with reduced alcohol and aldehydes emissions.

CO-FUNDING: Prospective investigators have a complementary project funded by National Milk Producers Federation on developing the VOC emission models for dairies.

COST: $300,000

REFERENCES:

1. Zhang, R. et al. 2010. "Process-based farm emission model for estimating volatile organic compound emissions from California dairies." A final research report (contract 05-344) submitted to the California Air Resources Board. http://www.arb.ca.gov/research/apr/past/05-344.pdf

TITLE: Developing, validating and implementing a process modeling system for California agriculture greenhouse gas inventories

PROBLEM: Agriculture represents a significant source of methane and nitrous oxide. The traditional approach of using simple emission factors for agricultural emission inventories is limited due to the complex temporal and spatial variability of soil, crop, climate and management factors that control GHG emissions. New methodologies linking GIS databases with process-based models are being used to bring complex agroecosystems into a computable framework for building emission inventories and for assessing the impact of alternative management practices on net soil carbon (C) storage and GHG emissions. While the International Panel on Climate Change suggests process modeling (referred to as TIER 3 method) can improve accuracy of emission inventories, it is important to calibrate this method to specific cropping systems, perform model validation to estimate model structural uncertainties and to understand model sensitivity to inputs and overall uncertainty (upper and lower bounds).

PREVIOUS WORK: Over the past 20 years, the DNDC process-based model has been developed to predict impacts of various farming practices including fertilization, crop residue management and manure amendment on C and nitrogen (N) biogeochemical cycles and trace gas emissions (CH_4 and N_2O) for forests and agro-ecosystems. DNDC was constructed with two components to reflect the two-level driving forces that control geochemical and/or biochemical processes related to C and N fluxes. The first component, consisting of the soil climate, crop/tree growth and decomposition sub-models, predicts soil temperature, moisture, pH, redox potential (Eh) and substrate concentration profiles (ammonium, nitrate, dissolved organic carbon) based on ecological drivers (e.g., climate, soil, vegetation and anthropogenic activity). The second component, consisting of the nitrification, denitrification and fermentation sub-models, predicts NO, N_2O, CH_4 and ammonia (NH_3) fluxes based on the soil environmental variables.

With on-going funding from California Energy Commission (CEC), California Department of Food and Agriculture (CDFA), Packard Foundation and ARB, field studies to measure soil carbon dynamics and N_2O emissions for a wide range of California crops. These projects are collecting critical data for model calibration and validation. A project funded by the United States Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) from 2008-2010 developed detailed databases on rice production systems, validated the DNDC model for rice CH_4 emissions, developed an initial inventory of net GHG emission from California rice, and has evaluated several alternative water and straw management practices for reducing GHG emission. Prior to this NRCS project, a scoping project was completed with CEC PIER funding (see report CEC 500-04-038) to assess carbon sequestration and GHG emission from agricultural soils in California. With funding from CEC, USDA and National Milk Producers Federation a new version of DNDC, called Manure-DNDC, has been developed to quantify air emissions (CH_4, N_2O, NO, NH_3, CO_2 and VOCs) from dairy systems.

OBJECTIVE: The goal is to develop, demonstrate and transfer to ARB a framework for collecting GIS and agricultural management data, link these data in a GIS framework with DNDC process models (cropland and dairy versions) for agricultural N_2O, CO_2 and CH_4 emission inventories, and develop an explicit uncertainty budget due to both structural (derived from model validation) and scaling (unknowns in model input data for inventory, e.g. soils, agricultural management, crops, etc). Therefore, investigators will undertake to meet the following objectives: (1) collect N_2O emissions data from dairy drylots and manure solids treatment/storage systems, (2) develop GIS databases for statewide GHG modeling, (3) compile agricultural management databases, (4) assess model uncertainties (both structural and scaling) through model validation, (5) perform comparison of DNDC and DAYCENT models, (6) compile GHG emission inventory for California agriculture, and (7) work with ARB inventory staff on use and updates to the modeling system.

DISCUSSCION: The task list for this research is as follows.

1: An FTIR system and INNOVA portable gas analyzer will be used to collect N_2O, CO_2 and CH_4 flux data from manure solids (storage, treatment and compost piles) and drylots. The INNOVA unit samples six gasses continuously at ppb detection levels. These field data will be collected at the NAEMS site and an additional dairy in California.

2: Build GIS databases on soils (NRCS SSURGO), climate (CIMIS stations) and crops (DWR and NASS CDL). For each crop field, probability distribution functions (PDFs) for SOC, bulk density, pH, and texture will be calculated from the soil surveys. Daily precipitation, temperature, wind speed, and solar radiation will be compiled for each field using CIMIS with cokriging.

3: Collect and compile regional-specific crop growth/yield (calibrate growth model) and management data (tillage, irrigation, fertilizer, crop residue management, cover crops, etc). Data sources include UCCE Cost/Return Studies, UC Extension, and commodity groups. GIS data will be used to characterize growing regions by soil, climate and cropping systems (e.g. truck crops, grains, etc). Application of remote sensing for mapping and monitoring rice area and water management will be demonstrated.

4: Validate and calibrate DNDC crop growth model. Since accurate crop growth modeling is critical for process modeling, investigators will calibrate/test crop growth (physiology/phenology) submodels in DNDC based on data collected in Task 3.

5: Validate DNDC using data from Task 1 and from other projects collecting N_2O emissions from land application of Manure (e.g. ARB- and Waste Board- funded project with Dr. Will Horwath, Dr. Goorahoo ARI funded project).

6: Compare DNDC and DAYCENT models for cropland sites. This comparison will provide insight into relative model uncertainties. Both models are extensively used for estimating GHGs emissions, and a quantitative evaluation of the differences will provide a common base for comparing the inventories and uncertainties.

7: Run validated DNDC and Manure-DNDC models to compile CO_2, N_2O and CH_4 agricultural inventory for California using the integrated GIS databases (Task 2) and crop models (Task 3).

8: Quantify sensitivities and uncertainties in inventory estimate due to both model precision (structural uncertainty) and scaling up using GIS data. Uncertainties will be quantified using a series of statistical approaches. DNDC model structural uncertainty will be derived from field validation analyses (see discussion in previous work and Co-funding sections). Scaling uncertainty will be derived using Monte Carlo analyses and the PDFs from Task 2. Model sensitivity will identify critical input data needed to minimize uncertainties and guide future data collection efforts.

Throughout these tasks investigators propose to work with ARB inventory staff for training, model validation, and updating the modeling system for future inventories. The modeling system will a living system that will improve over time as new research is completed, improved spatial data are available and future improvements in the model derived from additional validation.

BENEFITS: Successful completion of this study will deliver spatial databases on crop model parameters (including regional management data), a GIS database design and a process modeling framework for future greenhouse gas emission inventories for California agriculture. These databases and tools can also be used to examine opportunities for mitigation and carbon offsets. Carbon offset opportunities would benefit California farmers, who represent 400 different commodities and $22 billion in state revenue. In addition to providing an inventory for land-based GHG emissions, the results of this project will help provide potential incentives (through carbon offsets) for land owners to change to land management practices that reduce GHG emissions and provide other environmental co-benefits. There are significant opportunities to achieve permanent reductions in N_2O and CH_4 emissions.

CO-FUNDING: Environmental Defense Fund (EDF) will provide matching funding from Packard Foundation and anticipated CDFA Block Grant funding for validating the DNDC model and calibrating crop growth submodels in DNDC. In addition, through existing projects funded by ARB, CEC, CDFA and Packard Foundation, N_2O data are being collected across a broad swath of cropping systems in California. DNDC model validation effort are currently funded for the CEC and CDFA projects, validation of the model for the N_2O data collected by the ARB project is not currently funded. This task will expand the current validation efforts to include the data collected under the on-going ARB project led by Dr. Will Horwath.

COST: $300,000 (plus $100,000 match from EDF)

TITLE: Investigation of Combined Aerodynamic Modifications to Reduce Emissions from the Current Heavy Duty Fleet

PROBLEM: In addition to meeting criteria pollutant standards, ARB is responsible for meeting ambitious greenhouse emission reduction targets. In collaboration with stakeholders and agencies throughout the state, ARB is actively exploring cost-effective strategies, both regulatory and voluntary. The 700,000+ heavy duty-trucks in California are a vital part of our State's economy and freight system; however, they consume significantly more fuel—producing more criteria pollutants and GHG emissions—per vehicle than light duty vehicles due to their aerodynamic profile, weight, and distances traveled. Advanced aerodynamic modifications to reduce fuel consumption from the heavy duty fleet could help reduce emissions from this sector without adversely affecting our state's economy.

PREVIOUS WORK: Significant development of aerodynamic fairings, skirts and other devices has been undertaken in both the public and private sectors, resulting in many such devices currently on the market that can be used by truckers to improve fuel economy. These devices have been the subject of much testing, including research by federal agencies and manufacturer verification via the SmartWays program. However, little work has been done to investigate and quantify the benefits from combinations of multiple devices used simultaneously.

Current ARB rules require use of technologies that can provide 5 percent or more fuel economy improvement. This project would investigate the possibility that even greater fuel economy improvements could be achieved by use of various combinations of aerodynamic technologies.

OBJECTIVE: The U.S. EPA SmartWay Program has verified several individual aerodynamic technologies that reduce fuel consumption and emissions. Some of the verified technologies focus on diverting air flow away from the trailer's axle while other technologies have focused on air flow improvements at the rear of the trailer. However, there has been very limited work in evaluating the benefits of using several technologies together that may provide synergistic benefits. Also, many trailers are designed with various types of equipment that require modifications to some of the verified aerodynamic technologies, such as refrigeration units or under-mounted tool boxes and loading ramps. However, it is not well understood how the necessary modifications to the technologies affect their aerodynamic performance. In addition, the current SmartWay test method to verify technology is the SAE 1321 test method, which is very costly and time consuming. This project will investigate development of a new test method that would utilize Portable Emission Measurement System (PEMS) or similar technologies to determine both fuel economy benefits, through carbon emission analysis, as well as criteria emission benefits. The evaluation will probe the following:

- Potential benefits of using multiple SmartWay verified aerodynamic technologies on trailers
- Affects of modifying verified aerodynamic technologies to accommodate various types of trailer equipment

- Correlation of calculating fuel consumption utilizing PEMS compared to methods established by the SAE 1321 test method
- Evaluating criteria emission benefits of aerodynamic technologies utilizing PEMS

DISCUSSION: The proposed project will involve an evaluation of aerodynamic devices in multiple combinations on multiple platforms for increased reductions of greenhouse gases from on-highway trucks. These configurations would be evaluated through detailed on-road testing using PEMS technology or other mobile equipment such as a Mobile Emissions Laboratory (MEL). The results of the on-road testing would then be utilized to quantify and characterize the emissions reductions for the different configurations tested.

BENEFITS: Results from this study will ultimately reduce our dependence on petroleum-based fuels, improve air quality, and aid in mitigating our green house gas contribution.

COST: $300,000

TITLE: **Probing the intrinsic ability of particles to generate reactive oxygen species**

PROBLEM: Oxidative stress mediated by reactive oxygen species (ROS) is a leading hypothesis for the mechanism by which particulate pollution contributes to a range of illnesses, including asthma and cardiovascular mortality. ROS are generated endogenously in response to inhalation of particulate matter (PM), but the "exogenous" ability of the particles themselves to generate ROS may also be important. This work will elucidate the ability of particles to generate ROS under physiological conditions, delineate the components in particles responsible for "exogenous" ROS formation, and clarify the interplay between H_2O_2 and OH. Understanding the particular components in PM that lead to adverse health effects is essential to formulating targeted control strategies to reduce PM related morbidity and mortality.

PREVIOUS WORK: A series of studies have reported H_2O_2 and related ROS in fine and/or coarse mode aerosols. Measurements in urban areas indicate averages for H_2O_2 or H_2O_2 combined with other ROS ranging from 2 to over 200 ng/m^3.[1-8] In a detailed study using simultaneous measurements of gas and aerosol H_2O_2, aerosol mass and ambient relative humidity, our group found that H_2O_2 associated with particles exceeded the expected value from Henry's law by an average factor of about 700.[2] Hydroperoxides measured in these field campaigns are generated during the extraction procedure. Some particles stop generating H_2O_2 after an hour, while others continue to generate H_2O_2 for days.[3, 8]

OH radicals are more reactive than other ROS. As a result, their estimated concentrations in condensed phases are generally low. Like H_2O_2, they undoubtedly partition between the gas and condensed phases, and are also generated by aerosols.[9-12] Their primary source in the dark may be breakdown of H_2O_2 catalyzed by transition metals,[10, 11] although this remains to be determined.

In *in vitro* studies, hydrogen peroxide and OH radicals have been shown to damage lung epithelial cells at levels well below those associated with ambient samples.[13-16] Additionally, an *in vivo* study[17] showed that two-hour exposures to H_2O_2 dissolved in ammonium sulfate particles, at levels similar to those associated with urban particulate matter,[18] produced symptoms associated with respiratory distress, while gas-phase peroxides or particles alone elicited minimal responses.

Short duration exposures, such as those made in previous work, usually use concentrated air pollution; statistically significant responses for ambient levels of particulate H_2O_2 are notable. While this result strongly suggests that H_2O_2 generation itself may be toxic, it remains unclear how the H_2O_2 and ROS generation activity intrinsic in the particles (exogenous, or 'exo-ROS') compares to ROS produced in vivo in response to particles depositing in the lungs. The proposed study's measurements will significantly constrain exogenous ROS. Although direct measurements of endogenous H_2O_2 and ROS (endo-ROS) production are beyond the scope of this project, efforts will be made to make quantitative comparisons of exo- and endo-ROS throughout the full proposal preparation and project stages. The combined approach will be continuous monitoring of on-going animal studies and efforts to develop or catalyze separate studies or collaborations to address this key question. An important related question is whether the particles or components that generate the most exo-ROS also induce higher levels of endo-ROS.

OBJECTIVE: Objectives of this investigation are to (1) determine the strength of ROS production intrinsic in ambient particles, (2) probe the sources and relative strengths of ROS production via (speciated) transition metals and quinones, (3) probe the balance between H_2O_2 and OH and the underlying mechanism(s) of ROS generation, and (4) elucidate the sources of quinones in particles.

DISCUSSION: Samples will be collected on Teflon filters and polyurethane foam plugs. Aerosol-phase OH and hydroperoxides will be extracted in physiologically relevant solutions with adjusted ionic strength, pH and with added electron donors such as ascorbate, and control solutions. Hydroperoxides will be quantified using high performance liquid chromatography (HPLC)-fluorescence.[2] The HPLC-*p*-hydroxybenzoate method will be used for OH quantification,[10, 12] requiring an additional HPLC. Aerosol mass and about 16 soluble trace elements will also be quantified.

Quinones and related organics will be extracted, concentrated, and analyzed by Gas Chromatography-Mass Spectrometry (GC-MS) for nine quinones, eleven PAHs, C_{20}-C_{32} n-alkanes, levoglucosan, cholesterol and selected hopanes/steranes.[19] Results will also be combined with the OH, peroxide and elemental measurements in a multivariate analysis to evaluate the relative contributions of the measured components to the ROS. The target compounds include markers for engine exhaust, leaf abrasion, biomass combustion, meat cooking and combustion,[20] and will be used in a Positive Matrix Factorization analysis[21] to evaluate the sources of quinones as well as other ROS active species such as transition metals.[8]

Samples will be collected at selected sites in Fresno and Los Angeles, areas with rather different PM characteristics, in on-going measurements and intensives. To the extent that it makes sense, investigators will join with other researchers, to create synergies where possible. In addition, on-going measurements will be performed on in-lab source materials such as diesel exhaust to address focused questions.

Synthetic mixtures containing quinones and metals to produce peroxides and OH will be measured to test the hypothesized mechanisms, at concentrations reflecting those measured in field sample extracts and at higher concentrations similar to those in particles. The role of electron donors that may be present in PM (such as phenol), and endogenous electron donors (such as ascorbate) will be probed.

BENEFITS: The ROS mechanism work proposed here will help unravel the cause of particle-mediated damage to human health. The most likely sources of ROS are transition metals, quinones and possibly other unknown organics in the particles themselves. These species are also prime candidates responsible for eliciting endo-ROS formation. To date, studies have focused on limited segments of the phenomenon, such as measuring OH or H_2O_2 separately and their relationships to transition metals or quinones. This study proposes to take a comprehensive approach to understanding particulate formation of ROS, by monitoring H_2O_2 and OH radical generation as well as transition metals and organics, including quinones, in ambient aerosol samples and laboratory-generated test aerosols. This will shed light on the question of the degree to which H_2O_2 is in steady state, i.e., continuously formed and destroyed, thus potentially releasing large quantities of OH; or if it is a stable end product. The detailed organic analysis in addition to specific source testing will allow us to attribute the active components to their sources. The work determining the active agents in ROS generation will advance and inform the search for species that generate exo-ROS, and possibly elicit endo-ROS as well.

CO-FUNDING: Two current grants at Fresno State can be used to leverage the project by providing funding to support up to four research students (salary and travel) and some of the supplies and consumables that would be required. Two of these students would be supported through Fresno State's subcontract for the NOAA-funded Interdisciplinary Scientific Environmental Technology (ISET)-Cooperative Science Center (CSC) Center ($446,000; 9/01//06-8/31/11) and two through the National Science Foundation (NSF)-funded Geosciences METRO Center ($1.4M; 09/01/09-08/31/13). A renewal of the National Oceanic Administration (NOAA) center will be pursued, as will other potential co-funding opportunities.

A potential collaboration with Professor Anastasio of UC Davis making measurements of OH radicals in the field will be pursued during the proposal stage. Prof. Anastasio's extensive expertise in this area will be a valuable addition to this project, and the collaboration will provide intellectual synergies that will further advance the understanding of particle toxicity. Funds for Prof. Anastasio's part of the collaboration are not included in the proposed budget.

COST: $260,000

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TITLE: Understanding primary organic aerosol volatility at atmospherically realistic concentrations for State Implementation Plan analysis

PROBLEM: Recent emissions tests have determined that primary organic aerosol (POA) generated from combustion sources behaves like a series of semi-volatile compounds when the particulate phase concentrations range between 100 – 10,000 μg m-3. The data available for atmospherically relevant concentrations below 30 $\mu g/m^3$ are sparse and the data below 10 $\mu g/m^3$ are missing entirely. The simple absorption theory that appears to explain the behavior of gas-particle distribution of condensable organics at high concentrations may not be accurate at atmospherically relevant concentrations. It is likely that other processes such as chemical and physical adsorption onto elemental carbon and/or partitioning into the aqueous phase play significant roles at lower concentrations. The details of the primary organic aerosol partitioning need to be understood to predict the benefits of emissions control programs contained in the SIP and the impact of climate change on atmospheric organic aerosol pollution.

PREVIOUS WORK: Experiments in which exhaust from combustion sources is cooled to ambient temperature and then diluted have been used to study the semi-volatile nature of POA emitted from a simple diesel engine and flash vaporized motor oil.[1-3] Thermal denuders have also been employed to reheat the diluted exhaust to study the partitioning of the POA.[1] The resulting dataset has been used to generate "best fit" partitioning curves that have been extrapolated from the high concentration range (COA = 100–10,000 $\mu g/m^3$), where most of the experiments have been performed, to the atmospherically relevant range (COA = 1–30 $\mu g/m^3$) where almost no experiments have been reported. This situation is analogous to the extrapolation of SOA partitioning curves generated at high concentrations in smog chamber experiments to atmospherically relevant concentrations.[4] The SOA extrapolation was ultimately shown to be incorrect (5), and preliminary evidence suggests the POA extrapolation may also be incomplete (6). Recent light duty vehicle emissions testing carried out at the CARB Haagen Smit Facility examined POA partitioning under atmospherically relevant concentrations (COA = 1–10 $\mu g/m^3$).[7-10] New chemical analysis techniques were able to characterize ~20–30% of the POA present under these low concentration conditions. The majority of the identified POA was comprised of small oxygenated organic compounds with relatively high vapor pressures.[7] This contradicts the behavior predicted by the absorption theory. Rigorous absorption calculations failed to reproduce the observed partitioning behavior.[7] Some other processes besides absorption must account for the observed POA at atmospherically relevant concentrations.

OBJECTIVE: The objective of the proposed research is to identify the dominant partitioning mechanism for primary organic aerosol emitted from diesel-powered and gasoline-powered vehicles at atmospherically realistic concentrations in the range from < 5–30 $\mu g/m^3$. The results will provide input for regional airshed models that seek to predict changes to ambient organic aerosol concentrations in the presence of emissions control programs and/or climate change.

DISCUSSION: <u>Task 1</u>: POA emissions from diesel-powered and gasoline-powered motor vehicles will be diluted to concentrations ranging from < 5–50 $\mu g/m^3$. The influence of changing temperature on the aerosol will be investigated using a thermal denuder system. Simultaneous measurements of gas-phase compounds will be made and related directly to the aerosol composition measurements. Dilution and heating can be used to independently adjust the final aerosol concentration and will determine to what extent these provide equivalent results with respect to the observed partitioning. The dilution system will be modified so that the relative humidity of the system can be manipulated. The RH will be adjusted between 50–80% to study the effects of aqueous partitioning. The secondary dilution system will be further modified so that black carbon (BC) particles produced from a separate burner can be introduced into the dilution air with a final concentration between 0–10 $\mu g/m^3$ to study the effect of adsorptive partitioning.

Major Task 2: The organic aerosol concentrations produced during each experiment will be measured as a function of dilution amount and thermodenuder temperature using a high-resolution Aerosol Mass Spectrometer capable of providing information about the size-resolved chemical composition of the particles and the elemental composition (i.e., ratios of carbon, hydrogen, oxygen and nitrogen) of the POA. Simultaneously, gas-phase concentrations and elemental compositions of carbonyls, alcohols, ketones and organic acids will be determined using a Time-of-Flight Chemical Ionization Mass Spectrometer and BC concentrations will be monitored using a multi-wavelength photoacoustic spectrometer.

Major Task 3: The gas and particle phase organic compounds will also be captured separately for offline analysis using a denuder-filter-PUF sampling train and analyzed using LC-MS for the concentration of individual organic compounds. Partitioning calculations that consider absorption into organic aerosol, aqueous partitioning, and adsorption onto elemental carbon will be used to identify the dominant processes at atmospherically relevant concentrations.

BENEFITS: The results of experiments conducted at atmospherically relevant concentrations will determine if the simple absorption theory can be extrapolated to the real atmosphere. These findings will have broad application within regional air quality models used to predict the efficiency of emissions control programs during State Implementation Plan (SIP) analysis. The results will strengthen the scientific basis for the emissions controls within the SIP.

COST: $300,000

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TITLE: Quantification of ammonia slip from Selective Catalytic Reduction - equipped vehicles and estimation of secondary aerosol formation potential

PROBLEM: Selective Catalytic Reduction (SCR) technology is becoming common for NO_X emissions control for diesel vehicles. For SCR, ammonia (direct or through thermal decomposition of urea) is injected into the exhaust stream to promote a chemical reaction with NO_X in the presence of a catalyst. Excess ammonia that does not react with NO_X is called "ammonia slip," a source of ammonia emissions. Ammonia in the atmosphere is very reactive and causes the formation of ammonium sulfate ($(NH_4)_2SO_4$) and ammonium bisulfate (NH_4HSO_4). Ammonia slip also reacts with NO_X to form ammonium nitrate if the SCR catalyst efficiency decreases after prolonged usage. Ammonia salt can cause downstream metal corrosion and promote PM formation. Atmospheric free ammonia, PM, and secondary organic aerosol (SOA) constitute a serious health and environmental hazard.

PREVIOUS WORK: Several in-house studies[1] form a basis for this research. Measurements of emissions from diesel cars equipped with urea injection SCR were made using an AVL SESAM FTIR system in early 2009. Preliminary results indicated ammonia concentrations in raw exhaust as high as approximately 100 ppm, as well as the presence of toxic gases such as hydrogen cyanide.

Related projects were undertaken to:

- determine the characteristics of the high Particulate Matter (PM) emitter, investigate the viability, cost-effectiveness, and potential benefits of professional repairs for emission reductions for the high PM emitters, and provide emission data of high PM emitters. These results can be used by ARB staff to develop emission estimates for inventory purposes for the present and the future;
- characterize the effect of sampling temperature on the production of primary particulate matter from year 2000 and newer model year light duty gasoline vehicles operated on winter-time and summer-time commercially available fuels;
- support efforts to improve the basic knowledge of how PM emissions are affected by future fuels, new vehicle technologies, sampling condition, variations in ambient temperature, humidity, and certain chemical compounds in the atmosphere that act as seeding agents for particle formation.

OBJECTIVE: This project will quantify the amount of amount slip emitted from two SCR-equipped vehicles operating at high, low, and transient modes; and investigate the correlation between ammonia slip and its effect on PM formation as well as PM mass emissions.

Major tasks include: 1) monitoring real-time exhaust gases concentrations; 2) monitoring real-time PM emission; 3) measuring real-time NO_X emissions; 4) quantifying NH_4^+, NO_3^-, SO_4^{2-} ion concentrations from collected PM; 5) investigating the relationship with additional PM formation relative to ammonia slip; 6) estimating the environmental impact from SCR NO_X reduction technology.

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[1] In-house projects 2R0601, 2R0805, 2R0903, and 2R0905.

DISCUSSION: Using ARB's Haagen-Smit Laboratory, Test Cells 2 and 3 offer:

- a 48" Chassis Dynamometer;
- a 10" Full Flow Dilution Tunnel;
- a Diluted Exhaust Emission Analysis Bench that can handle Bag Sampling for CO_2, THC, CH_4, CO, NO/ NO_X , N_2O, and detailed HC analysis, as well as 1Hz Modal Sampling for CO_2, THC, CO, NO_X;
- AVL SESAM FTIR for real-time ammonia concentrations; and
- three independent, temperature-controlled particulate sampling units with secondary dilution capability. One of the sampling units can accommodate PUF filter cartridges for PAH sampling; real-time particulate sizer-Engine Exhaust Particle Sizer (EEPS).

Results will include PM and real-time ammonia emissions measurements from light diesel vehicle exhaust, combined with gaseous criteria pollutant measurements, gravimetric PM measurement, and filter ion analysis. These results will enable improved estimation and better understanding of how ammonia slip contributes to additional PM and SOA formation.

BENEFITS: Better understanding of the relationship between ammonia slip and PM formation will enable improved control of PM and SOA.

COST: $140,000 ($60k per vehicle procurement/purchase. $2k for fuel, $50k for equipment, 20k for repair and analysis). Cost can be significantly reduced if performed in-house.

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TITLE: Development of innovative instrumentation to enable investigation of the relationship between SO_2 and sulfate

PROBLEM: Reduction in particulate matter emissions from vehicles is a critical issue for meeting air quality improvement goals. Understanding the composition of particles is important to evaluate their health impacts as well as their formation mechanisms. Sulfur or sulfate is one of the major components of combustion and lubricant-derived particles. Sulfate levels in vehicle exhaust particulates can be readily measured, but it is important to understand the relative contribution between combustion and oil-derived particles and the conversion rates found for SO_2 to sulfate. With the low level of sulfur present in the fuel and oil products used in modern vehicles, detection limits in the part per billion (PPB) range are needed to measure the SO_2 contribution. Previous studies have shown a differential optical absorption spectrometer (DOAS) can be used successfully to make measurements at these levels from raw vehicle exhaust. The goal of this program will be to develop a DOAS and apply the technology to exhaust measurements from vehicles at the ARB Heavy Duty Emissions Test laboratory in Los Angeles.

PREVIOUS WORK: The Coordinating Research Council (CRC) [E-61 program] funded UCR to investigate the impact of sulfur content in the lubricating oil on four ultra-low-emission vehicles (ULEVs) and two super-ultra-low-emission vehicles (SULEVs), all with low mileage. Sulfur content in the lube oils ranged from 0.01% to 0.76% while the sulfur content of the gasoline was fixed at 0.2 ppmw. Vehicles were configured with aged catalysts and tested over the Federal Test Procedure (FTP), at idle, and at 50 miles per hour (mph) cruise conditions. In all testing modes, variations in sulfur level of the lubricant did not significantly affect the regulated gas-phase tailpipe emissions. In addition to the regulated gas-phase emissions, a key element of the research was measuring the engine-out sulfur dioxide (SO_2) in near real-time. This research used a methodology based on a differential optical absorption spectrometer (DOAS) to measure SO_2 from the lubricants used in this study. To provide near real-time, low-level measurement of engine-out SO_2, a differential optical absorption spectrometer (DOAS) was developed. This technique is commonly used for the measurement of SO_2 under low-level ambient conditions.

OBJECTIVE: The objective of this research is to construct, test and provide ARB a DOAS that can measure down to 10 ppbV in real time and evaluate SO_2 so a mass balance can be ascertained between SO_2 and sulfate, investigations would be done comparing the DOAS to integrated bags to see if there are any low level losses in bag samples. This would be a state of the art instrument. Training for ARB's technicians would also be provided as part of this program so they can run this instrument independently.

DISCUSSION: The DOAS measures the absorbance of ultraviolet (UV) light in the exhaust stream as it passes through an extractive sample cell with the sample gas filtered to remove PM. For the earlier work done on the CRC project, this sample cell was equipped with two quartz windows to allow the light to enter and exit a multi-pass mirror system White cell with a base length of 1.4 meters (m). To obtain the low detection limits needed for this project, optical path lengths of 14.0 meters were used. In this configuration, noise levels of 15 ppbv at one standard deviation were obtained. The

DOAS software was developed to determine the SO_2 concentration using a multi-dimensional least squares regression routine that removed interferences from molecules such as formaldehyde and SO_2. Operational tests with the instrument being used for a variety of SO_2 concentrations ranging from low to high sulfur oils, indicated that the DOAS readings were consistently within one standard deviation (15 ppbV) of the calibration gas value. For the CRC, study second-by-second SO_2 concentrations were obtained from the three-second DOAS readings using a linear interpolation. The concentrations were then converted into mass emissions rates by multiplying by the density of SO_2, and the time-aligned exhaust flow rate. The exhaust flow rate was determined on a second-by-second basis using the CO_2 tracer method.

For the proposed instrument, investigators will expand the pathlength so that detection limits of approximately 5 ppbV at 3 seconds integration time will be achievable. The DOAS will be made transportable so that it can measure either engine out or dilution tunnel values, as well as be simply moved to other labs within ARB. Faster response times are achievable and so are better detection limits, but this would require a very high flow sampling pump and a far more expensive White Cell to do this. UCR will develop the DOAS system for implementation in ARB's laboratories. The system will be developed and evaluated at UCR prior to installation in the ARB laboratory.

Once the instrument is completed, UCR will work with ARB on the installation of DOAS into one of its laboratories. UCR will work with ARB for a period of approximately 2 weeks, which will include on-site installation of the unit, verification and on-site calibration of the instrument, training, and an evaluation of the system on one test vehicle that will be provided by ARB. A brief manual will also be provided giving a description of the unit and simple instructions on how the instrument is operated.

BENEFITS: The benefits are that ARB would have an instrument with the capabilities to measure very low level SO_2. The instrument will be constructed so that it can measure SO_2 from both direct exhaust as well as from dilution tunnels. The instrument will be designed so ARB can transport it to other facilities in their system. The instrument will remain with ARB and training will be provided so ARB technicians will be able to use it independently.

COST: $90,000

TITLE: Development of a high quality proportional gravimetric PM system for reliable in-use emissions measurements at low emissions rates

PROBLEM: Particulate matter is known to cause adverse health effects. PM from diesel engines is classified as a Toxic Air Contaminant (TAC) by ARB. Regulations that have been implemented in 2007 require the use of diesel particulate filters (DPF) and provide significant reductions in PM levels. As PM emissions continue to be reduced, there is increasing interest in the measurement of PM in-use, by means of particle number, or with portable emissions measurement systems (PEMS). Unfortunately, these PM PEMS comparisons to gravimetric reference methods have proven to be unreliable where deviations are on the order of 100% and their measurements are dramatically dependent on composition, particle size and concentration. The real time instruments are not faulty, but their measurement principles do not correlation with the gravimetric method, where a combination of size, shape, composition, and chemistry contributions vary, causing the poor correlation. The focus of this research will be on the development and evaluation of a high quality gravimetric proportional PM measurement system designed for in-use conditions based on the reference method.

PREVIOUS WORK: ARB, in conjunction with the University of California at Riverside CE-CERT (Bourns College of Engineering Center for Environmental Research and Technology), has ongoing programs in the areas of in-use PM measurement using both number and gravimetric methods. CE-CERT has conducted a preliminary evaluation of the PMP methodology using CE-CERT's Mobile Emissions Laboratory (MEL) and with testing at ARB's heavy-duty chassis laboratory in Los Angeles. CE-CERT has also recently completed the PM PEMS measurement allowance program were UCR's MEL was an integral part of the allowance determination. The PM PEMS MA program evaluated the state of the art PM PEMS that were designed specifically for in-use conditions while correlating with the gravimetric reference method. These PM PEMS measurement techniques did not perform well and have shown to have measurement errors on the order of 100% at the proposed in-use thresholds of 0.03 g/hp-h.

OBJECTIVE: The objective of this research is to develop and evaluate a new gravimetrically based system designed specifically for in-use conditions including on-highway, marine, and non-road applications. The evaluation will include both laboratory-based and on-road measurements in comparison with UCR's MEL gravimetric reference method.

DISCUSSION: The development of a reliable in-use gravimetric PM system will be based on the latest regulations in Title 40 Part 1065, with consideration for possible changes to Part 1065 such as dilution air set points and residence times. The goal of the system is to sample a proportional amount of exhaust and sample that diluted exhaust onto a gravimetric filter with a system consistence with Part 1065 specifications. The technology for proportional sampling and loading a filter is established, but has not been suitably packaged for in-use conditions. In addition, in-use testing requires autonomous control which will be implemented using a work-based window approach where a maximum of 24 filters can automatically be sequenced into the system. The controls will be designed to be remotely controlled and a final product that will be reproducible for ARB scientists and investigators.

The system will be evaluated and compared against UCR's MEL on UCR's dynomometer, then on UCR's chassis dynomometer, then final deployment on a 2007 or newer diesel vehicle with a bypass system to evaluate the ability to detect various conditions of DPF status.

In order to perform proportional sampling, an exhaust flow meter is needed. CE-CERT will use its experience in flow measurement and integrated a design between flow and sampling for the gravimetric system design. During development of the system, specific details about portability and robustness will be considered, while archiving optimizing dilution and PM sampling methods.

BENEFITS: The development of a reliable, in-use gravimetric PM system is necessary to quantify and understand in-use emissions inventories for on-highway, non-road and marine applications. The results from this program can be used to help improve emission inventories, our PM models and thus provide needed information to suggest new legislation for continued improved air quality. Current regulations require the measurement of PM in-use, but the tools being used do not necessarily measure all parts of the PM and will not be reliable for inventory purposes. This project will provide the necessary tools to accurately quantify the emissions from California's in-use fleets.

COST: $300,000

TITLE: Extended analysis of the CARES aerosol chemistry data to characterize the sources and processes of organic fine particulate matter

PROBLEM: Organic aerosol (OA) represents a major mass fraction of fine particles in California and in many regions globally. But the emission sources, formation mechanisms, and evolution processes of atmospheric OA remain poorly characterized. This knowledge gap limits the ability of current models to simulate ambient OA concentrations and properties. In particular, there is critical need to improve the description of the mechanisms of secondary OA formation in models.

Because the results from model predictions usually guide emission control strategies, an improved understanding of OA pollution is important to developing effective regulatory policies on air quality. This is directly relevant to California since over the years the state's emission control programs have not reduced OA loading as rapidly as the reductions in inorganic particulates and black carbon. That means further fine particle control may need to focus on OA.

Evaluation and improvement of models require data-driven phenomenological PM descriptions. Real time, quantitative, and size-resolved measurement on ambient aerosol composition (e.g., with Aerosol Mass Spectrometers) is the key to this critical need. These measurements, however, were rare in California. Furthermore, while advanced analysis is essential to exploring the rich information contents of fast compositional measurement data, so far it has not been done in Northern California. The U.S. Department of Energy (DOE) funded Carbonaceous Aerosols and Radiative Effects Study (CARES) in the Sacramento area in 2010 will yield sophisticated ambient aerosol measurement data, of which detailed analyses will provide valuable insights into sources and processes of OA in the Sacramento and foothills region.

PREVIOUS WORK: The Aerodyne Aerosol Mass Spectrometers (AMS) provide real-time, quantitative, and size-resolved data on submicron particulate (PM1) species (e.g., sulfate, nitrate, ammonium, chloride, and organics) with fast time resolution.[1] Numerous field campaigns have proven AMS as a powerful tool for characterizing the properties and lifecycle of atmospheric fine PM.[2, 3]

The new High-Resolution Time-of-Flight AMS (HR-ToF-AMS) has a high mass resolution of ~ 5000 – 6000.[4] It allows the determination of the elemental ratios (O/C, N/C, etc) of OA materials,[5] based on which insights into particle sources and processes may be gained. For instance, the O/C ratio could be used as a key indicator for aerosol aging.

Coupled with a temperature-controlled thermodenuder (TD), the AMS can also provide information about volatility of individual species.[6] This information is critically important to understanding aerosol growth and lifetime.[7]

Multivariate statistical analysis of the AMS data has broadened the field of OA source appointment. These analyses deconvolve the total sub-micron OA mass into contributions from several OA types associated with distinctive sources and processes (e.g., primary, secondary, biogenic, biomass burning, etc) [Zhang et al., 2005; Zhang et al., 2007; Lanz et al., 2007; Ulbrich et al., 2009]. This lumped classification of the total organic mass may offer a simple parameterized representation of the complex OA appropriate for model evaluations and developments.

OBJECTIVE: Investigators will be funded by DOE to deploy a TD–AMS/SMPS system during CARES and to perform initial analysis to determine the concentration, size distribution, and volatility of aerosol species.

ARB funding will support advanced analyses to characterize the sources, formation, and atmospheric evolution of OA in the Sacramento and foothills region. Specific objectives are to:

1) Determine the elemental composition of OA.
2) Classify OA mass into source- and process-specific types, focusing on unraveling the influences from primary vs. secondary and urban vs. biogenic emissions.
3) Investigate the photochemical processing and evolution of aerosol pollutants in urban plumes and in mixtures of biogenic and urban emissions.
4) Collaborate with atmospheric modelers at ARB to use research results to improve and validate models.

DISCUSSION: Investigators will be funded by DOE to deploy in parallel an HR-ToF-AMS and a Scanning Mobility Particle Sizer (SMPS) after a temperature-stepping thermodenuder at Cool (the T1 site of CARES; http://acrf-campaign.arm.gov/cares) during the CalNex study period. DOE will also support the initial analyses of the TD–AMS/SMPS dataset, from which will be determined: 1) The size-resolved chemical composition of particles; 2) The temporal variations (at minutes resolution) of sulfate, nitrate, ammonium, chloride, and total organics and their size distributions; and 3) The volatility profiles of these species.

ARB funding will enable investigators to conduct further, advanced analysis to this TD-AMS/SMPS dataset and collaborate with ARB's atmospheric modelers. Research will focus on the organic content of the aerosols. Investigators will first analyze the high resolution mass spectra (HRMS) to determine the elemental compositions of OA, then perform multivariate analyses to the HRMS, chemically-resolved size distributions, and volatility profiles. Investigators will deconvolute and determine distinct OA types, which will be related to different sources and processes based on extensive examinations on their correlations with tracer compounds and other parameters.

Investigators will probe photochemical processing and evolution of OA properties characteristic to the Sacramento area via integrated analyses and focused case studies. Backtrajectory or FLEXPART analyses will be performed to examine plume sources. Photochemical behavior of air-masses will be inferred using VOC oxidation clock and AMS internal indictors such as O/C ratio.

The study will also compare the results from this research to information available from simultaneous AMS measurements to be performed at three other ground sites (i.e., downtown Sacramento, LA, and Bakersfield), two aircraft platforms (DOE and NOAA), and a ship platform (NOAA).

Finally, investigators will collaborate with atmospheric modelers at ARB to incorporate, compare, and otherwise make use of as much of the detailed study results as possible.

BENEFITS: This research will provide useful new data on organic carbonaceous PM in the Sacramento and Sierra foothills of California. Quantitative time trends, size distributions and temperature-dependent volatility profiles of multiple primary and secondary OA (i.e., POA and SOA) components in submicron particles will be obtained. From these data, important insights may be gained on the relative source strength of POA, the mechanisms leading to SOA formation, and the photochemical processing of particulate organics in Northern California. These results may be compared directly to findings from the South Coast Air Basin, the San Joaquin Valley, and mobile platforms where similar measurements will be made during CalNex. These comparisons will lead to a better understanding of regional differences in OA characteristics, sources, and effects within California. Also importantly, since these data represent a self-consistent observation-based PM description, they will have broad application within regional air quality models used to predict the efficiency of emissions control programs. In summary, the results from this research will be of immediate value for developing air quality attainment strategies in California.

CO-FUNDING: The Atmospheric System Research (ASR) Program of DOE will fund the deployment of the Thermodenuder – HR-ToF-AMS & SMPS system at the Cool site (i.e., the T1 site downwind of urban Sacramento) of the CARES campaign. The ASR will also provide three months of funding for the initial analysis of the TD-AMS/SMPS dataset. The cost of this project is much reduced because of the DOE funding.

COST: $155,000

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TITLE: Methane Emissions Source Apportionment Using Stable Isotopes

PROBLEM: Methane (CH_4) is emitted both naturally and through human activities. The global mixing ratio of CH_4 in the atmosphere has more than doubled since the pre-industrial period, rising from around 750 parts per billion (ppb) in 1800 to the current level of around 1770 ppb. With a global warming potential is 25 times that of carbon dioxide (CO_2) methane is second only to carbon dioxide as a greenhouse gas responsible for enhanced climate forcing between the pre-industrial era and the present.

As required by the AB 32, ARB developed a statewide GHG emissions inventory that provides estimates of the amount of GHGs released into the atmosphere by human activities annually within California. In addition to developing and verifying the statewide GHG emissions inventory, AB 32 also requires ARB to adopt a reduction plan of GHG emissions to 1990 levels by 2020. Researchers have recommended that controlling CH_4 emissions a cost-effective solution for reducing GHG emissions. Therefore, a verified CH_4 emissions inventory with accurate source information is critical for ARB to develop well-designed mitigation plans.

PREVIOUS WORK: Stable isotope information provides useful information on CH_4 sources and sink processes.[1,2] Stevens and Rust[3] (1982) first proposed that a mass-weighted stable carbon isotopic balance between CH_4 sources and sink processes and the $\delta^{13}CH_4$ value in the atmosphere would help define the CH_4 budget. Air samples measured for $\delta^{12}C$ and $\delta^{13}C$ values of CH_4 as well as CH_4 mixing ratio can be used to help in determining CH_4 source apportionment.

Tyler et al[4] (2009) demonstrated the effectiveness of using the above approach to study CH_4 source apportionment in the Los Angeles Basin. Individual point sources of CH_4 such as dairy farms, oil wells, oil refineries, landfills, car traffic, and sewage treatment plants were measured to characterize their CH_4 $\delta^{12}C$ and $\delta^{13}C$ compositions. In addition, integrated whole air samples were collected from various regions in the Los Angeles basin. Preliminary results indicate that Los Angeles air is dominated with thermogenic emission sources which are similar to natural gas isotopic signatures from oil extraction field and refinery emissions.

OBJECTIVE: The objective of this proposal is to provide critical CH_4 isotopic information from emission sources and at existing CH_4 monitoring network stations for source apportionment purpose. The expected results are essential to verify ARB's GHG emissions inventory. In addition, long-term records of CH_4 isotopic signatures are extremely valuable for monitoring changes of CH_4 emissions and evaluating the effectiveness of California's efforts to reduce CH_4 emissions. This study can also help identify possible un-inventoried sources.

DISCUSSION: The proposed work can be divided into four major tasks:

Task 1. Purchasing a cavity enhanced laser CH_4 isotope analyzer. As of recently, there are reliable instruments available commercially to measure $\delta^{12}C$ and $\delta^{13}C$ values of CH_4 in real time. These laser analyzers accurately generate a data point every few seconds which provides essential source isotopic information -- as opposed to the traditional gas chromatography (GC) method which requires collecting samples in vials or canisters, transporting them back to the laboratory, followed by cryogenic pre-concentration and cryo-focusing, and then analyzing them with an expensive isotope ratio mass spectrometer.[5,6] The traditional GC method is labor-intensive and expensive. With this proposed laser analyzer, one can measure essentially unlimited number of samples with significantly less instrumentation cost and maintenance expenditures. Note that the CH_4 analyzers currently installed at the CH_4 monitoring network stations are still the best choice for their accuracy and stability. However, those CH_4 analyzers measure total CH_4 mixing ratio without the isotopic composition information which is needed to further study contributing sources.

Task 2. Establish a CH_4 isotopic signatures library. The accurate method of characterizing source isotopic signatures is to apply so-called "Keeling Plot algorithm" with lots of isotopic data points measured from an emission source. The proposed laser CH_4 isotope analyzer is well designed for this task. It will be deployed at or near emission sources (e.g., landfills, natural gas production facilities, wastewater treatment plants, wetlands, dairies, rice paddies, etc). A CH_4 isotope library which includes $\delta^{12}C$ and $\delta^{13}C$ values will be established cost effectively.

Task 3. Stationary CH_4 isotope measurements. The same proposed laser CH_4 isotope analyzer will be rotated amongst existing CH_4 monitoring network stations for an extended period of time (e.g., weeks). The measured $\delta^{12}C$ and $\delta^{13}C$ values, along with wind direction and wind trajectories, will be studied and compared with those collected from CH_4 emission sources to characterize source sectors. This source contribution information will be compared with CARB's CH_4 emissions inventory which is available by source sectors. The studied results will also provide essential emissions message to the ongoing CH_4 inverse modeling project.

Task 4. Long term CH_4 isotope measurements. Long term measurements of CH_4 isotopes will continuously monitor isotopic compositions for seasonal variations and changes in emission activities.

BENEFITS: This project will enhance ARB's CH_4 monitoring network by using stable isotopes of CH_4 to differentiate emission sources, thereby facilitating source apportionment and providing critical data to verify CH_4 emissions inventory in California which is required by AB32. Effective GHG reduction strategies rely largely on accurate GHG emissions inventory. Research results will help prioritize, achieve, and verify CH_4 emissions reductions.

COST: $128,000

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TITLE: Improving California's GHG emission inventory through ground-referenced remote sensing of fossil fuel industry emissions, and biological methane and carbon dioxide emissions

PROBLEM: Meeting legislatively mandated greenhouse gas (GHG) emission targets requires accurate knowledge of GHG budgets and good decisions regarding where to focus scarce resources. Although policy has focused mostly on carbon dioxide (CO_2), methane's (CH_4) lifetime radiative impact is significant, approximately 30% of CO_2 at current concentrations. Its far shorter atmospheric residence time suggests methane regulation can be more economically efficient than regulating CO_2.[1]

Methane exhibits strong spatial variations, as well as strong diurnal and seasonal variability. These heterogeneities have been characterized by small-scale studies in select cases, but many remain uncharacterized. Spatio-temporal variability presents a significant challenge for scaling from local site and time-specific GHG measurements (e.g., ARCTAS or field sensors) to annual statewide GHG budgets. Also, discrepancies between top-down (or atmospheric inversion) and bottom up (inventory) approaches for methane budget estimation suggest significant inventory emission underestimation.[2]

Fossil Fuel Industry (FFI) emissions are the primary anthropogenic source of ancient carbon (besides combustion), while they represent the largest non-anthropogenic US CH_4 source, slightly larger than landfills;[3] yet uncertainties are three-fold. Despite their importance, a thorough literature search revealed only a couple of peer reviewed, published measurements studies in recent decades,[4,5] as opposed to inventory approaches.[6,7]

Investigators will evaluate temporal and spatial variability in CH_4 emissions using the GOSAT satellite sensor in combination with targeted field measurements, and complimentary remote observations from MODIS (Moderate Resolution Imaging Spectrometer) and AVIRIS (Airborne Visible Infrared Imaging Spectrometer). Researchers will also derive improved emission estimate for FFI emissions from key terrestrial and marine production facilities and refineries using a combination of repeat remote sensing and ground-reference measurements.

PREVIOUS WORK: AVIRIS data analysis has mapped CH_4 plumes from marine seeps using radiative transfer calculations[8] and spectral band ratios,[9] an imaging spectrometer first. Preliminary analysis of AVIRIS data for rice paddies shows strong CH_4 signatures. AVIRIS and ground-reference data are being analyzed in conjunction with contemporaneous ARCTAS/CARB data. AVIRIS data for Platform Holly captured CH_4 flaring during five overflights and is being analyzed. Analysis of SeBASS (Aerospace Corporation's hyperspectral, thermal imaging spectrometer) data mapped CH_4, CO_2, and trace gas plumes from terrestrial and marine sources, including refineries and power plants, and captured the atmospheric plumes' extreme heterogeneity, a key imaging spectrometer advantage.

Temporal emission trends were identified from two decades of West Campus Station THC data for geologic seep field emissions on diurnal, seasonal, and decadal scales.[10] Analysis shows strong, storm-driven emission modulation.[11]

Investigators have developed a field gas chromatograph (GC) four-channel, flame ion detector for CH_4, CO_2 and CO (by methanizer), and higher n-alkane for small mobile platform (boat, truck) measurement in hostile environments (sea spray) with internal air, hydrogen, and calibration gases with THC at 2 Hz and CH_4 speciation at 0.04 Hz. THC and CH_4 speciation accuracy is ~40 and ~20 ppb, respectively.

Satellite GOSAT xCH_4 data analysis is starting for geologic marine emissions and for SCIAMACHY data, CH_4 emission are being analyzed in collaboration with Bremen IUP (Germany), and show high correlation between anomalously high, regional CH_4 columns and FFI production. These preliminary analyses justified (NSF supported) vicarious collection of Gulf of Mexico platform observations during AVIRIS operations in response to the Gulf Oil Spill. The MODIS active fire product data has been used to validate fire danger indices[12] and to estimate fire temperature and area, which modify emission efficiency.[13]

OBJECTIVE: The objective is to investigate the seasonal and diurnal variability of a range of important biological GHG emission sources, particularly, rice paddies, forest fires, coastal wetlands, shallow lakes or reservoirs, and FFI facilities, using a combination of GOSAT GHG satellite data, ground-reference measurements (GC and fixed stations), and AVIRIS and MODIS data. For FFI emissions, we will derive an improved emission estimate from key marine and terrestrial production sources including refineries by repeat remote sensing and ground reference measurements.

This study leverages the successful NASA-funded approach that pioneered mapping CH_4 with AVIRIS for natural marine (low-albedo surface) geologic CH_4 emissions,[8] and Aerospace Corporation experience mapping methane emissions with the SeBASS sensor. To reduce costs we will seek to combine with other NASA projects to share AVIRIS launch costs, including data from calibration flights (courtesy of collaboration with JPL), or through collaboration with a JPL Ventures project to measure CH_4 spectroscopically, or from existing AVIRIS data. Methane will be mapped directly from AVIRIS data, while MODIS data will allow evaluation of the relationship between MODIS-derived measures of rice productivity (from measures such as the Normalized Difference Vegetation Index) and GOSAT-derived GHG budgets. The MODIS active fire product will be used to evaluate the relationship between GHG emissions and active fires. This will dramatically improve annual California GHG budgets by improving scaling of disparate ground-based sensor measurements, such as the California GHG monitoring network, to a statewide basis. Further improvements in inventories will result from including seasonal variations based on satellite data. Scaling FFI methane emissions will be based on California facility data and compared with SCIAMACHY and GOSAT CH_4 products.

DISCUSSION: Our approach is nested (satellite, GOSAT–10x10km pixels; aerial, AVIRIS; surface ground-reference measurements). We will collect and analyze GOSAT and SCIAMACHY (historical) CH_4 column-abundances for important California CH_4 sources: FFI emissions, fires, rice paddies, wetland emissions, and shallow water reservoirs on a regional (e.g., Sacramento basin) and statewide basis and for ground-reference sites. GOSAT CH_4 column-abundances will be compared for California rice growing areas and wetland areas with MODIS NDVI data of plant productivity and biomass. Studies show the two are correlated, although underlying processes (temperature, microbial activity, plant productivity, etc) likely are important. MODIS fire data also will be related to CH_4 emissions. Here, biomass buildup provides available fuel for fires and CH_4 emissions. Satellite data will allow assessment of temporal (annual estimate) emissions.

AVIRIS reference data will be used to reference GOSAT and MODIS satellite data, timed to coincide with GOSAT overpasses for optimum time in terms of illumination (solstice), and weather (low cloud cover probability), i.e., towards mid-summer, and emissions from seasonally varying sources like agriculture and fires. A single ER2 AVIRIS flight can cover all sites in one day; however, costs are high if not requested within NASA. We are endeavoring to secure support through JPL collaborations by providing local, California-based ground reference data. Data analysis will use the methods of Roberts[8] and Bradley[10] modified to terrestrial (heterogeneous) surfaces.

Airborne data will be ground referenced with coordinated measurements from fixed (air pollution stations) and mobile (boat, plane, truck) platforms, coordinated with aerial overflights to characterize CH_4 plumes including aerial *in situ* sampling (during SeBASS flights). Then, emissions are derived from plume modeling,[14] while relative facility emissions can be inferred directly from retrieved CH_4 column abundances. Where accessible, air pollution station data analysis will be used to derive annual emissions and identify temporal trends.[10]

California study sites leverage proximity to Edwards AFB, UCSB, offshore facilities, and Aerosopace Corporation. AVIRIS has overflown offshore SB Channel platforms–1×10^6 barrel day^{-1}; flights are needed for the Elk Hills Field (2387 wells, 7×10^4 barrel day^{-1}) and other oil fields in the Bakersfield area. Here, ARCTAS measured the highest CH_4 levels anywhere in California. These levels could relate to enhanced emissions through natural migration pathways due to re-injection, which spatial mapping could reveal.

Method application will focus on quantifying approach limitations with respect to detection limits by radiative transfer modeling (e.g., Roberts[8]), statistical analysis of variability between facility emissions, and comparison with bottom-up emission budgets.

BENEFITS: The primary study benefits are improved estimates of important biological and geological CH_4 source emissions, from FFI, fires, rice paddies, wetland emissions, and shallow water reservoirs. FFI is the largest anthropogenic CH_4 source, yet emissions estimates largely remain unvalidated. Data analysis will identify the most economically efficient mitigation targets, enabling more effective regulatory mitigation strategies.

Biological source uncertainties are large and highly variable, seasonally and interannually. Relating these source emissions to MODIS data will improve statewide inventories, which are based on scaling from local to statewide emissions. Further, through connection to GOSAT methane data, the discrepancy between top-down and bottom-up estimates on a statewide basis can be reduced for these important sources.

Anticipated publications from this research (PIs have a proven publication track record) will be an important benefit given the near absence of peer-reviewed literature on FFI CH_4 emissions and the paucity of studies on other biological sources. Finally, we will further refine remote sensing techniques developed for the relatively spectrally homogeneous sea surface to terrestrial sources.

CO-FUNDING: A NASA proposal is under consideration to identify Gulf of Mexico FFI emissions by remote sensing and ground reference measurements ($400k). Benefits arise from a NASA AVIRIS project (Leifer $589) to remote sense and ground-reference CH_4, and a University of Utah subcontract (Roberts $296K) to develop hyperspectral indices for estimating fire temperatures and mapping methane. Leifer and Roberts are GOSAT Research Associates, providing access to GOSAT data that are not publicly available. Leifer also is PI for the first NASA Gulf Oil Spill Airborne Response for data collection (~487.5k), and has collected extensive platform data. Further, a NSF RAPID (200k) study is funded to analyze the GOM platform data and collect *in situ* samples.

COST: $350,000

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TITLE: Synthesis of policy-relevant findings from the CalNex 2010 field study

PROBLEM: The field phase of the joint ARB-NOAA CalNex 2010 field study (see Study Overviews referenced below) was completed during the summer of 2010. It is important to now ensure that the results of that study are made fully available to California policy makers who must deal with air quality and climate change issues. The fieldwork was planned to address twelve Science Questions (see the CalNex White Paper referenced below for a listing of these questions) that were formulated to guide the study planning. The questions address many specific and general science needs that are required to improve policy responses to air quality and climate change issues. They address emissions (both greenhouse gases and ozone and aerosol precursors), important atmospheric transformation and climate processes, and transport and meteorology. Instrumentation and platforms were deployed to collect the data sets necessary to address these questions. Analysis of the resulting data sets will lead to a great many science publications during the coming years. However, these publications are intended to present interesting scientific findings, but will not necessarily directly address the Science Questions. *As fully as possible the findings from these publications and from other needed analysis must be synthesized in a timely fashion and in a form most useful to policy makers. Completing that synthesis is the problem to be addressed by this work.*

PREVIOUS WORK: Preliminary data sets from the completed CalNex 2010 fieldwork have been prepared, for the most part while the field deployments were underway. Presently, measurement results are being subjected to quality assurance/quality control procedures, and the final data archives are being prepared. Individual scientists are formulating the analyses that they find exciting and intend to follow through to scientific publications. ARB's contracts for data collection also funded data analysis by the Principle Investigators and NOAA has plans for a significant data analysis effort.

OBJECTIVE: The goal of the proposed work is to bring the results of the ongoing CalNex 2010 analysis together to answer the twelve Science Questions as fully as possible, in a timely fashion and in a form most useful to policy makers.

DISCUSSION: The proposed work can be divided into three major parts:

1) ***Coordination and integration of ongoing analyses*** being conducted by separate scientists with a diverse range of interests. The results of these analyses will be presented at a variety of forums, and published in a variety of journals. A coherent synthesis of these results as they pertain to the Science Questions in a single location will greatly benefit policy makers. This synthesis will comprise a whole that is significantly greater than the sum of the individual analyses.
2) ***Identification and performance of additional needed analysis.*** It is very likely that some aspects of the Science Questions will not be directly addressed by the spontaneous analyses conducted by individual scientists. Such "holes" will be identified and filled with additional analysis to the extent that resources allow.
3) ***Interaction with California regional air quality modelers.*** The CalNex 2010 data set will provide an unprecedented wealth of data to which model simulations can be compared. In previous field studies we have found that close interaction

between the measurement people and the modelers significantly improves the ultimate scientific as well as policy relevant information that finally emerges. One goal of the proposed work is to facilitate one-on-one and small group interactions between these two, often disconnected, groups of workers.

The work outlined in the above three parts could be a very resource intensive process. Support requested here is relatively modest, and close attention will be paid to prioritizing the effort in order to maximize the return from this support.

BENEFITS: The state of California (as well as the federal government) has made a substantial investment in conducting the field measurement phase of the CalNex 2010 field study. A very wide range of scientific findings based upon the resulting data sets will be published in the coming years. The work proposed here will maximize the policy relevant information that can result from these findings, and will present that information in a timely fashion and in a form most useful to policy makers. The availability of this information will provide the basis for improving the effectiveness and the efficiency of California air quality and climate change policies.

COST: $250,000

CO-FUNDING: Several hundred scientists in the federal, state and university systems have been involved in the measurement phase of CalNex, and generally all are supported through various channels to participate in the ongoing data analysis and presentation of results. The work proposed here is designed to leverage this very large investment to maximize the relevant information that can be conveyed to the California policy community as efficiently as possible.

REFERENCES:

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NOAA CalNex Science and Implementation Plan, http://esrl.noaa.gov/csd/calnex/scienceplan.pdf
Study overviews, http://www.arb.ca.gov/research/calnex2010/calnex2010.htm and http://esrl.noaa.gov/csd/calnex/

APPENDIX C: Concepts Recommended for Climate Change, Energy Efficiency and Conservation

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Concepts Recommended for Funding

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TITLE: Developing databases to estimate California-specific climate forcing benefits of "cool roofs"

PROBLEM: Recognition of the potentially devastating environmental impact of uncontrolled emissions of greenhouse gases (GHGs) led to passage of the Global Warming Solutions Act in 2006 which committed California to cap and then reduce emissions of anthropogenic GHGs to 1990 levels by 2020. "Cool roofs" - roofs which reflect a larger potion of the sun's radiation than conventional roof materials - are recognized to decrease air conditioning load, thereby saving electricity and the associated CO_2 emissions. In addition to energy savings, modifications that increase roof reflectivity (albedo) also produce a climate "benefit" by creating a negative radiative forcing proportional to the amount of additional sunlight reflected back through the atmosphere to space, compared to the preexisting surface. The magnitude of this benefit for any particular building or community depends on the marginal increase in albedo achieved by changing or coating roofing material, the total area of roof converted, and the amount of sunlight at the building site(s). The effect of albedo change on radiative forcing, and thus the magnitude of the benefit, is likely to vary widely across the state, as California climates range from cloudy temperate rainforest to sunny desert. Thus, to accurately estimate the impact of a large number of "cool roofs" in California it is necessary to collect and assimilate baseline data on incident radiation and current albedo of urban areas in the state.

PREVIOUS WORK: Investigators from Lawrence Berkeley National Laboratory, the National Center for Atmospheric Research, the Climate Institute, and the University of Almeria Spain have developed estimates of energy reduction (due to cooling load reduction) and general estimates of climate forcing benefits for indirect albedo associated with cool roofs and pavements, as well as shade trees. Lenton et al.[1] have provided pointed criticism of the general nature and methods of calculation for Akbari et al.[2] ARB-sponsored peer reviewers of Akbari et al. concluded that indirect albedo benefits of cool surfaces were real but suggested than California-specific data must be used to accurately and precisely estimate the state-wide climate forcing benefits for cool communities in California. Responding to this guidance and using the California Irrigation Management Information System (CIMIS) hourly broadband solar radiation data, ARB staff computed detailed, local (specific to CIMIS sites) fluxes of shortwave radiation for various areas of the state and then used these fluxes to estimate total cool roof indirect albedo climate forcing benefits for California.

OBJECTIVE: This project will collect and develop inputs of local urban core radiation and albedo necessary for improved estimates of the climate benefits of increasing urban albedo through the widespread application of "cool roofs". Additional funding would be needed to model the carbon dioxide (CO_2) equivalent total climate forcing benefits for cool roofs and pavements,

DESCRIPTION: Computing the benefit to climate of increasing urban albedo requires knowing the optical characteristics of old and new roofing materials, the applied roof area (horizontal surface "footprint"), and how much sunlight can be rejected back to space at the building site. This project will improve the model inputs for the first and last items. The current or baseline albedo of urban areas is typically treated in these types of calculations as a single value, representative of global urban albedo. Actual urban albedo in California varies due to a number of factors such as roof color and amount of tree canopy. This proposal will use satellite albedo measurements available for seven major urban areas in California (Los Angeles, San Diego, San Jose, San Francisco, Fresno, Long Beach and Sacramento) and incorporate previous albedo approaches to create an albedo maps for California.

California's climate has a relatively large variation from cool, frequent overcast areas such as the north coast to hot and very sunny desert. To help manage irrigation resources, California maintains a broad network of 120 solar radiation measurement sites. However, none of the CIMIS sites are located in urban areas. Since it is not clear that CIMIS sites are representative of California's urban radiation flux this project will establish and monitor five solar radiation sites, three in major urban areas of diverse radiative strength and two co-located with existing CIMIS sites,

BENEFITS: The databases generated by this proposal will improve estimates of CO_2 equivalent climate forcing benefits of a program to increase urban albedo in California. If additional funding for the modeling effort were identified, the researchers developing the database in this project could interact and collaborate with the modelers, maximizing the utility of the database for radiative modeling. Improved confidence in the total benefits associated with "cool roofs" and, by analogy, "cool pavements", will allow regulators to properly include these benefits in efforts to mitigate the effects of climate change.

COST: $250,000

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TITLE: The role of land use planning in reducing residential energy consumption and greenhouse gas emissions

PROBLEM: The vast majority of literature concerning the relationship between land use planning and greenhouse gas emissions has focused on the emissions from the transportation sector. This is understandable, since 55 percent of the emissions from the average California household stem from transportation.[1-3] However, researchers have largely ignored the relationship between land use planning and the next largest end-use sector—residences—which account for 37 percent of household emissions in California.[3, 4]

Roughly one-fifth of these emissions (or seven percent of the residential total) are due to heating and cooling, which are partly a function of house size and orientation, and therefore strongly tied to land use planning decisions. However, this share may increase substantially in the future as the state experiences rapid population growth in inland areas with hotter climates and greater temperature differentials. Many counties in San Joaquin valley are now growing at over twice the rate of relatively mild coastal metropolitan areas.[5] The California Department of Finance (2007) estimates that the state population will rise from roughly 37 million today to 60 million in 2050 – the very same period in which greenhouse gas emissions must be cut by 80 percent relative to 1990 levels. To accommodate this growth and still meet climate goals, the state must use every tool available to reduce emissions from all sources, including residential heating and cooling.

PREVIOUS WORK: The few academic studies that have examined residential energy use as a function of urban form[6-8] have concluded that residents living in high density urban centers emit 20 to 50 percent fewer greenhouse gases due to heating and electricity than residents of low density suburbs.[7,9] These studies have relied upon data sets created by national energy agencies, rather than more disaggregated state- or local-scale data that more accurately reflects local climatic conditions.

Portland Metro, the regional planning agency in the Portland, OR area, created a simple residential emissions spreadsheet modeling tool in 2007 that used more localized data. Portland General Electric (PGE) supplied Metro with data on average electricity consumption for households by occupancy and housing type. Using additional data compiled by the Northwest Power Coordinating Council (NWPCC), which collects sample usage data from Oregon, Washington, and Idaho, the relationship between energy consumption, square footage, number of occupants, and housing type could be modeled for differing socio-economic strata using ordinary least squares regression. The modeling tool has found, for example, that energy use and greenhouse gas emissions are roughly 30 to 50 percent lower per square foot in multi-family than in single-family housing, given roughly comparably residence size and socio-economic status.

OBJECTIVE: The objective of the project is to create a spreadsheet modeling tool that analyzes residential energy use within California climate zones as a function of land use planning factors.

DISCUSSION: The research would involve the following tasks:

1. Obtain disaggregate residential energy use data at an appropriate scale within selected California climate zones of interest.
2. Obtain relevant data on land use planning factors that may influence residential energy use, including housing type (e.g. single-family vs. multi-family), residence size, solar orientation, shading, and configuration of multi-family units; as well as other factors that contribute to household energy use, such as climate and number of occupants.
3. Conduct statistical analyses (likely using ordinary least squares regression) of the relationship between land use planning factors and residential energy use while controlling for other factors.
4. Create a spreadsheet modeling tool that estimates residential GHG emissions as a function of land use planning factors by climate zone. Depending upon the quality of energy use data available, this will likely involve applying regression coefficients to existing data for average consumption by occupancy and housing type to model energy use across relevant dependent variables.
5. Apply the statistical model to calculate average annual energy use and emissions estimates for selected housing types or other categories of consumers.

BENEFITS: These research results will support implementation of AB32 by allowing local governments to estimate the residential energy use and greenhouse gas emission implications of land use planning decisions about housing type, density, orientation and configuration. For example, these findings can directly support achievement of AB32's Green Building Strategy (strategy #13 in the Scoping Plan). They can also complement analogous information about the relationship of land use planning variables to vehicle miles traveled (VMT) and transportation energy consumption, the topic of an ARB-sponsored research project in 2009-2010. Together, these two spreadsheet models can inform a variety of local and regional planning processes, including general plans, building and zoning code updates, climate action plans, and long-term blueprint growth plans. They can also create an analytical framework for expanding SB 375 to apply to GHG emissions in sectors beyond transportation. In addition, these findings could also help establish clear thresholds of significance for climate change-related impacts under the California Environmental Quality Act for proposed new housing developments.

COST: $100,000

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TITLE: Development and evaluation of energy-efficient approaches to keeping building occupants cool using room air motion

PROBLEM: Moving air cools the human body. In warm conditions, it can provide the same comfort as compression-based air conditioning, but at lower energy cost. Fans of very low wattage (as low as 3W for a personal fan) can produce 1 m/s (2 mph) near the occupant, offsetting 3K (6°F) of air temperature. The savings in HVAC energy is substantial (over 30% of cooling HVAC energy in mechanically conditioned buildings),[1] and greater if the fans enable the building to be successfully conditioned by natural ventilation or evaporative cooling systems, instead of chillers. In the past, air movement technology has been impeded by contrary standards, and there has been little innovation in the industry. The products on the market are mostly a limited set of generic ceiling, desk, and stand fans.

The challenge is to implement air movement in ways that are highly energy efficient, comfortable, and acceptable to occupants, as well as visually attractive to building management and designers. A few prototype systems meeting these criteria have been quantified in recent tests. Prototypes included fan and nozzle configurations that could be attached to office furniture, partitions, and ceilings. They were silent and could be reliably controlled with occupancy sensors. The opportunities for design improvements and new products are great. However, architects, interior designers, and manufacturers lack evidence that realistic configurations of fans can provide a high-quality comfort environment at low energy cost. This evidence is needed to encourage such a major change in indoor environmental control.

PREVIOUS WORK: In the past, ASHRAE Standard 55 restricted the use of air movement by treating it as draft. This has now been changed following Center for the Built Environment (CBE) findings that large majorities of office occupants prefer increased air movement.[2,3] The standard now contains robust provisions for using air movement cooling in warm environments.[4]

CBE has a history of studying air movement for comfort in both laboratory and field studies. Early laboratory studies showed that comfort can be well-maintained by air movement in high ambient temperatures as high as 82°F and 86°F.[5,6] Recent laboratory studies show that a 3W personally ventilated fan can make people comfortable at high ambient temperatures.[7] These studies also showed that air movement significantly improved people's perceived air quality, possibly by disrupting the body's thermal plume in which pollution is carried to the breathing zone. Field studies have shown personally controlled air movement systems to be highly popular in offices.[8] Currently CBE is designing several prototypes of low wattage personal fans/nozzles standing alone or combining with furniture (about 3W, with occupancy sensors) and will install approximately 200 of them in two to three naturally ventilated buildings (funding has been approved from CEC/PIER).

OBJECTIVE: Promote the use of fan-powered air movement to reduce compressor-based cooling in office buildings through the following steps:

- Test combinations of nozzles and propeller fans mounted on or in office furniture, partitions, and ceiling panels. Collaborate with CBE industry partners to integrate fans in their products: e.g., Armstrong for acoustic ceilings, Haworth and Steelcase for office furniture and partitions.

- Characterize the physiological cooling effect for these combinations using the CBE thermal manikin. Quantify how much the ambient indoor temperature range can be expanded.
- Test human subjects to quantify their comfort and satisfaction under long-term and short-term transient exposures. Characterize their use of personal environmental controls.
- Prepare a report for designers, owners, and manufacturers of interiors and furniture systems.

DISCUSSION:
Primary tasks include:

- Install ceiling and personal fans in four configurations (integration of ceiling fans/nozzle jets with suspended ceilings, personal fans with partitions and furniture, ceiling fan and personal fan alone or combinations of both). Investigators will set up one workstation in the chamber. One ceiling fan and one personal fan will be tested in each test configuration, but the types of fans will be changed in successive tests. Investigators will choose and test fans with low wattage inputs. Some of the ceiling fans and personal fans will be unique designs or modifications of existing fans.
- Measure the velocity profiles of various configurations, and heat loss from a 16-body segmented thermal manikin.
- Conduct human subject test in the CBE environmental chamber to determine the effect of air movement on human thermal comfort from different types of fans and modes of installation; optimize the configurations of the fan types, speed, installations. Thirty human subjects will each participate in all four test configurations. Transient effects on comfort will be examined between the different test configurations.

In all, the total number of human subjects tests will be 120 (4 configurations x 30 subjects/configuration).

BENEFITS: This study will directly support designs of naturally ventilated buildings. The use of well-designed fans makes naturally ventilated building designs more feasible for the times when wind is weak. They also extend the outdoor temperature range within which less powerful evaporative or ground-source cooling sources may be used. Fans also strengthen the effectiveness of other energy-efficient measures which may be inherently slow-acting or unpredictable, such as radiant ceilings/floors.

Room fans have advantages in both new and retrofit designs since they do not involve other HVAC systems, can be easily turned on and off (as with occupancy sensors or wireless controls), and they can provide instantaneous comfort. Well-integrated fan systems are both cost effective and energy effective.

There may be health benefits as well. Several large field studies surveying people in office buildings have found that sick building syndrome is significantly less in the NV buildings than in the HVAC buildings.[9,10]

CO-FUNDING: This project will be coupled with two CEC/PIER projects: in "Advanced Integrated Systems Tools Development and Performance Testing," investigators are designing and manufacturing several low-wattage prototype fan units for use in office workstations and furniture ($190,000), and improving EnergyPlus to better predict energy use by integrated fan systems. In the "Natural Ventilation for Energy Savings in California Commercial Buildings," investigators will monitor occupants' use of these fans and their satisfaction with them over a year in an office building ($180,000).

COST: $150,000

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TITLE: Using feedback from commercial buildings to support energy-conserving behavior at work and at home

PROBLEM: In 2006, California's residential buildings produced 34MMT of greenhouse gases (GHGs), while commercial buildings produced 14 MMT of GHGs.[1] Many efforts advance technological solutions for this problem. Yet, few people purchase such technologies for their homes; and interest in buying such technologies remains low. People are, however, generally interested in learning about their energy use.[2] This suggests that GHG reductions from residential sources may be achieved through social and behavioral approaches. Uptake of energy-conserving technologies is better among commercial buildings; however, occupant impacts often increase energy use far above expected levels.[3] For example, when occupants view building technologies as inconvenient, they may disable them.[4-6] Thus, occupant behavior is an important part of energy use and GHG reductions in the commercial realm as well. This research will look at a single method to reduce both residential and commercial GHG emissions.

PREVIOUS WORK: Recent articles have touted the energy savings offered by building feedback systems.[7-9] What is missing is a discussion of the population using these devices. Opt-in techniques generally attract homeowners that are already interested in resource-efficiency, those who have already taken steps to reduce their carbon footprint.[10] Comments from the CBE survey database suggest that a similar dichotomy of users exists in the commercial realm.[11] There is much research about the technological requirements of creating feedback outlets for occupants, and some discussion of potential energy use reductions among the motivated. Little work has focused on these systems' abilities to change motivations and behavior for the unmotivated. CBE has developed and widely used a survey designed to gauge opinions about buildings, their energy efficiency and their environmental conditions. This tool can be used in conjunction with CBE's newly developed building feedback systems to investigate the issue.

OBJECTIVE: The project has three objectives. It will identify the kinds of energy conservation-related information most likely to influence different segments of the workforce. It will quantify the degree to which this information affects energy-conserving beliefs and behaviors at work and at home. It will also quantify the GHG reduction potential associated with the stated behaviors.

DISCUSSION: At the conclusion of a CBE-funded pilot test described in the co-funding section, CBE will identify up to three buildings for installations.[2] One site will receive an information-only feedback system mirroring the industry standard. This will serve as the control case. The other sites will receive CBE's enhanced feedback systems. Occupants at each site will interact with the systems for six months. Occupants will be surveyed at the beginning and end of the implementation using largely identical questionnaires. In addition to demographic and psychographic batteries, they will be asked about their energy-related beliefs and actions at work and home. The survey will not gather any identifying information. After gathering the data, CBE will compare

[2] Several industry partners and research affiliates have expressed interest.

occupants' energy-conserving beliefs and actions before and after interacting with the feedback system as well as across demographic and psychographic groups. Differences between occupants that interacted with the standard and enhanced systems will also be analyzed. The reported behaviors will then be translated into energy and GHG reductions.

BENEFITS: This work will create a useful tool that the building industry may use for actual energy reductions, and thus GHG reductions. The results may also encourage more building owners to include such systems and policymakers to develop incentives for their inclusion in more buildings. The project will also be one of very few to report on potential to motivate the large portion of the population that has yet to take action to reduce GHG emissions through decreased energy use.

CO-FUNDING: CBE's industry partners provide ongoing support for the building occupant survey tools and have co-funded-- with the California Energy Commission PIER Program-- a research project to develop and test new types of building feedback for occupants. Funding from California ARB will support the next phase of this work: integration of the survey and feedback tools, and the installation of the systems into three buildings.

COST: $185,000

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TITLE: Reducing energy use through optimized communication of real-time residential energy usage information

PROBLEM: California must reduce GHG emissions by 30 percent over the next decade to meet goals set by AB32. In the realm of electricity, recent focus has emphasized increasing the share of renewable power sources on the grid, with less attention given to demand management. Recent studies estimate that behavioral changes can reduce residential energy consumption by between 22 and 30 percent over the next 5 to 8 years[1,2] To foster reduced residential energy consumption, high-resolution energy metering and electrical sub-meterings with dashboard displays are being rolled out across California. One of the potential benefits of these displays is that consumers can receive more information (feedback) about their electricity usage. This increased level of feedback is intended to empower consumers to make better decisions and cut back on their electricity usage. But given the high costs of action, and the low marginal costs of electricity, will consumers actually behave in this manner? Surprisingly little work has been done on the subject, with most previous studies involving small samples of homes and yielding mixed results. Indeed, some studies suggest that more information can lead to an increase in electricity usage.[3] Motivating energy-conserving behavioral change through provision of information requires a clear understanding of how target audiences respond to various styles and content of communication.

PREVIOUS WORK: In a survey of previous studies, covering a multitude of feedback mechanisms, Fischer (2008) reports that feedback results in a reduction of electricity usage of between 1.1 and 20 percent.[4] The majority of these studies surveyed took place in Europe, with only 3 out of 26 taking place in the United States. Many U.S. colleges have experimented with feedback mechanisms following a successful study at Oberlin College, where a mixture of dormitory-level feedback and competition between the dormitories reduced electricity usage by 32 percent over a two-week period.[5] OPower offers consumers feedback on neighborhood-level norms for electricity usage and find that electricity usage is reduced by an average of 2.5 percent. There is, however, significant heterogeneity in this result, with some users increasing their electricity usage. A formal evaluation is forthcoming. In California, a number of utilities are currently installing Smart Grid systems with possible real time consumer feedback. It remains to be determined how this information will be presented and how its effects will be evaluated.

OBJECTIVE: The goal of this project is to determine how to best present electricity usage information to heterogeneous electricity consumers so as to induce conservation. To this end, investigators will test and evaluate a number of non-pecuniary interventions based on increased feedback (information) to customers. Private information is information about an individual's usage that is available strictly to the individual. Public information is usage information that is available in the public realm, either at the aggregate or individual level. Varying the quantity and type of public and private information available will help investigators clarify the linkages between personal responsibility, social norms and social pressure/status effects. Investigators will also probe how the connection between new information and existing preconceptions about electricity usage leads to behavior change.

DISCUSSION: Residents of college dormitories face no marginal cost for electricity consumption. As a result, they have no financial incentive to curtail their usage. This makes them a convenient study group for pure information effects.

Investigators have developed the technology to wirelessly monitor plug load, lighting and HVAC usage within a room and have the funding to conduct a pilot study at UCLA. Investigators are currently in the process of installing electricity monitors in 90 dorm rooms. These monitors will give real-time room level feedback on electricity usage. The goal of this pilot is to determine if an incentive structure based on personal responsibility (through providing real-time, room-level energy consumption information) and social pressure (by sharing energy consumption information within the residence hall community) effectively encourages energy conservation.

The proposed effort will expand upon this ongoing pilot project to enable a larger number of treatments as well as include users with apartment-style living arrangements. Several private information treatments will be devised, in which investigators will vary the type of information that is available and evaluate how different consumers respond to this information. Private information can vary according to the units presented (CO_2, kWh, ecological effects, etc.), the time period presented (real time usage, daily usage), the method of aggregation (deviations from the user's norm, deviations from the group norm), and the mode of presentation (chart, display dial, animated picture, etc.). Several public treatments are also proposed, in which investigators will vary what other people know about the user (full disclosure of all usage, voluntary disclosure of top energy savers, involuntary disclosure of energy "hogs"), as well as what the user knows about others (average usage, usage of neighbors most similar, average improvements of other users, etc.). The study will expand from 80 rooms in the pilot to an entire residence hall (300 rooms) and to 200 graduate student family apartments.

BENEFITS: A large number of utilities are rolling out Smart Meters that have the capabilities for real-time feedback to consumers. However, there is a lack of research regarding how information can be used as to promote residential electricity conservation. Better knowledge on how consumers respond to this information and how to best share this information with consumers will serve to reduce aggregate electricity demand and help California meet its obligations under AB32. Lessons learned can also be applied to universities across California to reduce the State's electric bill.

CO-FUNDING: Investigators have received $15,000 from UC Centre for Energy and Environmental Economics (UCEEE), and $42,000 from The Green Initiative Fund at UCLA for a pilot study.

COST: $330,000 (Based on 10% overhead. Original request figured 54% UCLA overhead for total requested $461,722.)

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TITLE: Monitoring and evaluating strategies for changing behavior using the CoolCalifornia.org resource developed by ARB

PROBLEM: Evidence from social psychology indicates that improved access to information does not suffice to motivate individuals and communities to take action, even when action is rational and/or in the audience's best interests. In addition to information, individuals' values, habits, abilities, worldviews, and social and economic constraints are among the factors influence behavior. Social psychologists contend that it is critical to tailor information-based messages to different audiences and to leverage social motivations for behavior change. For example, encouraging individuals to make public commitments, fostering group identification, and developing competitions have all been demonstrated as effective strategies to foster behavior change. As articulated in the Scoping Plan, voluntary emissions reductions will play a critical role in meeting California's climate change goals. Hence, understanding how to motivate voluntary emissions reductions is a crucial part of the State's climate change strategy.

PREVIOUS WORK: In November 2008, ARB partnered with UC Berkeley (UCB) to develop interactive, advanced California-specific consumption-based carbon footprint calculators for households and small businesses. The intention of developing calculators is to support voluntary emissions reductions. The first phase of the project has produced sophisticated calculators that incorporate advanced life cycle assessment, carbon footprint benchmarking, financial and greenhouse gas scenario building, GIS-based carbon footprint maps, and online community social networking.

Starting in early 2010, versions of the CoolCalifornia Calculator and the full CoolClimate Calculator are being extended to communities and organizations throughout California and the nation. Each community will use the calculator in a somewhat different way. For example, volunteers in Monterey and Santa Cruz counties will go to hundreds of households door-to-door, initially targeting low income communities; Davis is already bringing hundreds of households together physically and online to tack progress toward commitments using the calculator; Berkeley is conducting dozens of workshops and training trainers to conduct programs in schools; and each of these communities is interested in engaging in competitions both within and between communities. Other organizations will model similar initiatives on the success of these pilots.

OBJECTIVE: This investigation will provide the state with empirical evidence from a California-based study to help illuminate barriers to adopting climate-friendly behaviors. Specifically, this work will 1) assess total greenhouse gas emissions reduced via a variety of projects involving CoolCalifornia and CoolClimate resources, 2) illuminate how new information tools can be most effectively used by the State to encourage more sustainable behavior, and 3) compare the behavioral changes induced by different community-based greenhouse gas reduction programs in California.

DISCUSSION: Ongoing, voluntary community initiatives that incorporate CoolCalifornia resources into efforts to reduce GHG emissions provide excellent opportunities to test the effectiveness of different messaging strategies, community participation models, and social marketing techniques and theories to demographically and geographically distinct audiences.

In addition to assessing ongoing initiatives involving CoolCalifornia, the investigator will conduct a randomized controlled study to monitor and evaluate the effectiveness of different program models using the CoolCalifornia calculator and to test social marketing and social networking strategies that build on behavioral psychology theory. Participating households will be asked to make pledges for GHG emissions-reducing actions. Households will be contacted several times over the study period allowing us to track compliance with pledge commitments under different program models. Investigators will track users' carbon footprints, commitments, pledges and profile information, including location and demographic variables. Quantitative analysis of household data will be complemented by interviews to discern what features of the programs were (or were not) meaningful, motivational, and effective to the participants.

Additionally, staff is in discussion internally and with UCB researchers to identify a simple pilot strategy that households can adopt to reduce emissions, and to design a voluntary intervention effort for testing and evaluation. The objective of this effort is to craft low-cost interventions that are replicable across the State. Appropriate pilot strategies will be low-cost, based on readily adoptable behavioral change, and build on tools developed by the State.

BENEFITS: This investigation will add significantly to the State's understanding of how to effectively motivate voluntary GHG emissions reductions and energy conservation by providing empirical evidence from a California-based study. The results will be directly relevant to ARB, as the initiatives to be tested involve a resource developed by ARB in collaboration with UCB for promotion of voluntary emissions reductions by households and small businesses in California.

CO-FUNDING: The calculator has already has hundreds of thousands of users. By working with programs in different communities that are actively engaged with households we will be able to provide monitoring of data collection and verification of results. Several communities are already enthusiastic about participating in such a study and will supply staffing and trained volunteers to conduct much of the data collection.

COST: $300,000

APPENDIX D: Concepts Recommended for Technology Research and Development

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TITLE: Zero on-site pollution for portable power applications including generators and lawnmowers

PROBLEM: Over 5.85 Million lawnmowers were purchased in 2004 and only 13% of the purchased mowers were electric. The vast majority of heavy users such as professional landscapers only use combustion based lawnmowers. Lawnmowers continue to be a significant pollution source. It has been estimated that 15% of GHG emissions come from small spark ignition engines and 5% from lawnmowers alone. While improvements in small combustion engine technology are occurring, engines continue to be a major source of pollution especially when considering the relatively small amount of energy consumption. Electric lawnmowers are effective for some homeowners but even the most advanced battery technology is not capable of providing a reasonable solution for professional landscape crews and the bulk of small combustion engine users.

Hydrogen fuel cells can run at very high efficiencies with near zero on-site pollution. However, hydrogen production, storage, and distribution issues continue to encompass the most significant set of challenges impacting practical fuel cell commercialization. Small combustion engines are a strong contender for early fuel cell adoption as they are highly polluting, have poor energy efficiency, and may potentially be serviced with existing distribution channels. A hydrogen storage solution is required with low cost, low operating pressure, easy-to-use operation, and has high energy/power density.

PREVIOUS WORK: SiGNa Chemistry is based on the company's core technology for transforming reactive alkali metals and their derivatives into safe, free-flowing powders. Sodium silicide, NaSi, produces up to 10 wt.% hydrogen just from the reaction with water. The production of hydrogen can be controlled by the rate of water addition. Hydrogen can be generated on demand for portable applications such as: personal mobility, backup power, emergency power, and small combustion engines. The reaction by-product is a common industrial chemical, $Na_2Si_2O_5$, which is benign creating no risk to the environment and has an array of industrial uses. The chemical reaction is as follows:

$2NaSi(s) + 5H_2O(\ell)\ 5H\Diamond_2(g) + Na_2Si_2O_5(aq)$

The net result is a lightweight, packaged fuel which generates hydrogen at a nominal pressure of 15 psi. With packaging, the fuel energy density is approximately 1400 W-Hr/kg. For comparison, high-performance / high-power batteries store energy at below 60 W-Hr/kg. This translates to a 20X decrease in weight as compared to batteries which makes sodium silicide a strong contender for a range of portable power applications like lawnmowers. SiGNa has demonstrated the technology on electric bicycles and small generators capable of 300 Watts of continuous power. Initial research indicates lawnmowers require an average power of 750 to 1500 Watts. The NaSi reaction is readily capable of generating the higher required flow rates. However, an improved cooling system and a scaled-up water feed system is required. SiGNa has separate activities in place to ramp up manufacturing of the raw materials themselves.

OBJECTIVE: The proposed research will result in the demonstration of a sodium silicide fueled lawnmower. The developed system will look and feel like a professional product. The demonstrated designs will be suitable to serve as the template for production ramp. A significant technical focus will include the reaction control, thermal management, and fuel cell systems integration. The specific objectives are as follows:

1. Demonstrate the reaction control system to support a nominal ~1 kW fuel cell output
2. Demonstrate the thermal management system with safe-to-touch swappable cartridges
3. Demonstrate a fuel cell powered lawnmower fueled by sodium silicide

DISCUSSION: The Work Plan for the proposed work is summarized by the following:

Task 1.0 Hydrogen Fuel Cell System Requirements Development.
The hydrogen fuel cell system requirements will be developed for an early market application with high volume potential: lawnmowers. Using available operational data, specific requirements for a fuel cell system for areas including: duty cycle, peak power modes (thick grass patch), or transient conditions (motor start-up).

Task 2.0 Development of Reaction Control Mechanisms
SiGNa will scale-up its reaction control mechanism from the currently capable 300 W system to approximately 1 kW. A small water pump is used to inject a water mist into a reactor bed. The scale-up will include design, assembly, and testing of all management and other reaction control features. A similar design will be employed as compared to what has been previously demonstrated, but different pumps and misting networks are required.

Task 3.0 Development of Thermal Control Sub-System
To date, SiGNa has focused on simple air cooled systems. SiGNa will develop a liquid cooled heat exchanger system suitable for small portable devices to control the reaction as well as provide surfaces that may be readily touched by the user when swapping cartridges.

Task 4.0 Development and Integration of Fuel Cell Powered Lawnmower
SiGNa will procure an electric lawnmower and fuel cell system from known partners. SiGNa will perform the final end system design and integration. This program will also include the final assembly, testing, and demonstration of the NaSi Lawnmower.

Task 5.0 Program Management.
Reporting and program management functions.

BENEFITS: The developed technology will foster an entire new industry of clean portable energy systems. In addition to immediate reductions in small combustion engine pollutants, this program will be supported by multiple known individuals and companies in California including machining in Placerville and Sacramento, injection molding in Vacaville, and system assembly in the San Francisco Bay Area. These partners have significant technical expertise and available capacity to support the program and more importantly to grow into a viable portable power industry. SiGNa's sodium silicide enables energy systems that are based on US produced raw materials and will provide substantial value to both military and consumer applications. One of the primary material components, sodium, is produced in New York based on energy from Niagara Falls. However, all of the system design, integration, and assembly work is conducted in California. This industry can readily generate 1000's of California jobs when fully commercialized.

CO-FUNDING:
The development budget is $470,000. 20% cost share is proposed. $376,000: Air Resources Board, $94,000: SiGNa Chemistry.

Federal Funding Received: In 2008-2009, SiGNa received $1,476,000 from the Department of Energy for material production and reaction mechanism development. An additional $951,500 is currently under contract for 2010.

Private Funding: SiGNa has contributed approximately $4M in private funding to date.

Potential Funding: SiGNa has requested additional development funds for supportive projects both through appropriations and the SBIR process.

COST: $376,000

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TITLE: An improved particle concentrator for inhalation studies

PROBLEM: Numerous epidemiological studies associate particle concentration exceedances with a range of pulmonary, cardiovascular and systemic health effects, yet toxicological support for these finds are elusive. One common technique is exposing laboratory animals to concentrated ambient particles to elicit health effects. There are two commonly available concentrators, developed by investigators at Harvard and the University of Southern California (USC), both with their strengths and weaknesses. In a previous CARB contract, we investigated some possible artifacts with USC concentrated (called VACES) both in terms of chemical composition of the gas phase and reliability of the particle phase. In a small follow-on subcontract, we improved VACES in a number of ways outlined in our final report to CARB but still the concentrating ability is insufficiently steady with time and overly dependent on ambient temperature, RH and particle concentration. Aerosol Dynamics has invented a water-based CPC (WCPC) that grows particles reliably over a wide temperature and RH range and a focusing virtual impactor that lowers the cutpoint substantially. Recently they applied the WCPC principle to the design of a 100 L/min system for particle collection. We propose to translate these Aerosol Dynamics innovations to a more efficient particle concentrator and test the resulting concentrator on a wide range of ambient conditions.

PREVIOUS WORK: UC Davis (UCD) investigators have tested VACES for both chemical and physical artifacts, reported on these in our final report to CARB and in a manuscript that is nearly accepted for publication. UCD has also made significant improvements to VACES, also discussed in our final report, that also outlines a number of ways in which the improved VACES can be further improved, especially for long-term operation and stability. Aerosol Dynamics invented the water-based CPC (WCPC) that is now built and marketed by TSI. The WCPC does many of the same tasks as the VACES in that it grows particles by condensation of water, but at much lower flow rates than the VACES. In addition, Aerosol Dynamics has recently invented a focusing virtual impactor with low cut point that also has low flow rate but that when scaled to VACES flow rates can help its performance during high particle loadings.

OBJECTIVE: The objective of this proposal is to establish a joint research program between Dr. Wexler's group at UCD and Dr. Hering's group at Aerosol Dynamics (AD) bringing the features developed by both groups together to develop a version of VACES that, in terms of its concentration factor, is nearly insensitive to ambient conditions and can operate for long periods of time with minimal or no attendance.

DISCUSSION: We will develop 100 LPM modules that concentrate by a factor of 20 with little or no maintenance over a 6 hour exposure period. The modules may be ganged together to build concentrators of arbitrary capacity to meet the needs of field toxicology studies. The WCPC must be laminar to operate properly, which imposes a range of constraints at the 100 LPM design goal, whereas the VACES developed by USC and the current version of iVACES developed at UCD are turbulent. To improve its long-term operation and stability, UCD has developed a Hybrid iVACES that cools both before and after the warming/humidifying stage. The first cooling stage narrows the range of ambient conditions that the warming section has to deal with thereby making the iVACES less sensitive to ambient conditions. All designs will employ the iVACES Nafion dryer eliminating maintenance problems and returning the particles to near ambient temperature and RH.

The current VACES and iVACES are not able to effectively concentrate high ambient particle concentrations due to a lack of available water content. Aerosol Dynamics has developed a virtual impactor with a smaller cut point than used currently, which will enable operation at ambient concentrations more common in plumes.

<u>AD Tasks</u>

1. Scale up the WCPC and recently-developed focusing virtual impactor to 100 LPM flow rates
2. Deliver the devices to UC Davis for testing
3. Iterate the designs based on tests by UC Davis

<u>UCD Tasks</u>

1. Test the hybrid iVACES with current and focusing virtual impactors at high particle concentration
2. Test the scaled up WCPC with both impactors at normal and high particle concentrations
3. Test the most promising configurations in multiple seasons for 6-hour runs to explore sensitivity to ambient conditions and its durability/reliability
4. Iterate designs in response to these tests

BENEIFITS: California violates the state and national ambient air quality standards for particulate matter in multiple air sheds, resulting in illness and death for large numbers of Californians. One well-accepted way to help establish safe PM levels and understand the relative toxicity of various sources of PM is to perform concentrated ambient particle toxicity studies. Yet the concentrators are difficult to operate reliably which introduces artifacts into these studies. The current project will develop a much more reliable and stable particle concentrator that will enable improved particle toxicity studies in the future.

COST: $150,000

TITLE 17. CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC HEARING TO CONSIDER THE ADOPTION OF PROPOSED AMENDMENTS TO THE AIRBORNE TOXIC CONTROL MEASURE FOR STATIONARY COMPRESSION IGNITION ENGINES

The Air Resources Board (ARB or Board) will conduct a public hearing at the time and place noted below to consider adoption of amendments to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines (Stationary Diesel Engine ATCM or ATCM).

DATE: October 21, 2010

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Air Resources Board
Byron Sher Auditorium
1001 I Street
Sacramento, California 95814

This item may be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., October 21, 2010, and may continue at 8:30 a.m., on October 22, 2010. This item may not be considered until October 22, 2010. Please consult the agenda for the hearing, which will be available at least 10 days before October 21, 2010, to determine the day on which this item will be considered.

INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

Sections Affected: Proposed amendments to title 17, California Code of Regulations (CCR), sections 93115.3, 93115.4, 93115.6, 93115.7, 93115.8, 93115.9, 93115.10, and 93115.13, the Stationary Diesel Engine ATCM.

Background:

In 2004, the Board adopted the Stationary Diesel Engine ATCM (title 17, CCR section 93115). The ATCM established emission controls on stationary diesel-fueled compression ignition (diesel) engines that were greater than 50 horsepower (hp). For new emergency standby engines, the ATCM requires these engines to meet a 0.15 grams per brake horsepower (g/bhp-hr) particulate matter (PM) emission limit or the Off-Road Compression Ignition Engine Standard (title 13, CCR, section 2423)(Off-Road Standards), whichever is more stringent. In California, the Off-Road Standards will become more stringent than the ATCM 0.15 g/bhp-hr PM emissions requirement beginning with Tier 4 engines. The Tier 4 emissions limits will most likely cause engine manufacturers to require after treatment technologies such as a diesel particulate filter (DPF) and a selective catalytic reduction (SCR) system on their engines to meet the PM and oxides of nitrogen (NOx) standards.

Effective July 11, 2006, the United States Environmental Protection Agency (U.S. EPA) promulgated Standards of Performance for Stationary Compression-Ignition Internal Combustion Engines (NSPS)[1]. However, the NSPS final rule does not require manufacturers of new emergency standby diesel engines to meet the Tier 4 emission standards if after-treatment controls must be installed.

In the summer of 2009, representatives from the Engine Manufacturers Association (EMA) requested that ARB staff consider harmonizing the requirements for new emergency standby engines in the ATCM with those in the NSPS. ARB staff agreed to investigate the feasibility, costs, and emissions impacts associated with aligning the ATCM with the federal NSPS. Based on this work, ARB staff is proposing amendments to the ATCM to closely align with the federal NSPS requirements. The proposed amendments will reduce the cost of complying with the ATCM while still providing health protective emission limits for new emergency standby engines. The proposed amendments primarily affect the requirements for new stationary diesel engines used in non-agricultural operations.

DESCRIPTION OF THE PROPOSED REGULATORY ACTION

ARB staff is proposing amendments to the Stationary Diesel Engine ATCM to closely align the emissions standards with those in the federal NSPS, to help clarify provisions in the ATCM and address new information, and to remove provisions no longer needed. A summary of the proposed amendments is presented below. A more detailed description can be found in the Initial Statement of Reasons for Rulemaking at http://www.arb.ca.gov/regact/2010/atcm2010/atcm2010.htm.

Exemptions: ARB staff is proposing to remove the exemption that creates a sell-through provision in the ATCM. This provision was originally included in the regulation to help ensure an adequate supply of complying engines was available for installation and to minimize the adverse economic impacts to dealers as the new engine standards transitioned from one tier to the next. Since the regulation will now only require new emergency standby engines that meet a 0.15 g/bhp-hr emission standard, and engines that meet this standard have been available for several years, the sell-through provision is no longer needed. As will be discussed later, a new sell-through provision for prime engines, consistent with that in the NSPS, is being proposed as part of this rulemaking.

Definitions: ARB staff is proposing to add a new criterion to the "emergency standby engine" definition to clarify that any diesel engine that supplies power to an electric grid or that supplies power as part of a financial arrangement with any entity, except for those engines enrolled in a demand response program (DRP) as defined in the ATCM,

[1]U.S. Environmental Protection Agency, Final New Source Performance Standards for Stationary Compression Ignition Internal Combustion Engines, 71 FR 39154, July 11, 2006.

is not considered an emergency standby engine. This amendment will make the emergency standby engine definition consistent with the NSPS final rule.

ARB staff is also proposing to modify the definition of "emergency use." The current definition of "emergency use" includes the operation of emergency standby engines on the day of rocket launch tracking performed by the U.S. Department of Defense at Command Destruct sites. This provision was originally included to address engines at Command Destruct sites supporting military operations at the Vandenberg Air Force Base. The base is now responsible for space plane landing and ARB staff is proposing to amend the definition of emergency use to specify that the operation of engines during rocket launch and space plane re-entry/landing is considered emergency use.

ARB staff is also proposing to amend the definition of "maintenance and testing" to add "uninterruptible power supply" to the list of supported equipment that may be tested during maintenance and testing operations.

Other minor amendments to the definitions are being proposed to reflect revised terminology or improve clarity.

Emission Limits for New Emergency Standby Engines: ARB staff is proposing to retain the 0.15 g/bhp-hr PM emissions limit for new emergency standby engines, align the other pollutant emission standards with the NSPS requirements, and, consistent with the NSPS requirements, require any new emergency standby engine to be 2007 model year or newer. This amendment will eliminate the existing requirement in the ATCM that would have required new emergency standby engines to meet the after-treatment based Tier 4 standards when they are more stringent than 0.15 g/bhp-hr. It will also require that any new emergency standby engine must meet the 2007 model year or newer emissions limits in the Off-Road Standards for all pollutants. No changes are proposed to the restrictions on the hours of operation for maintenance and testing or to the provisions that allow Districts to impose more stringent requirements.

Emission Limits for New Emergency Standby Direct-Drive Fire Pump Engines: ARB staff proposes to amend the ATCM to harmonize the PM and other pollutant emission standards with those in the NSPS for new emergency standby direct-drive fire pump engines. The NSPS final rule requires stationary fire pump diesel engines to meet emission standards similar to the NSPS stationary emergency standby engine standards with delays in implementation up to three years for most engines. There are also special extensions for engines with greater than 2,650 revolutions per minute. This decision was based on the timeframe required for these engines to meet National Fire Protection Association specifications, and the significant costs to require after-treatment when compared to amount of pollutant reduced. These amendments will not require new emergency standby direct drive fire pump engines to meet Tier 4 after-treatment based standards. Rather they will meet either Tier 2 or Tier 3 standards based on the horsepower and model year of the engine.

Tier 4 Emissions Limit and Sell-Through Requirements for Prime Engines: The current ATCM requires new prime engines to meet a 0.01 g/bhp-hr PM emissions limit. This emission limit is the Tier 4 final PM limit for most horsepower ranges. However, for certain horsepower ranges, the Tier 4 final PM emissions limit is 0.02 g/bhp-hr.[2] To address this difference in emission standards, in an earlier rulemaking, the Board approved an alternative compliance provision that allows engines certified to the 0.02 g/bhp-hr PM emissions standards to be in compliance with the ATCM. To simplify the regulatory language in the ATCM, ARB staff is proposing to align the PM emissions limits for these engines with the NSPS standard of 0.02 g/bhp-hr. In addition, ARB staff is proposing to align with the NSPS final rule deadlines for installing prime engines manufactured during the prior model year. This change essentially allows for a 2-year sell-through for engines when the new engine standards transition from one tier to the next.

Emissions Limit and Reporting for Less than or Equal to 50 Horsepower Engines: ARB staff proposes to exempt less than or equal to 50 hp direct drive fire pump engines from the requirement to meet the Off-Road Standards and instead rely on the federal NSPS requirements for these engines. To align the ATCM with the NSPS, ARB staff also proposes to not require after-treatment based Tier 4 standards for new emergency standby engines less than or equal to 50 hp. In addition, ARB staff proposes to delete the ATCM provision that requires sellers and dealers of less than or equal to 50 hp stationary engines to annually report to ARB the number of engines sold. This data is no longer needed to support ARB's emission inventory program.

Reporting: ARB staff is proposing an amendment to require the owners or operators of emergency standby engines used in demand response programs to annually report information on engines and hours of operation to the local district and the Executive Officer of ARB. The current ATCM requires this information to be provided to the District upon request. This amendment will ensure that both ARB and the Districts will obtain this data annually and will enable more routine monitoring of the hours that engines are operating during demand response programs.

COMPARABLE FEDERAL REGULATIONS

On July 11, 2006, the U.S. EPA promulgated the NSPS for Stationary Diesel Engines. The emission standards required by the NSPS are modeled after U.S. EPA's standards for nonroad and marine diesel engines, which are phased in over several years (tiered standards) with increasing levels of stringency for NOx and PM. However, the NSPS final rule does not require manufacturers of new stationary emergency standby diesel engines to meet the Tier 4 interim and final standards if after-treatment controls must be installed.

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[2] Engines in the 50 to 75 bhp range and those greater than 750 bhp have a 0.02 g/bhp-hr PM emissions limit. These engines are DPF-equipped to meet that limit.

AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

ARB staff has prepared a Staff Report: Initial Statement of Reasons (ISOR) for the proposed regulatory action, which includes a summary of the economic and environmental impacts of the proposal. The report is entitled: "Staff Report: Initial Statement of Reasons for Proposed Rulemaking – Proposed Amendments to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines."

Copies of the ISOR and the full text of the proposed regulatory language, in underline and strikeout format to allow for comparison with the existing regulations, may be accessed on ARB's website listed below, or may be obtained from the Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, First Floor, Sacramento, California, 95814, (916) 322-2990, at least 45 days prior to the scheduled hearing on October 21, 2010.

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on ARB's website listed below.

Inquiries concerning the substance of the proposed regulation may be directed to the designated agency contact persons, Peggy Taricco, Manager of the Technical Analysis Section, at (916) 323-4882, or Ryan Huft, Air Resources Engineer, at (916) 327-5784.

Further, the agency representative and designated back-up contact persons, to whom nonsubstantive inquiries concerning the proposed administrative action may be directed, are Ms. Lori Andreoni, Manager, Board Administration and Regulatory Coordination Unit, (916) 322-4011, or Ms. Amy Whiting, Regulations Coordinator, (916) 322-6533. The Board has compiled a record for this rulemaking action, which includes all the information upon which the proposal is based. This material is available for inspection upon request to the contact persons.

This notice, the ISOR and all subsequent regulatory documents, including the FSOR, when completed, are available on ARB's website for this rulemaking at http://www.arb.ca.gov/regact/2010/atcm2010/atcm2010.htm.

COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED

The determinations of the Board's Executive Officer concerning the costs or savings necessarily incurred by public agencies and private persons and businesses in reasonable compliance with the proposed regulations are presented below.

ARB staff does not expect any adverse economic impacts associated with the proposed amendments. Rather, the proposed amendments will create a future cost savings to any business or public entity that will be purchasing new emergency standby engines.

ARB staff estimates the total economic impact from the proposed amendments to the ATCM to affected private businesses and public agencies would be a cost savings of approximately $460 million between 2010 and 2020 or about $46 million annually. Of this, private businesses and public agencies are each expected to realize cost savings of about $23 million annually. These cost savings are due to the alignment of the ATCM emissions standards for new emergency standby engines with those in the NSPS which do not require after-treatment based emission standards. Foregoing the application of after-treatment technologies such as DPF and SCR for new emergency standby engines, results in cost savings of about $118 per hp. This translates to about $71,000 cost savings for a typical 600 hp emergency standby engine.

Pursuant to Government Code sections 11346.5(a)(5) and 11346.5(a)(6), the Executive Officer has determined that the proposed regulatory action would not create costs to any State agency or in federal funding to the State, costs or mandate to any local agency or school district, whether or not reimbursable by the State pursuant to Government Code, title 2, division 4, part 7 (commencing with section 17500), or other nondiscretionary cost to State or local agencies.

In developing this regulatory proposal, ARB staff evaluated the potential economic impacts on representative private persons or businesses. ARB is not aware of any cost impacts that a representative private person or business would necessarily incur in reasonable compliance with the proposed action.

The Executive Officer has made an initial determination that the proposed regulatory action would not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states, or on representative private persons.

In accordance with Government Code section 11346.3, the Executive Officer has determined that the proposed regulatory action would not affect the elimination of jobs within the State of California, or elimination of existing businesses within the State of California. The proposed regulatory action may result in the creation of jobs or businesses, or expansion of businesses if the cost savings are invested in productive assets other than Tier 4 engines. A detailed assessment of the economic impacts of the proposed regulatory action can be found in the ISOR.

The Executive Officer has also determined, pursuant to California Code of Regulations, title 1, section 4, that the proposed regulatory action would not affect small businesses, because the proposed amendment would create a net savings for some small businesses.

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

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

SUBMITTAL OF COMMENTS

Interested members of the public may also present comments orally or in writing at the meeting, and comments may be submitted by postal mail or by electronic submittal before the meeting. The public comment period for this regulatory action will begin on September 6, 2010. To be considered by the Board, written comments, not physically submitted at the meeting, must be submitted on or after September 6, 2010, and received **no later than 12:00 noon, October 20, 2010**, and must be addressed to the following:

Postal mail: Clerk of the Board, Air Resources Board
1001 I Street, Sacramento, California 95814

Electronic submittal: http://www.arb.ca.gov/lispub/comm/bclist.php

Please note that under the California Public Records Act (Gov. Code, § 6250 et seq.), your written and oral comments, attachments, and associated contact information (e.g., your address, phone, email, etc.) become part of the public record and can be released to the public upon request. Additionally, this information may become available via Google, Yahoo, and any other search engines.

The Board requests, but does not require, that 20 copies of any written statement be submitted and that all written statements be filed at least 10 days prior to the hearing so that ARB staff and Board members have time to fully consider each comment. The Board encourages members of the public to bring to the attention of staff in advance of the hearing any suggestions for modification of the proposed regulatory action.

STATUTORY AUTHORITY AND REFERENCES

This regulatory action is proposed under the authority granted to ARB in Health and Safety Code sections 39600, 39601, 39658, 39659, 39666, 41511 and 43013,. This action is proposed to implement, interpret, and make specific Health and Safety Code sections 39002, 39650, 39658, 39659, 39666, 40000, 41511 and 43013.

HEARING PROCEDURES

The public hearing will be conducted in accordance with the California Administrative Procedure Act, Government Code, title 2, division 3, part 1, chapter 3.5 (commencing with section 11340).

Following the public hearing, the Board may adopt the regulatory language as originally proposed, or with non-substantial or grammatical modifications. The Board may also adopt the proposed regulatory language with other modifications if the text as modified is sufficiently related to the originally proposed text that the public was adequately placed on notice and that the regulatory language as modified could result from the proposed regulatory action; in such event, the full regulatory text, with the modifications clearly indicated, will be made available to the public, for written comment, at least 15-days before it is adopted.

The public may request a copy of the modified regulatory text from ARB's Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, First Floor, Sacramento, California, 95814, (916) 322-2990.

SPECIAL ACCOMMODATION REQUEST

Special accommodation or language needs can be provided for any of the following:

- An interpreter to be available at the hearing;
- Documents made available in an alternate format (i.e. Braille, large print) or another language;
- A disability-related reasonable accommodation.

To request these special accommodations or language needs, please contact the Clerk of the Board at (916) 322-5594 or by facsimile at (916) 322-3928 as soon as possible, but no later than 10 business days before the scheduled Board hearing. TTY/TDD/Speech to Speech users may dial 711 for the California Relay Service.

Para solicitar alguna comodidade especial o si por su idioma necesita cualquiera de los siguientes:

- Un intérprete que esté disponible en la audiencia.
- Documentos disponibles en un formato alternativo (es decir, sistema Braille, letra grande) u otro idioma.
- Una acomodación razonable relacionados con una incapacidad.

Por favor llame a la officina del Consejo a (916) 322-5594 o envie un fax a (916) 322-3928 lo mas pronto possible, pero no menos de 10 dias de trabajo antes del el dia programado para la audencia del Consejo. TTY/TDD/ Personas que nesessitan este servicion pueden marcar el 711 para el Servicio de Retransmisión de Mensajes de California.

CALIFORNIA AIR RESOURCES BOARD

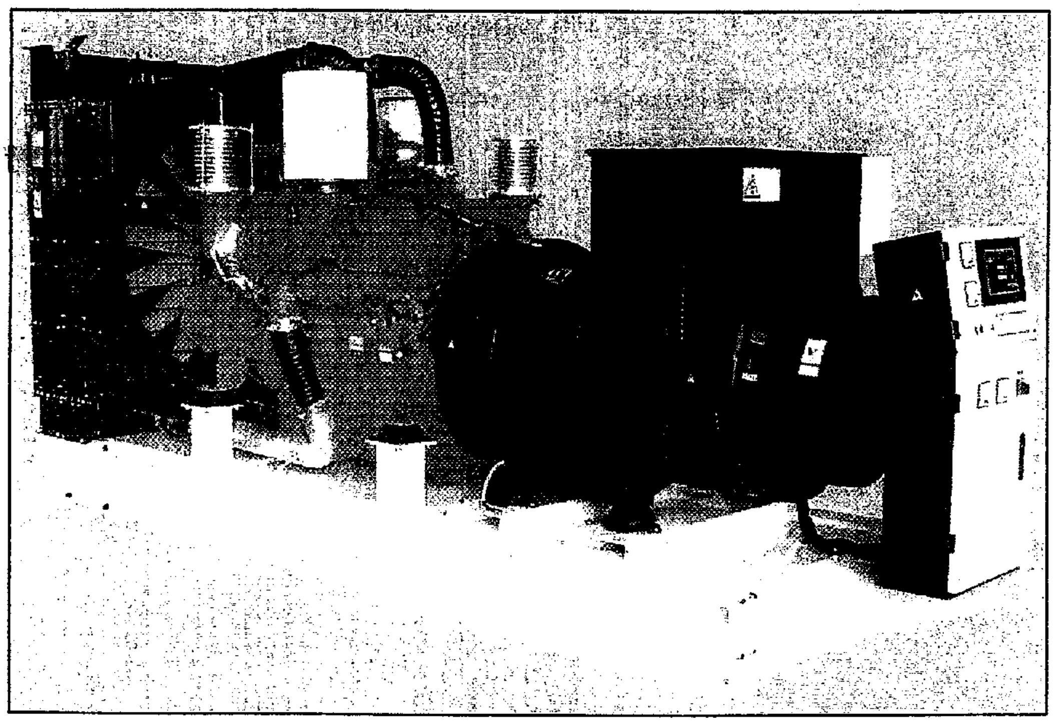
James N. Goldstene
Executive Officer

Date: August 24, 2010

California Environmental Protection Agency

AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING



PROPOSED AMENDMENTS TO THE AIRBORNE TOXIC CONTROL MEASURE FOR STATIONARY COMPRESSION IGNITION ENGINES

(Stationary Diesel Engine ATCM)

Stationary Source Division
Emissions Assessment Branch

September 2010

State of California
AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING

Public Hearing to Consider

PROPOSED AMENDMENTS TO THE AIRBORNE TOXIC CONTROL MEASURE FOR STATIONARY COMPRESSION IGNITION ENGINES

To be considered by the Air Resources Board on October 21-22, 2010, at:

California Environmental Protection Agency
Headquarters Building
1001 "I" Street
Byron Sher Auditorium
Sacramento, California

Stationary Source Division:
Richard Corey, Chief
Daniel E. Donohoue, Chief,
Emissions Assessment Branch
Peggy Taricco, Manager
Technical Analysis Section

State of California
AIR RESOURCES BOARD

PROPOSED AMENDMENTS TO THE AIRBORNE TOXIC CONTROL MEASURE FOR STATIONARY COMPRESSION IGNITION ENGINES

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Planning and Technical Support Division
Research Division

Acknowledgements

This report was prepared with the assistance and support from the other divisions and offices of the Air Resources Board. In addition, we would like to acknowledge the assistance and cooperation that we have received from many individuals and organizations.

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EXECUTIVE SUMMARY

The Air Resources Board (ARB or Board) staff is proposing amendments to the Airborne Toxic Control Measure for Stationary Compression-Ignition Engines (Stationary Diesel Engine ATCM or ATCM). The primary purpose of the proposed amendments is to closely align the emission limits for new emergency standby engines in the ATCM with the emission standards required by the federal Standards of Performance for Stationary Compression-Ignition Internal Combustion Engines (NSPS) which was promulgated on July 11, 2006. (U.S. EPA, 2006) The proposed amendments will reduce the cost of complying with the ATCM while still providing health protective emission limits for new emergency standby engines. The proposed amendments primarily affect the requirements for stationary compression-ignition (diesel) engines used in non-agricultural operations.

Presented below is an overview that briefly discusses the information presented in this document.

1. When was the Stationary Diesel Engine ATCM adopted and what does it require?

The ATCM was initially approved by ARB in 2004 (title 17, CCR section 93115) (ARB, 2003) and was designed to reduce public exposures to diesel particulate matter (diesel PM). The ATCM establishes emission standards and operating requirements for new and in-use stationary diesel engines.[1] Implementation of the ATCM is resulting in a reduction in the emissions of and exposure to diesel PM from stationary diesel engines throughout California. In the majority of cases, compliance with the ATCM results in potential cancer risks being below 10 in a million for people living close to a facility with stationary diesel engines.

The emission limitations in the ATCM are different depending on whether an engine is used as an emergency standby engine (*i.e.*, used only during emergencies such as an electrical outage, flood, or fire) or as a prime engine. Prime engines are not solely used for emergencies but provide prime power for compressors, rock crushing, cranes, etc. Emergency standby engines, since they typically operate no more than 20 to 50 hours a year, have less stringent standards than prime engines which can operate hundreds to thousands of hours annually.

For new emergency standby engines, the ATCM requires the engines to meet a 0.15 grams per brake horsepower hour (g/bhp-hr) diesel PM emission limit and to restrict the number of hours operated for maintenance and testing. In addition, the diesel PM emissions limit is linked to the Board's Off-Road Compression Ignition Engine Standards (Off-Road Standards)(title 13, CCR, section 2423), adopted by ARB such

[1] When the ATCM was approved in 2004, it included emissions limits for new engines used in agricultural operations. Requirements for in-use engines used in agricultural operations were subsequently added to the ATCM in 2006.

that when the more stringent Tier 4 standards, which are lower than 0.15 g/bhp-hr, become effective new emergency standby engines will have to meet the Tier 4 standards.[2] As a result, under the current ATCM, the diesel PM standard for new emergency standby engines will be as stringent as those for prime engines.

Tier 4 standards more stringent than the 0.15 g/bhp-hr standard for new off-road engines begin implementation in 2011 and mandate significantly more stringent oxides of nitrogen (NOx), hydrocarbon (HC), and PM controls. In most cases, achieving the standards will require addition of catalyzed after-treatment devices such as diesel particular filters (DPF) for PM control and selective catalytic reduction (SCR) devices for NOx control. At the time the ATCM was originally adopted, ARB staff assumed there would be a seamless transition to the Tier 4 standards for new emergency standby engines. We anticipated that these engines would be cost-effective, viable for use in emergency standby applications, and available "off-the shelf" from the engine manufacturers. However, as we will discuss in the following questions and answers, upon further investigation, ARB staff has found that not to be the case.

2. How are stationary emergency standby engines used and how are they typically operated?

Stationary emergency standby engines are engines that remain in one location for 12 months or longer and provide power during an emergency. The most common use of an emergency standby engine is in conjunction with a generator set to provide back-up electrical power during emergencies or unscheduled power outages. Emergency generator engines can range from less than 50 horsepower (hp) to over 6,000 hp, depending on the end users' needs. Emergency standby engines are also used with fire pumps as part of fire suppression systems. Engines used in fire pump applications are usually less than 200 hp. Since emergency standby engines are used primarily for emergency situations, their use is generally limited and most operating hours are used for maintenance and testing to ensure the engines will operate when needed in an emergency. The engines are owned and operated by various facilities and businesses, including hospitals, hotels, banks, office buildings, correctional facilities, airports, retail shopping centers, factories, military installations, schools, waste and water treatment facilities, and many other types of public agencies. Most emergency standby engines are diesel-fueled.

3. Why is staff proposing amendments to the ATCM?

ARB staff is proposing amendments to the ATCM to closely align California's requirements for new emergency standby engines with those in the federal NSPS. These amendments will ensure that the emission reductions from the ATCM are cost-effective, feasible, readily available, and continue to meet health protective requirements.

[2] The U.S. Environmental Protection Agency has adopted essentially equivalent emissions standards (40 CFR Parts 9,69, et. al. Control of Emissions of Air Pollution from Nonroad Diesel Engines and Fuel, Final Rule June 29,2004 – "Nonroad Standards") to the ARB's Off-Road Standards.

Subsequent to implementation of the ATCM, the U.S. Environmental Protection Agency (U.S. EPA) promulgated an NSPS for Stationary Compression-Ignition Internal Combustion Engines. The NSPS has different emissions standards for new emergency standby engines as compared to the ATCM in that the NSPS standards do not require new emergency stationary engines to meet the Tier 4 standards that generally require the application of after-treatment devices such as DPFs or SCR. To avoid the application of DPFs and/or SCR devices on engines that operate for relatively few hours each year, under the federal NSPS standards, new emergency standby engines would only be subject to the less stringent Tier 2 or Tier 3 Nonroad Standards depending on the horsepower of the engine.[3]

In July 2009, representatives from the Engine Manufacturers Association (EMA) requested that ARB staff consider harmonizing the requirements for new emergency standby engines in the ATCM with those in the NSPS. (EMA, 2009) EMA contends that, due to the high costs of after-treatment, it is not cost-effective to have DPF or SCR devices used in emergency standby applications that typically operate few hours annually. They expressed concerns about potential operational issues with using these after-treatment devices on emergency standby engines. They also stated that it is not economically viable for manufacturers to produce a unique emergency standby engine platform only for California that meets the ATCM requirements.

In response, ARB staff agreed to investigate the need for amendments to the ATCM to address concerns raised regarding feasibility and cost-effectiveness of after-treatment controls on new emergency standby engines than the ATCM.

4. What are the current requirements in the ATCM for new emergency standby engines and how are they different than the NSPS requirements?

ATCM

As mentioned previously, the existing ATCM requires new stationary emergency standby diesel engines greater than 50 hp to meet a 0.15 g/bhp-hr PM emission limit or the Off-Road Standards for PM, whichever is more stringent. The ATCM does not specify what model year engine must be installed, only that the engine meet the specified emissions limit for PM and the other pollutant standards (*i.e.*, NOx, HC) for the model year of the engine being installed. The ATCM also limits the number of hours a new emergency standby engine can operate for maintenance and testing purposes to no more than 50 hours per year. The ATCM does not limit emergency use hours. The PM emissions standard of 0.15 g/bhp-hr and hours limitation for maintenance and testing were established based on a conservative screening health risk assessment (HRA). (ARB, 2003) The HRA demonstrated a PM emission limit of 0.15 g/bhp-hr and 50 hours of operation would result in a potential cancer risk level of less than 10 in a

[3] The Tier 4 final standards for the less than 25 hp engines and the Tier 4 interim standards for engines greater than or equal to 25 hp and less than 75 hp do not require after-treatment controls.

million for the majority of emergency standby engine applications.[4] In recognition that there might be unique circumstances where the potential cancer risks may be higher, the ATCM allows the local air quality control or air quality management district (district) to establish more stringent requirements either through local rulemaking or on a site-specific basis through the district permitting process.[5]

The Off-Road Standards will become more stringent than the ATCM's 0.15 g/bhp-hr diesel PM standard beginning with Tier 4 engines. The Tier 4 PM emissions standards become more stringent beginning in 2011 for engines greater than 75 hp and in 2013 for engines 50 to 75 hp. To achieve these more stringent Tier 4 emissions limits, engine manufacturers will need to employ DPFs and SCR devices because other emission reduction technologies cannot meet the Tier 4 emissions limits.

The ATCM requires new direct-drive emergency standby fire pump engines to meet the same emissions standards as emergency standby engines. However, a district may approve alternative standards linked to the Off-Road Standards and allow for a three-year extension of the current standards after transition to the next tier occurs. For example, with district approval, an operator may install a Tier 2 direct-drive fire pump engine until three years after the date the Tier 3 standards are applicable for an engine of the same horsepower. This extension allows manufacturers and owners and operators to sell and install a direct-drive fire pump diesel engine that meets the emission standards immediately preceding the transition to a new tiered standard and, more importantly, provides additional time for testing and evaluation necessary for certification of fire pump engines required by the National Fire Protection Association (NFPA).

<u>NSPS</u>

With respect to the NSPS requirements for new emergency standby engines, U.S. EPA staff determined during the development of the NSPS that the high cost of after-treatment devices when compared to the amount of pollutant reduced did not justify requiring after-treatment controls for new stationary emergency standby diesel engines. (U.S. EPA, 2005) As a result, the final rule requires new stationary emergency standby engines to meet the most stringent federal Nonroad Standards that do not require add-on emission controls. It also requires any new emergency standby engine to be a certified 2007 or later model year engine. This means that, under federal regulation, new emergency standby diesel engines are required to meet the Tier 2 or Tier 3 new Nonroad Standards for all pollutants. For engines with horsepower greater than 175 hp, the PM emissions limit is 0.15 g/bhp-hr. For engines in the 50 to 175 hp range, the PM emissions limit ranges from 0.22 g/bhp-hr to 0.30 g/bhp-hr. In addition, the NSPS final rule established deadlines to install stationary diesel engines from a previous model year.

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[4] A survey conducted by ARB staff during the development of the ATCM revealed that on average, emergency standby engines operate 31 hours a year for all purposes *i.e.* maintenance and testing and emergency operation. (ARB, 2003)

[5] Other programs, such as New Source Review and the Toxics Hot Spots Program work in concert with the ATCM to ensure the risks from all stationary diesel engines are mitigated.

For new emergency standby fire pump engines, the NSPS establishes emission standards similar to the NSPS new emergency standby engine standards and includes a three-year extension to comply with the final standards for certain engine power categories. According to U.S. EPA staff, the time extension was added due to the lengthy time needed for these engines to be certified to the federal Nonroad Standards, as well as NFPA specifications, and Underwriters Laboratory (UL) and FM Global (FM) certification.

5. What are the results of ARB staff's analysis concerning the feasibility and costs of meeting Tier 4 standards for new emergency standby engines?

ARB staff conducted an analysis to evaluate the feasibility and availability of emergency standby engines equipped with DPFs and SCR after-treatment devices. ARB staff also investigated the costs and cost-effectiveness for five different scenarios that represented different potential compliance pathways to the Tier 4 standards that would have the DPF and SCR after-treatment devices. Based on the analysis, and those of U.S. EPA, ARB staff believes it is appropriate to closely align the ATCM emissions standards for new emergency standby engines with those in the NSPS. (U.S. EPA, 2006a) However, ARB staff believes it is also important to continue to provide the districts with the ability to impose more stringent conditions on a site-specific basis where the additional controls are warranted.

A summary of the results from the analysis concerning the feasibility and costs of Tier 4 standards for new emergency standby engines is presented below. Additional details are provided in Chapter II and Appendix B.

- Applications of DPF devices on emergency standby engines are technically feasible and there are currently about 300 emergency standby engines in California that have DPFs installed.

- There is very limited application of SCR devices on emergency standby engines. ARB staff is aware of a few applications on larger emergency standby engines in California. However, ARB staff believes that while the current generation of SCR systems may be technically feasible, there are significant economic and operational constraints to the routine use of SCR devices on emergency standby engines. This is because the majority of operating hours for emergency standby engines occur during short 15 to 30 minute maintenance and testing checks at low engine loads. In most cases, the temperature needed for the SCR catalyst to function will not be reached during this operation and the SCR device will not provide the expected NOx reductions.

- Tier 4 engines that rely on after-treatment technology for emergency standby applications will not be available from the original equipment manufacturers. Representatives from the EMA have indicated that it will not be economically viable for engine manufacturers to develop and maintain a Tier 4 emergency standby engine platform for California. Because of this, staff has concluded that Tier 4 engines for emergency standby applications will not be available "off-the-shelf." Therefore, each owner or operator will need to purchase a new Tier 2 or Tier 3 engine that meets a 0.15 g/bhp-hr PM standard and then work with suppliers to retrofit the engine with a DPF and SCR device to meet the Tier 4 emission standards for all pollutants.

- It is not cost-effective to routinely apply DPF or SCR after-treatment technologies on emergency standby engines. The costs of SCR and DPF after-treatment technology are very high and given the low number of hours that a typical emergency standby engine operates, about 31 hours per year, the cost effectiveness is significantly higher than other ARB diesel engine regulations.

6. What amendments are being proposed to the requirements for new emergency standby engines in the ATCM?

ARB staff is proposing the following amendments to the ATCM to closely align with the NSPS Emission Standards:

Emission Limits for New Emergency Standby Engines: For new emergency standby engines, ARB staff is proposing to retain the 0.15 g/bhp-hr PM emissions limit in the ATCM and to align the other pollutant emission standards with the NSPS requirements.[6] This amendment will eliminate the existing requirement in the ATCM that would have required new emergency standby engines to meet the after-treatment based Tier 4 standards when they are more stringent than 0.15 g/bhp-hr. It will also require that any new emergency standby engine must meet the 2007 model year or newer emissions limits in Off-Road Standards for all pollutants. No changes are proposed to the restrictions on the hours of operation for maintenance and testing or to the provisions that allow districts to impose more stringent requirements.

Emission Limits for New Emergency Standby Direct-drive Fire Pump Engines: ARB staff proposes to amend the ATCM to harmonize the PM and other pollutant emission standards with those in the NSPS for new emergency standby direct-drive fire pumps. The NSPS final rule requires stationary fire pump diesel engines to meet emission standards similar to the NSPS stationary emergency standby engine standards with delays in implementation up to three years for most engines. An additional three years is provided to engines between 50 and 600 hp with greater than 2,650 revolutions per minute. This decision was based on the timeframe required for these engines to design, certify, and manufacture an engine to meet NFPA specifications, including UL and FM certification. These amendments will not require new emergency standby direct-drive fire pump engines to meet Tier 4 after-treatment based standards.

[6] With one exception, this amendment will result in the emissions requirements for emergency standby engines being the same in the ATCM as those in the NSPS. The only exception is for engines with horsepower less than 175 hp. For these engines, the NSPS establishes a PM emissions limit of 0.22 to 0.30 g/bhp-hr depending on the horsepower, while the ATCM will retain a more stringent 0.15 g/bhp-hr PM emissions standard as it represents best available control technology.

Therefore, they will be required to meet either Tier 2 or Tier 3 standards based on the horsepower and model year of the engine.

Tier 4 Emissions Limit and Sell-Through Requirements for Prime Engines: The current ATCM requires new prime engines to meet a 0.01 g/bhp-hr PM emissions limit. This emission limit is the Tier 4 final PM limit for most horsepower ranges. However, for certain horsepower ranges, the Tier 4 final PM emissions limit is 0.02 g/bhp-hr.[7] To address this difference in emissions standards, in an earlier rulemaking, the Board approved an alternative compliance provision for these engines that, in effect, allows engines certified to the 0.02 g/bhp-hr PM emissions standards to be in compliance with the ATCM. To simplify the regulatory language in the ATCM, ARB staff is proposing to align the PM emissions limit for these engines with the NSPS standard of 0.02 g/bhp-hr. In addition, ARB staff is proposing to align with the NSPS final rule deadlines for installing prime engines from a previous model year. This change essentially allows for a two-year sell-through for engines when the new engine standards transition from one tier to the next.

Emissions Limit and Reporting for Less than or Equal to 50 Horsepower Engines: ARB staff proposes to not require direct drive fire pump engines less than or equal to 50 hp to meet the Off-Road Standards and instead rely on the federal NSPS requirements for these engines to mitigate the emissions from this subset of engines. To further align the ATCM with the NSPS, ARB staff also proposes to not require after-treatment based Tier 4 standards for new emergency standby engines less than or equal to 50 hp. In addition, ARB staff proposes to delete the ATCM provision that requires sellers and dealers of less than or equal to 50 hp stationary engines to annually report to the ARB the number of engines sold. This data is no longer needed to support ARB's emission inventory program.

7. What other amendments are being proposed?

ARB staff is proposing amendments to help clarify provisions in the ATCM, address new information or comments from the districts, and remove provisions no longer needed. These amendments are briefly summarized below.

Exemptions: ARB staff is proposing to remove the sell-through provision in the ATCM. This provision was originally included in the regulation to help ensure an adequate supply of complying engines were available and to minimize the adverse economic impacts to dealers as the new engine standards transitioned from one tier to the next. Since the regulation will now require new emergency standby engines to meet a 0.15 g/bhp-hr PM standard (Tier 2 or Tier 3 engines) and engines that meet these standards have been available for several years; the sell-through provision is no longer needed. This is also the case for engines used in agricultural operations. As discussed above, an amended sell-through provision for prime engines, consistent with that in the NSPS, is being proposed as part of this rulemaking.

[7] Engines in the 50 to 75 hp range and those greater than 750 bhp have a 0.02 g/bhp-hr PM emissions limit. These engines are DPF-equipped to meet that limit.

Definitions: ARB staff is proposing to add a new criterion to the "emergency standby engine" definition to make the definition more consistent with the NSPS final rule. Staff is proposing to clarify that any diesel engine that supplies power to an electric grid or that supplies power as part of a financial arrangement with any entity, except for those engines enrolled in a demand response program (DRP) as defined in the ATCM, is not considered an emergency standby engine.

ARB staff is also proposing to modify the definition of "emergency use." The current definition of "emergency use" includes the operation of emergency standby engines on the day of rocket launch tracking performed by the U.S. Department of Defense at Command Destruct sites. This provision was originally included to address engines at Command Destruct sites supporting military operations at the Vandenberg Air Force Base. Vandenberg is now responsible for space plane landing. ARB staff is proposing to amend the definition of emergency use to specify that the operation of emergency standby engines during rocket launch and space plane re-entry/landing be considered emergency use. However, this action will have very little impact on emissions because, according to the districts, the diesel engines at these sites have been or are in the process of being replaced with new diesel engines retrofitted with DPFs.

ARB staff is also proposing to amend the definition of "maintenance and testing" to add "uninterruptible power supply" to the lists of supported equipment that may be tested during maintenance and testing operations.

Other minor amendments to the definitions are being proposed to reflect revised terminology or improve clarity.

Reporting: ARB staff is proposing an amendment to require the owners or operators of emergency standby engines used in demand response programs to annually report information on engines and hours of operation to the district and the Executive Officer of the ARB. The proposed amendment requires an updated inventory to be submitted annually, unless the Executive Officer determines an updated inventory is not needed for any given year. The current ATCM requires this information to be provided to the district upon request. This amendment will ensure that both the ARB and the districts will obtain this data annually and will enable more routine monitoring of the hours that engines are operating during demand response programs.

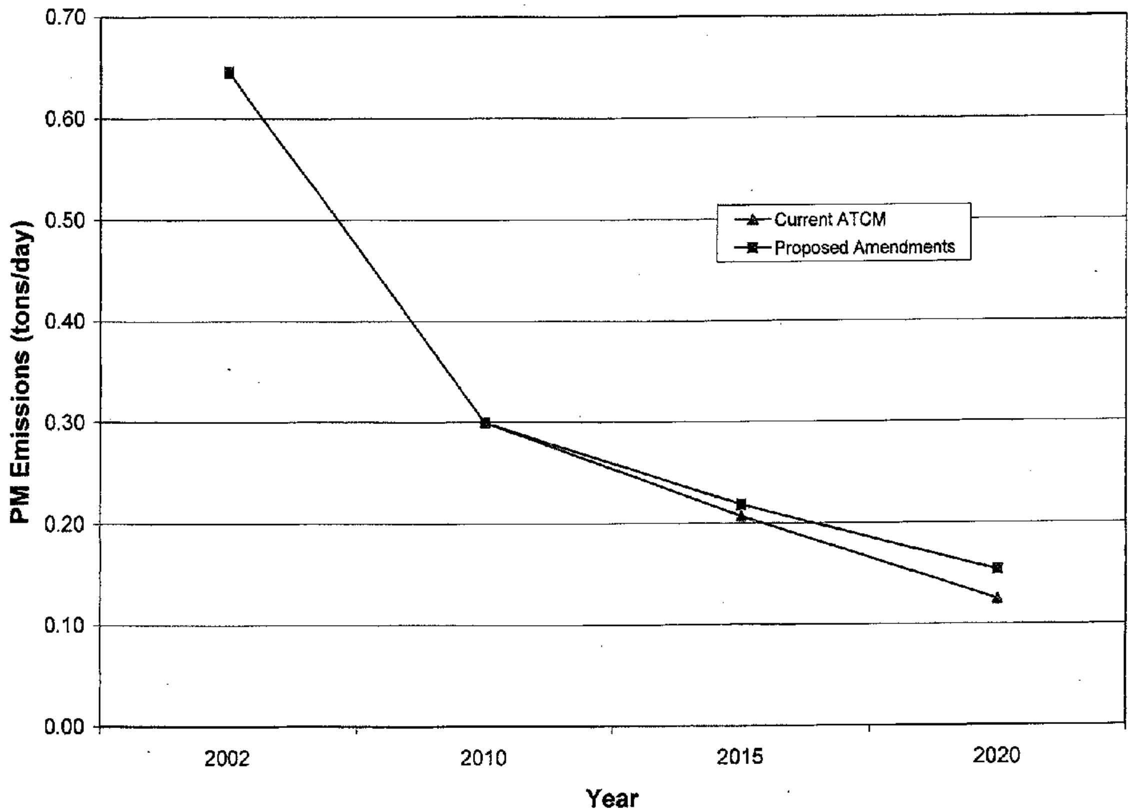
8. What are the environmental impacts of the proposed amendments?

As shown in Figure ES-1, with the proposed amendments, the PM emissions from stationary diesel engines are expected to continue to decline over the next decade.[8] However, the amendments will result in a small loss of projected diesel PM emission reductions of about 0.01 tons per day (T/D) in 2015 and 0.03 T/D in 2020 as compared to the current ATCM. We do not expect this small change in emissions to have a

[8] In Figure ES-1, the emissions represent the combined totals for both prime and emergency standby engines. Of this total, emergency standby engines comprise about 40 percent of the emissions in 2010.

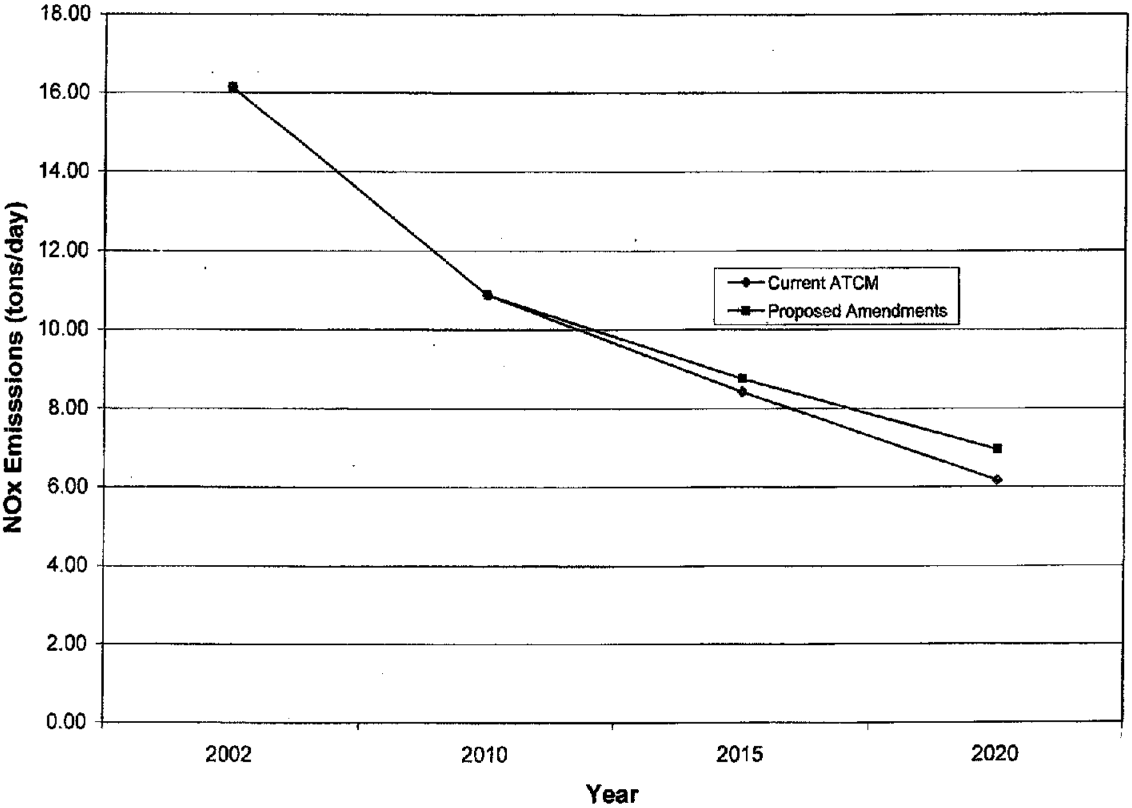
significant impact on projected regional PM emissions. These foregone emission reductions are about one hundredth of one percent (0.01%) of the total Statewide diesel PM emissions in 2015 and four hundredths of one percent (0.04%) in 2020.

Figure ES-1: Comparison of Statewide Stationary Non-Agricultural Diesel Engine PM Emissions with the Current ATCM and the Proposed Amendments



The proposed amendments will also impact the projected emissions of NOx from stationary diesel engines. While the primary focus of the ATCM is to reduce diesel PM, by linking the emissions standards for new engines to the Off-Road Standards, there are some ancillary NOx reductions. Foregoing Tier 4 engines for new emergency standby engines will result in fewer NOx reductions in future years. Figure ES-2 provides a graphic of the projected NOx emissions with the current ATCM emissions standards and with the proposed amendments. In 2015, we forego projected NOx emissions of 0.4 T/D and 0.8 T/D in 2020. This translates into about one hundredth of one percent (0.01%) of total Statewide emissions of NOx in 2015 and three hundredths of one percent (0.03%) in 2020.

Figure ES-2: Comparison of Statewide Non-Agricultural Stationary Diesel Engine NOx Emissions with the Current ATCM and the Proposed Amendments



The proposed amendments are expected to have little impact on emissions of greenhouse gases (GHGs). First, the proposed amendments would affect a relatively small number of engines. In 2010, new stationary emergency standby engines represent only about one percent of the total number of new non-road engines introduced into California. In addition, there are factors that would both slightly increase and decrease GHG emissions under the proposed amendments. To some extent, these factors would cancel each other out. Specifically, SCR and passive DPF's generally require engines to reach higher operating temperatures for best performance. These temperatures can be difficult to reach with normal maintenance and testing procedures. Requiring DPF or SCR after-treatment devices for emergency engines could lead to additional operating time and additional fuel use, with an associated increase in emissions of GHG. However, the proposed amendments would eliminate the need for after-treatment control devices, thus reducing these potential additional GHG emissions. On the other hand, engines equipped with DPFs could achieve greater reductions of "black carbon" PM, which contributes to climate change. Considering all these factors, there should be negligible change in GHG emissions due to the proposed amendments.

9. What are the impacts on potential cancer risk levels?

With the proposed amendments, the ATCM will continue to ensure that the risks from emergency standby engines are minimized. In most all cases, the diesel PM emissions from an emergency standby engine with a diesel PM emission rate of 0.15 g/bhp-hr results in potential cancer risks being below 10 in a million for people living close to emergency standby engines. In those rare cases that a new emergency standby engine results in a potential cancer risk greater than 10 in a million, the ATCM will continue to have a provision that allows the district to establish more stringent emission standards and operating requirements where necessary to protect public health.

In addition, there are other programs implemented by the districts, such as New Source Review and the Air Toxics "Hot Spots" Program (AB 2588), that work in concert with the ATCM to ensure the emissions and risks from stationary engines are adequately mitigated. Like the ATCM, these programs allow districts to address the emissions and risks from diesel engines on a site-specific basis taking into consideration environmental justice programs and any unique circumstances that may require additional controls.

10. What are the economic impacts of the proposed amendments?

ARB staff does not expect any adverse economic impacts associated with the proposed amendments. Rather, the proposed amendments will result in future cost savings to businesses or public entities that will be purchasing new emergency standby engines.

ARB staff estimates the total economic impact from the proposed amendments to the ATCM to affected private businesses and public agencies would be a cost savings of about $460 million between 2010 and 2020 or about $46 million annually. Of this, private businesses and public agencies are each expected to realize cost savings of $230 million or $23 million annually. These cost savings are primarily due to the alignment of the ATCM emissions standards for new emergency standby engines with those in the NSPS, which do not require after-treatment emission standards. Foregoing the application of after-treatment technologies such as DPF and SCR for new emergency standby engines, results in significant capital cost savings of about $118 per hp. This translates to about $71,000 cost savings for a typical 600 hp emergency standby engine.

11. Are there any potential issues that may not be fully addressed by the proposed amendments to the ATCM?

During the development of the proposed amendments, ARB staff began discussions with district staff on the need to address high use emergency standby engines, remotely located engines, or facilities with multiple emergency standby engines. Since the ATCM was originally approved in 2004, there have been some changes in the way emergency standby engines are being used. For example, due to the increase in web-based electronic communications and storage, a number of large server banks are being installed in California to provide electronic data storage. These server banks typically will have multiple large diesel emergency back-up engines to support the servers in the event of an emergency or when there are power fluctuations. In addition, as California transitions to greater reliance on renewable energy, such as solar, there is the possibility of the emergency standby engines used to support these power systems may be called upon to operate more frequently than what is typically seen with a natural gas fired power plant. Because the ATCM does not limit the number of hours for emergency use, there is a possibility that there will be situations where engines are operating a significant number of hours for emergency operations and where additional controls might be warranted. It is also possible that some of these "high-use" emergency standby engines will be located in remote areas, far away from where people work or live. In these situations, the same level of controls applied to an emergency standby engine in a more populated region may not be necessary if the engine is located away from people and in a region that is attainment for the State and federal ambient air quality standards.

While there are mechanisms in place to help address these concerns such as the provision in the ATCM that allows the district to establish more stringent requirements and New Source Review and the Air Toxics "Hot Spots" Program mentioned earlier, ARB staff believes these situations should be more carefully evaluated and quantified. To that end, ARB staff recommends that ARB staff work with the districts to collect information on "high-use" emergency standby engines, to identify situations that may merit additional controls beyond or less than those in the ATCM and to develop permitting guidance, if necessary, to ensure the health and regional impacts from all stationary diesel engines are adequately mitigated.

12. How did staff develop the amendments to the ATCM?

The staff developed the proposed amendments to the ATCM through consultations with industry, government agencies, and members of the public. Over the last year, the staff held two public workshops to discuss the proposed amendments. More than 3,000 companies, organizations, and individuals were notified of these public workshops through email notification. Workshop notices were posted to ARB's website and e-mailed to subscribers of the "diesel risk reduction" electronic list server. Numerous individual meetings also were held with affected stakeholders, including the engine manufacturers and emission control technology providers. ARB staff also held several meetings with district staff while developing the proposal to obtain their input.

Staff also surveyed engine manufacturers to gather current information on the cost and feasibility of developing Tier 4 emergency-standby and fire pump engines. The information provided by survey participants was used to help develop the proposed amendments.

13. What are the impacts on the State Implementation Plan?

The proposed revision will have minor impacts on the State Implementation Plan (SIP) that can be addressed in future plans submitted pursuant to federal Clean Air Act (CAA) planning requirements for nonattainment areas. The emission reductions that would be foregone as a result of this proposal are in all cases a very small portion of the local inventory, and there is no need to identify a specific source of new emission reductions that would compensate for the foregone reductions at this time. If the Board adopts this proposed revision, the impact would be reflected in inventories prepared for future ozone and PM 2.5 attainment demonstration plans, and if necessary, mitigated in the control strategies adopted as part of those plans.

14. What future activities are planned?

After Board consideration and approval of the proposed amendments to the ATCM, ARB staff will work with the districts to implement the revised requirements. After adoption, each district will consider whether to implement the amendments as is, or adopt alternative amendments that are at least equally effective in reducing emissions. ARB staff will also continue to monitor advances in the performance and cost-effectiveness of emission control technologies, the hours of operation for emergency standby engines, changes in the emissions inventory for stationary engines, and any future changes in the federal requirements for these engines. In addition, as discussed in Question number 11, ARB staff will work with district staff to investigate the need for additional measures to address high-use emergency standby engines.

15. What is staff's recommendation?

We recommend that the Board approve the proposed amendments to the ATCM presented in this report (Appendix A). ARB staff believes that the current ATCM restriction on operating hours for emergency standby engines, coupled with a PM level of 0.15 g/bhp-hr represents best available control technology for emergency standby applications. The proposed amendments will closely align the new engine emission standards for emergency-standby and fire pump engines with the federal NSPS standards. The proposal would maintain the vast majority of emission reduction benefits, while significantly improving the cost-effectiveness and feasibility of the ATCM.

I. INTRODUCTION

In this chapter, the Air Resources Board (ARB or Board) staff provides a brief description of the types and uses of stationary diesel engines, an overview of the Airborne Toxic Control Measure for Stationary Compression-Ignition Engines (ATCM or Stationary Diesel Engine ATCM) and the new federal Standards of Performance for Stationary Compression-Ignition Internal Combustion Engines (NSPS). Also included in this chapter is a brief summary of the Engine Manufacturers Association's (EMA) request to align the emission standards in the ATCM with the NSPS standards for stationary emergency standby engines. This chapter concludes with a discussion of the regulatory process and actions the ARB undertook to engage stakeholders in this rulemaking process.

A. Description of Stationary Diesel Engines

The ATCM establishes requirements for stationary diesel engines. Stationary engines are engines that remain in one location at a facility for 12 months or longer. These engines can be divided into two categories: emergency standby engines (including direct-drive fire pump engines) and prime engines. The regulatory requirements for prime engines are more stringent than those for emergency standby engines due to their greater hours of operation. In addition, there are different requirements for direct-drive fire pump engines, which are a special type of emergency standby engine, and agricultural engines.

Emergency Standby Engines

Emergency standby engines are engines installed and used to provide electrical power or mechanical work during an emergency or unscheduled power outage. As such, their use is typically limited to these emergency conditions, and scheduled maintenance and testing operations.

Emergency standby engines can range from less than 50 horsepower (hp) to greater than 6,000 hp, depending on the end user's needs. Based on an ARB survey, about 50 percent of emergency standby engines are in the 175 to 750 hp range.[9] Emergency standby engines represent the majority of all stationary engines (approximately 60 percent). There are over 20,000 diesel emergency standby engines currently in use in California. These engines are owned and operated by various facilities and businesses, including hospital, hotels, banks, office buildings, correctional facilities, airports, retail shopping centers, factories, military installations, schools, water and water treatment facilities, and many other publicly owned facilities and private businesses.

Direct-drive fire pumps are a special type of emergency standby engine. Rather than providing electrical power, these engines are directly coupled to fire pumps used in fire

[9] ARB conducted a survey of in-use emergency standby engines in 2002. Results from the survey are published in the Initial Statement of Reasons for Proposed Rulemaking, Airborne Toxic Control Measure for Stationary Compression-Ignition Engines. (ARB, 2003)

protection systems (building sprinkler systems). Engines used in fire pump applications are usually less than 200 horsepower. These engines are required to be operated for 30 minutes each week, plus additional hours for annual testing, by the National Fire Protection Agency (NFPA).

Prime Engines

Prime engines are stationary engines that are not classified as emergency standby engines. These engines are used in a wide variety of applications, including compressors, cranes, generators, pumps, and grinders/screening units. These engines are owned and operated by a variety of facilities and businesses, including ports, waste and recycling facilities, military installations, electrical generating companies in remote areas without access to the electrical grid, and by some public agencies. The size and operation of prime engines vary with the specific application. Prime engines can range in size from about 50 hp for an engine used to run a conveyor at a sand and gravel operation, to 2,000 hp or more to power a generator at a facility. Annual operation can be as low as 100 hours annually for a prime engine driving a compressor to several thousand hours a year for water pumping facilities. ARB staff estimates that there are approximately 1,100 diesel prime engines currently in use in California for non-agricultural applications.

Agricultural stationary engines are also categorized as prime engines. However, they have different emission standards than non-agricultural prime engines. There are approximately 12,300 stationary agricultural irrigation pump engines in California (for the 2010 year).

B. Regulatory Framework

Stationary engines are subject to regulations on the federal, State, and local levels. On the federal level, the U.S. Environmental Protection Agency (U.S. EPA) promulgated the NSPS emission standards for stationary diesel engines. The NSPS standards are modeled after the U.S. EPA Nonroad Standards for nonroad and marine diesel engines. At the State level, the ARB has adopted the ATCM which establishes emissions standards for stationary diesel engines. As will be discussed below, the ATCM establishes emission limits for PM and other pollutants and links the PM emissions limits to the Off-Road Standards when they become more stringent than those specified in the ATCM. For the other pollutants, CO, NOx, and NMHC, the ATCM generally requires the engines to meet the Off-Road Standards for the model year of the engine. The State Off-Road Standards are substantially equivalent to the federal Nonroad Standards. On the local level, the local air quality control or air quality management districts (districts) permit facilities with stationary engines. As part of this process, the districts implement other programs, such as New Source Review and the Air Toxics "Hot Spots" Program (AB 2588), that work in concert with the ATCM to ensure the emissions and risks from stationary engines are adequately mitigated. Like the ATCM, these programs allow districts to address the emissions and risks from diesel engines on a site-specific basis taking into consideration environmental justice programs and any unique circumstances that may require additional controls. Below, ARB staff provides brief overviews of the ATCM and the NSPS.

Current Stationary Diesel Engine ATCM

The ARB initially approved the ATCM at a public hearing on February 26, 2004, and the ATCM became effective on December 4, 2004 (ARB, 2003). The purpose of the ATCM is to reduce diesel PM and criteria pollutant emissions from stationary diesel engines. This was accomplished by establishing best available control technology requirements based on PM emission performance standards and operational practices for new and in-use stationary diesel engines.

The ATCM established diesel PM emission standards for new stationary emergency standby diesel engines greater than 50 hp based on the annual hours of operation needed for maintenance and testing. New emergency standby engines that do not operate more than 50 hours per year for maintenance and testing purposes are required to meet a 0.15 g/bhp-hr PM emission limit or the Off-Road Compression Ignition Engine Standards (title 13, CCR, section 2423)(Off-Road Standards), whichever is more stringent. Districts can allow emergency standby engines to operate more than 50 hours per year for maintenance and testing if it meets a diesel PM emission rate of less than or equal to 0.01 g/bhp-hr. The ATCM also requires the diesel engine installed to meet the Off-Road CI Engine Standards for HC, NOx, NMHC+NOx, and CO of the model year and maximum hp of the diesel engine installed.

The ATCM allows new direct-drive emergency standby fire pump engines to meet either the ATCM emissions standards for new emergency standby engines, or upon district approval, a three-year extension to meet the new Off-Road Standards applicable for the model year and maximum bhp. The three-year extension allows manufacturers and owners and operators to sell and install a direct-drive fire pump diesel engine that meets the emission standards immediately preceding the transition to a new tiered standard. The three year extension was provided to allow more time for these engines to meet Underwriters Laboratory (UL) and Global FM (FM) certification requirements. However, after the three-year extension only stationary direct-drive emergency standby fire pump engines that meet the Off-Road Standards may be sold and operated in California.

New stationary prime diesel engines greater than 50 hp are required to meet a diesel PM emission rate less than or equal to 0.01 g/bhp-hr, regardless of model year or maximum hp. The ATCM also requires the diesel engine to meet the Off-Road Standards for HC, NOx, NMHC+NOx, and CO of the model year and maximum hp of the diesel engine installed.

National Standards of Performance for Stationary Diesel Engines

The U.S. EPA promulgated the NSPS on July 11, 2006 (U.S. EPA, 2006). The NSPS emission standards are modeled after U.S. EPA's standards for nonroad and marine diesel engines. These standards are phased in over several years (tiered standards) with increasing levels of stringency. Stationary diesel engines whose construction, modification, or reconstruction commenced after July 11, 2005 are subject to the NSPS final rule. However, stationary diesel engines manufactured prior to April 1, 2006, are not subject to the final rule unless the engines are modified or reconstructed after July 1, 2005. Stationary diesel engines that are modified or reconstructed must meet the emission standards for the model year in which the engine was originally new, not the year the engine was modified or reconstructed.

The NSPS final rule requires stationary non-emergency (prime) diesel engines to meet the Tier 4 emission standards for all pollutants. Achieving the Tier 4 emissions standards requires the use of after-treatment devices for NOx and PM; these are likely to be SCR and DPF, respectively. However, U.S. EPA staff determined that the high cost of emission control when compared to the amount of pollutant reduced did not justify requiring manufacturers of stationary emergency standby diesel engines to meet Tier 4 standards if after-treatment devices were needed. As such, depending on the horsepower, the NSPS requires new stationary emergency standby diesel engines to meet either the Tier 2 or Tier 3 emission standards. These emissions standards don't require the use of after-treatment devices such as DPR or SCR.

For new stationary fire pump diesel engines, the NSPS establishes emission standards similar to the NSPS stationary emergency standby diesel engine standards. Up to a three-year extension to comply with the final standards based on the engine horsepower category is also provided. According to U.S. EPA, the requirements for new stationary fire pump diesel engines was based in part on the minimal increase in emissions to forego higher tier standards, the significant costs to require after-treatment, and the lengthy time needed for these engines to be certified to the federal nonroad new engine certification standards, as well as NFPA specifications and UL/FM certification.

Beyond the general compliance extensions for fire pumps, U.S. EPA also provided an additional three year extension for a limited number of engines within certain horsepower ranges and a rated engine speed greater than 2,650 rpm. According to the representatives of the fire pump industry, these higher speed engines provide greater water pressure in a more economical fire pump package for applications where the higher water pressure is needed, such as tall buildings. The extension will provide time for fire pump manufacturers to adapt lower speed engines for these high water pressure applications.

The NSPS final rule provides 24-months after the beginning of a model year to install stationary non-emergency (prime) diesel engines (except fire pump diesel engines) from a previous tier. The purpose of this 24-month "sell-through" provision is to allow the sale and installation of stationary diesel engines that were manufactured prior to the new or changed standards took effect. The NSPS conditioned this provision to prohibit the stockpiling of engines beyond normal business inventory practices.

Starting in 2011 through 2013, based on the model year and a specific horsepower range, stationary diesel engine manufacturers must add a permanent label to emergency standby diesel engines stating that the diesel engine is for stationary emergency use only. The purpose of this new labeling requirement is twofold: (1) it is intended to clarify that this subset of stationary diesel engines do not have to meet the new engine certification emission standards for non-emergency diesel engines; and (2) these engines do not meet all of the applicable Tier 4 emissions standards for off-road engines.

C. Engine Manufacturers Request

Representatives from the EMA began discussions with ARB staff in mid-2009 expressing their concerns regarding the upcoming Tier 4 emissions limits for new emergency standby engines. (EMA, 2009) EMA representatives stated that the Tier 4 standards would generally require the installation of exhaust after-treatment devices for PM and NOx, and these devices could be problematic for emergency standby engines for the following reasons.

- Emergency standby engines are operated mostly for short maintenance and testing runs, which may not allow the engine to achieve exhaust temperatures sufficient to oxidize the particulate matter that collects in DPFs. This may result in an excess accumulation of trapped particulate matter. Under emergency conditions, when the engine may achieve full exhaust temperatures for the first time, the oxidation of excess particulate matter in the DPF may generate excess heat, causing the device to fail. This would compromise the safety function provided by the engine.

- Engines operated for short maintenance and testing runs may not generate exhaust temperatures high enough to allow for efficient NOx control in SCR systems. Therefore, the expected emission reduction benefits of the devices may not be realized in actual practice.

- Exhaust after-treatment devices for PM and NOx will not be cost-effective for emergency standby engines because the cost of the control devices is high (typically $25,000 to $100,000), relative to the small air quality benefits resulting from engines that are operating very few hours.

- Engine manufacturers have reported that it is not economically feasible to make a California-only engine platform because the California-only market for these engines is too small to generate an adequate return on the investment in research and development and maintenance of a California-only product line.

For these reasons, EMA suggested that the ARB consider harmonizing the emission standards for emergency standby engines in the ATCM with the U.S. EPA NSPS standards, which do not apply Tier 4 emissions standards to emergency-standby engines. It was suggested that the ARB align with the federal NSPS standards either by directly referencing the NSPS standards in the ATCM, or by amending the ATCM to stop at the emissions tier level prior to Tier 4 (e.g., Tier 2 or Tier 3).

D. ARB Actions and Public Process to Develop Amendments

ARB staff agreed to investigate potential amendments and undertook an investigation into the technical feasibility and costs associated with the application of Tier 4 emission standards to new emergency standby engines. The staff conducted the investigation and developed the proposed amendments to the ATCM over the last year through consultations with industry, government agencies, and members of the public. As shown in Table I-1, the staff held two public workshops covering the cost-effectiveness, feasibility, and emission reduction impacts of various proposed amendments to the ATCM. More than 3,000 companies, organizations, and individuals were notified of these public workshops through email notification. Workshop notices were posted to ARB's website and e-mailed to subscribers of the "diesel risk reduction" electronic list server.

Table I-1: Workshops on the Proposed Amendments to the ATCM

Date	Location
March 1, 2010	Cal/EPA Building, Sacramento
June 21, 2010	Cal/EPA Building, Sacramento

As a way of inviting public participation and enhancing the flow of information between ARB and the public, staff maintains the "Stationary Diesel Engines and Portable Diesel Equipment" website (www.arb.ca.gov/diesel/statport.htm). Staff has made documents related to the proposed amendments, including workshop notices, presentations, and proposed draft regulatory language, available on this website. Participating in one or more of the workshops were representatives of the diesel engine manufacturers and suppliers, emission control system manufacturers, districts, utilities, and consultants. Numerous individual meetings also were held with affected stakeholders, including the engine manufacturers and emission control technology providers. In addition, ARB staff held regular meetings with district staff to obtain their input on the amendments and benefit from their knowledge regarding the permitting and operation of stationary diesel engines.

Staff also researched current information on the performance and cost of retrofit control technologies for emergency standby engines. As part of these efforts, ARB staff sent a survey to engine manufacturers in March 2010 to gather current information on the cost and feasibility of developing Tier 4 emergency-standby and fire pump engines. The information provided by survey participants was used to help develop the proposed amendments.

II. TECHNICAL FEASIBILITY AND COSTS OF AFTER-TREATMENT CONTROLS ON NEW EMERGENCY STANDBY ENGINES

As indicated previously, DPF and SCR after-treatment devices will be necessary to meet the Tier 4 Off-Road Standards. For most horsepower ranges, a DPF will be needed to meet the Tier 4 interim (Tier 4i) standards and both a DPF and SCR will be needed to meet the Tier 4 final (Tier 4f) standards. When the ATCM was originally developed, ARB staff investigated the feasibility of DPFs on emergency standby engines but there was little information available on the application of SCR on emergency standby engines. (ARB, 2003) When the regulation was adopted in 2004, ARB staff also did not investigate the incremental costs associated with the transition from Tier 2 or Tier 3 engines without after-treatment controls to the Tier 4 engines. This is because ARB staff expected that as Tier 4 engine technologies and after-treatment technologies were developed for the broad range of off-road applications, Tier 4 engines would also be available for emergency standby applications.

As part of this rulemaking, ARB staff revisited the technical feasibility and operational considerations associated with DPF devices on emergency standby engines and investigated the feasibility and operational considerations of SCR devices. ARB staff also estimated incremental costs associated with the transition from Tier 2 or Tier 3 emergency standby engines to Tier 4 engines. In this chapter, we provide a summary of this investigation and our findings. Additional details on this analysis are provided in Appendix B.

A. Technical Feasibility and Operational Considerations for DPF and SCR Devices on Emergency Standby Applications

Diesel Particulate Filters

DPFs are used in many applications to reduce emissions of diesel PM. In general, a DPF consists of a porous substrate that permits gases in the engine exhaust to pass through the DPF but collects or "traps" the diesel PM. Most DPFs employ some means to periodically remove the collected diesel PM, commonly referred to as regenerating the filter. During regeneration, the trapped PM, which is mostly carbon, is burned off the filter. Diesel PM emission reductions in excess of 85 percent are possible, depending on the associated engine's baseline emissions, fuel sulfur content, and emission test method or duty cycle. In addition, up to a 90 percent reduction in CO and a 95 percent reduction in HC can also be realized with DPFs. (ARB, 2003)

A DPF can collect PM for a set period of time before regeneration is required. The collection time will vary depending on the size and type of DPF but generally it ranges from 240 to 720 minutes (4-12 hours). The manufacturer will stipulate the duration that the engine can operate between regeneration events. For emergency standby engines, this is often identified in terms of the number of cold starts and 30 minute idle sessions that the engine can perform before the DPF needs regeneration. Because typical operation of an emergency standby engine includes either weekly, biweekly, or monthly

30 minute maintenance and testing operations with low or no load to ensure the engine is operating properly, the operator will need to verify that regeneration is occurring within manufacturer specified guidelines. The number of times that an engine can operate for maintenance and testing before regeneration can vary but typically is between 10 and 30 cold starts with 30 minute run sessions.

There are at least 13 manufacturers that have developed DPFs for use in stationary emergency standby applications. Ten manufacturers have DPFs that have been verified through the ARB's Diesel Emission Control Strategies Verification Program for use on emergency standby engines. There are also three manufacturers that provide DPFs for emergency standby applications; however their systems have not been verified by ARB. Under the ATCM, operators are not required to use verified systems; however, the use of verified systems can streamline the permitting process and avoid the costs of emissions testing.

There are about 300 emergency standby engines that have DPFs installed throughout California. In most cases, the DPFs were installed to meet district permit requirements or to address odor complaints from near-by neighbors. ARB staff believes the application of DPFs on emergency standby engines is technically feasible and can achieve significant diesel PM emission reductions. The operational considerations are minimal and can be easily accommodated by small adjustments in the routine monitoring of the engines and normal maintenance and testing procedures.

<u>SCR Technology</u>

SCR technology has been available for many years, primarily used on large power plants to lower NOx emissions. However, SCR is becoming more common in other applications due to the U.S. EPA and ARB on and off-road new compression-ignition diesel engine standards. For off-road applications, the Tier 4 final standards are phased in between 2011 and 2015; most engines greater than 75 hp will require highly effective NOx controls such as SCR.

SCR uses a catalyst (commonly precious metals, vanadium, or zeolites) and injection of a reductant (liquid ammonia or urea) to convert the NOx in the diesel exhaust to water (H_2O) and nitrogen (N_2). The catalyst lowers the reaction temperature that NOx needs to convert to H_2O and N_2. The temperature range is specific to each SCR system but in general is between 260 degrees Celsius (°C) to 540 °C. Once the exhaust temperature reaches the minimum operating temperature, the catalyst activates and the system begins to inject the reductant into the exhaust stream. The exhaust will then enter the catalyst where the conversion will take place. A well designed system can reduce the NOx emissions up to 95 percent.

There are at least eight manufacturers who have indicated they have SCR systems for installation on stationary diesel engines. These systems are generally used on prime generators and may need adaptation to work on emergency standby engines.

As mentioned above, SCR systems require an operating temperature between 260 °C to 540 °C. Reaching these temperatures may be difficult for emergency standby engines during typical maintenance and testing operations where the engine is used at low load or for short periods of time. If this temperature is not met while the engine is running, there will be no NOx emission reduction benefits. To circumvent this problem, the engine would need to be operated with higher loads and in many cases for longer periods of time. This could be a challenge for most emergency standby applications as most businesses do not have load banks in house and would have to create a larger load on the engine to get the catalyst up to operational temperature.

SCR systems have not yet seen wide application on emergency standby engines. According to district data, there are about seven facilities in California that have emergency standby engines with SCR. Most of these installations are on large engines greater than 1,000 horsepower. ARB staff believes that while the current generation of SCR systems may be technically feasible, there are significant operational hurdles to overcome before routine use of SCR on emergency standby engines is practical. This is because the majority of operating hours for emergency standby engines occur during short 15 to 30 minute maintenance and testing checks are at low engine loads. In most cases, the temperature needed for the SCR catalyst to function will not be reached during this operation and the SCR will not provide the expected NOx reductions.

B. Costs Associated with DPF and SCR Devices on Emergency Standby Engines

To determine the potential costs associated with the application of DPF and SCR technologies on emergency standby engines, ARB staff investigated the costs associated with five different "compliance pathways" or scenarios that resulted in the application of DPF and SCR devices on emergency standby generator engines (gen-set). Two scenarios were based on the end user retrofitting an existing Tier 2 or Tier 3 gen-set with after-treatment technologies and three scenarios were based on original equipment manufacturers (OEM) providing the gen-set with after-treatment technology installed. The five scenarios are:

- Scenario 1. end user aftermarket retrofit of a Tier 2 or Tier 3 gen-set with a DPF;
- Scenario 2. end user aftermarket retrofit of a Tier 2 or Tier 3 gen-set with a DPF and SCR;
- Scenario 3. OEM supplied new Tier 4 interim (Tier 4i) gen-set (DPF only);
- Scenario 4. OEM supplied new Tier 2 or Tier 3 gen-set retrofitted with OEM supplied DPF; and,
- Scenario 5. OEM supplied new Tier 4 final gen-set (with DPF and SCR).

In each case, to determine the cost increase, we compared the cost of a new Tier 2 or Tier 3 gen-set with the cost of a gen-set equipped with after-treatment controls via the compliance path specified for each scenario. Estimated costs for end-user retrofit were based on data from after-market technology providers and OEM costs were provided by

EMA members. For specified horsepower ranges, the percent increase in cost for a gen-set with after-treatment compared to a new Tier 2 or Tier 3 gen-set without after-treatment was determined for the average size horsepower engine within each horsepower range. It is important to note that, while EMA members provided estimates of their costs to produce the OEM supplied gen-sets, they also stated that it is not economically viable for them to maintain a California-only platform for these engines and that these engines will not be available "off-the-shelf" from the OEMs.

Table II-1 shows the increased costs associated with Scenarios 1 and 2 that entailed the end user retrofitting a new Tier 2 or Tier 3 gen-set with a DPF or with both a DPF and SCR. For each scenario, the costs are presented as a percentage increase and as the increase in actual dollar amount, relative to a new Tier 2 or Tier 3 gen-set. As can be seen in Table II-1, the costs for an end user to retrofit an emergency standby genset with a DPF range from $4,000 to $100,000 per engine depending on the horsepower. The cost for an end user retrofit with DPF and SCR ranges from $13,000 to $310,000 per gen-set.

Table II-1: End-User Retrofit Scenarios: Cost Increases for Emergency Standby Generator Sets

HP Range	Cost of NewTier 2/3 Gen-Set($)	Scenario 1 End-User Retrofit with DPF		Scenario 2 End-User Retrofit with SCR + DPF	
		% Increase	$ Increase	% Increase	$ Increase
50-174	$29,000	15%	$4,000	46%	$13,000
175-749	$67,000	26%	$18,000	81%	$55,000
750-1206	$141,000	26%	$37,000	82%	$115,000
1207-2000	$309,000	20%	$61,000	61%	$189,000
>2000	$523,000	19%	$100,000	59%	$310,000

The cost increases associated with Scenarios 3, 4, and 5 that relied on OEM provided after-treatment based engines and technologies are provided in Table II-2. The OEM costs for Tier 4i and Tier 4f gen-sets reflect the addition of DPF and SCR after-treatment devices where necessary and any costs the OEMs would incur for research, design, assembly line setups, tooling, inventory storage, engine markup, and other considerations. For Tier 4i, a DPF will be required to meet the PM standards on all engines greater than 75 hp. For engines greater than 1207 hp, SCR systems will also likely be required to meet the Tier 4i NOx standard. For the Tier 4f engines, both DPF and SCR systems will be required on all engines greater than 75 hp.

Table II-2: OEM Scenarios: Cost Increases for Emergency Standby Generator Sets

HP Range	Cost of Tier 2/3 Gen-Set($)	Scenario 3 OEM Supplied Tier 4i Gen-Set[1]		Scenario 4 OEM Supplied Tier 2/3 Gen-Set with DPF Retrofit		Scenario 5 OEM Supplied Tier 4f Gen-Set (DPF+SCR)	
		% Increase	$ Increase	% Increase	$ Increase	% Increase	$ Increase
50-174	$29,000	55%	$16,000	65%	$19,000	95%	$28,000
175-749	$67,000	105%	$71,000	55%	$36,000	125%	$85,000
750-1206	$141,000	100%	$136,000	40%	$57,000	110%	$156,000
1,207-1,999	$309,000	75%	$227,000	30%	$96,000	80%	$248,000
>2,000	$523,000	60%	$303,000	30%	$141,000	65%	$329,000

[1]To meet the Tier 4i PM standards, it is assumed DPFs will be required for all engines greater than 75 hp. In addition, SCR will likely be required for engines greater than 1,207 hp to meet the Tier 4i NOx standard.

As can be seen in Table II-2, the cost increase for an OEM supplied DPF equipped gen-set (Scenario 4), is $19,000 for less than 175 hp engines and about $100,000 for an engine in the 1,207 to 1,999 hp range. The costs for an OEM supplied gen-set equipped with both DPF and SCR (Scenario 5), is estimated to be more than two times the cost of an OEM supplied DPF only equipped gen-set. Comparing the estimated cost increases between the end-user Scenarios 1 and 2 presented in Table II-1 and the OEM Scenarios 3, 4, and 5 in Table II-2, it can be seen that it will be less costly for the end user to retrofit an existing Tier 2 or 3 gen-set than for the OEMs to supply the gen-set. This cost differential helps to support the OEMs contention that it is not economically viable for them to develop and maintain a "California only" emergency standby engine platform with after-treatment controls.

C. Cost-Effectiveness

The OEMs have stated they will not provide Tier 4 emergency standby engines for the California market. In the event the ATCM is not amended, the only reasonable compliance pathway for operators would be to retrofit a new Tier 2 or 3 engine with a DPF and SCR to meet the Tier 4 Offroad Standards. Therefore, using the cost estimates presented above, ARB staff determined the cost-effectiveness associated with the two scenarios (Scenarios 1 & 2) that entailed the end user retrofitting an existing Tier 2 or 3 gen-set to meet the Tier 4 standards. In each case, the cost effectiveness was estimated on a per engine basis by evaluating the emissions and costs impacts for the average size engine within each horsepower range.

To determine the cost-effectiveness, ARB staff calculated the difference in PM and NOx emissions between the new Tier 2 or Tier 3 gen-set and the gen-set described for each scenario. For Scenario 1, which relies on DPF after-treatment technology, the entire cost was applied to PM reductions. For Scenario 2, which has both NOx and PM reductions due to the application of DPF and SCR technologies, the costs were apportioned to the estimated emission reductions based on the contribution of the technology cost to the total costs. For example, the cost of the SCR is about 2/3 of the total costs for an engine with both a DPF and SCR. Using this relationship, for an engine equipped with both a DPF and SCR, 2/3 of the cost was attributed to the NOx reductions and 1/3 of the cost to the PM reductions. Table II-3 provides a summary of the costs and cost-effectiveness for each scenario.

Table II-3: Cost-Effectiveness Associated with the Application of DPF and SCR Devices on Emergency Standby Engines

Regulatory Scenario			HP Range				
			50-174	175-749	750-1206	1207-1999	>2000
	Average Horsepower:		112	462	978	1604	2630
Scenario 1: DPF Retrofit of Tier 2/3 engine	Cost Increase Due to Controls	PM	$4,300	$17,600	$37,200	$60,900	$99,900
		NOx	N/A	N/A	N/A	N/A	N/A
	Emission Reductions (lbs)	PM	8	33	70	115	189
		NOx	N/A	N/A	N/A	N/A	N/A
	Cost Effectiveness ($/lb)	PM	$540	$530	$530	$530	$530
		NOx	N/A	N/A	N/A	N/A	N/A
Scenario 2: DPF/SCR Retrofit of Tier 2/3 engine	Cost Increase Due to Controls	PM	$4,400	$18,200	$38,500	$63,100	$103,400
		NOx	$8,800	$36,300	$76,900	$126,100	$206,900
	Emission Reductions (lbs)	PM	8	33	70	115	189
		NOx	100	413	1456	2280	3740
	Cost Effectiveness ($/lb)	PM	$550	$550	$550	$550	$550
		NOx	$90	$90	$54	$56	$56

Notes: Assume emergency standby engine operates 31 hours per year at 30 percent load; 22 hours for maintenance and testing and 9 for emergency + DRP hours. DPF costs $38/hp and SCR costs $80/hp. 25 year life for DPF and SCR. Cost estimates are different than those in Table II-1 due to rounding.

To provide perspective on these estimates, ARB staff compared the cost-effectiveness for a gen-set in the 175-749 hp range (see second column under "HP Range" and "175-749" heading in Table II-3) to the cost effectiveness of regulations or programs currently being implemented by the ARB to reduce PM and NOx emissions. According to an earlier ARB survey, about 40% of all emergency standby engines are within the 175 to 749 hp range. (ARB, 2003). Table II-4 presents a comparison of the PM cost-effectiveness and Table II-5, the NOx cost-effectiveness. As can be seen, for emergency standby engines, the incremental cost-effectiveness associated with the transition from Tier 2 or 3 emission standards to either a Tier 4 DPF based emissions limit (0.01 - 0.02 g/bhp-hr PM emissions limit) or a Tier 4 SCR based emissions limit (0.3 -0.5 g/bhp-hr NOx emissions limit) is higher than any of the other regulations adopted by the Board. This is primarily due to the low number of hours that emergency standby engines typically operate.

Table II-4: PM Cost-Effectiveness Comparison [1]

Regulation or Airborne Toxic Control Measure	PM Cost Effectiveness ($/lb)
Stationary ATCM Incremental Cost-Effectiveness Tier 2/3 to Tier 4 for New Emergency Standby Engines	$530 - $550
In-Use Off-road Diesel Vehicle Rule[2]	$40
Solid Waste Collection Vehicle Rule	$32
Cargo Handling ATCM	$21
Ship Main/Aux/Boiler Proposal (2008)	$16
Ship Auxiliary Engine Regulation (2005)	$13
Public Fleets Rule	$160

[1] Chart taken from Fuel Sulfur and Other Operational Requirements for Ocean-Going Vessels Within California Waters and 24 Nautical Miles of the California Baseline (ARB, 2008)

[2] Attributes all regulation costs associated with diesel emission controls to PM and splits other regulation costs equally between PM and NOx.

Table II-5: NOx Cost-Effectiveness Comparison

Regulation or Airborne Toxic Control Measure	NOx Cost Effectiveness ($/lb)
Stationary ATCM Incremental Cost-Effectiveness Tier 2/3 to Tier 4 for New Emergency Standby Engines	$90
Carl Moyer Limit (2008 guidelines). (ARB, 2008b)	$8
Cargo Handling Equipment Rule. (ARB, 2005b)	$1
In-use Off-Road Diesel Vehicle Regulation. (ARB, 2007)	$2
Commercial Harbor Craft Rule (ARB, 2010)	$1
Portable Engine ATCM. (ARB, 2004)	$2
Public Fleet Rule (ARB, 2005c)	$11

D. Findings

Based on the analysis of the feasibility, costs, and cost-effectiveness associated with the application of DPF and SCR after-treatment devices on emergency standby engines, ARB staff makes the following findings.

- Applications of DPFs on emergency standby engines are technically feasible and there are currently about 300 emergency standby engines in California that have DPFs installed.

- There is very limited application of SCR on emergency standby engines. ARB staff is aware of a few applications on larger emergency standby engines in California. However, ARB staff believes that while the current generation of SCR systems may be technically feasible, there are significant economic and operation constraints to the routine use of SCR devices on emergency standby engines. This is because the majority of operating hours for emergency standby engines occur during short 15 to 30 minute maintenance and testing checks at low engine loads. In most cases, the temperature needed for the SCR catalyst to function will not be reached during this operation and the SCR will not provide the expected NOx reductions.

- Tier 4 engines that rely on after-treatment technology for emergency standby applications will not be available from the original equipment manufacturers. Representatives from the EMA have indicated that it will not be economically viable for engine manufacturers to develop and maintain a Tier 4 emergency standby engine platform for California. Because of this, staff concluded that Tier 4 engines for emergency standby applications will not be available "off-the-shelf." Therefore, each owner or operator will need to purchase a new Tier 2 or Tier 3 engine and then work with suppliers to retrofit the engine with a DPF and/or SCR to meet the Tier 4 emission standards for all pollutants.

- It is not cost-effective to routinely apply DPF or SCR after-treatment technologies on emergency standby engines. The costs of DPF and SCR after-treatment technology are very high and given the low number of hours that a typical emergency standby engine operates, about 31 hours per year, the cost effectiveness is significantly higher than other ARB diesel engine regulations.

Based on the analysis, and those of U.S. EPA (U.S. EPA, 2005), ARB staff believes it is appropriate to closely align the ATCM emissions standards for new emergency standby engines with those in the NSPS that do not require after-treatment based emission standards. However, ARB staff believes it is also important to continue to provide the districts with the ability to impose more stringent conditions on a site-specific basis where the additional controls are warranted.

III. SUMMARY OF EXISTING ATCM REQUIREMENTS AND PROPOSED AMENDMENTS

In this chapter, ARB staff describes the proposed amendments to the ATCM. The proposed amendments to the ATCM are designed to maintain the public health goals of the ATCM while reducing the impacts on engine manufacturers and businesses in California. This chapter is intended to meet the requirements of Government Code section (§) 11343.2 by providing to the public a "plain English" discussion of the proposed amendments.

A. Exemptions

The following amendments are being proposed to two exemptions in the ATCM.

Exemption § 93115.3 (s): Sell-Through Provision

ARB staff is proposing to delete section 93115.3 (s), the "sell-through provision," because it is no longer needed. This exemption allowed, subject to district approval, the limited sale and installation of never-been-used stock engines that do not meet the current Off-Road Standards required by title 13, CCR, section 2423. This exemption was included to help distributors and dealers manage their existing inventory of engines as the Off-Road Standards (tiered standards) transitioned from one tier to the next *e.g.*, Tier 2 to Tier 3.

If the proposed amendments discussed below are approved, then the sell-through provision is no longer needed. This is because for engines greater than 175 hp, the Tier 2 or Tier 3 PM standard of 0.15 g/bhp-hr has been in effect for a number of years so there should be no issue with dealers having new pre Tier 2 or Tier 3 engines in stock. For engines less than 175 hp, the Off-Road Standard PM emissions limit is higher than 0.15 g/bhp-hr. However, ARB staff has determined that there are many engines available that can meet a 0.15 g/bhp-hr emissions limit and these engines have also been available for several years. (ARB, 2010a) As a result, the sell-through provision is no longer necessary for emergency standby diesel engines. However, an amended sell-through provision is being proposed in this rulemaking for non-emergency (i.e., prime) diesel engines, which is consistent with the NSPS final rule. This amendment will be discussed in greater detail later in this chapter.

Exemption § 93115.3 (t): Command Destruct Sites

This exemption applies to emergency standby engines primarily used by the U.S. Department of Defense at "Command Destruct" sites. Due to a change in the mission for these sites, the terminology for these sites is being changed from "Command Destruct" to "Command Transmitter." ARB staff is proposing to amend this exemption to replace "Command Destruct" with "Command Transmitter" to reflect the military's current terminology.

B. Definitions

ARB staff is proposing amendments to four definitions in the ATCM. These definitional changes are proposed to improve the clarity of the ATCM, or to correct grammatical errors.

Definition § 93115.4 (a)(29): Emergency Standby Engine

The definition of emergency standby engine provides criteria and conditions that a diesel engine must meet to be considered a stationary emergency standby engine. The primary purpose of an emergency standby diesel engine is to provide electrical power or mechanical work during an emergency. An emergency standby engine provides backup power and is not the source of primary power for the facility. As defined in the ATCM, their uses are limited to emergency use, compliance testing, required maintenance and testing operations, operating in response to an impending outage, or participating in one of two Demand Response Programs (DRPs) allowed by the ATCM. To align with the NSPS requirements for emergency standby engines, ARB staff is proposing to amend the definition of emergency standby engine to add a new criterion which specifies that an emergency standby engine may not be used to supply power to an electric grid or supply power as part of a financial arrangement with any entity, except as allowed in § 93115.6 (a)(2), (b)(1), or (c). Section 93115.6 (a)(2) and (b)(1) contain criteria that an owner or operator must meet to operate a emergency standby engine in response to an impending rotating outage. Section 93115.6 (c) contains the operating requirements and emission standards for emergency standby engines participating in DRPs.

Definition § 93115.4 (a)(30): Emergency Use

The definition of emergency use identifies what constitutes emergency use under the ATCM. One of the conditions pertains to the use of emergency standby engines at U.S. Department of Defense "Command Destruct" sites. ARB staff is proposing to change the name "Command Destruct" sites to "Command Transmitter" sites to better reflect the mission of these sites primarily operated by the U.S. Department of Defense. In addition, these sites are now not only used in tracking rocket launching but to assist in the landing of space planes. ARB staff is proposing to amend the definition to reflect these changes in operation.[10]

Definition § 93115.4 (a)(47): Maintenance and Testing

The ATCM limits the number of hours emergency standby engines can operate for maintenance and testing. The definition of maintenance and testing describes what

[10]A recent new expansion of military operations requires Vandenberg Air Force Base to use its Command Transmitter sites for re-entry-landings of the military's new space plane. It is important to note that the stationary emergency standby diesel engines at these sites have been or are in the process of being replaced with the latest tier diesel engine and retrofitted with a verified Level 3 DPF.

operations constitute maintenance and testing activities. One of the identified activities that meet the definition of maintenance and testing is when the engine is operated to evaluate the ability of the engine or its supported equipment to perform during an emergency. Examples of supported equipment include generators, pumps, transformers, switch gears, and breakers. ARB staff is proposing to add "uninterruptable power supply" to the list of examples of supported equipment in the definition of maintenance and testing. An uninterruptible power supply is an electrical apparatus that provides instantaneous or near instantaneous protection from input power disruptions. This proposed change is in response to a request by staff from several districts to clarify that operation of an emergency standby engine to test the ability of uninterruptable power supply is considered to be maintenance and testing operation.

Definition § 93115.4 (a)(73): Stationary Source

In the definition of stationary source, ARB staff is proposing to add an "s" to the term "include" to be more grammatically correct.

C. Emission Standards for New Emergency Standby Engines

ARB staff is proposing to closely align the emission standards for new emergency standby engines to the NSPS emission standards. Below, we summarize the current requirements for new emergency standby engines in the ATCM, the NSPS requirements, and the amendments proposed to the ATCM.

Current ATCM: § 93115.6 (a)(3): Emission Standards for New Emergency Standby Engines

Section 93115.6 contains the operating and emission standards for new emergency standby diesel engines greater than 50 hp. Under the current ATCM, new stationary emergency standby diesel engines are required to meet a 0.15 g/bhp-hr PM emission limit or the Off-Road Standard, whichever is more stringent. The new stationary emergency standby diesel engine must also meet the HC, NOx, NMHC+NOx, and CO standards for the model year and maximum hp rating specified in the Off-Road Standards of the engine installed. If there are no standards, the new stationary diesel engine must meet the Tier 1 standards in the Off-Road Standards for an off-road engine of the same model year and maximum rated power, irrespective of the new stationary emergency standby engine's model year.

A new stationary emergency standby diesel engine must not operate more than 50 hours per year for maintenance and testing purposes. Upon district approval, the new diesel engine may operate up to 100 hours per year for maintenance and testing, provided the diesel PM emission rate is less than or equal to 0.01 g/bhp-hr. The ATCM does not limit engine operation for emergency use or emission testing to show compliance to the applicable emission standards. In addition, the ATCM stipulates a district may establish more stringent emission standards for PM, NMHC+NOx, HC, NOx, and CO, and more stringent limits on hours of operation for maintenance and testing and demonstrating compliance with other district rules and initial start-up testing.

NSPS Final Rule: 40 CFR § 60.4202: Emissions Standards for New Stationary Emergency Standby Diesel Engines

The NSPS requires new stationary emergency engines to meet the most stringent federal Nonroad Standards that do not require add-on emission controls. (U.S. EPA, June 27, 2005) The NSPS also requires manufacturers to certify their 2007 or later model year engines to the certification emission standards in the Nonroad Standards for the same model year and maximum engine power for all pollutants. This means for the majority of engine powers that, under federal regulation, new emergency standby diesel engines are required to meet the Tier 2 or Tier 3 new Nonroad Standards for all pollutants. For engines with horsepower greater than 175 hp, the PM emissions limit is 0.15 g/bhp-hr. For engines in the 50 to 175 hp range, the PM emissions limit ranges from 0.22 g/bhp-hr to 0.30 g/bhp-hr. In addition, the NSPS final rule established deadlines to install stationary diesel engines from a previous model year for emergency standby engines (excluding fire pump diesel engines) and non-emergency engines (prime engines).

Beginning in 2011, the NSPS also requires engine manufacturers to label each new diesel engine that meets all the emission standards for emergency standby diesel engines but do not meet all the emission standards for non-emergency engines. A permanent label must be affixed to the engine stating that the engine is "for stationary emergency use only."

Proposed ATCM Amendments to § 93115.6 (a)(3) Emission Standards for New Stationary Emergency Standby Diesel Engines

For new emergency standby engines, ARB staff is proposing to retain the 0.15 g/bhp-hr PM emissions limit in the ATCM for all horsepower categories. With one exception, this proposed amendment will result in the emissions requirements for emergency standby engines being the same in the ATCM as those in the NSPS. The only exception is for engines less than 175 hp. For these engines, the NSPS establishes a PM emissions limit of 0.22 to 0.30 g/bhp-hr depending on the horsepower, while the ATCM will retain a more stringent 0.15 g/bhp-hr PM emissions standard. ARB staff believes this emissions limit represents best available control technology for this application and many engines less than 175 hp are available that can meet the 0.15 g/bhp-hr PM. ARB staff maintains a website that posts listings of the engines by horsepower and model year that are less than 175 hp and meet the ATCM PM standard for new emergency standby engines. (ARB, 2010a) The other pollutant emission standards would be the same as the NSPS requirements. This amendment will eliminate the existing requirement in the ATCM that would have required new emergency standby engines to meet the after-treatment based Tier 4 standards when they are more stringent than 0.15 g/bhp-hr. It will also prevent the installation of any new emergency standby engine that does not meet the 2007 model year or newer emissions limits in the Off-Road Standards (title 13, CCR, section 2423) for all pollutants. No changes are proposed to the restrictions on the hours of operation for maintenance and testing or to the provisions that allow districts to impose more stringent requirements.

Table III-1 provides a summary of the proposed emission standards for new emergency standby engines.

Table III-1: Proposed Emission Standards for New Stationary Emergency Standby Diesel Engines g/bhp-hr (g/kW-hr)[1]

Maximum Engine Power	Model year(s)	PM	NMHC+NOx	CO
50 ≤ HP < 75 (37 ≤ kW < 56)	2007	0.15 (0.20)	5.6 (7.5)	3.7 (5.0)
	2008+		3.5 (4.7)	
75 ≤ HP < 100 (56 ≤ kW < 75)	2007	0.15 (0.20)	5.6 (7.5)	3.7 (5.0)
	2008+		3.5 (4.7)	
100 ≤ HP < 175 (75 ≤ kW < 130)	2007	0.15 (0.20)	3.0 (4.0)	3.7 (5.0)
	2008+			
175 ≤ HP < 300 (130 ≤ kW < 225)	2007	0.15 (0.20)	3.0 (4.0)	2.6 (3.5)
	2008+			
300 ≤ HP < 600 (225 ≤ kW < 450)	2007	0.15 (0.20)	3.0 (4.0)	2.6 (3.5)
	2008+			
600 ≤ HP < 750 (450 ≤ kW < 560)	2007	0.15 (0.20)	3.0 (4.0)	2.6 (3.5)
	2008+			
HP > 750 (kW > 560)	2007	0.15 (0.20)	4.8 (6.4)	2.6 (3.5)
	2008+			

[1] Standards are expressed in both grams per brake horsepower hour and grams per kilowatt-hour. Standards may be subject to emission limitations as specified in current applicable district rules, regulations, or policies.

No amendments are being proposed to the limitations on the operating hours or the provision that allows the district to establish more stringent emission standards for PM, NMHC+NOx, NOx, HC, and CO.

D. Emission Standards for Direct-Drive Fire Pumps

Direct-drive fire pumps are diesel engines directly coupled to pumps used in water-based fire protection systems. These fire pumps differ from the majority of fire pumps which are powered by electric motors that use the building's electrical power supply, or in some cases backup electrical power provided by a diesel generator.

In direct-drive fire pumps, the building's water supply is connected to the pump, and in the event of a fire, the engine automatically starts and operates the pump to supply water for the sprinkler systems. In addition, the engines are operated for maintenance and testing purposes as specified in the NFPA 25 guidelines – "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems. These guidelines specify operation of the engine for 30 minutes each week plus additional time for annual testing.

ARB staff is proposing to align the emission standards for new emergency standby direct-drive fire pumps with those in the NSPS. Below, ARB staff describes: (1) the current ATCM requirements for new direct-drive fire pumps; (2) the NSPS requirements; and (3) the proposed amendments to the ATCM.

Current ATCM: § 93115.6 (a)(4): Emission Standards New Direct-Drive Emergency Standby Fire Pump Engines

Under the current ATCM, new fire pumps are subject to either requirements that are specific to direct-drive fire pump engines (under section 93115.6 (a)(4)), or the general requirements for new emergency standby diesel engines (under section 93115.6 (a)(3)). ARB staff believes that most operators have chosen to meet the relatively less stringent requirements specific to fire pumps. These provisions specify that new direct-drive fire pump engines: (1) meet the applicable Off-Road Standards (title 13 CCR, section 2423) three years later than they would be required for other emergency back-up engines; and (2) operate no more than the number of hours necessary to comply with the testing requirements of the National Fire Protection Agency (NFPA) 25 - "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems." Although the requirements for fire pumps under the current ATCM provide a three-year delay in the implementation of the Off-Road Standards, the more stringent Tier 4 standards requiring the use of after-treatment emission control devices would eventually apply to fire pump engines.

The requirements for fire pump engines are different from those for other emergency back-up engines because of the time required to develop and certify these engines to NFPA requirements. Fire pump suppliers work together with engine manufacturers to modify a standard diesel engine for use as a fire pump. This typically involves changes to the software that controls the engine. For example, the engine may be programmed to deactivate engine protection features (such as stopping the engine) during a fire, while activating these features during normal maintenance and testing runs. Electronically-controlled engines may also be supplied with two engine control units to provide redundancy in case one fails. Fire pump engines are also typically designed without a radiator, instead utilizing the water they are designed to pump, creating a constant flow of cooling water through the engine (in addition to the fire suppression system).

In addition to the development time with the engine manufacturer, the fire pump supplier must certify the engine to the requirements of NFPA 20 - "Standard for the Installation of Stationary Pumps for Fire Protection." Third party certification companies such as Underwriters Laboratories (an independent product safety certification organization) and FM Global (an insurance company) approve (or "list") products to the NFPA 20 requirements. These organizations certify each component in fire protection systems, including the engine, fire pump, pump control unit, coupling between the engine and pump. For example, the engines used in fire pumps must be certified by the company to ensure that the engine power is at least 10 percent greater than the maximum power required by the pump under any conditions of pump load (among other requirements).

<u>NSPS Final Rule: 40 CFR § 60.4202 (d): Emission Standards for New Stationary Emergency Standby Fire Pump Engines</u>

The U.S. EPA NSPS for emergency stationary diesel fire pump engines are shown in Table III-2 for 2007 and later model years.

Table III-2: NSPS Fire Pump Diesel Engine Standards
NMHC+NOx/CO/PM in g/bhp-hr and (g/kW-hr)

Maximum Power	2007	2008	2009	2010	2011	2012	2013	2014	2015+
50≤hp<75[1] (37≤kW<56)	7.8/3.7/0.60 (10.5/5.0/0.80)				Tier 4 interim 3.5/3.7/0.30 (4.7/5.0/0.40)				
75≤hp<100[1] (56≤kW<75)	7.8/3.7/0.60 (10.5/5.0/0.80)				Tier 3 3.5/3.7/0.30 (4.7/5.0/0.40)				
100≤hp<175[2] (75≤kW<130)	7.8/3.7/0.60 (10.5/5.0/0.80)			Tier 3 3.0/3.7/0.22 (4.0/5.0/0.30)					
175≤hp<300[3] (130≤kW<225)	7.8/2.6/0.40 (10.5/3.5/0.54)		Tier 3 3.0/2.6/0.15 (4.0/3.5/0.20)						
300≤hp<600[3] (225≤kW<450)	7.8/2.6/0.40 (10.5/3.5/0.54)		Tier 3 3.0/2.6/0.15 (4.0/3.5/0.20)						
600≤hp≤750 (450≤kW≤560)	7.8/2.6/0.40 (10.5/3.5/0.54)		Tier 3 3.0/2.6/0.15 (4.0/3.5/0.20)						
hp>750 (kW>560)	7.8/2.6/ 0.40 (10.5/3. 5/0.54)	Tier 2 4.8/2.6/0.15 (6.4/3.5/0.20)							

1. For model years 2011–2013, manufacturers, owners and operators of fire pump stationary CI ICE in this engine power category with a rated speed of greater than 2,650 revolutions per minute (rpm) may comply with the emission limitations for 2010 model year engines.
2. For model years 2010–2012, manufacturers, owners and operators of fire pump stationary CI ICE in this engine power category with a rated speed of greater than 2,650 rpm may comply with the emission limitations for 2009 model year engines.
3. In model years 2009–2011, manufacturers of fire pump stationary CI ICE in this engine power category with a rated speed of greater than 2,650 rpm may comply with the emission limitations for 2008 model year engines.

The primary difference between the NSPS standards for fire pumps and non-fire pump emergency engines is that the implementation of the fire pump standards is delayed. Specifically, for fire pump engines between 75 and 750 hp, there is a three year delay in the implementation of the Tier 3 standards relative to non-fire pump engines. For example, as shown in Table III-2 above, for fire pump engines in the 100 to 175 hp range, the Tier 3 standards begin in 2010, while for non-fire pump engines in this power range, the Tier 3 standards began in 2007. For fire pump engines greater than 750 hp, there is a two year delay in the Tier 2 standards relative to non-fire pump engines. And for engines between 50 and 75 hp, there is a three year delay in the implementation of the Tier 4 interim standards.

Proposed ATCM Amendments to § 93115.6 (a)(4) Emission Standards for New Stationary Emergency Standby Direct-Drive Fire Pump Engines

ARB staff proposes to align the emission standards in the ATCM with the NSPS standards for fire pump engines, as listed in Table II-2. Under the proposed amendments, direct-drive fire pump engines would not need to use exhaust after-treatment devices. The amendments would also reflect the delayed implementation of fire-pump engine standards relative to other emergency-standby engines, to allow for the extra time needed to develop and certify these engines to meet NFPA requirements.

E. Miscellaneous Amendments

§ 93115.7 (a): Requirements for Prime Engines

Section 93115.7 (a) prohibits the sale and installation of a new stationary prime diesel engine that has a rated hp greater than 50 unless the engine emits diesel PM at a rate less than or equal to 0.01 g/bhp-hr. This section also requires the new prime diesel engine to meet the HC, NOx, NMHC+NOx, and CO Off-Road Standards for the model year and maximum rated hp of the diesel engine installed to meet the 0.01 g/bhp-hr PM emission standard. This PM emission limit is the Tier 4 final PM limit for most horsepower ranges. However, for certain horsepower ranges, the Tier 4 final PM emissions limit is 0.02 g/bhp-hr.[11] To address this issue, in an earlier rulemaking, the Board approved an alternative compliance provision for these engines that in effect, allows engines certified to the 0.02 g/bhp-hr PM emission standard to be in compliance with the ATCM. To simplify the regulatory language in the ATCM, ARB staff is proposing to align the PM emissions limits for these engines with the Off-Road Standard PM emissions limit of 0.02 g/bhp-hr. ARB staff is also proposing to align with the NSPS final rule deadlines for installing prime engines from a previous model year. Essentially this provision allows 2 years to sell and install engines from the previous tiered standard after transitioning to a new tiered standard.

Table III-3 provides a summary of the proposed emission standards for new stationary prime diesel engines greater than 50 hp.

[11] Engines in the 50 to 75 hp range and those greater than 750 hp have a 0.02 g/bhp-hr PM emissions limit. These engines are DPF-equipped to meet that limit.

Table III-3: Proposed Emission Standards for New Stationary Prime Diesel Engines > 50 HP g/bhp-hr (g/kW-hr)[1]

Maximum Engine Power	Model year(s)	PM	NOx	NMHC +NOx	NMHC	CO
50 ≤ HP <75 (37 ≤ kW <56)	2007	0.01 (0.02)		5.6 (7.5)		3.7 (5.0)
	2008-2012	0.01 (0.02)		3.5 (4.7)		3.7 (5.0)
	2013+	0.02 (0.03)		3.5 (4.7)		3.7 (5.0)
75≤ HP <100 (56≤ kW <75)	2007	0.01 (0.02)		5.6 (7.5)		3.7 (5.0)
	2008-2011	0.01 (0.02)		3.5 (4.7)		3.7 (5.0)
	2012-2014	0.01 (0.02)	2.5 (3.4)		0.14 (0.19)	3.7 (5.0)
	2015+	0.01 (0.02)	0.30 (0.40)		0.14 (0.19)	3.7 (5.0)
100 ≤ HP <175 (75≤ kW <130)	2007-2011	0.01 (0.02)		3.0 (4.0)		3.7 (5.0)
	2012-2014	0.01 (0.02)	2.5 (3.4)		0.14 (0.19)	3.7 (5.0)
	2015+	0.01 (0.02)	0.30 (0.40)		0.14 (0.19)	3.7 (5.0)
175 ≤ HP < 750 (130≤ kW <560)	2007-2010	0.01 (0.02)		3.0 (4.0)		2.6 (3.5)
	2011-2013	0.01 (0.02)	1.5 (2.0)		0.14 (0.19)	2.6 (3.5)
	2014+	0.01 (0.02)	0.30 (0.40)		0.14 (0.19)	2.6 (3.5)
750 < HP ≤ 1,207 (560 < kW ≤ 900) Gen. sets	2007-2010	0.01 (0.02)		4.8 (6.4)		2.6 (3.5)
	2011-2014	0.02 (0.03)	2.6 (3.5)		0.30 (0.40)	2.6 (3.5)
	2015+	0.02 (0.03)	0.50 (0.67)		0.14 (0.19)	2.6 (3.5)
HP > 1,207 (kW > 900) Gen. sets	2007-2010	0.01 (0.02)		4.8 (6.4)		2.6 (3.5)
	2011-2014	0.02 (0.03)	0.50 (0.67)		0.30 (0.40)	2.6 (3.5)
	2015+	0.02 (0.03)	0.50 (0.67)		0.14 (0.19)	2.6 (3.5)

[1] May be subject to additional emission limitations as specified in current district rules, regulations, or policies governing distributed generation.

§ 93115.10: Reporting Requirements for Emergency Standby Diesel Engines Participating in Demand Response Programs

Sections 93115.10 (i) and (j) contain reporting requirements for stationary emergency diesel engines participating in two ATCM-approved Demand Response Programs

(DRPs). One is the Rolling Blackout Reduction Program (RBRP), which exists only in the entire service territory of the San Diego Gas and Electric Company (SDG&E); and the other DRP is the Interruptible Service Contracts (ISC), which are allowed in the entire service territory of any utility distribution company. The ATCM defines a utility distribution company as "one of several organizations that control energy transmission and distribution in California. This includes, but is not limited to, companies such as Pacific Gas and Electric Company, Southern California Edison, Sacramento Municipal Utility District, and the Imperial Irrigation District."

The ATCM currently requires SDG&E to provide an update of their RBRP engines or owners or operators enrolled in an ISC to update the information required by § 93115.10 (i) or (j) to the district only upon request. Staff is proposing to require the SDG&E and the owners or operators of DRP engines to provide a complete and updated inventory annually to the district and the Executive Officer of the ARB. The proposed amendment requires an updated inventory to be submitted annually, unless the Executive Officer determines an updated inventory is not needed for any given year. The affected parties will be notified in writing that a submittal is not necessary for that year or subsequent years.

The purpose of the proposed reporting amendment is to provide ARB staff with a current inventory of stationary emergency standby diesel engines and their associated emissions that participate in DRPs. This information will provide ARB staff the necessary information to evaluate the emissions and potential health impacts associated with DRP hours of operation.

§ 93115.9 and 93115.10 (b): Emission Standards and Reporting Requirements for New Diesel Engines Less Than or Equal to 50 hp

Section 93115.9 prohibits, except as provided in the exemptions section of the ATCM, the sale, lease, or use in California of any stationary diesel-engine that has a rated hp less than or equal to 50, unless it meets the current Off-Road Standards for diesel off-road engines of the same maximum rated power.

ARB staff proposes to not require less than or equal to 50 hp direct-drive fire pump engines to meet the Off-Road Standards and instead rely on the federal NSPS requirements for these engines to mitigate the emissions from this subset of engines. To further align the ATCM with the NSPS, ARB staff also proposes to not require after-treatment based Tier 4 standards for new emergency standby engines less than or equal to 50 hp. In addition, ARB staff proposes to delete the ATCM provision that requires sellers and dealers of less than or equal to 50 hp stationary engines to annually report to the ARB the number of engines sold. This data is no longer needed to support ARB's emission inventory program.

Minor Amendments and Clarifications

Section 93115.6 (a)(3) identifies the requirements that sellers and owners/operators must meet to sell and use new stationary emergency standby diesel engines in California. Staff is proposing to delete the reference in this section to Table 1 and replace it with a reference to section 93115.6 (a)(3). This change is necessary to be consistent with the proposed amendments previously mentioned to this section.

Section 93115.10 (e) identifies the monitoring requirements for new or in-use emergency standby diesel engines subject to sections 93115.6, 93115.7, or 93115.8 (a). Section 93115.10 (e)(2) requires all DPFs installed pursuant to the requirements in these sections to install a backpressure monitor. Unfortunately, section 93115.10 (e)(2) did not reference the aforementioned sections. Staff is proposing to include these sections to ensure the applicability of this subpart and installation of backpressure devices only on stationary diesel engines subject to those sections.

Section 93115.10 (g) contains the reporting requirements for stationary emergency standby diesel engines. Staff is proposing to include a requirement to report DRP engine hours of operation. The current ATCM does not include this requirement. The intent of this provision is to clarify that the owner and operator must keep and report these operations as well for each emergency standby diesel engine.

F. Alternatives to the Proposed Amendments

Government Code section 11346.2 requires ARB to consider and evaluate reasonable alternatives to the proposed amendments to the ATCM and provide the reasons for rejecting those alternatives. ARB staff evaluated three alternative strategies to the current proposed amendments. Based on the analysis, none of the alternative strategies were considered to be more effective than the proposed amendments. Implementation of the proposed amendments is necessary to ensure cost-effective and health protective emission reductions from stationary diesel engines. A description of the alternatives considered and staff's rationale for finding them unsuitable follows below.

Alternative 1: Do Not Adopt the Proposed Amendments and Enforce the Existing ATCM

Under this alternative, ARB staff would not propose amendments to the ATCM; rather the existing ATCM would be implemented. This would result in operators of new emergency standby engines having to install after-treatment devices such as DPFs and SCR. As discussed in Chapter II, because the OEMs will not supply an "off-the-shelf" DPF or SCR equipped emergency standby engine to the California market, the end-user will need to purchase a new Tier 2 or 3 gen-set and retrofit that gen-set engine with a DPF and SCR device as necessary to meet the Tier 4i and Tier 4f emissions limits. These systems significantly increase the cost of the engine. The installation of DPF and SCR devices on a stationary engine increases the cost of the engine by approximately

$118 per hp. In addition, there are technical issues in applying SCR devices on emergency standby engines. Because the SCR catalyst takes time to warm up, during routine maintenance and testing runs, the SCR will not reduce NOx emissions.

The cost-effectiveness for requiring both a SCR system and DPF is very high. This is because the costs for the devices are very high and the emissions benefits are very small due to the fact that emergency standby engines operate, on average, about 31 hours per year. As shown in Table II-3 in Chapter II, the average cost-effectiveness for PM reductions from the DPF is about $530 to $550 per pound of PM. The cost-effectiveness range for the NOx reductions from the SCR system is $54 to $90 per pound of NOx. These cost-effectiveness values are much higher than any regulation previously adopted by the ARB.

This option was rejected due to the high cost-effectiveness, technical issues associated with SCR systems on emergency standby engines, and the unwillingness of the engine manufacturers to provide a viable product to the market.

Alternative 2: Require Retrofit of a New Tier 2 or 3 Engine with an Aftermarket DPF

Another alternative considered is to require an operator to purchase a new Tier 2 or 3 engine that meets a 0.15 g/bhp-hr PM emissions standard and to retrofit that new engine with an aftermarket DPF to meet a diesel PM emission rate of about 0.01 g/bhp-hr. This would retain the PM benefits of the current ATCM. However this alternative would result in foregoing about 0.33 T/D and 0.78 T/D NOx reductions in 2015 and 2020, respectively.

This alternative is less costly than Alternative 1, but it is still very high. As discussed in Chapter II, it will cost end users approximately $38 per hp to add on a DPF device to their emergency standby engines. Because of the low number of annual hours an emergency standby engine operates, the PM cost-effectiveness is still very high. As presented in Table II-3 in Chapter II, the cost-effectiveness to $550 per pound of diesel PM reduced. Due to the high cost-effectiveness, ARB staff rejected Alternative 2 from consideration.

Alternative 3: Require the OEMs to Provide Tier 4i Engines for the California Market

The third alternative considered was to require the OEMs to provide Tier 4i certified engines for the California marketplace. Under the Tier 4i standards, engines greater than 75 hp would require a DPF and some level of NOX control. For the very large horsepower engines, those greater than 750 hp, SCR would most likely be required to achieve the NOx emissions standards. For engines less than 750 hp, other NOx controls will be applied such as exhaust gas recirculation (EGR). With this alternative the diesel PM emission reductions from the current ATCM would be preserved, but there would be a decrease in the expected NOx emissions reductions.

Under this alternative, the costs of a gen-set would increase significantly relative to a Tier 2 or Tier 3 engine. As shown in Table II-2 the costs for a gen-set could increase by over 50 to 105% depending on the horsepower of the engine. This is due to the costs that the OEM would incur if required to provide a Tier 4i emergency standby engine platform for California. However, manufacturers have stated that it is not economically viable for them to provide an emergency standby engine to meet the Tier 4 interim standard just for California.

This option was rejected due to the high costs and the unwillingness of the engine manufacturers to provide Tier 4i emergency standby engines for the California market. In addition, this approach would not be consistent with the overall goal of ARB and U.S. EPA to harmonize on-road and off-road emission standards for new engines.

IV. EMISSIONS AND ENVIRONMENTAL IMPACTS FROM PROPOSED AMENDMENTS

In this chapter, ARB staff describes the potential environmental impacts of the proposed amendments to the ATCM including a brief overview of the emissions from stationary engines and the impacts of the proposed amendments on the projected emissions of stationary diesel engines and the State Implementation Plan (SIP). In addition, the potential public health impacts are also discussed.

A. Legal Requirements

The California Environmental Quality Act (CEQA) and ARB policy require an analysis to determine the potential environmental impacts of proposed regulations. Because ARB's program involving the adoption of regulations has been certified by the Secretary of Resources pursuant to Public Resources Code section 21080.5, the CEQA environmental analysis requirements may be included in the Initial Statement of Reasons (ISOR) for this rulemaking. In the ISOR, ARB must include a "functionally equivalent" document, rather than adhering to the format described in CEQA of an Initial Study, a Negative Declaration, and an Environmental Impact Report. In addition, staff will respond, in the Final Statement of Reasons for the proposed amendments to the ATCM, to all significant environmental issues raised by the public during the public review period or at the Board public hearing.

Public Resources Code section 21159 requires that the environmental impact analysis conducted by ARB include the following:

- an analysis of reasonably foreseeable environmental impacts of the methods of compliance;
- an analysis of reasonably foreseeable feasible mitigation measures; and
- an analysis of reasonably foreseeable alternative means of compliance with the proposed amendments to the ATCM.

Regarding reasonably foreseeable mitigation measures, CEQA requires an agency to identify and adopt feasible mitigation measures that would minimize any significant adverse environmental impacts described in the environmental analysis.

The ATCM reduces the risk from exposures to diesel PM as required by Health and Safety Code (H&SC) section 39666 and to fulfill the goals of the Diesel Risk Reduction Plan. (ARB, 2000) The proposed amendments to the ATCM reduce the cost of complying with the ATCM while still ensuring the emissions and risks from stationary diesel engines are mitigated.

B. Methodology for Estimating Emissions

To estimate the emissions from stationary diesel engines, ARB staff relied upon the methodology and the emission inventory developed during the initial rulemaking for the ATCM. (ARB, 2003) However, this inventory for stationary engines (2003 ISOR Inventory) was updated and corrected in three ways. First, the emission factors were updated to the current version used in the ARB's OFFROAD model. Second, revised fuel correction factors were incorporated and third, a growth adjustment for the recent economic recession was included. The updated inventory, referred to as the "2010 Inventory Update," was then used to determine the emissions impacts of the proposed amendments. The updated inventory and emissions model, Stationary Commercial Engine Emission Model, is posted on ARB's website at www.arb.ca.gov/diesel/statport.htm. (ARB, 2010b) Below we briefly describe the emission inventory adjustments and present a comparison of the 2003 ISOR Inventory and the 2010 Inventory Update.

Emission Factors

The 2003 ISOR Inventory was revised to include the July 24, 2006 update to large compression-ignited engine emission factors used in the OFFROAD model. (ARB, 2006) The 2003 ISOR Inventory used emission factors generated based on the emission standards for engines with an additional assumption that 50 percent of new engines brought into service would be new and 50 percent would be used. In the updated inventory, these emission factors were replaced with the appropriate new emission factors from the OFFROAD model. Also, the OFFROAD emission factors incorporate improved Tier 4 emission factors which should more accurately reflect actual Tier 4 engine emissions.

Revised Final Corrected Factors

The 2003 ISOR Inventory was also updated using the fuel correction factors released on July 25, 2005. (ARB, 2005) The fuel correction factors contained in the OFFROAD model are dimensionless multipliers applied to the basic exhaust emissions rates that account for differences in the properties of certification fuels compared to those of commercially dispensed fuels. The purpose for the 2005 fuel correction factor update was to align the factors more closely to those used for on-road emission estimates produced by ARB's Emission Factor (EMFAC) model.

Recession Adjustment

The effects of the recent economic recession were incorporated into the 2010 Inventory Update. The adjustment was based on forecasted non-agricultural employment obtained from the University of California at Los Angeles - Anderson Forecast for the Nation and California, June, 2010. (UCLA, 2010) Non-agricultural employment was chosen because ARB staff believes it to be the best surrogate for the population of stationary commercial engines. In a recession, not only are new engines not purchased because of lack of growth and less construction, but existing engines belonging to entities that have gone out of business are taken out of the engine fleet. Non-agricultural employment should be a reasonably good surrogate to cover both of these possibilities.

Three recession recovery scenarios were estimated: 1) a fast recovery, in which the bottom of the recession occurs in 2009 and full recovery from the recession occurs in 2017; 2) a slow recovery, in which the full recovery from the recession never occurs and the old growth rate resumes in 2010; and 3) a medium recovery recession scenario averaging the fast and slow scenarios. The latter (third) scenario was used to adjust projected emissions, with a net recession impact of 8 percent reductions in 2010 emissions, 5 percent in 2015, and 4 percent in 2020.

Table IV-1 summarizes the estimated engine population for prime and emergency standby engines for the years 2010, 2015, and 2020. The estimated total population of stationary non-agricultural engines is expected to increase by about 18 percent between 2010 and 2020.

Table IV-1: Projected Population of Stationary Diesel Engines[1]

Population			
Year	**Prime**	**Standby**	**Total**
2010	1084	20,683	**21,767**
2015	1072	22,607	**23,679**
2020	1044	24,578	**25,622**

1. Population estimate based on the medium economic recovery scenario.

Table IV-2 summarizes the total statewide emissions originally estimated with the 2003 ISOR Inventory and the 2010 Inventory Update. Relative to the 2003 ISOR inventory, in the 2010 Inventory Update, NOx emissions increase by about 15 percent, and PM10 emissions decrease about 30 percent for 2020. The emissions are for stationary diesel engines used in non-agricultural applications. As a reminder, the 2010 Inventory Update reflects the medium recovery recession scenario as discussed above.

Table IV-2: Stationary Diesel Emissions Inventory Comparison: 2003 ISOR Inventory vs. 2010 Inventory Update (tons per day)

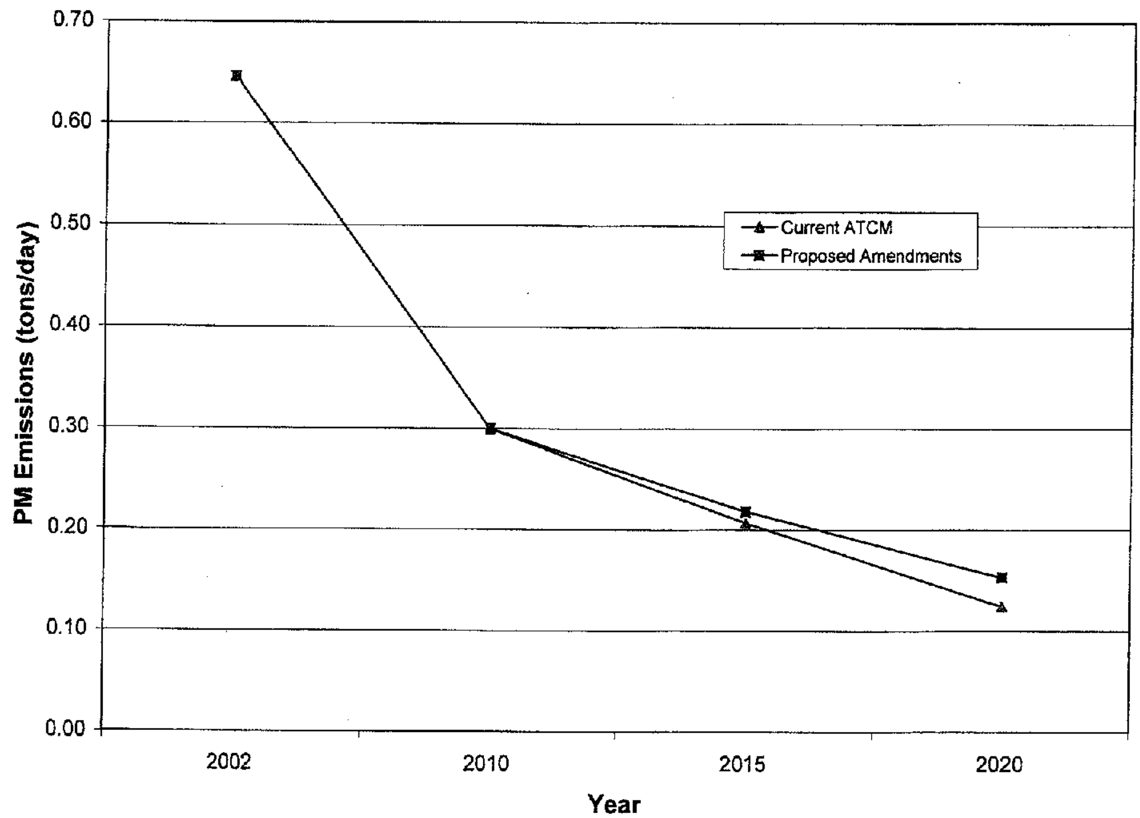
		NO_x	PM_{10}	CO	ROG
2003 ISOR Inventory	2010	13.2	0.35	3.0	0.8
	2015	9.0	0.21	2.7	0.6
	2020	5.4	0.17	2.4	0.5
2010 Inventory Update	2010	10.9	0.30	2.9	0.7
	2015	8.4	0.21	2.4	0.5
	2020	6.2	0.12	2.3	0.4

C. Emission Impacts of the Proposed Amendments

As shown in Figure IV-1 and Table IV-3 below, with the proposed amendments, the PM emissions from stationary diesel engines are expected to continue to decline over the next decade.[12] However, the amendments will result in a small loss of projected diesel PM emission reductions of about 0.01 tons per day (T/D) in 2015 and 0.03 T/D in 2020 as compared to the current ATCM. We do not expect this small change in emissions to have a significant impact on projected regional PM emissions. These foregone emission reductions are about one hundredth of one percent (0.01%) of the total Statewide diesel PM emissions in 2015 and four hundredths of one percent (0.04%) in 2020.

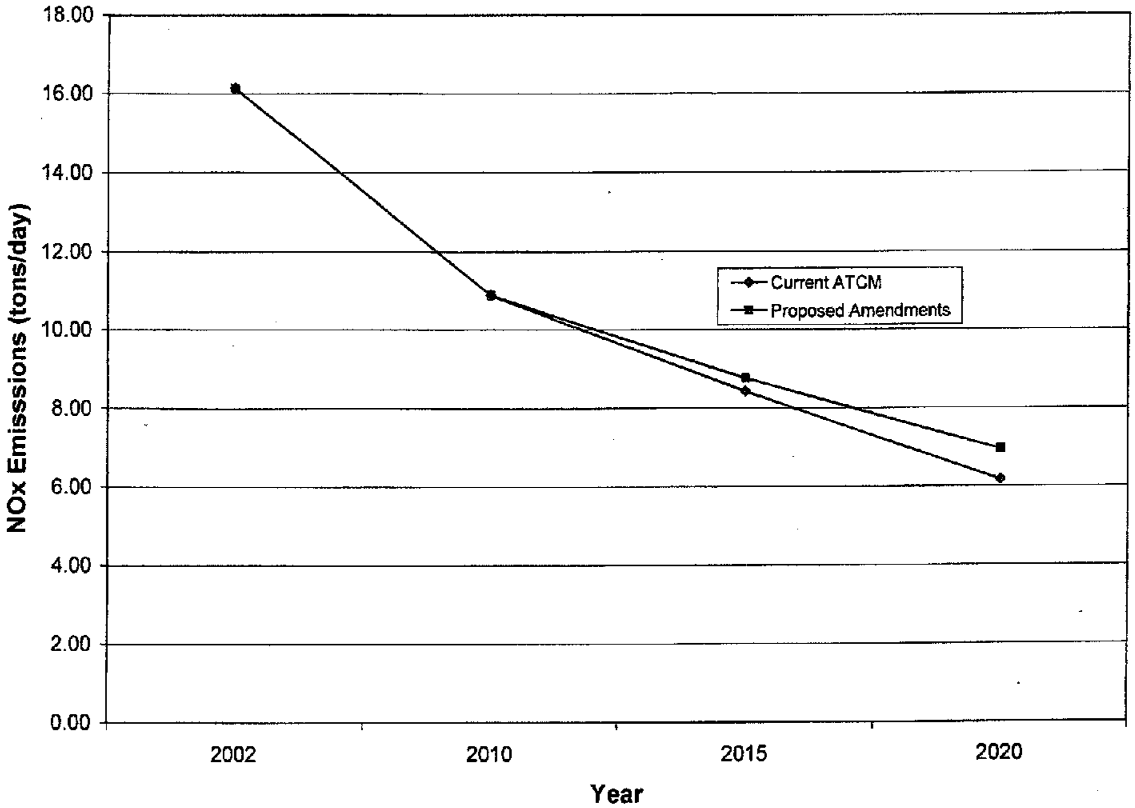
[12] In Figure IV-1 and Table IV-3, the emissions represent the combined totals for both prime and emergency standby engines. Of this total, emergency standby engines comprise about 40 percent of the emissions in 2010.

Figure IV-1: Comparison of Statewide Stationary Non-Agricultural Engine Diesel PM Emissions with the Current ATCM and the Proposed Amendments



The proposed amendments will also impact the projected emissions of NOx from stationary diesel engines. While the primary focus of the ATCM is to reduce diesel PM, by linking the emissions standards for new engines to the off-road engine standards, there are some ancillary NOx reductions. Foregoing Tier 4 engines for new emergency standby engines will result in fewer NOx reductions in future years. Figure IV-2, provides a graphic of the projected NOx emissions with the current ATCM emissions standards and with the proposed amendments. In 2015, we forego projected NOx emissions of 0.4 T/D and 0.8 T/D in 2020. This translates into about one hundredth of one percent (0.01%) of total Statewide emissions of NOx and three hundredths of one percent (0.03%) in 2020.

Figure IV-2: Comparison of Statewide Stationary Non-Agricultural Engine Diesel NOx Emissions with the Current ATCM and the Proposed Amendments



The emissions impacts presented graphically in Figures IV-1 and IV-2 above are also provided in Table IV-3 below.

Table IV-3: Projected Stationary Non-Agricultural Diesel Engine Emissions with Implementation of the Proposed Amendments (tons per day)

		NO_x	PM_{10}	CO	ROG
2010 Inventory Update	2010	10.9	0.30	2.9	0.7
	2015	8.4	0.21	2.4	0.5
	2020	6.2	0.12	2.3	0.4
2010 Inventory Update with Proposed Amendments	2010	10.9	0.30	2.9	0.7
	2015	8.8	0.22	2.4	0.5
	2020	7.0	0.15	2.3	0.5

With the proposed amendments, the ATCM will continue to ensure that the cancer risks from emergency standby engines are minimized. In most all cases, the diesel PM emissions from an emergency standby engine with a diesel PM emission rate of

0.15 g/bhp-hr results in potential cancer risks being below 10 chances in a million for people living close to a facility with emergency standby engines. In those rare cases that a new emergency standby engine has a potential cancer risk greater than 10 chances in a million, the ATCM will continue to have a provision that allows a district to establish more stringent emission standards and operating requirements where necessary to protect public health.

In addition, there are other programs implemented by the districts, such as New Source Review and the Air Toxics "Hot Spots" Program (AB 2588), that work in concert with the ATCM to ensure the emissions and public health risk from stationary engines are adequately mitigated. Like the ATCM, these programs allow districts to address the emissions and risks from diesel engines on a site-specific basis taking into consideration environmental justice programs and any unique circumstances that may require additional controls

D. State Implementation Plan Impacts

The proposed revision will have minor impacts on the State Implementation Plan (SIP) that can be addressed in future plans submitted pursuant to federal Clean Air Act (CAA) planning requirements for nonattainment areas. The emission reductions that would be foregone as a result of this proposal are in all cases a very small portion of the local inventory, and there is no need to identify a specific source of new emission reductions that would compensate for the foregone reductions at this time. If the Board adopts this proposed revision, the impact would be reflected in inventories prepared for future ozone and PM 2.5 attainment demonstration plans, and if necessary, mitigated in the control strategies adopted as part of those plans. Below, ARB staff summarizes the analysis of the impacts of the proposed amendments on the SIP.

The emission inventories used in the most recent ozone and PM 2.5 attainment demonstration plans submitted to U.S. EPA assume the full implementation of the Stationary Diesel Engine ATCM as adopted in 2004. The 2007 SIP update included PM 2.5 attainment demonstration plans for the South Coast and San Joaquin Valley, and 8-hour ozone attainment demonstration plans for the South Coast, San Joaquin, and six other areas in California. Most of the sources that would be affected by the proposed amendments are located in the South Coast and San Joaquin Valley. The ATCM reductions of ROG and PM 2.5 that would be foregone if the Board adopts the proposed amendments make up a less than one hundredth of one percent of each area's total baseline inventory for the ozone and PM 2.5 attainment years (2023 and 2014, respectively), as show below in Table IV-4. Similarly, the foregone NOx reductions would compromise less than one-tenth of one percent of NOx emissions in those years. The foregone reductions for the South Coast and the San Joaquin Valley represent approximately half of the potential foregone emission reductions statewide, as an estimated 42 percent of the foregone reductions statewide would occur in the South Coast, and about 10 percent would occur in the San Joaquin Valley. Note that the following table shows emissions as tons per day, the metric used in the SIP calculations. The ARB SIP legal commitment remains unchanged.

Table IV-4: Foregone Emission Reductions Compared to SIP Emissions Inventories for the South Coast and San Joaquin Valley Air Basins (tons per day)

	NOx		ROG		PM2.5
	2014	2023	2014	2023	2014
South Coast Air Basin					
Baseline inventory	650	505	566	534	98
SIP reduction commitments	194	391	57	74	10
Foregone emission reductions	0.1	0.4	<0.01	0.02	<0.01
Percent Loss	<0.01%	<0.1%	<0.001%	<0.01%	<0.01%
San Joaquin Valley Air Basin					
Baseline inventory	420	295	405	410	109
SIP reduction commitments	76	46	23	24	5
Foregone emission reductions	<0.1	0.1	<0.001	<0.01	<0.001
Percent Loss	<0.01%	<0.1%	<0.001%	0.001%	0.001%

E. Reasonably Foreseeable Environmental Impacts as a Result of Potential Compliance Methods

When the ATCM was originally adopted, ARB staff evaluated the reasonably foreseeable environmental impacts associated with compliance with the ATCM. (ARB, 2003) At that time, ARB staff identified and evaluated potential environmental impacts associated with the application of after-treatment controls on stationary diesel engines. Based on the analysis, ARB staff concluded that there were potential adverse environmental impacts from the use of diesel oxidation catalysts and DPFs but that options were available to mitigate these potential adverse impacts. Because the proposed amendments to the ATCM remove the emission limitations that would have resulted in the application of after-treatment controls on new emergency standby engines, ARB staff expects a positive environmental impact on the environment since after-treatment controls will no longer be required for new emergency standby engines.

However, as noted above in section C., the proposed amendments will result in a small loss in projected diesel PM and NOx emission reductions in future years. The magnitude of potential emission increases is very small when compared to the statewide emissions of these pollutants from all sources. Nevertheless, this loss of anticipated future emissions reduction could still constitute an adverse environmental impact.

F. Reasonably Foreseeable Mitigation Measures

CEQA requires an agency to identify and adopt feasible mitigation measures that would minimize any significant adverse environmental impacts. Staff evaluated a number of alternatives to the proposed amendments (see Chapter III). However, staff was not able to identify any feasible alternatives or mitigation measures that would achieve cost-effective emission reductions and, at the same time, substantially reduce the potential adverse impacts of the proposed amendments. As discussed above under "D. State Implementation Plan Impacts," the small emissions increases will be reflected in inventories prepared for future ozone and PM 2.5 attainment demonstration plans, and if necessary, mitigated in the control strategies adopted as part of those plans.

G. Reasonably Foreseeable Alternative Means of Compliance with the Proposed Amendments

Alternatives to the proposed amendments to the ATCM are discussed in Chapter III of this report. ARB staff has concluded that the proposed amendments to the ATCM provides the most effective and least burdensome approach to reducing exposures to diesel PM and other air pollutants emitted from diesel-fueled stationary engines and at the same time ensuring that the action is technically and economically feasible.

V. ECONOMIC IMPACTS OF THE PROPOSED AMENDMENTS

In this chapter, ARB staff discusses the legal requirements that must be satisfied in analyzing the economic impacts of the proposed amendments to the Stationary Diesel Engine ATCM and the methodology used to estimate cost impacts. A discussion on the economic impacts anticipated from the proposed amendments is also provided.

A. Summary

ARB staff does not expect any adverse economic impacts associated with the proposed amendments. Rather, the proposed amendments will result in future cost savings to any businesses or public entities that will be purchasing new emergency standby engines.

ARB staff estimates the total economic impact from the proposed amendments to the ATCM to affected private businesses and public agencies would be a cost savings of about $460 million between 2010 and 2020 or about $46 million annually. Of this, private businesses and public agencies are each expected to realize cost savings of about $23 million annually. These cost savings are primarily due to the alignment of the ATCM emissions standards for new emergency standby engines with those in the NSPS, which do not require after-treatment emission standards. Foregoing the application of after-treatment technologies such as DPF and SCR, results in significant capital cost savings, about $118 per hp. As an example, this translates into a cost savings of $71,000 for a typical 600 hp emergency standby engine.

B. Legal Requirements

Section 11346.3 of the Government Code requires State agencies to assess the potential for adverse economic impacts on California business enterprises and individuals when proposing to adopt or amend any administrative regulation. The assessment shall include a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination or creation, and the ability of California business to compete with businesses in other states.

Also, State agencies are required to estimate the costs or savings to any state or local agency and school district in accordance with instructions adopted by the Department of Finance. The estimate shall include any non-discretionary costs or savings to local agencies and the cost or savings in federal funding to the State.

Finally, H&SC section 57005 requires ARB to perform an economic impact analysis of submitted alternatives to a proposed regulation before adopting any major regulation. A major regulation is defined as a regulation that will have a potential cost to California business enterprises in an amount exceeding ten million dollars in any single year. Because the estimated cost of the amendments does not exceed ten million dollars in a single year, the proposed amendments do not constitute a major regulation.

C. Methodology for Estimating Costs

In this section, ARB staff describes the methodology used to estimate the economic impacts from the proposed amendments.

The proposed amendments are designed to closely align the emission standards for new emergency standby engines with the federal NSPS emission standards. This will result in the installation of new Tier 2 or Tier 3 emergency standby engines produced by the original equipment manufacturer (OEM) instead of having after-treatment controls (DPF and SCR) retrofitted after purchase by a non-OEM provider. This will result in cost-savings to the end-user.

To estimate the cost savings, ARB staff determined the cost for the end-user to retrofit a new Tier 2 or Tier 3 engine with DPF and SCR devices. ARB staff believes this is the most appropriate comparison as the OEMs have indicated that they will not provide Tier 4 engines to support a "California only" requirement for Tier 4 emergency standby engines (see Chapter II and Appendix B). The total cost savings were then determined by multiplying the retrofit costs per hp by the average horsepower within three defined horsepower ranges times the number of new emergency standby engines expected to come into service within each horsepower range between 2010 and 2020. That is:

$$\text{Total \$ Savings} = \Sigma_h (HP \times N \times C) \qquad (1)$$

Where

h = one of three horsepower ranges (50 hp to 174 hp; 175 hp to 749 hp; 750 hp and above)
HP = average horsepower within each horsepower range
N = number of new engines within a defined horsepower range coming into service between 2010 and 2020, and
C = cost, in dollars per horsepower, to retrofit one engine with a SCR and DPF

The number of new engines expected to come into service was estimated from the projected emissions inventory assuming the medium economic recovery scenario. As shown in Table V-1, it is anticipated that about 600 to 700 new emergency standby engines greater than 50 hp will be put into service each year between 2010 and 2020. Of these engines, about 45 percent are new engines replacing existing engines and 55 percent are new construction. The total number of new engines expected to come into service between 2010 and 2020 is about 7,200 engines. The number of new engines expected within each horsepower range is provided in Table V-1.

Table V-1: Projected New Non-Agricultural Emergency Standby Diesel Engine Population

Engine HP Range	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
50-174	196	200	203	207	211	214	218	222	226	229	233	2,359
175-750	276	281	287	292	297	302	307	313	318	323	328	3,324
>750	128	130	132	135	137	140	142	144	147	149	152	1,536
Standbys Total	600	611	622	633	645	656	667	679	690	702	713	7,218

As discussed in Chapter II and Appendix B of this report, the costs for the end user to retrofit an engine with a DPF and SCR are estimated to be about $118 per horsepower. These costs are summarized in Table V-2 below. The capital costs to install a DPF are estimated to be about $38 per horsepower. This includes both the equipment costs and installation costs. The equipment cost for an end user or after-market retrofit of a SCR system is approximately $80 per hp. As noted in Chapter II and Appendix B, SCR manufacturers indicated that installation costs could increase the capital cost by 50 percent to 150 percent. Thus, the SCR cost assessed for the economic analysis is conservative to the actual capital cost to install an SCR system on an engine.

Table V-2: Estimated Cost for End User Retrofit of SCR and DPF Control Technologies

Technology	Cost ($/hp)	Comments
DPF	$38	Includes the capital cost of equipment and installation.
SCR	$80	Only capital cost of equipment is included in the cost estimate. Does not include the cost of installation.
Total	$118	

D. Economic Impacts of the Proposed Amendments

In this section, ARB staff describes the economic impacts from the estimated cost savings resulting from the proposed amendments to the ATCM, including the impacts on private businesses and public agencies.

<u>Total Industry Cost Savings and Total Annual Cost Savings</u>

As shown in Table V-1 above, between 2010 and 2020 it is anticipated that about 7,200 new emergency standby engines will be brought into service. Using the methodology outlined in section C. of this chapter, ARB staff estimates that the proposed amendments will result in a total cost savings of approximately $460 million between 2010 and 2020. Annually this equates to about $46 million in savings to private and public agencies.

Table V-3: Projected Cumulative Statewide 2010 to 2020 Cost Savings

HP Range	Average Engine Size (HP)	Number of New Engines	Cost ($/HP)	Total Cost Savings
50-174	112	2,359	$118	$30 million
175-749	462	3,324	$118	$180 million
>750	1,375	1,536	$118	$250 million
Total	N/A	7,218	$118	$460 million

Potential Additional Cost Savings

The cost savings estimated above are likely to be greater than estimated. This is because there will also be savings in SCR and DPF maintenance, installation costs for SCR systems, urea for SCR operation, and various other retrofit costs that were not taken into account. Because these costs vary widely with each individual installation it was not feasible to quantify these additional cost savings.

Estimated Cost to Business

Businesses will realize future cost savings from the proposed amendments. Based on a survey conducted previously in support of the original ATCM adoption, the average emergency standby engine size was 600 horsepower. (ARB, 2003) For an operator purchasing a new 600 hp emergency standby engine, the proposed amendments result in a cost savings of about $71,000. The survey also revealed that a typical business had two to three engines with a hp rating of 700 hp. For this typical business, there would be a cost savings of about $207,000 due to the proposed amendments. The average small business that has a diesel emergency standby engine owns one to two engines with an average hp of 500. The owner would save about $89,000 when the engines were replaced. Overall, the proposed amendments to the ATCM will create a cost savings for any business purchasing a new emergency standby engine. Therefore, the proposed amendments will have no additional costs to businesses.

As noted in Chapter III, the proposed amendments make minor changes in the ATCM reporting requirements by having owners and operators annually provide copies of data on DRP engines and operation to the Executive Officer and the district. Since these records are already required to be kept, the amendments will essentially require the operator to provide a copy to the ARB and the district. The costs associated with this transmittal should be very minor.

Potential Business Impacts

The proposed amendments will result in cost savings for any business purchasing a new emergency engine. Based on the survey noted above, private business account for approximately 50 percent of the total emergency standby engine population. Based on this percentage, ARB staff estimates that private businesses will save approximately $23 million annually between 2010 and 2020. These cost savings from the proposed amendments, if invested in productive assets, could result in the creation and expansion of businesses.

Because the proposed amendment to the ATCM will create a cost savings for any business purchasing a new emergency engine, ARB staff believes the proposed amendments will have no adverse impact on business competiveness, employment, business creation, elimination, or expansion. The proposed regulatory action may result in the creation of jobs or businesses, or expansion of businesses if the cost savings are invested in productive assets other than Tier 4 engines.

In addition, the proposed amendments to the ATCM will not adversely affect small businesses because the proposed amendments create a net savings. Based on a survey conducted previously in support of the adoption of the original ATCM, a typical small business owns approximately one to two emergency standby engines of about 500 horsepower. (ARB, 2003) When these engines are replaced, the average cost savings (assuming $118/hp for an SCR and DPF) will be approximately $89,000 per company.

Estimated Cost to Federal, State, and Local Governments

Public entities use approximately half of the stationary engines throughout the State. The federal, State, and local governments use 18 percent, 4 percent, and 27 percent, respectively, of the entire emergency standby engine population according to the 2004 staff report. This equates to approximately 125, 30, and 200 new engines per year, respectively. When the older emergency standby engines are replaced or new ones purchased, the federal government will save approximately $8 million per year from the proposed amendments. The State government will save approximately $2 million per year and local government will save approximately $13 million per year.

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Appendix A

Proposed Regulation Order

Amendments to the Airborne Toxic Control Measure For Stationary Compression Ignition Engines

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PROPOSED REGULATION ORDER

AMENDMENTS TO THE AIRBORNE TOXIC CONTROL MEASURE FOR STATIONARY COMPRESSION IGNITION ENGINES

Note: The amendments are shown in underline to indicate additions and ~~strikethrough~~ to indicate deletions compared to the existing regulatory text.

Amend title 17, California Code of Regulations, sections 93115.3, 93115.4, 93115.6, 93115.7, 93115.8, 93115.9, 93115.10, and 93115.13 to read as follows:

§ 93115.3 ATCM for Stationary CI Engines – Exemptions.
(a) – (r) (No Change)

~~(s) The District may exempt any stock engine from the new stationary diesel-fueled engine emission standards in sections 93115.6(a), 93115.7(a), 93115.8(a), and 93115.9 provided the seller and the owner or operator demonstrate to the District's satisfaction that the following conditions are met:~~

~~(1) *Seller:* Any stationary diesel-fueled engine greater than 50 bhp shall meet the following standards and conditions:~~

~~(A) The stationary diesel-fueled engine emission standards in sections 93115.6(b), 93115.7(b), or 93115.8(b), or~~

~~(B) The Off-Road CI Engine Certification Standards (title 13, CCR, section 2423) immediately preceding the transition to new standards for an off-road CI engine of the same model year and maximum rated power, and~~

~~(C) The engine was delivered to California no more than twelve months immediately preceding the transition to new standards for an off-road CI engine of the same model year and maximum rated power, and~~

~~(D) The engine was sold no later than six months after the effective date of the new standards for an off-road CI engine of the same model year and maximum rated power,~~

~~(2) *Owner/operator:*~~

~~(A) The date of acquisition of the stock engine is no later than six months from the date an emission standard applicable to new engines becomes more stringent than the emission standard to which the stock engine is certified.~~

~~(B) The date the District determines the application is complete for an Authority to Construct permit is no later than six months after the date of acquisition of the stock engine.~~

(~~t~~s) The requirements of section 93115.6(b)(3) do not apply to any stationary diesel-fueled emergency standby engine primarily used by the United States Department of Defense located at Command ~~Destruct~~ Transmitter (CT) sites until

December 31, 2009. Each stationary diesel-fueled emergency standby engine at a CT site will be allowed a maximum of 100 total annual hours of operation for maintenance and testing.

(~~u~~ t) Upon the prior written approval of the APCO, the requirements of this ATCM do not apply to stationary CI engines used exclusively:

(1) as engine test cells and test stands for testing burners, CI engines, or CI engine components, e.g., turbochargers;
(2) for operation or performance testing of fuels, fuel additives, or emission control devices at research and development facilities; or
(3) for maintenance, repair, or rebuild training at educational facilities.

(~~v~~u) If the Executive Officer or District finds, based on verifiable information from the engine manufacturer, distributor, or dealer, that current model year engines meeting the current emission standards are not available or not available in sufficient numbers or in a sufficient range of makes, models, and horsepower ratings, then the Executive Officer or the District may allow the sale, purchase, or installation of a new stock engine meeting the emission standards from the previous model year to meet the new stationary diesel-fueled engine emission standards pursuant to title 13 of the California Code of Regulations or 40 CFR part 89.

NOTE: Authority cited: Sections 39600, 39601, 39658, 39659, 39666, 41511 and 43013, Health and Safety Code. Reference: Sections 39002, 39650, 39658, 39659, 39666, 40000, 41511 and 43013, Health and Safety Code.

§ 93115.4 ATCM for Stationary CI Engines – Definitions.

(a)(1) - (28) (No Change)

(29) "Emergency Standby Engine" means a stationary engine that meets the criteria specified in (A) ~~and~~ (B), and (C) and any combination of (~~C~~D) or (~~D~~E) or (~~E~~F) below:

(A) is installed for the primary purpose of providing electrical power or mechanical work during an emergency use and is not the source of primary power at the facility; and
(B) is operated to provide electrical power or mechanical work during an emergency use; and
(C) is not operated to supply power to an electric grid or does not supply power as part of a financial arrangement with any entity, except as allowed in sections 93115.6 (a)(2), (b)(1) or (c): and
(~~C~~D)is operated under limited circumstances for maintenance and testing, emissions testing, or initial start-up testing, as specified in sections 93115.6(a),(b), and (c); or
(~~D~~(E)is operated under limited circumstances in response to an impending outage, as specified in sections 93115.6(a),(b), and (c); or
(~~E~~F)is operated under limited circumstances under a DRP as specified in section 93115.6(c).

(30) "Emergency Use" means providing electrical power or mechanical work during any of the following events and subject to the following conditions:

(A) the failure or loss of all or part of normal electrical power service or normal natural gas supply to the facility:
1. which is caused by any reason other than the enforcement of a contractual obligation the owner or operator has with a third party or any other party; and
2. which is demonstrated by the owner or operator to the district APCO's satisfaction to have been beyond the reasonable control of the owner or operator;

(B) the failure of a facility's internal power distribution system:
1. which is caused by any reason other than the enforcement of a contractual obligation the owner or operator has with a third party or any other party; and
2. which is demonstrated by the owner or operator to the district APCO's satisfaction to have been beyond the reasonable control of the owner or operator;

(C) the pumping of water or sewage to prevent or mitigate a flood or sewage overflow;

(D) the pumping of water for fire suppression or protection;

(E) the powering of ALSF-1 and ALSF-2 airport runway lights under category II or III weather conditions;

(F) the pumping of water to maintain pressure in the water distribution system for the following reasons:
1. a pipe break that substantially reduces water pressure; or
2. high demand on the water supply system due to high use of water for fire suppression; or
3. the breakdown of electric-powered pumping equipment at sewage treatment facilities or water delivery facilities; or

(G) ~~the~~ day-of-<u>rocket</u> launch <u>and day of space plane vehicle re-entry/landing</u> system checks and ~~launch~~ tracking performed (in parallel with grid power) by the United States Department of Defense at Command ~~Destruct~~ <u>Transmitter</u> sites (also known as "CT" sites) that occur within the 24-hour time period associated with the scheduled time of the launch <u>or re-entry/landing</u>.

(31) – (46) (No Change)

(47) "Maintenance and Testing" means operating an emergency standby CI engine to:

(A) evaluate the ability of the engine or its supported equipment to perform during an emergency. "Supported Equipment" includes, but is not limited to, generators, pumps, transformers, switchgear, <u>uninterruptible power supply,</u> and breakers; or

(B) facilitate the training of personnel on emergency activities; or

(C) provide electric power for the facility when the utility distribution company takes its power distribution equipment offline to service that equipment for any reason that does not qualify as an emergency use; or

(D) provide additional hours of operation to perform testing on an engine that has experienced a breakdown or failure during maintenance. Upon air district approval, these additional hours of operation will not be counted in the maximum allowable annual hours of operation for the emergency standby CI engine that provided the electrical power.

(48) – (72) (No change)

(73) "Stationary Source" means any building, structure, facility, or installation that emits any pollutant directly or as fugitive emissions. Building, structure, facility, or installation includes all pollutant emitting activities which:

(A) are under the same ownership or operation, or which are owned or operated by entities which are under common control; and

(B) belong to the same industrial grouping either by virtue of falling within the same two-digit standard industrial code or by virtue of being part of a common industrial process, manufacturing process, or connected process involving a common raw material; and

(C) are located on one or more contiguous or adjacent properties.

74) – (79) (No change)

NOTE: Authority cited: Sections 39600, 39601, 39658, 39659, 39666, 41511 and 43013, Health and Safety Code. Reference: Sections 39002, 39650, 39658, 39659, 39666, 40000, 41511 and 43013, Health and Safety Code.

§ 93115.6 ATCM for Stationary CI Engines – Emergency Standby Diesel-Fueled CI Engine (>50 bhp) Operating Requirements and Emission Standards.

(a) New Emergency Standby Diesel-Fueled CI Engine (>50 bhp) Operating Requirements and Emission Standards.

(1) (No Change)
(2) (No Change)

(3) *New Engines*: As of January 1, 2005, except as provided in section 93115.3, no person shall sell, offer for sale, purchase, or lease for use in California any new stationary emergency standby diesel-fueled CI engine that has a rated brake horsepower greater than 50 unless it meets the following applicable emission standards, and no person shall operate any new stationary emergency standby diesel-fueled CI engine that has a rated brake horsepower greater than 50, unless it meets all of the following applicable operating requirements and emission standards specified in 93115.6(a)(3) ~~(which are summarized in Table 1)~~:

(A) *~~Diesel PM~~ Emissions Standards and Hours of Operating Requirements.*

1. ~~*General Requirements*:~~ New stationary emergency standby diesel-fueled engines (>50 bhp), excluding direct-drive fire pump engines, shall:
   a. meet the applicable emission standards for all pollutants for the same model year and maximum horsepower rating as specified in Table 1 Emission Standards for New Stationary Emergency Standby Diesel-Fueled CI Engines, in effect on the date of acquisition or submittal, as defined in section 93115.4, and ~~emit diesel PM at a rate less than or equal to 0.15 g/bhp-hr; or~~
   b. after December 31, 2008, be certified to the new nonroad compression-ignition (CI) engine emission standards for all pollutants for 2007 and later model year engines as specified in 40 CFR Parts 60, 85, et al. Standards of Performance for Stationary Compression-Ignition Internal Combustion Engines; and ~~meet the diesel PM standard, as specified in the Off-Road Compression Ignition Engine Standards for off-road engines with the same maximum rated power (title 13 CCR, section 2423), in effect on the date of acquisition or submittal, as defined in section 93115.4 whichever is more stringent; and~~
   c. not operate more than 50 hours per year for maintenance and testing purposes, except as provided in 93115.6(a)(3)(A)2. This subsection does not limit engine operation for emergency use and for emission testing to show compliance with 93115.6(a)(3).
2. The District may allow a new stationary emergency standby diesel-fueled CI engine (> 50 hp) to operate up to 100 hours per year for maintenance and testing purposes on a site-specific basis, provided the diesel PM emission rate is less than or equal to 0.01 g/bhp-hr.

Table 1: Emission Standards for New Stationary Emergency Standby Diesel-Fueled CI Engines g/bhp-hr (g/kW-hr)				
Maximum Engine Power	**Model year(s)**	**PM**	**NMHC+NOx**	**CO**
50 ≤ HP < 75 (37 ≤ kW < 56)	2007 2008+	0.15 (0.20)	5.6 (7.5) 3.5 (4.7)	3.7 (5.0)
75 ≤ HP < 100 (56 ≤ kW < 75)	2007 2008+	0.15 (0.20)	5.6 (7.5) 3.5 (4.7)	3.7 (5.0)
100 ≤ HP < 175 (75 ≤ KW < 130)	2007 2008+	0.15 (0.20)	3.0 (4.0)	3.7 (5.0)
175 ≤ HP < 300 (130 ≤ kW < 225)	2007 2008+	0.15 (0.20)	3.0 (4.0)	2.6 (3.5)
300 ≤ HP < 600 (225 ≤ kW < 450)	2007 2008+	0.15 (0.20)	3.0 (4.0)	2.6 (3.5)
600 ≤ HP < 750 (450 ≤ kW < 560)	2007 2008+	0.15 (0.20)	3.0 (4.0)	2.6 (3.5)
HP > 750 (kW > 560)	2007 2008+	0.15 (0.20)	4.8 (6.4)	2.6 (3.5)

1. May be subject to additional emission limitations as specified in current applicable district rules, regulations or policies.

~~Table 1: Summary of the Emission Standards and Operating Requirements for New Stationary Emergency Standby Diesel-Fueled CI Engines > 50 BHP (See section 93115.6(a)(3))~~				
~~*Diesel PM*~~				~~*Other Pollutants*~~
~~*Diesel PM Standards (g/bhp-hr)*~~	~~*Maximum Allowable Annual Hours of Operation for Engines Meeting Diesel PM Standards*~~			~~*HC, NOx, NMHC+NOx, and CO Standards (g/bhp-hr)*~~
	~~*Emergency Use*~~	~~*Non-Emergency Use*~~		
		~~*Emission Testing to show compliance*~~[2]	~~*Maintenance & Testing (hours/year)*~~	
~~≤0.15~~[1]	~~Not Limited by ATCM~~[3]	~~Not Limited by ATCM~~[3]	~~50~~	~~Off-Road CI Engine Certification Standards for an off-road engine of the model year and horsepower rating of the engine installed to meet the applicable PM standard, or Tier 1 standards.~~[4]
~~≤0.01~~[1]	~~Not Limited by ATCM~~[3]	~~Not Limited by ATCM~~[3]	~~51 to 100 (Upon approval by the District)~~	

~~1. Or off-road certification standard (title 13 CCR section 2423) for an off-road engine with the same maximum rated power, whichever is more stringent.~~

~~2. Emission testing limited to testing to show compliance with section 93115.6(a)(3).~~

~~3. May be subject to emission or operational restrictions as defined in current applicable district rules, regulations, or policies.~~

~~4. The option to comply with the Tier 1 standards is available only if no off-road engine certification standards have been established for an off-road engine of the same model year and maximum rated power as the new stationary emergency standby diesel-fueled CI engine.~~

~~(B) *HC, NOx, NMHC + NOx, and CO standards*: New stationary emergency standby diesel-fueled CI engines (> 50 bhp) must meet the standards for off-road engines of the same model year and maximum rated power as~~

~~specified in the Off-Road Compression Ignition Engine Standards (title 13, CCR, section 2423). If no standards have been established for an off-road engine of the same model year and maximum rated power as the new stationary emergency standby diesel-fueled CI engine, then the new stationary emergency standby diesel-fueled CI engine shall meet the Tier 1 standards in title 13, CCR, section 2423 for an off-road engine of the same maximum rated power, irrespective of the new stationary emergency standby diesel-fueled CI engine's model year.~~

(~~C~~B)The District:

1. may establish more stringent diesel PM, NMHC+NOx, HC, NOx, and CO emission rate standards; and
2. may establish more stringent limits on hours of maintenance and testing on a site-specific basis; and
3. shall determine an appropriate limit on the number of hours of operation for demonstrating compliance with other District rules and initial start-up testing.

(4) *New Direct-Drive Emergency Standby Fire Pump Engines*: Except as provided in section 93115.3, no person shall sell, offer for sale, purchase, or lease for use in California any new stationary ~~direct-drive~~ emergency standby diesel-fueled direct-drive fire-pump CI engine rated greater than 50 brake horsepower unless the fire pump engine meets the applicable emission standards and certification requirements specified in ~~it meets either the emission standards of section 93115.6(a)(3) or the emission standards defined in~~ section 93115.6(a)(4), and no person shall operate any new stationary emergency standby diesel-fueled direct-drive fire pump CI engine rated greater than 50 brake horsepower, unless it meets all of the applicable operating requirements and emission standards specified in ~~either 93115.6(a)(3) or~~ 93115.6(a)(4).

(A) *Standards and Hours of Operating Requirements.*

1. ~~*General Requirements:*~~ New direct-drive emergency standby diesel-fueled fire-pump engines (>50 bhp) shall, ~~upon District approval of installation:~~
   a. meet the applicable emissions standards for all pollutants as specified in Table 2 Emissions Standards for New Stationary Emergency Standby Direct-Drive Fire Pump Engines for the model year and NFPA nameplate power rating; ~~Tier 2 emission standards specified in the Off-Road Compression Ignition Engine Standards for off-road engines with the same maximum rated power (title 13 CCR, section 2423) until 3 years after the date the Tier 3 standards are applicable for off-road engines with the same maximum rated power. At that time, new direct-drive emergency standby diesel-fueled fire-pump engines (>50 bhp) are required to meet the Tier 3 emission standards, until 3 years after the date the Tier 4 standards are applicable for off-road engines with the same maximum rated power. At that time, new direct-drive emergency~~

~~standby diesel-fueled fire pump engines (>50 bhp) are required to meet the Tier 4 emission standards;~~ and

b. meet the new fire pump engine certification requirements and emission standards required by 40 CFR § 60.4202(d); and

c. not operate more than the number of hours necessary to comply with the testing requirements of the National Fire Protection Association (NFPA) 25 - "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems," 2002 edition, which is incorporated herein by reference. This subsection does not limit engine operation for emergency use and for emission testing to show compliance with 93115.6(a)(4).

Table 2: Emission Standards for New Stationary Emergency Standby Direct-Drive Fire Pump Engines > 50 BHP g/bhp-hr (g/kW-hr)

Maximum Engine Power	Model year(s)	PM	NMHC+NOx	CO
50 ≤ HP < 75 (37 ≤ kW < 56)	2010 and earlier 2011+[1]	0.60 (0.80) 0.30 (0.40)	7.8 (10.5) 3.5 (4.7)	3.7 (5.0)
75 ≤ HP < 100 (56 ≤ kW < 75)	2010 and earlier 2011+[1]	0.60 (0.80) 0.30 (0.40)	7.8 (10.5) 3.5 (4.7)	3.7 (5.0)
100 ≤ HP < 175 (75 ≤ kW < 130)	2009 and earlier 2010+[2]	0.60 (0.80) 0.22 (0.30)	7.8 (10.5) 3.0 (4.0)	3.7 (5.0)
175 ≤ HP < 300 (130 ≤ kW < 225)	2008 and earlier 2009+[3]	0.40 (0.54) 0.15 (0.20)	7.8 (10.5) 3.0 (4.0)	2.6 (3.5)
300 ≤ HP < 600 (225 ≤ kW < 450)	2008 and earlier 2009+[3]	0.40 (0.54) 0.15 (0.20)	7.8 (10.5) 3.0 (4.0)	2.6 (3.5)
600 ≤ HP < 750 (450 ≤ kW < 560)	2008 and earlier 2009+	0.40 (0.54) 0.15 (0.20)	7.8 (10.5) 3.0 (4.0)	2.6 (3.5)
HP > 750 (kW > 560)	2007 and earlier 2008+	0.40 (0.54) 0.15 (0.20)	7.8 (10.5) 4.8 (6.4)	2.6 (3.5)

1. For model years 2011–2013, manufacturers, owners and operators of fire pump stationary CI ICE in this engine power category with a rated speed of greater than 2,650 revolutions per minute (rpm) may comply with the emission limitations for 2010 model year engines.
2. For model years 2010–2012, manufacturers, owners and operators of fire pump stationary CI ICE in this engine power category with a rated speed of greater than 2,650 rpm may comply with the emission limitations for 2009 model year engines.
3. In model years 2009–2011, manufacturers of fire pump stationary CI ICE in this engine power category with a rated speed of greater than 2,650 rpm may comply with the emission limitations for 2008 model year engines.

(B) The District:

1. may establish more stringent diesel PM, NMHC+NOx, HC, NOx, and CO emission rate standards; and
2. may establish more stringent limits on hours of maintenance and testing on a site-specific basis; and
3. shall determine an appropriate limit on the number of hours of operation for demonstrating compliance with other District rules and initial start-up testing.

(b) In-Use Emergency Standby Diesel-Fueled CI Engine (> 50 bhp) Operating Requirements and Emission Standards.

(1) (No Change)
(2) (No Change)

(3) Except as provided in section 93115.3, no owner or operator shall operate an in-use stationary emergency standby diesel-fueled CI engine (> 50 hp) in California unless it meets, in accordance with the applicable compliance schedules specified in sections 93115.11 and 93115.12, the following requirements (which are summarized in Table ~~2~~3):

Table ~~2~~ 3: Summary of the Emission Standards and Operating Requirements for In-Use Stationary Emergency Standby Diesel-Fueled CI Engines > 50 BHP
(See section 93115.6(b)(3))

Diesel PM				*Other Pollutants*
Diesel PM Standards (g/bhp-hr)	*Maximum Allowable Annual Hours of Operation for Engines Meeting Diesel PM Standards*			*HC, NOx, NMHC+NOx, and CO Standards (g/bhp-hr)*
	Emergency Use	*Non-Emergency Use*		
		Emission Testing to show compliance[1]	*Maintenance & Testing (hours/year)*	
>0.40[2]	Not Limited by ATCM[2]	Not Limited by ATCM[2]	20	Not limited by ATCM[2]
>0.15 and ≤0.40	Not Limited by ATCM[2]	Not Limited by ATCM[2]	21 to 30	For engines with emission control strategies not verified through the verification procedure: Off-Road CI Engine Certification Standards for an off-road engine of the model year and maximum rated power of the engine installed to meet the applicable PM standard, or Tier 1 standards.[3] OR Both (i) and (ii) must be met: (i) No increase in HC or NOx above 10% from baseline levels OR No increase in NMHC+NOx emissions above baseline levels (ii) No increase in CO above 10% from baseline levels
>0.01 and ≤0.15	Not Limited by ATCM[2]	Not Limited by ATCM[2]	31 to 50 (Upon approval by the District)	
≤0.01	Not Limited by ATCM[2]	Not Limited by ATCM[2]	51 to 100 (Upon approval by the District)	

1. Emission testing limited to testing to show compliance with section 93115.6(b)(3).
2. May be subject to emission or operational restrictions as defined in current applicable district rules, regulations, or policies.
3. The option to comply with the Tier 1 standards is available only if no off-road engine certification standards have been established for an off-road engine of the same model year and maximum rated power as the new stationary emergency standby diesel-fueled CI engine.

(A) diesel PM Standard and Hours of Operating Requirements **(No Change)**

(B) HC, NOx, NMHC+NOx, and CO standards:
(No Change)

(C) The District...
(No Change)

(c) *Operating Requirements and Emission Standards for New and In-Use Emergency Standby Stationary Diesel-Fueled CI Engines that Have a Rated Brake Horsepower of Greater than 50 (>50 bhp) Used in Demand Response Programs (DRP Engines).*

(1) *New Emergency Standby Diesel-Fueled CI DRP Engines (>50 bhp) Operating Requirements and Emission Standards.*
(No Change)

2. *HC, NOx, NMHC + NOx, and CO standards:* No owner or operator shall operate any new stationary emergency standby diesel-fueled CI DRP engine (>50 bhp), unless it meets the standards for off-road engines of the same model year and maximum rated power as specified in <u>section 93115.6(a)(3)(A)</u> ~~the Off-Road Compression Ignition Engine Standards (title 13, CCR, section 2423). If no standards have been established for an off-road engine of the same model year and maximum rated power as the new stationary emergency standby diesel-fueled CI DRP engine, then the new stationary emergency standby diesel-fueled CI DRP engine shall meet the Tier 1 standards in title 13, CCR, section 2423 for an off-road engine of the same maximum rated power~~, irrespective of the new stationary emergency standby diesel-fueled CI DRP engine's model year.

3. A District: **(No Change)**

(2) *In-Use Emergency Standby Diesel-Fueled CI DRP Engine (> 50 bhp) Operating Requirements and Emission Standards.*
(No Change)

2. *Additional Standards.*
(No change)

3. A District:
(No change)

(3) *Other Requirements Specific to RBRP Engines and the San Diego. Gas and Electric Company (SDG&E).*
(No change)

(4) *Requirements Applicable to DRP Engines after a DRP is Terminated*
(No change)

NOTE: Authority cited: Sections 39600, 39601, 39658, 39659, 39666, 41511 and 43013, Health and Safety Code. Reference: Sections 39002, 39650, 39658, 39659, 39666, 40000, 41511 and 43013, Health and Safety Code.

§ 93115.7 ATCM for Stationary CI Engines – Stationary Prime Diesel-Fueled CI Engine (>50 bhp) Emission Standards.

(a) New Stationary Prime Diesel-Fueled CI Engine (>50 bhp) Emission Standards.

(1) As of January 1, 2005, except as provided in section 93115.3, no person shall sell, purchase, offer for sale, or lease for use in California a new stationary prime diesel-fueled CI engine that has a rated brake horsepower greater than 50 unless it meets the following applicable emission standards as specified in Table 4 Emission Standards for New Stationary Prime Diesel-Fueled CI Engines, and no owner or operator shall operate any new stationary prime diesel-fueled CI engine that has a rated brake horsepower greater than 50 unless it meets all of the following emission standards and installation and operational requirements as specified in section 93115.7(a).~~(which are summarized in Table 3):~~

(2) After December 31, 2008, owners and operators shall only purchase and install new prime diesel-fueled CI engines certified to the new nonroad compression-ignition engine emission standards for all pollutants for 2007 and later model year engines as specified in 40 CFR Parts 60, 85, et al. Standards of Performance for Stationary Compression-Ignition Internal Combustion Engines.

(3) Owners and operators shall not install new prime diesel-fueled CI engines from a previous model year unless it meets the applicable requirements and deadlines specified in 40 CFR § 60.4208 (c)-(f).

Table 4: Emission Standards for New Stationary Prime Diesel-Fueled CI Engines > 50 BHP g/bhp-hr (g/kW-hr)[1]						
Maximum Engine Power	Model year(s)	PM	NOx	NMHC+NOx	NMHC	CO
50 ≤ HP <75 (37 ≤ KW <56)	2007	0.01 (0.02)		5.6 (7.5)		3.7 (5.0)
	2008-2012	0.01 (0.02)		3.5 (4.7)		3.7 (5.0)
	2013+	0.02 (0.03)		3.5 (4.7)		3.7 (5.0)
75≤ HP <100 (56≤ KW <75)	2007	0.01 (0.02)		5.6 (7.5)		3.7 (5.0)
	2008-2011	0.01 (0.02)		3.5 (4.7)		3.7 (5.0)
	2012-2014	0.01 (0.02)	2.5 (3.4)		0.14 (0.19)	3.7 (5.0)
	2015+	0.01 (0.02)	0.30 (0.40)		0.14 (0.19)	3.7 (5.0)
100 ≤ HP <175 (75≤ KW <130)	2007-2011	0.01 (0.02)		3.0 (4.0)		3.7 (5.0)
	2012-2014	0.01 (0.02)	2.5 (3.4)		0.14 (0.19)	3.7 (5.0)
	2015+	0.01 (0.02)	0.30 (0.40)		0.14 (0.19)	3.7 (5.0)
175 ≤ HP < 750 (130≤KW<560)	2007-2010	0.01 (0.02)		3.0 (4.0)		2.6 (3.5)
	2011-2013	0.01 (0.02)	1.5 (2.0)		0.14 (0.19)	2.6 (3.5)
	2014+	0.01 (0.02)	0.30 (0.40)		0.14 (0.19)	2.6 (3.5)
750<HP≤1,207 (560<KW≤900) Gen. sets	2007-2010	0.01 (0.02)		4.8 (6.4)		2.6 (3.5)
	2011-2014	0.02 (0.03)	2.6 (3.5)		0.30 (0.40)	2.6 (3.5)
	2015+	0.02 (0.03)	0.50 (0.67)		0.14 (0.19)	2.6 (3.5)
HP > 1,207 (KW > 900) Gen. sets	2007-2010	0.01 (0.02)		4.8 (6.4)		2.6 (3.5)
	2011-2014	0.02 (0.03)	0.50 (0.67)		0.30 (0.40)	2.6 (3.5)
	2015+	0.02 (0.03)	0.50 (0.67)		0.14 (0.19)	2.6 (3.5)

1. May be subject to additional emission limitations as specified in current district rules, regulations, or policies governing distributed generation.

~~Table 3: Summary of the Emission Standards for New Stationary Prime Diesel-Fueled CI Engines >50 BHP (See section 93115.7(a)(1))~~	
~~*Diesel PM Standards (g/bhp-hr)*~~	~~*HC, NOx, NMHC+NOx, and CO Standards (g/bhp-hr)*~~
~~Meet the more stringent of:~~ ~~≤0.01[1]~~ ~~OR~~ ~~Off-Road CI Engine Certification Standard for an off-road engine of the same maximum rated power~~	~~Off-Road CI Engine Certification Standard for an off-road engine of the model year and maximum rated power of the engine installed to meet the applicable PM standard, or Tier 1 standards.[1,2]~~

~~1. May be subject to additional emission limitations as specified in current district rules, regulations, or policies governing distributed generation.~~

~~2. The option to comply with the Tier 1 standards is available only if no off-road engine certification standards have been established for an off-road engine of the same model year and maximum rated power as the new stationary prime diesel-fueled CI engine.~~

(~~1~~4) *~~Diesel PM~~ Emissions Standards:* All new stationary prime diesel-fueled CI engines (> 50 bhp) shall meet the applicable emission standards for all pollutants for the model year and maximum horsepower rating as specified in Table 4 Emission Standards for New Stationary Prime Diesel-Fueled CI Engines ~~emit diesel PM at a rate that is less than or equal to 0.01 grams diesel PM per brake-horsepower-hour (g/bhp-hr) or shall meet the diesel PM standard, as specified in the Off-Road Compression Ignition Engine Standards for off-road engines with the same maximum rated power (title 13, CCR, section 2423),~~ in effect on the date of acquisition or submittal, as defined in section 93115.4 ~~whichever is more stringent~~;

~~(2) *HC, NOx, NMHC+NOx, and CO Standards:* All new stationary prime diesel-fueled CI engines (> 50 bhp) shall meet the standards for off-road engines of the same model year and maximum rated power as specified in the Off-Road Compression Ignition Engine Standards (title 13, CCR, section 2423). If no limits have been established for an off-road engine of the same model year and maximum rated power as the new stationary prime diesel-fueled CI engine, then the new stationary prime diesel-fueled CI engine shall meet the Tier 1 standards in title 13, CCR, section 2423, for an off-road engine of the same maximum rated power, irrespective of the new stationary prime diesel-fueled CI engine's model year;~~

(~~3~~4)New stationary prime diesel-fueled CI engines that are used to provide electricity near the place of use (also known as "distributed generation") may be subject to additional emission limitations as specified in current district rules, policies, or regulations governing distributed generation;

(~~4~~5)The District may establish more stringent diesel PM, NMHC+NOx, HC, NOx, and CO emission rate limits on a site-specific basis.

(b) *In-Use Stationary Prime Diesel-Fueled CI Engine (>50 bhp) Emission Standards.* Except as provided in section 93115.3, no owner or operator shall operate an in-use stationary prime diesel-fueled CI engines (> 50 bhp) in California unless it meets the following requirements (which are summarized in Table ~~4~~5):

<table>
<tr><th colspan="3">Table 4-5: Summary of the Emission Standards for In-Use Stationary Prime Diesel-Fueled CI Engines > 50 BHP
(See section 93115.7(b)(1))</th></tr>
<tr><th colspan="2">Diesel PM</th><th>Other Pollutants</th></tr>
<tr><th colspan="2">Diesel PM Standards
(g/bhp-hr)</th><th rowspan="2">HC, NOx, NMHC+NOx, and CO Standards
(g/bhp-hr)</th></tr>
<tr><th>Applicability</th><th>Standard</th></tr>
<tr><td>All off-road certified in-use prime engines</td><td>85% reduction from baseline levels (Option 1)

OR

0.01 g/bhp-hr (Option 2)</td><td rowspan="2">For engines with emission control strategies not verified through the verification procedure: Off-Road CI Engine Certification Standards for an off-road engine of the model year and maximum rated power of the engine installed to meet the applicable PM standard, or Tier 1 standards.[1]

OR

Both (i) and (ii) must be met:

(i) No increase in HC or NOx emissions above 10% from baseline levels

OR

No increase in NMHC+NOx emissions above baseline levels

(ii) No increase in CO above 10% from baseline levels</td></tr>
<tr><td>Only in-use prime engines NOT certified in accordance with the Off-Road Compression Ignition Standards</td><td>85% reduction from baseline levels (Option 1)

OR

0.01 g/bhp-hr (Option 2)

OR

[30% reduction from baseline levels

AND

0.01 g/bhp-hr by no later than July 1, 2011] (Option 3)</td></tr>
</table>

1. The option to comply with the Tier 1 standards is available only if no off-road engine certification standards have been established for an off-road engine of the same model year and maximum rated power as the new stationary emergency standby diesel-fueled CI engine.

(1) *Diesel PM Standards:*
(No Change)

(2) *Additional Standards:*
(No Change)

(3) The District may establish more stringent diesel PM, NMHC+NOx, HC, NOx, and CO emission rate standards.
(No Change)

NOTE: Authority cited: Sections 39600, 39601, 39658, 39659, 39666, 41511 and 43013, Health and Safety Code. Reference: Sections 39002, 39650, 39658, 39659, 39666, 40000, 41511 and 43013, Health and Safety Code.

§ 93115.8 ATCM for Stationary CI Engines – Emission Standards for Stationary Diesel-Fueled CI Engines (>50 bhp) Used in Agricultural Operations.

(a) Emission Standards for New Stationary Diesel-Fueled CI Engines (>50 bhp) Used in Agricultural Operations.

(1) As of January 1, 2005, except as provided in sections 93115.3, 93115.8(a)(1)(A)5., and 93115.8(a)(2), no person shall sell, purchase, or lease for use in California any new stationary diesel-fueled engine to be used in agricultural operations that has a rated brake horsepower greater than 50, or operate any new stationary diesel-fueled engine to be used in agricultural operations that has a rated brake horsepower greater than 50, unless the engine meets all of the following emission performance standards (which are summarized in Table ~~5~~6.):

Table ~~5~~6: Summary of the Emission Standards for New Stationary Diesel-Fueled CI Engines > 50 BHP Used in Agricultural Operations (See section 93115.8(a))

Horsepower Range (hp)	*Diesel PM* *Diesel PM Standards (g/bhp-hr)*	*Other Pollutants* *HC, NOx, NMHC+NOx, and CO Standards (g/bhp-hr)*
All Applications Greater Than 50 But Less Than 100, Other Than Generator Sets	Less Than or Equal to 0.30[1] OR Off-Road CI Engine Certification Standard for an off-road engine of the same maximum rated power, whichever is more stringent	Off-Road CI Engine Certification Standard for an off-road engine of the model year and maximum rated power of the engine installed to meet the applicable PM standard, or Tier 1 standards.[1]
All Applications Greater Than or Equal to 100 But Less Than 175, Other Than Generator Sets	Less Than or Equal to 0.22[1] OR Off-Road CI Engine Certification Standard for an off-road engine of the same maximum rated power, whichever is more stringent	
All Applications Greater Than or Equal to 175, Other Than Generator Sets	Less than or Equal to 0.15[1] OR Off-Road Engine Certification Standard for an off-road engine of the same maximum rated power, whichever is more stringent	
Generator Set Engines Greater Than 50	Less Than or Equal to 0. 15[1] OR Off-Road CI Engine Certification Standard for an off-road engine of the same maximum rated power, whichever is more stringent.	

1. Prior to January 1, 2008, these limits shall not apply to engines sold from one agricultural operation to another and funded under State or federal incentive funding programs, as specified in 93115.8(a)(2).

(A) *Diesel PM Standard:*
(No change)

(B) *NMHC, NOx, and CO Standards:*
(No change)

(2) **(No change)**

(b) Emission Standards for In-Use Stationary Diesel-Fueled CI Engines (>50 bhp) Used in Agricultural Operations.

(1) Except as provided in sections 93115.3 and 93115.8(b)(5) through (7), no owner or operator shall operate an in-use stationary diesel-fueled CI engine greater than 50 bhp in an agricultural operation in California unless it meets the requirements in sections 93115.8(b)(2) through (4) (which are summarized in Tables ~~6~~7 and ~~7~~8):

Table ~~6~~7: Emission Standards
Noncertified Greater than 50 BHP In-Use Stationary
Diesel-Fueled Engines Used in Agricultural Operations
See sections 93115.8(b)(2) and (4)

Horsepower Range (hp)	*Application*	*Compliance* *On or After December 31*	*Diesel PM* *Not to Exceed (g/bhp-hr)*	*HC, NOx, NMHC+NOx, and CO* *Not to Exceed (g/bhp-hr)*
Greater Than 50 But Less Than 75	Generator Sets	2015	0.02	Off-Road CI Engine Certification Standards for an off-road engine of the model year and maximum rated power of the engine installed to meet the applicable PM standard.[1]
	All Other Applications	2011	0.30	
Greater Than or Equal to 75 But Less Than 100	Generator Sets	2015	0.01	
	All Other Applications	2011	0.30	
Greater Than or Equal to 100 But Less Than 175	Generator Sets	2015	0.01	
	All Other Applications	2010	0.22	
Greater Than or Equal to 175 But Less Than or Equal to 750	All Applications	2010	0.15	
Greater Than 750	All Applications	2014	0.075	

1. If no limits have been established for an off-road engine of the same model year and maximum rated power, then the in-use stationary diesel-fueled engine used in an agricultural operation shall not exceed Tier 1 standards in title 13, CCR, section 2423 for an off-road engine of the same maximum rated power irrespective of model year.

Table ~~7~~8: Emission Standards
Tier 1- and Tier 2-Certified Greater than 50 BHP In-Use Stationary
Diesel-Fueled Engines Used in Agricultural Operations
See sections 93115.8(b)(3) and (4)

Horsepower Range (hp)	*Compliance On or After December 31*	*Diesel PM Not to Exceed (g/bhp-hr)*	*HC, NOx, NMHC+NOx, and CO Not to Exceed (g/bhp-hr)*
Greater Than 50 But Less Than 75	2015 or 12 years after the date of initial installation, whichever is later	0.02	Off-Road CI Engine Certification Standards for an off-road engine of the model year and maximum rated power of the engine installed to meet the applicable PM standard.[1]
Greater Than or Equal to 75 But Less Than 175	2015 or 12 years after the date of initial installation, whichever is later	0.01	
Greater Than or Equal to 175 But Less Than or Equal to 750	2014 or 12 years after the date of initial installation, whichever is later	0.01	
Greater Than 750	2014 or 12 years after the date of initial installation, whichever is later	0.075	

1. If no limits have been established for an off-road engine of the same model year and maximum rated power, then the in-use stationary diesel-fueled engine used in an agricultural operation shall not exceed Tier 1 standards in title 13, CCR, section 2423 for an off-road engine of the same maximum rated power irrespective of model year.

(2) *Diesel PM Standards for Noncertified In-use Stationary Diesel-fueled CI Engines Used in Agricultural Operations (except as provided in section 93115.3):*
(No change)

(3) *Diesel PM Standards for Tier 1- and Tier 2-Certified In-use Stationary Diesel-fueled Engines Used in Agricultural Operations (except as provided in section 93115.3):*
(No change)

(4) *HC, NOx, NMHC+NOx, and CO Standards:*
(No change)

(5) - (6) **(No change)**

(7) A District may:
(No change)

c) *Registration Requirements for Greater than 50 bhp Stationary Diesel-Fueled CI Agricultural Engines.*
(No change)

(d) *Fee Requirements for Greater than 50 bhp Stationary Diesel-Fueled CI Agricultural Engine Owners or Operators.*

(No change)

NOTE: Authority cited: Sections 39600, 39601, 39658, 39659, 39666, 41511 and 43013, Health and Safety Code. Reference: Sections 39002, 39650, 39658, 39659, 39666, 40000, 41511 and 43013, Health and Safety Code.

§ 93115.9 ATCM for Stationary CI Engines – Emission Standards for New Stationary Diesel-Fueled Engines, Less Than or Equal to 50 Brake Horsepower (<50 bhp).

a. As of January 1, 2005, and prior to [effective date of amended rule], except as provided in section 93115.3, no person shall sell, offer for sale, or lease for use in California any stationary diesel-fueled CI engine that has a rated brake horsepower less than or equal to 50, unless the engine meets the current Off-Road Compression Ignition Engine Standards (title 13, CCR, section 2423) for PM, NMHC+NOx, and CO for diesel off-road engines of the same maximum rated power. ~~(These requirements are summarized in Table 8.)~~

~~Table 8: Summary of the Emission Standards for Stationary Diesel-Fueled CI Engines ≤ 50 BHP (See section 93115.9)~~
~~Diesel PM Standards, NMHC+NOx, and CO Standards (g/bhp-hr)~~
~~Current Off-Road CI Engine Certification Standard for an off-road engine of the same maximum rated power~~

b. As of the [effective date of amended rule], except as provided in section 93115.3, no person shall sell, offer for sale, or lease for use in California any stationary diesel-fueled CI engine that has a rated brake horsepower less than or equal to 50 hp unless the stationary diesel-fueled CI engine meets the following applicable emission standards for the same maximum rated power and operation.

1. New Prime Engines and New Emergency Standby Engines (less than 25 hp):
   (A) shall meet the current Off-Road Compression Ignition Engine Standards (title 13, CCR, section 2423) for PM, NMHC+NOx, and CO.
2. New Emergency Standby Engines greater than or equal to 25 bhp but less than 50 hp:
   (B) Shall meet the tier 4 interim Off-Road Compression Ignition Engine Standards (title 13, CCR, section 2423) for PM, NMHC+NOx, and CO.
3. New Direct-Drive Fire Pump Engines
   (A) As of the [effective date of amended rule], except as provided in section 93115.3, no person shall sell, offer for sale, or lease for use in California any new stationary direct-drive emergency standby diesel-fueled fire pump engine with a maximum rated brake horsepower less than or equal to 50 hp unless it meets the requirements in 40 CFR 60.4202 Standards of Performance for Stationary Compression Ignition Internal combustion Engines Final Rule Dated Tuesday July 1, 2006.

NOTE: Authority cited: Sections 39600, 39601, 39658, 39659, 39666, 41511 and 43013, Health and Safety Code. Reference: Sections 39002, 39650, 39658, 39659, 39666, 40000, 41511 and 43013, Health and Safety Code.

§ 93115.10 ATCM for Stationary CI Engines – Recordkeeping, Reporting, and Monitoring Requirements.

(a) *Reporting Requirements for Owners or Operators of New and In-Use Stationary CI Engines, Including Non-Diesel-Fueled CI Engines, Having a Rated Horsepower Greater than 50 (> 50 bhp).*
(No change)

~~(b) *Reporting Requirements for Sellers of Stationary Diesel-Fueled CI Engines Having a Rated Brake Horsepower Less Than or Equal to 50 (≤ 50 bhp).*~~

~~(1) Except as provided in section 93115.3, no later than January 31, 2006 and by January 31st of each year thereafter, all sellers of stationary diesel fueled CI engines sold for use in California that have a rated brake horsepower less than or equal to 50 shall provide the following information for the previous calendar year to the Executive Officer of the Air Resources Board:~~

~~(A) Contact Information~~
~~1. Sellers Company Name (if applicable);~~
~~2. Contact name, phone number, e-mail address;~~

~~(B) Engine Sales Information (for each engine sold for use in California in the previous calendar year)~~
~~1. Make,~~
~~2. Model,~~
~~3. Model year (if known),~~
~~4. Rated brake horsepower,~~
~~5. Number of engines sold,~~
~~6. Certification executive order number (if applicable),~~
~~7. Engine family number (if known),~~
~~8. Emission control strategy (if applicable).~~

(~~c~~b) *Demonstration of Compliance with Emission Limits.*

(1) Prior to the installation of a new stationary diesel-fueled CI engine at a facility, the owner or operator of the new stationary diesel-fueled CI engine(s) subject to the requirements of section 93115.6(a)(3), 93115.6(a)(4), 93115.6(c)(1)(C), and 93115.7(a)(1) shall provide emission data to the District APCO in accordance with the requirements of section 93115.13 for purposes of demonstrating compliance.

(2) By no later than the earliest applicable compliance date specified in sections 93115.11 or 93115.12, the owner or operator of an in-use stationary diesel-fueled CI engine(s) subject to the requirements of section 93115.6(b)(3), 93115.6(c)(2)(C), or 93115.7(b)(1) shall provide emissions and/or operational data to the District APCO in accordance with the

requirements of section 93115.13 for purposes of demonstrating compliance.

(~~d~~c) *Notification of Loss of Exemption.*

(1) Owners or operators of in-use stationary diesel-fueled CI engines, who are operating under an exemption specified in sections 93115.3 or 93115.8(a)(2) from all or part of the requirements of subsections 93115.6, 93115.7, or 93115.8 shall notify the District APCO within five days after they become aware that the exemption no longer applies and shall demonstrate compliance with the applicable requirements of:

(A) section 93115.6 or 93115.7, no later than 180 days after the date the exemption no longer applies; or

(B) section 93115.8, no later than 18 months after the date the exemption no longer applies or no later than 18 months after the emission standard compliance date set forth in section 93115.8, whichever is later.

(2) A District APCO shall notify owners or operators of in-use stationary diesel-fueled CI engines, operating under an exemption specified in section 93115.3(g) from the requirements of section 93115.5 and sections 93115.6, 93115.7, or 93115.8, when the exemption no longer applies and the owner or operator shall demonstrate compliance with the applicable requirements of:

(A) section 93115.5, 93115.6, or 93115.7, no later than 180 days after notification by the District APCO; or

(B) section 93115.8, no later than 18 months after notification by the District APCO or no later than 18 months after the emission standard compliance date set forth in section 93115.8, whichever is later.

(3) An owner or operator of an in-use stationary diesel-fueled CI engine(s) subject to the requirements of sections 93115.6, 93115.7, or 93115.8 shall provide emissions data to the District APCO in accordance with the requirements of section 93115.13 for purposes of demonstrating compliance pursuant to section 93115.10(d)(1) or (2).

(~~e~~d) *Monitoring Equipment.*

(1) A non-resettable hour meter with a minimum display capability of 9,999 hours shall be installed upon engine installation, or by no later than January 1, 2005, on all engines subject to all or part of the requirements of sections 93115.6, 93115.7, or 93115.8(a) unless the District determines on a case-by-case basis that a non-resettable hour meter with a different minimum display capability is appropriate in consideration of the historical use of the engine and the owner or operator's compliance history.

(2) All DPFs installed pursuant to the requirements in sections 93115.6, 93115.7, or 93115.8 (a) must, upon engine installation or by no later than January 1, 2005, be installed with a backpressure monitor that notifies the owner or operator when the high backpressure limit of the engine is approached.

(3) The District APCO may require the owner or operator to install and maintain additional monitoring equipment for the particular emission control strategy (ies) used to meet the requirements of sections 93115.6, 93115.7, or 93115.8(a).

(~~f~~e) *Reporting Provisions for Exempted Agricultural Emergency, Prime, and Nonagricultural Emergency Engines.*
An owner or operator of an agricultural emergency standby generator set engine subject to section 93115.3(a) or an engine subject to sections 93115.3(d) or 93115.3(j) shall keep records of the number of hours the engines are operated on a monthly basis. Such records shall be retained for a minimum of 36 months from the date of entry. Record entries made within 24 months of the most recent entry shall be retained on-site, either at a central location or at the engine's location, and made immediately available to the District staff upon request. Record entries made from 25 to 36 months from the most recent entry shall be made available to District staff within 5 working days from the district's request.

(~~g~~f) *Reporting Requirements for Emergency Standby Engines.*

(1) Starting January 1, 2005, each owner or operator of an emergency standby diesel-fueled CI engine shall keep records and prepare a monthly summary that shall list and document the nature of use for each of the following:
(A) emergency use hours of operation;
(B) maintenance and testing hours of operation;
(C) hours of operation for emission testing to show compliance with sections 93115.6(a)(3) and 93115.6(b)(3);
(D) initial start-up testing hours;
(E) if applicable, hours of operation to comply with the requirements of NFPA 25;
(F) hours of operation for all uses other than those specified in sections 93115.10(g)(1)(A) through (D) above;
(G) if applicable, DRP engine hours of operation, and
(~~G~~F)the fuel used.
1. For engines operated exclusively on CARB Diesel Fuel, the owner or operator shall document the use of CARB Diesel Fuel through the retention of fuel purchase records indicating that the only fuel purchased for supply to an emergency standby engine was CARB Diesel Fuel; or
2. For engines operated on any fuel other than CARB Diesel Fuel, fuel records demonstrating that the only fuel purchased and added to an emergency standby engine or engines, or to any fuel tank directly attached to an emergency standby engine or engines, meets the requirements of section 93115.5(b).

(2) Records shall be retained for a minimum of 36 months. Records for the prior 24 months shall be retained on-site, either at a central location or at the engine's location, or at an offsite central location within California, and shall be made immediately available to the District staff upon request. Records for the

prior 25 to 36 months shall be made available to District staff within 5 working days from request.

(hg)*Reporting Requirements for the San Diego Gas and Electric Company Regarding the RBRP.*

(1) The San Diego Gas and Electric Company shall provide to the San Diego County Air Pollution Control District the following information, by January 31, 2005, to the extent the District does not already have the information:

(A) For each diesel-fueled engine enrolled in the RBRP:

1. Owner's Company Name (if applicable);
2. Contact name, phone number, e-mail address;
3. Load reduction capacity of engine, which is the rated brake horsepower expressed in megawatts (megawatts);
4. Model year and engine manufacturer;
5. Annual hours of operation engine under DRP and emergency use; and
46. Diesel PM emission rate of the engine (g/bhp-hr);

(B) The San Diego Gas and Electric Company shall update the information identified in section 93115.10 (g)(1)(A) annually as necessary to reflect the current inventory of RBRP engines and provide a complete and the updated inventory/information to the SDAPCD and the Executive Office no later than 90 days after December 31st, of any given year thereafter upon request.

1. The Executive Officer shall evaluate the submitted inventory and information annually to determine whether any subsequent year's submittal is necessary.
2. If the Executive Officer determines a submittal is not necessary for any subsequent year, the Executive Officer will notify San Diego Gas and Electric Company by December 31st of any given year of such determination.

(2) The San Diego Gas and Electric Company shall provide the San Diego County Air Pollution Control District with an environmental dispatch protocol for the RBRP that meets all of the following requirements:

(No change)

(ih) *Additional Reporting Requirements for the Stationary Emergency Standby Diesel-Fueled CI Engines Used To Fulfill the Requirements of an Interruptible Service Contract (ISC).*

(1) The owner or operator of an ISC engine shall provide to the District the following information, as necessary to the extent the District does not already have the information:

(A) For each diesel-fueled engine enrolled in the ISC:

1. Owner's Company Name (if applicable);
2. Contact name, phone number, e-mail address;
3. Model year and engine manufacturer;

4. Annual hours of operation engine under ISC and emergency use; and
~~3~~5. Diesel PM emission rate of the engine (g/bhp-hr).

~~(B) For engines enrolled in an ISC prior to January 1, 2005, the information identified in 93115.10(i)(1)(A) shall be provided to the District by January 31, 2005; and~~

~~(C) For engines enrolled in an ISC after January 1, 2005, the information identified in 93115.10(i)(1)(A) shall be provided to the District no later than 30 days after the engine is enrolled in an ISC.~~

(2) The owner or operator shall update the information identified in section 93115.10(h)(1)(A) as necessary to reflect the current inventory of ISC engines and shall provide a complete and ~~the~~ updated inventory/information annually to the District and Executive Officer no later than 90 days after December 31st of any given year thereafter ~~upon request~~.

(A) The Executive Officer shall evaluate the submitted inventory and information annually to determine whether any subsequent year's submittal is necessary.

(B) If the Executive Officer determines a submittal is not necessary for any subsequent year, the Executive Officer will notify the owner or operator by December 31st of any given year of such determination.

NOTE: Authority cited: Sections 39600, 39601, 39658, 39659, 39666, 41511 and 43013, Health and Safety Code. Reference: Sections 39002, 39650, 39658, 39659, 39666, 40000, 41511 and 43013, Health and Safety Code.

§ 93115.13 ATCM for Stationary CI Engines – Compliance Demonstration.

(a) – (e) **(No change)**

(f) *Alternative Compliance Demonstration:* The owner or operator of a new or in-use stationary diesel-fueled CI engine greater than 50 bhp may demonstrate compliance with the 0.01 g/bhp-hr PM emission standard of sections 93115.6 through 93115.9 by using one of the following:

(1) A Level 3 Verified Diesel Emission Control Strategy in combination with a certified CI engine that meets the 0.15 g/bhp-hr PM emission standard, or

(2) An 85 percent PM emission reduction control strategy in combination with a certified CI engine that meets 0.15 g/bhp-hr PM emission standard, or

(3) A certified CI engine that meets the 0.15 g/bhp-hr PM emission standard in combination with one of the emission control strategies identified in section 93115.13(f)(1) or (f)(2) and meets the requirements of ~~section 93115.3(s) or~~ section 93115.3(~~v~~u), or

(4) Off-road CI equipment manufactured in compliance with the Transitional Implementation Flexibility Provisions for Equipment Manufacturers specified in title 13, CCR, section 2423(d); title 40 CFR, section 89.102(d); or title 40, CFR, section 1039.625 in combination with one of the emission control strategies

identified in sections 93115.13(f)(1) or (f)(2) provided the CI engine meets the 0.15 g/bhp-hr PM emission standard, or

(5) A certified CI engine in an engine family identified by the manufacturer to participate in the averaging, banking, or trading program for that model year in compliance with the applicable subparts of title 40, CFR, section 89; title 40, CFR, section 1039; or title 13, CCR, section 2423(b)(2), provided the CI engine meets the 0.15 g/bhp-hr PM emission standard and is used in combination with one of the emission control strategies identified in sections 93115.13(f)(1) or (f)(2), or

(6) A Tier 4 certified CI engine or a new piece of equipment identified in section (f)(4) that emits no more than 0.015 g/bhp-hr PM.

NOTE: Authority cited: Sections 39600, 39601, 39658, 39659, 39666, 41511 and 43013, Health and Safety Code. Reference: Sections 39002, 39650, 39658, 39659, 39666, 40000, 41511 and 43013, Health and Safety Code.

Appendix B

Analysis of the Technical Feasibility and Costs of After-Treatment Controls on New Emergency Standby Engines

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I. ANALYSIS OF THE TECHNICAL FEASIBILITY AND COSTS OF AFTER-TREATMENT CONTROLS ON NEW EMERGENCY STANDBY ENGINES

In this appendix, ARB staff summarizes the results of an investigation into the technical feasibility, availability, costs, and operational considerations associated with DPFs and SCRs on emergency standby engines. ARB staff also provides an analysis of the estimated incremental costs associated with the transition from the Tier 2 or Tier 3 emission standards to Tier 4 standards for emergency standby engines.

A. Technical Feasibility and Operational Considerations for DPFs and SCR on Emergency Standby Applications

Diesel Particulate Filter Technology Description and Availability

DPFs are used in many applications to reduce emissions of diesel PM. In general, a DPF consists of a porous substrate that permits gases in the engine exhaust to pass through but collects or "traps" the diesel PM. Most DPFs employ some means to periodically remove the collected diesel PM. This is typically referred to as regenerating the DPF. During regeneration, the collected PM, which is mostly carbon, is burned off. Diesel PM emission reductions in excess of 85 percent are possible, depending on the associated engine's baseline emissions, fuel sulfur content, and emission test method or duty cycle. In addition, up to a 90 percent reduction in CO and a 95 percent reduction in HC can also be realized with DPFs. (ARB, 2003)

Particulate filters can employ active or passive systems. Active DPFs use a source of energy beyond the heat in the exhaust stream itself to help regeneration. Active DPF systems can be regenerated electrically, with fuel burners, with microwaves, or with the aid of additional fuel injection to increase exhaust gas temperature. Some active DPFs induce regeneration automatically onboard the vehicle or equipment when a specified engine back pressure is reached. Others simply indicate when to start the regeneration process. Some active systems collect and store diesel PM over the course of a full day or shift and are regenerated at the end of the day when the vehicle or equipment is no longer needed. Because they have greater control when regeneration occurs and are not as dependent on the engine exhaust temperatures, active DPFs have a much broader range of application and a much lower probability of getting plugged than passive DPFs.

A passive DPF is one in which a catalytic material, typically a platinum group metal, is applied to the substrate. The catalyst lowers the temperature at which trapped PM will oxidize to temperatures periodically reached in diesel exhaust. No additional source of energy is required for regeneration, hence the term "passive." Field experience has indicated that the success or failure of a passive DPF is primarily determined by the average exhaust temperature at the filter's inlet and the rate of PM generated by the engine. These two variables, however, are determined by a host of factors pertaining to both the details of the application and the state and type of engine being employed. As a result, the technical information that is readily accessible can sometimes serve as a guide, but it may be insufficient to determine whether a passive DPF will be successful in a given application. (ARB, 2003)

There are at least 13 manufacturers of DPFs for use in stationary emergency standby applications. As shown in Table B-1, ten manufacturers have DPFs that have been verified through the ARB's Diesel Emission Control Strategies Verification Program for use on emergency standby engines. There are three manufacturers that also provide DPFs for emergency standby applications; however their systems have not been verified by ARB.

Table B-1: Manufacturers of DPFs for Emergency Standby Applications

Company Name	DPF Type	ARB Verified
Catalytic Exhaust Products	Passive	Yes
CleanAir Systems	Passive	Yes
DCL International	Passive	Yes
GTE Industries	Passive	Yes
Johnson Mathey	Passive	Yes
Miratech	Passive	Yes
NETT Technologies	Passive	Yes
Rypos	Active	Yes
Sud-Chemie	Passive	Yes
Universal Emissions Technologies	Passive	Yes
Corning Environmental Technologies	Passive	No
Extengine	Active	No
Cleaire	Passive	No

DPF Operating Requirements

A DPF can collect PM for a set period of time before regeneration is required. The collection time will vary depending on the size, type, and manufacturer of the DPF but generally it ranges from 240 to 720 minutes (4-12 hours). Once this limit is reached the DPF system is designed to stop collecting PM and at this point, the filter should be regenerated. The manufacturer will stipulate the duration that the engine can operate between regeneration events. This is often specified as the number of cold starts and 30 minute idle sessions that the engine can perform before the DPF needs regeneration. Table B-2 below provides additional details pertaining to the manufacturer limits imposed on the passive DPFs for those systems verified through the ARB's Diesel Emission Control Strategies Verification Program. As shown in Table B-2, the number of cold starts that can be completed between regeneration events ranges from 10 to 30. Cold starts are commonly used to determine regeneration frequency because most emergency standby engine operation is associated with maintenance and testing operations, which generally entails short 15 to 30 minute engine operation at low or no loads. Regeneration requires exhaust temperatures ranging from 300 degrees celsius (°C) to 465 °C for 30 to 120 minutes depending on the DPF system.

Table B-2: Summary of Recommended Operating Requirements for Verified Passive DPFs

Parameters	General Operating Requirements
Minimum Exhaust Temperature for Filter Regeneration	300 °C to 465 °C for a duration of 30-120 minutes
Maximum Conservative Minutes Operating Below Passive Regeneration Required	240-720 Minutes
Number of Cold Starts & 30 Mins. Idle Sessions before Regeneration Required	10-30
Other Requirements	Engine cannot be equipped with exhaust gas recirculation

Operational Considerations for DPFs on Emergency Standby Engines

Typical operation of an emergency standby engine includes either weekly, biweekly, or monthly 30 minute maintenance and testing operations with low or no load to ensure the engine is operating properly.[1] As shown in Table B-2, the number of times that an engine can operate for maintenance and testing before regeneration can vary but typically is between 10 and 30 cold starts with 30 minute run sessions. For regeneration to occur, the exhaust temperature needs to be between 300 °C to 465 °C. To reach this temperature and for a regeneration cycle to be completed, the engine should operate for about 30 minutes at a 30 percent load. This longer maintenance and testing session at a higher load would need to be performed when the filters require regeneration. In most cases, this would only be once or twice in a year.

Active DPFs are independent of temperature and will work on emergency standby engines without the same regeneration concerns noted above for the passive systems. The active DPF uses an electrical current or fuel combustion to remove or burn off the collected PM.

[1] A survey conducted by ARB staff revealed that the average number of hours operated for maintenance and testing is about 22 hours, 7 hours for emergencies, and 2 hours for DRP operation per year. (ARB, 2003)

Emergency Standby Engines with DPF Applications

Actual in-use experiences with the application of DPFs on emergency standby engines were previously investigated when the ATCM was originally adopted. (ARB, 2003) At that time, ARB staff found that there were about 50 emergency standby engines operating in California that had DPFs installed. In most cases, the DPFs were installed to meet district permit requirements or to address odor complaints from near-by neighbors. Operators indicated that there was little or no additional maintenance associated with the DPF. To determine how this has changed since the initial staff report, staff asked the local air quality control and air quality management districts (districts) to provide data on emergency engines equipped with after-treatment devices. Eight districts provided this data which collectively reported 300 DPFs equipped emergency standby engines. (District, 2010)

ARB staff continue to believe that the application of DPFs on emergency standby engines is technically feasible and can achieve significant diesel PM emission reductions. The operational considerations are minimal and can be easily accommodated by small adjustments in the routine monitoring of the engines and normal maintenance and testing procedures.

SCR Technology Description and Availability

SCR technology has been available for many years, primarily used on large power plants to lower NOx emissions. However SCR is becoming more commonplace in other applications due to the U.S. EPA and ARB on and off-road new compression-ignition diesel engine standards.[2] For off-road applications, the Tier 4 final (Tier 4f) standards which are phased in between 2011 and 2015, most engines with horsepower (hp) greater than 75 hp will require highly effective NOx controls such as SCR.

SCR uses a catalyst (commonly precious metals, vanadium, or zeolites) and injection of a reductant (liquid ammonia or urea) to convert the NOx in the diesel exhaust to water (H_2O) and nitrogen (N_2). The catalyst lowers the reaction temperature that NOx needs to convert to H_2O and N_2. The temperature range is specific to each SCR system but in general it is between 260 °C to 540 °C. Once the exhaust temperature reaches the minimum operating temperature, the catalyst activates and the system begins to inject the reductant into the exhaust stream. The exhaust will then enter the catalyst where the conversion will take place. A well designed system can reduce the NOx emissions up to 95 percent.

[2] U.S. EPA and ARB have adopted essentially the same emission standards for off-road engines. The ARB's Off-Road Compression Ignition Engine Standards (Off-Road Standards) can be found in title 13, CCR, section 2423. The U.S. EPA's Control of Emissions of Air Pollution from Nonroad Diesel Engines and Fuel, Final Rule June 29,2004 (Nonroad Standards) can be found at 40 CFR Parts 9,69, et. al. In both regulations, the diesel engine standards are phased in over several years and have Tiers, i.e. Tier 1, 2, 3 and 4; with increasing levels of stringency. The Tier 4 standards are broken into two subsets of emission standards, the Tier 4 interim (Tier 4i) and the Tier 4 final (Tier 4f). Generally, the Tier 4i standards require the application of DPF technology and the Tier 4f the application of both DPF and SCR technologies.

As shown in Table B-3, there are at least eight manufacturers who have indicated they have SCR systems for installation on stationary diesel engines. In most cases, these systems were designed for application on prime generators but can be adapted to work on emergency standby engines.

Table B-3: Manufacturers of Selective Catalytic Reduction Systems for Stationary Emergency Standby Engine Applications

CRI Catalyst
Ducon Technologies, Inc.
Epcon Industrial Services, LP
Foster Wheeler Energy Corp.
Johnson Matthey
Miratech Corporation
NETT Technologies
Universal Emissions Technologies

SCR Operating Requirements

As discussed earlier, SCR systems have two key operating variables that work together to achieve the NOx reductions. These are the exhaust temperature and the injection of the reductant (urea or ammonia). With respect to the exhaust temperature, the exhaust temperature must be between 260 °C to 540 °C for the catalyst to operate properly. For this reason, SCR systems will not begin injection of urea or ammonia until the catalyst has reached the minimum operating temperature. During this warm-up period, the engine can operate but without the benefits of the NOx reductions from the SCR system. The urea or ammonia injection is also a critical component in determining the control efficiency of a SCR. It must be injected into the exhaust stream upstream of the SCR system. In the catalyst, it reacts to reduce the NOx to form N_2 and H_2O. The reaction is able to take place because the catalyst lowers the reaction temperature necessary for NOx.

Operational Considerations for SCR Systems on Emergency Standby Engines

As mentioned above, SCR systems require an operating temperature between 260 °C to 540 °C. Reaching these temperatures may be difficult in routine maintenance and testing operations where the engine is typically operated at low load for short periods of testing. If this temperature is not met while the engine is running, there will not be any NOx emission reduction benefits. To circumvent this problem, the engine would need to be operated with higher loads and in many cases for longer periods of time. This could be a challenge for most emergency standby applications as most businesses do not have load banks in house and would have to create a larger load on the engine to get the catalyst up to operational temperature.

Urea handling and maintenance is also an important consideration. Urea crystallization in the lines can cause damage to the SCR system and to the engine itself. Crystallization in the lines is more likely in emergency standby engines due to their periodic and low hours of usage. Urea also has a shelf life of approximately two years. This could increase the cost of operating a SCR for emergency standby engines since the low number of annual hours of operation experienced by most emergency standby engines could lead to urea expiration. The urea would then have to be drained and replaced, creating an extra maintenance step and an increased cost to the end user.

Emergency Standby Engines with SCR Applications

There are a limited number of examples to draw upon for SCR installations in California. There are 7 facilities with SCR systems on 17 engines in California based on district permit data from eight districts. (District, 2010) These SCR systems were installed to comply with local district rules and regulations. ARB staff contacted operators of two facilities, one in California and one in Delaware, to obtain information on actual in-use experience with SCR systems on emergency standby engines. Brief summaries of what was reported are provided below.

Raging Wire: Raging Wire located in Sacramento, California, provides electronic data storage for businesses. They have equipped two of their diesel generators with SCR to meet the district's best available control technology (BACT) requirements for NOx. The SCR systems are installed on two Tier 1 two megawatt diesel engines and according to the district permit, are designed to reduce NOx between 35 and 60 percent. The two SCR systems are manufactured by Johnson Matthey. A Raging Wire representative provided ARB with their maintenance and testing records from the past two years. On average they operate about 20 hours per year for maintenance and testing procedures and 3 hours per year for emergency operation. It was indicated that a representative from Johnson Matthey must come out and service the SCR system twice a year to insure proper operation of the system.

Verisign, Inc.: ARB staff contacted representatives with Verisign, Inc. in New Castle, Delaware to discuss their experiences with SCR systems installed on six Caterpillar 3516 emergency standby diesel engines. Verisign, Inc. is a data and internet protection business. The engines have had an SCR system installed for approximately one year. The operator was very impressed with the system and was pleased with the results that he was seeing. For their SCR systems, the catalyst must reach 260 °C (500°F) to start to operate. When the engine is used at full load (2.2 MW) the SCR system begins to operate in approximately 10 minutes. Urea usage is 7-9 gallons per hour at full load. At very low load, the SCR system will not begin to operate for 30-40 minutes. It was their experience that occasionally the SCR system will not operate during an emergency because the loads are too low and the desired temperature is not reached. One major concern that they found with low use was that the urea had crystallized in the lines and leaked on multiple occasions.

SCR systems have not yet seen wide application on emergency standby engines and SCR systems currently in-use are on large emergency standby diesel engines greater than 1,000 horsepower. ARB staff believes that while the current generation of SCR systems may be technically feasible, there are significant operational hurdles to overcome before routine use of SCR on emergency standby engines is practical. This is because the majority of operating hours for emergency standby engines occur during short 15 to 30 minute maintenance and testing checks are at low engine loads. In most cases, the temperature needed for the SCR catalyst to function will not be reached during this operation and the SCR will not provide the expected NOx reductions.

B. Incremental Costs Associated with DPF and SCR on Emergency Standby Engines

To determine the potential costs associated with the application of DPF and SCR technologies on emergency standby engines, ARB staff investigated the costs associated with five different "compliance pathways" or scenarios that resulted in the application of DPFs and/or SCRs on emergency standby generator engines (gen-set). Two scenarios were based on the end user retrofitting an existing Tier 2 or Tier 3 engines with after-treatment technologies and three scenarios were based on original equipment manufacturers (OEM) providing the engine with after treatment technology installed. The five scenarios are:

Scenario 1) end user aftermarket retrofit of a Tier 2 or Tier 3 gen-set with a DPF;
Scenario 2) end user aftermarket retrofit of a Tier 2 or Tier 3 gen-set with a DPF and SCR;
Scenario 3) OEM supplied new Tier 4 interim (Tier 4i) gen-set (DPF only);
Scenario 4) OEM supplied new Tier 2 or Tier 3 gen-set retrofitted with OEM supplied DPF; and,
Scenario 5) OEM supplied new Tier 4 final gen-set (with DPF and SCR).

<u>Approach for Estimating Costs</u>

In each case, to determine the cost increase, we compared the cost of a new Tier 2 or Tier 3 gen-set with the cost of a gen-set equipped with after-treatment controls via the compliance path specified for each scenario. ARB staff aggregated engines into five horsepower ranges: 50-174, 175-749, 750-1,206, 1,207-2,000, and greater than 2,000. Estimated costs for end-user retrofit were based on data from after-market technology providers and OEM costs were provided by EMA members. For each specified horsepower range, the percent increase in cost for a gen-set with after-treatment compared to a new Tier 2 or Tier 3 gen-set without after-treatment was determined for the average size horsepower engine within each horsepower range.

To collect information on the costs for a new Tier 2 or Tier 3 gen-set and the costs associated with gen-sets that would meet each scenario that relied on OEM supplied engines, ARB staff worked with EMA to survey the OEMs. The survey asked for the current average costs for a Tier 2 or Tier 3 gen-set which are currently being sold. ARB asked manufacturers to estimate the future cost as a percent increase over a Tier 2 or Tier 3 gen-set of an OEM supplied DPF on a Tier 2 or Tier 3 engine, a Tier 4i engine (with DPF), and a Tier 4 gen-set (with DPF & SCR). The cost was the total cost to the end user without the cost of installation. This survey was sent to EMA to distribute to its members. ARB received responses from four manufacturers: Caterpillar, Inc., Cummins, Inc., Cummins West, and MTU Detroit Diesel.[3] To protect the confidentiality of the data provided by each OEM, the data provided was combined and the average used for the cost estimates and presented in this appendix. The estimated costs were the cost for emergency standby gen-sets only and included any costs the OEMs would incur for research, design, assembly line setups, after-treatment technologies, tooling, inventory storage, engine markup, and other considerations. It is important to note that, while EMA members provided estimates of their costs to produce the OEM supplied engines, they also stated that it is not economically viable for them to maintain a California-only platform for these engines and that these engines will not be available "off-the-shelf" from the OEMs.

For the end-user DPF retrofit scenarios, ARB staff relied on DPF retrofit cost data collected during the development of the ATCM. At that time, as outlined in the staff report developed in support of the ATCM, the estimated cost to retrofit a stationary diesel engine with a DPF was $38 per hp which includes capital and installation costs. (ARB, 2003) ARB staff conducted additional outreach to current DPF vendors to verify that this cost estimate is still applicable. ARB staff contacted manufactures of DPFs currently verified through ARB's verification procedure and found that the cost ranges from $25 to $55 for both active and passive systems with an average cost of $39 per horsepower.[4] Based on this, ARB staff believes the estimate of $38 per horsepower is still a reasonable cost estimate for a DPF retrofit. To determine the retrofit costs for a SCR system, staff contacted four SCR manufacturers and solicited SCR cost data. Based on the responses received, the capital costs for SCR systems ranged from $50 to $150 with an average cost of $80 per hp. This does not include the cost of installation which, according to the SCR manufacturers, could increase costs by 25 percent to over 100 percent. (Miratech, 2010)

The various cost assumptions and considerations for the different scenarios are summarized below.

Scenario 1: End User Aftermarket Retrofit of a Tier 2 or Tier 3 Gen-Set with a DPF

In this scenario, it is assumed that the end user purchases an "off-the-shelf Tier 2 or Tier 3 gen-set that meets a 0.15 g/bhp-hr PM standard and installs a DPF purchased from an aftermarket supplier. As discussed above, the estimated costs to retrofit an gen-set with an aftermarket DPF were $38 per hp. This estimate reflects the costs to

[3] Clarke also provided cost information; however, it was excluded due to the fact that they provide direct drive fire pumps instead of generator sets. The data would not be compatible.
[4] Miratech, Johnson Matthey, and Rypos provided estimated costs for DPFs for multiple horsepower ranges. The estimated costs were aggregated to protect confidentiality.

purchase the DPF and install it on the gen-set. As shown in Table B-4, the estimated percent cost increase for this scenario relative the costs for a new Tier 2 or Tier 3 gen-set without after-treatment is between 15 percent and 26 percent.

Scenario 2: End User Aftermarket Retrofit of a Tier 2 or Tier 3 Gen-Set with a DPF and SCR

This scenario assumes the end user purchases an 'off-the-shelf" Tier 2 or Tier 3 gen-set that meets a 0.15 g/bhp-hr PM standard and installs both a DPF and a SCR. ARB staff relied on the estimated costs of $38 per hp noted previously to retrofit an gen-set with a DPF and added to that cost, the cost to also retrofit with a SCR. As discussed above, the SCR retrofit costs were estimated to be $80 per horsepower. This estimate included only the capital cost because the manufacturers indicated that the installation costs are site-specific exercise and it is difficult to estimate an average cost. As shown in Table B-4, the estimated percent cost increase for this scenario relative the costs for a new Tier 2 or Tier 3 gen-set without after-treatment is between 46 percent and 82 percent.

Scenario 3: OEM Supplied New Tier 4 Interim Gen-Set

Under this scenario, it is assumed that the OEMs will develop and maintain a Tier 4i platform for emergency standby gen-sets. The Tier 4i standards, for most horsepower ranges, require a DPF to meet stringent PM limits and additional engine modifications to meet lower NOx limits. To meet the lower NOx limits, engine manufacturers indicated that exhaust gas recirculation (EGR) would be required; SCR would probably be required for gen-sets greater than 1207 hp. For this scenario, ARB staff relied on the OEM data provided on the estimated percent increase in costs relative to a new Tier 2 or Tier 3 gen-set without aftermarket controls. These estimates are provided in Table B-5 below and range from 55 percent to 105 percent. As noted above, the final OEM costs reflected the cost to the end user and included research, design, assembly line setups, tooling, inventory storage, engine markup, add-on control devices, and other considerations.

Scenario 4: OEM Supplied New Tier 2 or Tier 3 Gen-Set with DPF

In this scenario, we assumed that the OEM would provide a Tier 2 or Tier 3 gen-set with OEM supplied DPF after-treatment. As shown in Table B-5, the estimated percent cost increase for this scenario relative the costs for a new Tier 2 or Tier 3 gen-set without after-treatment is between 30 percent and 65 percent, about double the costs of those in Scenario 1 where the end user would retrofit a DPF to an existing gen-set.

Scenario 5: OEM Supplied New Tier 4 Gen-Set (with DPF and SCR)

This scenario assumes that the OEMs would develop and maintain a Tier 4f emergency standby diesel gen-set platform for the California market. The costs for this scenario were based on the data provided by the OEMS. As shown in Table B-5, the estimated percent cost increase for this scenario relative the costs for a new Tier 2 or Tier 3 gen-set without after-treatment is between 65 percent and 125 percent.

<u>Estimated Increase in Gen-Set Costs for the Five Scenarios</u>

Table B-4 provides a summary of the estimated cost increase associated with the Scenarios 1 and 2 that entailed the end user retrofitting a new Tier 2 or Tier 3 gen-set with a DPF or with both a DPF and SCR. For each scenario, the costs are presented as a percentage increase and as the increase in actual dollar amount, relative to a new Tier 2 or Tier 3 gen-set. As can be seen in Table B-4, the costs for an end user to retrofit an emergency standby gen-set with a DPF range from $4,000 to $100,000 per gen-set depending on the horsepower. The cost for an end user retrofit with DPF and SCR ranges from $13,000 to $310,000 per gen-sets.

Table B-4: End-User Retrofit Scenarios: Cost Increases for Emergency Standby Generator Sets

HP Range	Cost of NewTier 2/3 Gen-Set ($)	Aftermarket DPF Regulatory Scenario		Aftermarket SCR + DPF Regulatory Scenario	
		% Increase	$ Increase	% Increase	$ Increase
50-174	$29,000	15%	$4,000	46%	$13,000
175-749	$67,000	26%	$18,000	81%	$55,000
750-1206	$141,000	26%	$37,000	82%	$115,000
1207-2000	$309,000	20%	$61,000	61%	$189,000
>2000	$523,000	19%	$100,000	59%	$310,000

The cost increases associated with Scenarios 3, 4, and 5 that relied on OEM provided after-treatment based engines and technologies are provided in Table II-2. The OEM costs for Tier 4i and Tier 4f gen-sets reflect the addition of DPF and/or SCR after-treatment devices and any costs the OEMs would incur for research, design, assembly line setups, tooling, inventory storage, engine markup, and other considerations. For Tier 4i, a DPF will be required to meet the PM standards on all engines greater than 75 hp. For engines greater than 1207 hp, SCR systems will also likely be required to meet the Tier 4i NOx standard. For the Tier 4f engines, both DPF and SCR systems will be required on all engines greater than 75 hp

Table B-5: OEM Provided Average Cost Increases for Emergency Standby Generator Sets

HP Range	Cost of Tier 2/3 Gen-Set ($)	Tier 4i Regulatory Scenario (DPF)*		OEM Tier 2/3 Scenario (DPF)		Tier 4f Regulatory Scenario (DPF/SCR)	
		% Increase	$ Increase	% Increase	$ Increase	% Increase	$ Increase
50-174	$29,000	55%	$16,000	65%	$19,000	95%	$28,000
175-749	$67,000	105%	$71,000	55%	$36,000	125%	$85,000
750-1206	$141,000	100%	$136,000	40%	$57,000	110%	$156,000
1,207-1,999	$309,000	75%	$227,000	30%	$96,000	80%	$248,000
>2,000	$523,000	60%	$303,000	30%	$141,000	65%	$329,000

* For > 1,207hp, both SCR and DPF required.

As can be seen in Table B-5, the cost increase for an OEM supplied DPF equipped gen-sets ranges from $16,000 to $19,000 for less than 175 hp gen-sets and about $100,000 for a gen-set in the 1,207 to 1,999 hp range. The costs for OEM gen-sets with DPF and SCR are estimated to be more than 2 times the cost of DPF only gen-sets. Comparing the estimated cost increases between the end-user scenarios and the OEM scenarios, it can be seen that it will be less costly for the end user to retrofit an existing Tier 2 or 3 gen-set than for the OEMs to supply the gen-set. This cost differential helps to support the OEMs contention that it is not economically viable for them to develop and maintain a "California only" emergency standby gen-set platform with after-treatment controls.

Table B-6 below provides a summary of the estimated average cost per hp for each scenario. As is shown, on a per horsepower basis, the costs for an end user to retrofit an existing gen-set is less in most all cases than the potential costs if the gen-set with after-treatment were provided by the OEM. One reason for this cost differential is that the cost data from the OEM included research, design and manufacturing cost associated with producing a CA only product.

Table B-6: Average Cost per Horsepower for Each Scenario Investigated

HP Range	Tier 4 Interim	OEM Tier 2/3 with DPF	Tier 4 Final	Aftermarket DPF[1]	Aftermarket DPF & SCR
50-174	$143	$170	$250	$38	$118
175-749	$154	$78	$184		
750-1,206	$139	$58	$160		
1,207- 2,000	$142	$60	$155		
>2,000	$115	$54	$125		

[1]Includes installation costs

C. Cost-Effectiveness

ARB staff determined the cost-effectiveness associated with the two scenarios that entailed the end user retrofitting an existing Tier 2 or 3 engine to meet the Tier 4 standards. Because the OEMs have stated they will not provide Tier 4 emergency standby engines for the California market, in the event the ATCM is not amended, the only reasonable compliance pathway for operators would be to retrofit a new Tier 2 or 3 engines with a DPF and SCR to meet the Tier 4 Offroad Standards. In each case, the cost-effectiveness was estimated on a per engine basis by evaluating the emissions and costs impacts for the average size engine within each horsepower range. To determine the cost-effectiveness, ARB staff calculated the difference in PM and NOx emissions between the new Tier 2 or Tier 3 gen-set and the gen-set described for each scenario. For Scenario 1, which relies on DPF after-treatment technology, the entire cost was applied to PM reductions. For Scenario 2, which has both NOx and PM reductions due to the application of DPF and SCR technologies, the costs were apportioned to the estimated emission reductions based on the contribution of the technology cost to the total costs. For example, the cost of the SCR is about 2/3 of the total costs for an engine with both a DPF and SCR. Using this relationship, for an engine equipped with both a DPF and SCR, 2/3 of the cost was attributed to the NOx reductions and 1/3 of the cost to the PM reductions. Table B-7 provides a summary of the costs and cost-effectiveness for each scenario.

Table B-7: Cost-Effectiveness Associated with the Application of DPF and SCR on Emergency Standby Engines

Regulatory Scenario			HP Range				
			50-174	175-749	750-1206	1207-1999	>2000
	Average Horsepower:		112	462	978	1604	2630
Scenario 1: DPF Retrofit of Tier 2/3 engine	Cost Increase Due to Controls	PM	$4,300	$17,600	$37,200	$60,900	$99,900
		NOx	N/A	N/A	N/A	N/A	N/A
	Emission Reductions (lbs)	PM	8	33	70	115	189
		NOx	N/A	N/A	N/A	N/A	N/A
	Cost Effectiveness ($/lb)	PM	$540	$530	$530	$530	$530
		NOx	N/A	N/A	N/A	N/A	N/A
Scenario 2: DPF/SCR Retrofit of Tier 2/3 engine	Cost Increase Due to Controls	PM	$4,400	$18,200	$38,500	$63,100	$103,400
		NOx	$8,800	$36,300	$76,900	$126,100	$206,900
	Emission Reductions (lbs)	PM	8	33	70	115	189
		NOx	100	413	1456	2280	3740
	Cost Effectiveness ($/lb)	PM	$550	$550	$550	$550	$550
		NOx	$90	$90	$54	$56	$56

Assumptions: Emergency standby engine operates 31 hours per year at 30 percent load; 22 hours for maintenance and testing, 7 for emergency hours, and 2 for DRP. DPF costs $38/hp and SCR costs $80/hp. Scenario 2 attributes one-third of the cost to PM reductions and two-thirds to NOx reductions. SCR and DPF have 25 year life. For the SCR, it was assumed that for half of the maintenance and testing hours of operation and for all emergency hours (20 hours) the SCR was operating at full efficiency and the NOx emission rate was consistent with the Tier 4 emission standards. For one half of the maintenance and testing operation (11 hours) it was assumed the SCR was not at the correct operating temperature and the NOx levels reflected Tier 2 or Tier 3 NOx emission levels. This assumption is based on the 15 minute warm up time for typical SCR systems. Note, cost estimates are different than those in Table B-4 due to rounding

To provide perspective on these estimates, ARB staff compared the cost-effectiveness for an engine in the 175-749 hp range (see second column under "HP Range" "175-1206" heading in Table B-7) to the cost-effectiveness of regulations or programs currently being implemented by the ARB to reduce PM and NOx emissions. According to an earlier ARB survey, about 40% of all emergency standby engines are within the 175 to 749 hp range. (ARB, 2003). Table B-8 presents a comparison of the PM cost-effectiveness and Table B-9, the NOx cost-effectiveness. As can be seen, the incremental cost-effectiveness associated with the transition from Tier 2 or 3 emission standards to either the Tier 4i or Tier 4f for emergency standby engines is higher than any of the other regulations adopted by the Board. This is primarily due to the low number of hours that emergency standby engine typically operate.

Table B-8: PM Cost-Effectiveness Comparison [1]

Regulation or Airborne Toxic Control Measure	PM Cost Effectiveness ($/lb)
Stationary ATCM Incremental Cost-Effectiveness Tier 2/3 to Tier 4 for New Emergency Standby Engines	$530
In-Use Off-road Diesel Vehicle Rule[2]	$40
Solid Waste Collection Vehicle Rule	$32
Cargo Handling ATCM	$21
Ship Main/Aux/Boiler Proposal (2008)	$16
Ship Auxiliary Engine Regulation (2005)	$13
Public Fleets Rule	$160

[1] Chart taken from Fuel Sulfur and Other Operational Requirements for Ocean-Going Vessels Within California Waters and 24 Nautical Miles of the California Baseline (ARB, 2008)
[2] Attributes all regulation costs associated with diesel emission controls to PM and splits other regulation costs equally between PM and NOx.

Table B-9: NOx Cost-Effectiveness Comparison

Regulation or Airborne Toxic Control Measure	NOx Cost Effectiveness ($/lb)
Stationary ATCM Incremental Cost-Effectiveness Tier 2/3 to Tier 4 for New Emergency Standby Engines	$90
Carl Moyer Limit (2008 guidelines)	$8
Cargo Handling Equipment Rule	$1
In-use Off-Road Diesel Vehicle Regulation	$2
Commercial Harbor Craft Rule	$1
Portable Engine ATCM	$2
Public Fleet Rule	$11

Load Specific Cost-Effectiveness Calculations

Diesel engines typically have varying emissions rates that are dependent on many variables including the engine load and application. For the analysis of the emissions impacts associated with application of a DPF on a Tier 2 or 3 engine, ARB staff assumed that the PM emission rate of the engine would be equivalent to the 0.15 g/bhp-hr PM emissions standard for Tier 2 or 3 engines greater than 175 hp. This emissions rate is also the publically available emissions rate that is published on the certification executive orders and what manufacturers provide to ARB when demonstrating certification for an engine.

During the development of the proposed amendments, it was commented that when evaluating the cost-effectiveness of applying DPF after-treatment to an emergency standby engine, it is not appropriate to use the Tier 2 or 3 PM emissions limit for a particular horsepower. Rather, it was recommended that ARB staff use the emissions rate that reflects the specific load that the engine is operating. As noted above, ARB staff relied on the 0.15 g/bhp-hr PM emissions limit for a certified Tier 2 or 3 engine and assumed that is the emissions rate at a 30% load. As a check on this estimation, ARB staff collected available emissions test data at various test loads for 44 different engines. Table B-10 shows the emission rates and the reported values at each load. Using the average emission rates for the 10% and 25% load points, ARB staff calculated the PM cost-effectiveness for a 600 hp engine using the same assumptions for annual hours of operation and DPF life as was used above to generate the values presented in Table B-7. For comparison purposes, ARB staff also recalculated the cost-effectiveness with a 0.15 g/bhp-hr PM emission rate and assumed a 10% and 25% load to provide a more unbiased comparison.

Table B-10: Diesel Generator Engine Emissions Test Data at Different Load Points[5]

No.	MY	Power	10% load	25% load	50% load	75% load	100% load
1	2007	50	0.25	0.21	0.16	0.16	0.25
2	2010	100	0.25	0.21	0.20	0.19	0.17
3	2007	147	0.27	0.15	0.12	0.09	0.07
4	2010	150	0.19	0.16	0.09	0.08	0.07
5	2010	250	0.51	0.43	0.20	0.05	0.04
6	2010	298	0.87	0.40	0.22	0.04	0.04
7	1985	300	0.68	0.43	0.30	0.20	0.19
8	1999	300	0.17	0.07	0.09	0.08	0.07
9	1991	300	0.41	0.21	0.10	0.09	0.18
10	1986	300	1.25	0.32	0.07	0.07	0.10
11	2010	310	0.29	0.23	0.10	0.05	0.03
12	2000	350	0.96	0.26	0.18	0.17	0.15
13	1999	350	0.36	0.16	0.08	0.07	0.06
14	1991	350	0.77	0.48	0.36	0.18	0.11
15	2000	350	0.74	0.26	0.26	0.23	0.20
16	2000	350	0.73	0.28	0.24	0.24	0.18
17	2000	350	0.74	0.24	0.22	0.20	0.16
18	2005	350	0.17	0.15	0.08	0.07	0.07
19	2010	351	0.12	0.12	0.04	0.04	0.06
20	1990	360	0.68	0.37	0.34	0.28	0.25
21	2005	400	0.16	0.13	0.08	0.07	0.07
22	1990	450	1.31	0.62	0.38	0.40	0.65
23	2005	450	0.13	0.11	0.07	0.07	0.04
24	2005	500	0.13	0.11	0.07	0.07	0.07
25	2010	511	0.24	0.54	0.10	0.12	0.09
26	1998	545	0.57	0.26	0.17	0.20	0.28
27	1998	545	0.70	0.30	0.20	0.23	0.35
28	2010	600	0.32	0.27	0.11	0.07	0.05
29	2010	750	0.30	0.25	0.23	0.19	0.16
30	2010	800	0.30	0.25	0.23	0.19	0.16
31	2010	1000	0.30	0.25	0.20	0.16	0.15
32	2002	1000	0.86	0.36	0.19	0.10	0.07
33	2010	1250	0.51	0.43	0.12	0.09	0.05
34	2000	1500	0.90	0.39	0.23	0.14	0.09
35	2010	1500	0.49	0.42	0.08	0.08	0.05
36	2010	1750	0.33	0.28	0.19	0.08	0.04
37	2010	2000	0.32	0.27	0.16	0.04	0.05
38	2000	2000	0.98	0.34	0.18	0.09	0.07
39	2010	Varies	0.60	0.35	0.15	0.11	0.06
40	2010	Varies	0.28	0.32	0.24	0.06	0.04
41	2010	Varies	0.32	0.17	0.09	0.03	0.05
AVERAGES	**g/KW-hr**	**611 KW**	**0.50**	**0.28**	**0.17**	**0.13**	**0.12**
	g/BHP-hr	**819 HP**	**0.37**	**0.21**	**0.13**	**0.09**	**0.09**

[5] Engine emission data provided by Caterpillar, Inc. (Caterpillar, 2010), Cummins, Inc. (Cummins, 2010), John Deere Power Systems (John Deere, 2010), MTU Detroit Diesel (Detroit Diesel, 2010), and "Emissions of regulated pollutants from in-use diesel back-up generators." (U.C. Riverside, 2006)

Using the data in Table B-10, ARB staff calculated the PM cost-effectiveness for a typical 600 hp engine assuming the engine emitted at the average PM emissions rate for the 10% load (0.37 g/bhp-hr) and for the 25% load (0.21 g/bhp-hr). The cost-effectiveness was calculated according to the following equations:

(1) Total PM Reductions = (HP x L) x (EF_{PM} - (EF_{PM} x .85)) x (1lb/454g) x LF x H

Where

HP = horsepower of an emergency standby engine (600 hp)
L = operational load of engine (10% and 25%)
EF = emission rate of diesel PM at the specified load (g/bhp-hr)
LF = expected DPF life (25 years)
H = annual hours of operation (31 hrs)

(2) Total Cost Effectiveness = (HP x C) / (Total PM Reductions)

Where

HP = horsepower of an emergency standby engine (600 hp)
C = cost of DPF ($38 per hp)

Table B-11: Comparison of PM Cost-Effectiveness Calculated with Load Specific PM Emission Rates to Cost-Effectiveness Calculated Using the PM Emission Standard

Load	HP	PM Emission Rate g/bhp-hr	PM Emission Rate with DPF g/bhp-hr	Total PM Reduced Over 25 Years (lbs)	Total DPF Cost	Cost Effectiveness ($/lb)
10%	600	0.37	0.05	32	$22,800	$710
25%		0.21	0.03	46		$495
10%		0.15	0.01	14		$1,630
25%		0.15	0.01	36		$630
30%		0.15	0.01	43		$530

Table B-11 provides a summary of the cost-effectiveness values. The first two rows present the cost effectiveness calculated using the equation above and the average PM emissions rates at 10% and 25% load presented in Table B-10. The last three rows provide the cost-effectiveness values at 10%, 25%, and 30% loads that were calculated using the approach ARB staff used to evaluate the cost-effectiveness of DPF after-treatment on emergency standby engines *i.e.* assume the engine has the same PM emission rate equivalent to 0.15 g/bhp-hr at all loads. As can be seen, at the 25% load, using the load specific values reduces the cost-effectiveness by about 20% as compared to the cost-effectiveness calculated assuming the engine emits at the 0.15 g/bhp-hr emission rate. The difference is more significant at a 10% load, with cost-effectiveness calculated using the load-specific values being about 60 percent lower than that calculated using the 0.15 g/bhp-hr PM emission rate. However, in each case, it is clear that the cost effectiveness is still prohibitively high compared to previous regulations as can be seen in Table B-8.

D. Direct Drive Fire Pumps

The analysis above focused on emergency standby generator sets. The same costs estimates and conclusions regarding cost-effectiveness also apply to emergency direct-drive fire pump engines. However, as discussed below, there are also other factors concerning the application of SCR and DPF on emergency standby direct drive fire pumps. Due to the substantial cost and time to develop Tier 4 engines specifically for fire pump applications, and the relatively small market for these engines in California, (about 100 new engines per year), suppliers have indicated that it may not be economically viable for them to offer new fire pump engines in California if the Tier 4 standards are implemented. (Clarke, 2010a)(Clarke, 2010b)

Emergency standby fire pump engines are unique in that they must be certified to the National Fire Protection Association (NFPA) requirements and certified by an independent produce safety organization. Engine manufacturers and fire pump system suppliers work together to develop and certify these engines to NFPA requirements, a process that can take many months or years. Having an added SCR or DPF device on the fire pump engine would likely complicate and lengthen this process.

On the engine manufacturer side, achieving certification typically involves changes to the software that controls the engine. For example, the engine may be programmed to deactivate engine protection features during a fire (such as stopping the engine when it is operating outside of normal parameters), while activating these features during normal maintenance and testing runs. Electronically-controlled engines may also be supplied with two engine control units to provide redundancy in case one fails. Fire pump engines may also be designed without a radiator, instead utilizing the cooling water they are designed to pump. In addition to the development time with the engine manufacturer, the fire pump supplier must certify the engine to the requirements of NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection. Third party certification companies such as Underwriters Laboratories (an independent product safety certification organization) and FM Global (an insurance company) approve (or "list") products to the NFPA 20 requirements. These organizations certify each component in fire protection systems, including the engine, fire pump, pump control unit, coupling between the engine and pump. For example, the engines used in fire pumps must be certified by the company to ensure that the engine power is at least 10 percent greater than the maximum power required by the pump under any conditions of pump load (among other requirements). Fire pump system suppliers typically seek separate certifications for both FM Global and UL. FM Global certification may be needed for manufacturing sites, while UL may be needed for other applications. Since the supplier wants their fire pump systems to be acceptable in all possible applications, certification to both FM Global and UL is typical.

E. Findings

Based on the analysis of the feasibility, costs, and cost-effectiveness associated with the application of DPF and SCR after-treatment devices on emergency standby engines, ARB staff has the following findings.

- Applications of DPFs on emergency standby engines are technically feasible and there are currently about 300 emergency standby engines in California that have DPFs installed.

- There is very limited application of SCR on emergency standby engines. ARB staff is aware of a few applications on larger emergency standby engines in California. However, ARB staff believes that while the current generation of SCR systems may be technically feasible, there are significant economic and operational constraints to the routine use of SCR on emergency standby engines. This is because the majority of operating hours for emergency standby engines occur during short 15 to 30 minute maintenance and testing checks are at low engine loads. In most cases, the temperature needed for the SCR catalyst to function will not be reached during this operation and the SCR will not provide the expected NOx reductions.

- Tier 4 engines that rely on after-treatment technology for emergency standby applications will not be available from the original equipment manufacturers. Representatives from the EMA have indicated that it will not be economically viable for engine manufacturers to develop and maintain a Tier 4 emergency standby engine platform for California. Because of this, staff has concluded that Tier 4 engines for emergency standby applications will not be available "off-the-shelf." Rather, each owner or operator will need to purchase a new Tier 2 or Tier 3 engines and then work with suppliers to retrofit the engine with a DPF and/or SCR to meet the Tier 4 emission standards for all pollutants.

- It is not cost-effective to routinely apply DPF or SCR after-treatment technologies on emergency standby engines. The costs of SCR and DPF after-treatment technology are very high and given the low number of hours that a typical emergency standby engine operates, about 31 hours per year, the cost-effectiveness is significantly higher than other ARB diesel engine regulations.

Based on the analysis, and those of U.S. EPA (EPA, 2006), ARB staff believes it is appropriate to more closely align the ATCM emissions standards for new emergency standby engines with those in the NSPS that do not require after-treatment based emission standards. However, ARB staff believes it is also important to continue provide the districts with the ability to impose more stringent conditions on a site-specific basis where the additional controls are warranted.

REFERENCES

(ARB, 2003) Airborne Toxic Control Measure for Stationary Compression-Ignition Engines, California Air Resources Board, September 2003

(Caterpillar, 2010) Telephone Conversation with Gordon Gerber, Global Engine Emissions Manager, Caterpillar, Inc., Dated August 31, 2010

(Clarke, 2010a) Telephone Conversation with John Whitney – Clarke Fire Protection Products, Inc., Dated June 23, 2010

(Clarke, 2010b) Telephone Conversation with John Whitney – Clarke Fire Protection Products, Inc., Dated June 30, 2010

(Cummins, 2010) Telephone Conversation with Mike Brand, Director - Regulatory Affairs, Cummins, Inc., Dated August 31, 2010

(Detroit Diesel, 2010) Telephone Conversation with Frank Seymour, Compliance & Regulatory Affairs, MTU Detroit Diesel, Dated August 31, 2010

(District, 2010) Summary Table of District SCR and DPF Installations. District 2010.xls, Last modified January 2010

(John Deere, 2010) Telephone Conversation with Rick Bishop, Environmental Compliance, John Deere Power Systems, Dated August 31, 2010

(Johnson Matthey, 2010) Johnson Matthey Email Correspondence with Wilson Chu. Dated August 2, 2010

(Miratech, 2010) Miratech Email Correspondence with Nick Detor, Dated August 1, 2010

(Rypos, 2010) Telephone Conversation with Greg Korst, Applications Engineer, Rypos, Dated July 26, 2010

(U.C. Riverside 2006) Sandip D. Shah. David R. Cocker III. Kent C Johnson. John M. Lee. Bonnie L. Soriano. J. Wayne Miller. *Emissions of regulated pollutants from in-use diesel back-up generators.* Department of Chemical and Environmental Engineering, University of California, Riverside. Bourns College of Engineering, Center for Environmental Research and Technology. California Air Resources Board. Published July 2006

(U.S. EPA, 2006) Cost per Ton for NSPS for Stationary CI ICE. Alpha-Gamma Technologies, Inc. May 16, 2006

TITLE 13. CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC HEARING TO CONSIDER PROPOSED MINOR AMENDMENTS TO THE PERIODIC SMOKE INSPECTION PROGRAM IN RESPONSE TO THE INCLUSION OF DIESEL VEHICLES IN SMOG CHECK (ASSEMBLY BILL 1488, MENDOZA 2007)

The Air Resources Board (ARB or Board) will conduct a public meeting at the time and place noted below to consider minor amendments to the Periodic Smoke Inspection Program (PSIP).

DATE: October 21, 2010

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Air Resources Board
Byron Sher Auditorium
1001 I Street
Sacramento, California 95814

This item may be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., October 21, 2010, and may continue at 8:30 a.m., on October 22, 2010. This item may not be considered until October 22, 2010. Please consult the agenda for the meeting, which will be available at least 10 days before October 21, 2010 to determine the day on which this item will be considered.

INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

Sections Affected: Proposed amendments to sections 2190, 2191 and 2194, title 13, California Code of Regulations (the regulations for the Periodic Smoke Inspection Program).

Background

Periodic Smoke Inspection Program

The PSIP was signed into law in 1990 (Senate Bill 2330) to control excessive smoke emissions from and tampering in commercial fleets of heavy-duty trucks and busses. It was implemented in July, 1998. The PSIP requires that owners of California based fleets of two or more diesel vehicles with gross vehicle weight ratings (GVWR) of greater than 6,000 pounds conduct annual smoke opacity inspections of their vehicles, repair those with excessive smoke emissions, and retain applicable records for a minimum of two years. Staff estimates that 379,242 vehicles in about 12,600 fleets are subject to PSIP in 2010[1]. More information regarding the PSIP can be accessed at: http://www.arb.ca.gov/enf/hdvip/hdvip.htm.

Diesel Smog Check

Assembly Bill 1488 was enacted in 2007. It requires that diesel passenger cars and trucks, manufactured after the 1997 model year with GVWR of 14,000 pounds or less, be included in the California Smog Check Program beginning January 1, 2010. The diesel Smog Check Program is registration based and requires emissions checks on a biennial basis. The program is administered by the Department of Consumer Affairs, Bureau of Automotive Repair (BAR) with assistance from ARB. Diesel Smog Check inspections consist of a visual inspection of the emission control devices, an interrogation of the vehicle's on-board diagnostic (OBD) system, and a visual assessment of the vehicle's smoke level. About 510,700 diesel vehicles are subject to the diesel Smog Check Program, the vast majority of which are privately owned and not subject to the PSIP.

Concurrent Impacts of the PSIP and Smog Check Programs

With the 2010 implementation of biennial Smog Checks for lighter diesel vehicles, about 76,740 diesel vehicles will be subject to both Smog Checks and PSIP opacity inspections. Every other year, owners of these vehicles will have to perform both tests in the same year. The tests are largely duplicative because they both evaluate smoke emissions of the vehicle.

The staff believes there is little or no air quality benefit from performing both tests in one year. There is a cost to the vehicle owner however; a PSIP inspection averages $55 per test, and a Smog Check averages $47 per test.

Proposed Action

ARB staff is proposing regulatory amendments to the current PSIP program to allow commercial truck fleets, subject to both the PSIP and the Smog Check Program to submit evidence of passing a Smog Check inspection as proof of compliance with the PSIP. The effect of the staff proposal is to reduce the cost of complying with these two programs by about $55 every other year, with little or no loss of air quality benefits.

For those years when a Smog Check inspection is not required, the vehicle would still be required to perform a PSIP smoke inspection. Submission of documentation of passing Smog Check inspection, in lieu of a PSIP annual smoke opacity inspection, would only be for those calendar years when a Smog Check inspection is required. This change would apply to 1998 and subsequent model-year vehicles with GVWR of 14,000 pounds or less that are currently subject to the PSIP. The PSIP requirements

1 California Air Resources Board, "Staff Report: Initial Statement of Reasons for Proposed Rulemaking. Public Hearing to Consider Proposed Amendments to California Regulations Governing The Heavy-Duty Vehicle Inspection Program (HDVIP) and the Periodic Smoke Inspection Program (PSIP), October 1997, pp 21.

for diesel vehicles not subject to Smog Check would be unchanged.

COMPARABLE FEDERAL REGULATIONS

There are no comparable federal regulations at this time. Federal regulations for heavy-duty engines are limited to establishing new engine emission standards for oxides of nitrogen (NOx), particulate matter (PM), hydrocarbons (HC), and carbon monoxide (CO). This proposed amendment applies to the operation of in-use diesel vehicles in California.

AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

ARB staff has prepared a Staff Report: Initial Statement of Reasons (ISOR) for the proposed regulatory action, which includes a summary of the economic and environmental impacts of the proposed amendment. The report is entitled: "Public Hearing to Consider Minor Amendments to the Periodic Smoke Inspection Program in Response to the Inclusion of Diesel Vehicles in Smog Check (Assembly Bill 1488, Mendoza 2007)".

Copies of the ISOR and the full text of the proposed regulatory amendment language, in underline and strikeout format to allow for comparison with the existing regulations, may be accessed on ARB's website listed below, or may be obtained from the Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, First Floor, Sacramento, California, 95814, (916) 322-2990 at least 45 days prior to the scheduled hearing on October 21, 2010.

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on ARB's website listed below.

Inquiries concerning the substance of the proposed amendment may be directed to the agency contact persons, Mr. Robert Ianni, Air Resources Engineer, at (916) 322-0845 or Mr. Wayne Sobieralski, Air Resources Engineer, at (916) 323-1099, of the Heavy-Duty Vehicle Inspection and Maintenance Development Section.

Further, the agency representative and designated back-up contact person to who nonsubstantive inquiries concerning the proposed administrative action may be directed to Lori Andreoni, Manager, Board Administration and Regulatory Coordination Unit, (916) 322-4011, or Trini Balcazar, Regulations Coordinator (916) 445-9564.
The Board has compiled a record for this rulemaking action, which includes all the information upon which the proposed amendment is based. This material is available for inspection upon request to the contact persons.

This notice, the ISOR and all subsequent regulatory documents, including the FSOR, when completed, are available on ARB's website for this rulemaking at: http://www.arb.ca.gov/regact/2010/psip2010/psip2010.htm.

COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED

The determination of the Board's Executive Officer concerning the costs or savings necessarily incurred by public agencies and private persons and businesses in reasonable compliance with the proposed regulations is presented below.

The Executive Officer has determined that, except as discussed below, the proposed regulatory action would not create costs or savings, as defined in Government Code sections 11346.5(a)(5) and 11346.5(a)(6), to any State agency or in federal funding to the State, costs or mandate to any local agency or school district, whether or not reimbursable by the State pursuant to Government Code, title 2, division 4, part 7 (commencing with section 17500), or other nondiscretionary cost or savings to State or local agencies.

The proposed regulation amendments would result in small cost savings to some State and local agencies and school districts that operate diesel powered trucks, manufactured after the 1997 model year with GVWR of 14,000 pounds or less that are subject to both the California Smog Check Program and the PSIP.

In developing this regulatory proposal, ARB staff evaluated the potential economic impacts on representative private persons or businesses. The Executive Officer has determined that certain private persons and businesses would not incur additional costs due to this regulatory item and in fact will incur a saving by not performing a PSIP test during years in which a vehicle would be subject to both programs. While, some PSIP testing services may see a small decline in the number of smoke tests performed on vehicles having GVWR of 6,000 to 14,000 pounds[2], other Smog Check testing services may experience a small increase in the number of smoke tests. The proposed amendments only modify the frequency of PSIP inspections for vehicles having GVWR of 6,000 to 14,000 pounds to every other year. The Executive Officer has made an initial determination that the proposed regulatory action would not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states, or on representative private persons.

In accordance with Government Code sections 11346.3, the Executive Officer has determined that the proposed regulatory action would not affect the creation or elimination of jobs within the State of California, the creation of new businesses or elimination of existing businesses within the State of California, or the expansion of businesses currently doing business within the State of California. A detailed assessment of the economic impacts of the proposed regulatory action can be found in the ISOR.

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2 There are about 150 smoke testing services throughout the state and the vast majority of their testing service is for vehicles having GVWR greater then 14,000 pounds.

The Executive Officer has also determined, pursuant to California Code of Regulations, title 1, section 4, that the proposed regulatory action would affect small businesses. Before taking final action on the proposed regulatory action, the Board must determine that no reasonable alternative considered by the Board or that has otherwise been identified and brought to the attention of the Board would be more effective in carrying out the purpose for which the action is proposed or would be as effective and less burdensome to affected private persons than the proposed action.

SUBMITTAL OF COMMENTS

Interested members of the public may also present comments orally or in writing at the meeting, and comments may be submitted by postal mail or by electronic submittal before the meeting. The public comment period for this regulatory action will begin on September 6, 2010. To be considered by the Board, written comments, not physically submitted at the meeting, must be submitted on or after September 6, 2010, and received **no later than 12:00 noon, October 20, 2010**, and must be addressed to the following:

Postal mail: Clerk of the Board, Air Resources Board
1001 I Street, Sacramento, California 95814

Electronic submittal: http://www.arb.ca.gov/lispub/comm/bclist.php

Please note that under the California Public Records Act (Gov. Code, § 6250 et seq.), your written and oral comments, attachments, and associated contact information (e.g., your address, phone, email, etc.) become part of the public record and can be released to the public upon request. Additionally, this information may become available via Google, Yahoo, and other search engines.

The Board requests, but does not require, that 20 copies of any written statement be submitted and that all written statements be filed at least 10 days prior to the hearing so that ARB staff and Board Members have time to fully consider each comment. The Board encourages members of the public to bring to the attention of staff in advance of the hearing any suggestions for modification of the proposed regulatory action.

STATUATORY AUTHORITY AND REFERENCES

This regulatory action is proposed under that authority granted in Health and Safety Code, sections 39600, 39601, and 43701. This action is proposed to implement, interpret and make specific sections 39002, 39003, 39010, 39033, 43000, 43018, 43701(a), 44010.5, 44011, 44011.6 and 44012, Health and Safety Code.

HEARING PROCEDURES

The public hearing will be conducted in accordance with the California Administrative Procedure Act, Government Code, title 2, division 3, part 1, chapter 3.5 (commencing with section 11340).

Following the public hearing, the Board may adopt the regulatory language as originally proposed, or with non-substantial or grammatical modifications. The Board may also adopt the proposed regulatory language with other modifications if the text, as modified, is sufficiently related to the originally proposed text that the public was adequately placed on notice and that the regulatory language, as modified, could result from the proposed regulatory action; in such event, the full regulatory text, with the modifications clearly indicated, will be made available to the public for written comment at least 15 days before it is adopted.

The public may request a copy of the modified regulatory text from ARB's Public Information Office, Visitors and Environmental Services Center, 1001 I Street, First Floor, Sacramento, California, 95814, (916) 322-2990.

SPECIAL ACCOMMODATION REQUEST

Special accommodation or language needs can be provided for any of the following:

- An interpreter to be available at the hearing;
- Documents made available in an alternate format (i.e. Braille, large print) or another language;
- A disability-related reasonable accommodation.

To request these special accommodations or language needs, please contact the Clerk of the Board at (916) 322-5594 or by facsimile at (916) 322-3928 as soon as possible, but no later than 10 business days before the scheduled Board hearing. TTY/TDD/Speech to Speech users may dial 711 for the California Relay Service.

Para solicitar alguna comodidade especial o si por su idioma necesita cualquiera de los siguientes:

- Un intérprete que esté disponible en la audiencia;
- Documentos disponibles en un formato alternativo (es decir, sistema Braille, letra grande) u otro idioma;
- Una acomodación razonable relacionados con una incapacidad.

Por favor llame a la officina del Consejo a (916) 322-5594 o envie un fax a (916) 322-3928 lo mas pronto possible, pero no menos de 10 dias de trabajo antes del el dia programado para la audencia del Consejo. TTY/TDD/ Personas que nesessitan este servicion pueden marcar el 711 para el Servicio de Retransmisión de Mensajes de California.

CALIFORNIA AIR RESOURCES BOARD

Robert Fletcher
James N. Goldstene
Executive Officer

Date: August 24, 2010

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

AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING

PUBLIC HEARING TO CONSIDER MINOR AMENDMENTS TO THE PERIODIC SMOKE INSPECTION PROGRAM (PSIP) IN RESPONSE TO THE INCLUSION OF DIESEL VEHICLES IN SMOG CHECK (ASSEMBLY BILL 1488, MENDOZA 2007)

Date of Release: September 2010
Scheduled for Consideration: October 21-22, 2010

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EXECUTIVE SUMMARY

Assembly Bill (AB) 1488, Mendoza was signed into law on October 14, 2007. The bill requires that beginning January 1, 2010, diesel passenger cars and trucks, manufactured after the 1997 model year with a Gross Vehicle Weight Rating (GVWR) of 14,000 pounds or less be included in the California Smog Check Program. The diesel Smog Check Program is a registration based program and requires most California vehicles undergo emissions checks on a biennial basis. The program is administered by the Department of Consumer Affairs, Bureau of Automotive Repair (BAR) with assistance from the Air Resources Board (ARB). Diesel Smog Check inspections which began in 2010, consist of a visual inspection of the emission control devices, an interrogation of the vehicle's on-board diagnostic (OBD) system, and a visual assessment of the vehicle's smoke level. ARB estimates that about 510,700 diesel vehicles are subject to the diesel Smog Check Program, the vast majority of which are not part of a fleet.

The Periodic Smoke Inspection Program (PSIP) was signed into law in 1990 (Senate Bill 2330) to control excess smoke emissions and tampering from fleets of heavy-duty diesel trucks and buses. It was implemented in October 1999. The PSIP requires that owners of California based fleets with two or more diesel-powered vehicles with GVWR greater than 6,000 pounds to conduct annual smoke opacity inspections. ARB randomly audits fleet inspection and maintenance records to ensure compliance. The staff estimates that 379,242 vehicles in about 12,600 fleets are subject to PSIP in 2010.

Most of the diesel vehicles recently added to the Smog Check program are not part of a fleet, and thus are not also subject to the PSIP. Most vehicles subject to PSIP are larger than 14,000 GVWR, and are not subject to Smog Check. However, an estimated 76,740 vehicles are subject to both programs in 2010. As a result these vehicles will be required to perform two emission checks in alternating years: An annual PSIP test and a biennial Smog Check. Since both tests evaluate emissions, staff believes there is little or no air quality benefit from conducting both emissions tests within any one year. The unnecessary second test costs about $55.

The proposed revision would amend the current PSIP regulation to allow commercial truck fleets, which are now subject to both the PSIP and the Smog Check Program, to submit evidence of passing a Smog Check inspection as proof of compliance with the PSIP for those years when a Smog Check inspection is required. For those years when a Smog Check test is not required, the vehicle would still be required to perform a PSIP smoke inspection. Requirements for diesel vehicles subject to PSIP but not subject to Smog Check would remain unchanged.

State of California
AIR RESOURCES BOARD

Staff Report: Initial Statement of Reasons for Proposed Rulemaking

I. Introduction

Existing law establishes a motor vehicle inspection and maintenance program (Smog Check), administered by the Department of Consumer Affairs[1] Bureau of Automotive Repair (BAR), that provides for the inspection of all motor vehicles, except those specifically exempted from the program, upon registration, biennially upon renewal of registration, upon transfer of ownership, and in certain other circumstances.

Assembly Bill (AB) 1488, Mendoza was signed into law on October 14, 2007 enhancing the existing Smog Check Program. The bill requires that beginning January 1, 2010, diesel passenger cars and trucks, manufactured after the 1997 model year with Gross Vehicle Weight Rating (GVWR) of 14,000 pounds or less be included in the California Smog Check Program. The new law has resulted in a duplication of test requirements with another pre-existing vehicle inspection program, the Periodic Smoke Inspection Program (PSIP).

II. Background

A. Periodic Smoke Inspection Program

The PSIP was signed into law in 1990 (Senate Bill 2330) to control excess smoke emissions and tampering from fleets of heavy-duty diesel trucks and buses. The PSIP requires owners of California based fleets with two or more diesel-powered vehicles with a GVWR greater than 6,000 pounds to conduct annual smoke opacity inspections. The PSIP complements ARB's other in-use vehicle anti-smoke program - the Heavy Duty Vehicle Inspection Program (HDVIP), which is based on random roadside inspection of diesel trucks.

For both the PSIP and HDVIP, the smoke opacity test is performed on a stationary vehicle using a standardized smoke opacity meter. The test protocols and smoke opacity meter specifications are defined by the Society of Automotive Engineers J1667 recommended practice. Opacity limits of 40 percent for 1991 and newer model year engines and 55 percent for pre-1991 model year engines apply. A PSIP inspection ranges in cost from $40 to $100 with an average cost of about $55 per test.

Vehicles determined to be non-compliant with the applicable opacity limits must be removed from service, repaired and retested. Test, maintenance, and repair records, as well as post-repair emissions test records, must be maintained by the fleet for a period of two years and are subject to audit by ARB. ARB has authority to audit fleet maintenance records and perform confirmatory tests of vehicles as necessary to ensure compliance. ARB randomly audits fleet maintenance and inspection records. The program was implemented in October 1999. Staff estimates that 379,242 vehicles in about 12,600 fleets are subject to PSIP in 2010[1].

B. Diesel Smog Check

Assembly Bill 1488 requires that diesel passenger cars and trucks, manufactured after the 1997 model year with GVWR of 14,000 pounds or less to be included in the California Smog Check Program beginning January 1, 2010. The Smog Check Program is registration based and requires most California vehicles to undergo emissions checks on a biennial basis. Diesel Smog Check inspections consist of a visual inspection of the emission control devices, an interrogation of the vehicle's on-board diagnostic (OBD) system, and a visual assessment of the vehicle's smoke level. The BAR estimates the cost of a diesel Smog Check to be $47.25. ARB estimates that about 510,700 diesel vehicles are subject to the diesel Smog Check Program, the vast majority of which are privately owned and not subject to the PSIP.

The new diesel Smog Check inspection process is similar to the process used for passenger cars and trucks. Upon receipt of a registration renewal notice, the vehicle owner will be informed that a Smog Check inspection is required. The owner will then proceed to a Smog Check inspection station and obtain a Smog Check test. The vehicle owner will also be given a Vehicle Inspection Report (VIR) indicating the test results and whether the vehicle passed or failed the test. The same process would apply to commercial fleets. However, public fleets follow a slightly different process, in that they do not receive registration renewals from DMV. Instead, public fleets inspect their fleet vehicles biennially based on the vehicle's Vehicle Identification Number (VIN). If the VIN ends with an even number, inspections occur in even calendar years; and VINs ending with odd numbers are inspected in odd calendar years.

C. Concurrent Impacts of the PSIP and Diesel Smog Check Programs

The implementation of the new diesel Smog Check Program results in a duplicative emission control requirement for some vehicles subject to the PSIP. The current PSIP requires all diesel-powered vehicles, greater than 6,000 pounds GVWR, that are a part of a fleet of two or more vehicles to be inspected annually for excessive smoke. Since AB 1488 now includes all 1998 and newer diesel vehicles with GVWRs of 14,000 pounds or less to be included in the Smog Check Program, some vehicles will be subject to both programs. The overlap of the two programs causes additional costs and confusion to fleets as a result of having to perform a PSIP smoke test every year and also a Smog Check test every other year.

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[1] California Air Resources Board, "Staff Report: Initial Statement of Reasons for Proposed Rulemaking. Public Hearing to Consider Proposed Amendments to California Regulations Governing The Heavy-Duty Vehicle Inspection Program (HDVIP) and the Periodic Smoke Inspection Program (PSIP), October 1997, pp 21.

III. Vehicles Affected

To determine the number of vehicles impacted, the staff analyzed registration records collected by the DMV. The data set included registration data through 2008. Vehicle model years included years 1998 through 2008. To quantify the number of vehicles impacted, the staff analyzed the following: the vehicle classes, the total number of vehicles impacted by class, the vehicle fuel type, the model year distribution, and the split between private versus fleet vehicle ownership.

The staff estimates that in 2010, there are about 510,700 model year 1998 through 2008 diesel vehicles with GVWR between 5,751[2] to 14,000 pounds; these vehicles are subject to Smog Check. The vast majority of these vehicles are privately owned (i.e. are not part of a commercial fleet). However, about 76,740 of these vehicles belong to commercial fleets of two or more and therefore are also subject to the PSIP. Every other year, these vehicles will be required to perform a Smog Check test as well as a PISP opacity test. The main purpose of each test is to inspect for excessive smoke, and thus the two tests are duplicative.

IV. Summary of the Regulatory Proposal

The staff's proposal is designed to eliminate the duplicate test requirements resulting from the implementation of AB 1488 and the existing PSIP by amending the PSIP regulations. The proposed amendments would change the PSIP regulation to allow commercial truck fleets that are subject to both the PSIP and the Smog Check Program, to submit evidence of passing a Smog Check inspection as proof of compliance with the PSIP. Every other year when a Smog Check inspection is not required, the vehicle would still be required to perform a PSIP smoke inspection. Staff believes that the proposal will result in lower costs to industry with no adverse air quality impacts. An amendment to the regulation would be made to title 13, CCR section 2190 (a).

V. Environmental and Economic Impacts

The staff estimated both the emissions impacts and the costs associated with the proposed amendments.

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[2] Under current vehicle weight classifications, no distinct break exists at the 6,000 pound GVWR. The closest break is at 5,751 pounds, which could mean that some vehicles having GVWR between 5,751 to 6,000 pounds might be included in the inventory; however, the staff believes that number to be very small.

A. Air Quality Impacts

With the implementation of Smog Checks for diesel trucks rated at less than 14,000 pounds GVWR, 76,740 trucks (15 percent of trucks in this weight range) will be subject to both a Smog Check test (which includes a visual smoke inspection) and a PSIP smoke opacity test within one year, followed by another PSIP smoke opacity test the next year. Staff is proposing that the PSIP test can be skipped in a year in which the vehicle is also required to pass a Smog Check. Staff believes that the Smog Check test and PSIP opacity test provide a similar amount of assurance that smoking vehicles will be identified and repaired. If the requirement for double testing every other year were retained, staff believes that owners would likely have both tests performed at the same time, and thus no additional emission reduction of smoke of PM would be realized from performing the second test, which ever it is. Thus reducing the number of tests to one each year-a Smog Check one year, and a PSIP opacity test the next-will not reduce the emissions reductions achieved from these two programs.

Some context for the amount of emissions reduction at stake may clarify this issue. Diesel trucks under 14,000 GVRW emit much fewer emissions per mile than their larger, over-the-road counterparts, and travel far fewer miles per year. Furthermore, the diesel trucks subject to the double inspection requirement account for only 15 percent of all trucks under 14,000 GVRW. As a result, staff estimates that the 76,740 trucks affected by the proposed amendments account for less than one percent of the PM emissions from all diesel trucks. Thus even if there were a loss of emission reduction from eliminating the double testing requirement every second year, it would have a very small impact on air quality. If the entire 76,740 trucks were excluded from the PSIP, the staff estimates that the PM disbenefit would be around 0.01 tpd[3]. However, as stated above, staff does not believe there will be any negative impact on air quality resulting from the proposed amendments because a diesel Smog Check test will be substituted for a PSIP smoke test.

B. Costs

The proposed amendments to the PSIP regulation affects 76,740 diesel powered vehicles that are subject to both the PSIP and the Smog Check Program. In any one year half of these vehicles would see a $55/vehicle savings from eliminating the duplicate test requirement.

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[3] California Air Resources Board Memorandum, Emissions Impact of Proposed Amendment to Periodic Smoke Inspection Program (PSIP), Todd Sax, Chief, Mobile Source Analysis Branch, Planning and Technical Support Division to John Urkov, Chief, In-Use Vehicle Program Branch, Mobile Source Operations Division, August 25, 2010.

The total estimated cost savings can be seen in the table below.

Estimated Cost Savings to Private Fleets and State and Local Agencies		
Fleet Owners Costs Savings	Savings Per Vehicle	Annual Savings
Elimination of Duplicate Tests	$55.00/vehicle	$2.1 million*

* Of the $2.1 million annual savings, State and Local agencies will realize savings of approximately $42,000 and $168,000, respectively.

C. Cost to Private Fleets

Private fleets account for about 90 percent of the affected fleets and will realize cost savings of $1.9 million annually by eliminating duplicate emissions test requirements.

D. Cost to State and Local Agencies

There will be no new costs to state agencies as a result of the amendments to the PSIP. State government fleets make up about 2 percent of the fleets and will realize cost savings of approximately $42,000 annually by eliminating duplicative emissions test requirements. School Districts, Cities and Counties, Fire Districts, and other local government fleets comprise about 8 percent of the fleets and will also realize cost savings of approximately $168,000 per year through the elimination of duplicative emissions test requirements.

E. Cost to Engine and Motor Vehicle Manufacturers

There will be no costs incurred by engine and motor vehicle manufacturers as a result of the amendments to the PSIP.

F. Economic Impacts on the Economy of the State

ARB's goal is to design clean air programs that are effective while being sensitive to the economic impacts of regulation. The proposed amendments to the PSIP regulation apply to a small number of diesel powered vehicles that are currently subject to both diesel Smog Check and PSIP. The proposed amendments will eliminate the duplicative emission test, saving owners the cost of inspecting these trucks.

G. Potential Impacts on Other Businesses

The staff expects that the proposed amendments may have a negligible impact on a small number of businesses that provide smoke testing services to fleets subject to the PSIP. The impact is negligible for the PSIP businesses since the vast majority of smoke tests provided by these businesses are for heavy-duty trucks greater than 14,000 pounds GVWR which these proposed amendments do not affect. Conversely, a small increase in business is likely for businesses that provide diesel Smog Check services instead.

H. Potential Impacts on Business Competitiveness

The staff believes that business competitiveness will improve because commercial fleets will no-longer have to pay additional monies for PSIP tests on those years when a Smog Check inspection is also required.

I. Potential Impacts on Employment

There will be no potential impact on employment as a result of the amendments to the PSIP.

J. Environmental Justice

State law defines environmental justice as the fair treatment of people of all races, cultures and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. ARB has established a framework for incorporating environmental justice into ARB's programs consistent with the directives of State law. The policies developed apply to all communities in California. ARB recognizes that environmental justice issues have been raised more in the context of low income and minority communities which sometimes experience higher exposures to some pollutants as a result of the cumulative impacts of air pollution from multiple mobile, commercial, industrial, area wide, and other sources.

The staff's proposal does not change the stringency nor the effectiveness of the inspections of diesel vehicles, and thus should have no impact on the environmental justice commitment.

VI. Alternatives Considered

The staff has considered two alternatives to address the complications that have arisen through the implementation of the statutory requirements of AB 1488. These alternatives include making no change to the PSIP, and exempting the impacted diesel vehicles from the PSIP requirements.

A. No Change to the PSIP

The staff has considered making no change to the PSIP therefore continuing the requirement that commercial fleet owners perform annual PSIP smoke tests as well as obtain a diesel Smog Check inspection every other year. The staff does not recommend this alternative because the duplication between the PSIP and diesel Smog Check creates additional costs to California fleet owners with zero emissions benefits.

B. Exempt Diesel Vehicles Subject to Smog Check from the PSIP

The second alternative that the staff considered was to exempt diesel vehicles subject to diesel Smog Check from the PSIP. This alternative would exempt approximately 76,740 diesel vehicles currently subject to the PSIP. The staff believes that this alternative is the most straightforward approach and would result in a small increase in PM emissions.

VII. Summary and Conclusion

The staff recommends that the Board adopt the amendments to the PSIP regulation to allow commercial truck fleets, which are subject to both the PSIP and the Smog Check Program, to submit evidence of passing a Smog Check inspection; as proof of compliance with the PSIP. For those years when a Smog Check inspection is not required, the vehicle would still be required to perform a PSIP opacity smoke test.

Submission of documentation of a passing Smog Check inspection, in lieu of a PSIP annual smoke inspection, would only be for those calendar years when a Smog Check inspection is required. The staff's proposal will lower compliance costs to fleet owners by eliminating duplicate emissions tests with no loss of emission benefit.

VIII. Summary and Rational for the Proposed Amendments

The staff's proposal is designed to eliminate the duplicate test requirements resulting from the implementation of AB 1488 and the existing PSIP by amending the PSIP regulations. The proposed amendments would change the PSIP regulation to allow commercial truck fleets that are subject to both the PSIP and the Smog Check Program, to submit evidence of passing a Smog Check inspection as proof of compliance with the PSIP. Every other year when a Smog Check inspection is not required, the vehicle would still be required to perform a PSIP smoke inspection. Staff believes that the proposal will result in lower costs to industry with no adverse air quality impacts. The affected sections are 2190, 2191, and 2194, title 13, chapter 3.6, California Code of Regulations.

Section 2190. Vehicles Subject to the Periodic Smoke Inspection Requirements.

Summary of Section 2190(g).

This new section identifies a new class of vehicles that are exempted from the PSIP requirements, but must undergo a diesel Smog Check inspection.

Rationale for Section 2190(g).

This section is needed to identify those vehicles that are concurrently impacted by both the PSIP and the new diesel Smog Check requirements as mandated by AB1488. This section defines the remedial action that these vehicles must follow in order to comply with the PSIP.

Section 2191. Definitions.

Summary of Section 2191(a)(3).

This new section defines the term Vehicle Inspection Report (VIR)

Rationale for Section 2191(a)(3).

This new definition is needed to specify the type of documentation that must be provided by a commercial fleet to demonstrate compliance with the PSIP for those vehicles that undergo a diesel Smog Check inspection.

Section 2194. Record Keeping Requirements.

Summary of Section 2194(a)(1)(13).
Subsection (a)(1)(13) is a new section and is needed to address the record keeping requirements for those vehicles that undergo a diesel Smog Check inspection instead of a PSIP smoke test.

Rationale for Section 2191(a)(1)(13).

This section is needed to specify the documents that must be maintained by a commercial fleet to demonstrate compliance with the PSIP for those vehicles that undergo a diesel Smog Check inspection.

References

1. California Air Resources Board, January 2009. "Regulations for the Heavy-Duty Vehicle Inspection Program, Periodic Smoke Inspection Program, Title 13, California Code of Regulations, sections 2180-2194", http:www.arb.ca.gov

2. California Air Resources Board and Environmental Analysis, Inc., *"Regulatory Amendments to California's Heavy Duty Vehicle Inspection Program and Periodic Smoke Inspection Program – Technical Support Document"*, October 1997.

Appendix A:
AB 1488 Legislation

Assembly Bill No. 1488

CHAPTER 739

An act to amend Section 44010.5 of, and to amend, repeal, and add Sections 44011 and 44012 of, the Health and Safety Code, relating to air pollution.

[Approved by Governor October 14, 2007. Filed with Secretary of State October 14, 2007.]

LEGISLATIVE COUNSEL'S DIGEST

AB 1488, Mendoza. Air pollution: smog check program: diesel-powered vehicles.

(1) Existing law establishes a motor vehicle inspection and maintenance program (smog check), administered by the Department of Consumer Affairs and the State Air Resources Board, that provides for the inspection of all motor vehicles, except those specifically exempted from the program, upon registration, biennially upon renewal of registration, upon transfer of ownership, and in certain other circumstances. Existing law also establishes an enhanced motor vehicle inspection and maintenance program (smog check II) in each urbanized area of the state, any part of which is classified by the United States Environmental Protection Agency as a serious, severe, or extreme nonattainment area for specified air contaminants. Existing law also requires the smog tests to include, at minimum, loaded mode dynamometer testing in enhanced areas, and 2-speed testing in all other program areas, and a visual or functional check of emission control devices specified by the department. Existing law exempts diesel-powered vehicles from these requirements, unless the department determines that the inclusion of those vehicles is technologically and economically feasible, and, if the department makes that determination, requires a visual inspection of emission control devices and the diesel-powered vehicle's exhaust emissions, and authorizes the testing of emissions of specified pollutants and the measurement of emissions of smoke or particulates, or both. Violations of smog check requirements are a crime.

This bill would, starting January 1, 2010, include diesel-powered vehicles manufactured after the 1997 model-year that have a gross vehicle weight rating of less than 8,501 pounds in the biennial smog check program, as provided.

The bill would authorize diesel-powered vehicle smog check testing to include on-board diagnostic testing.

Because violations of these requirements would be a crime, this bill would impose a state-mandated local program.

(2) The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement.

This bill would provide that no reimbursement is required by this act for a specified reason.

The people of the State of California do enact as follows:

SECTION 1. Section 44010.5 of the Health and Safety Code is amended to read:

44010.5. (a) The department shall implement a program with the capacity to commence, by January 1, 1995, the testing at test-only facilities, in accordance with this chapter, of 15 percent of that portion of the total state vehicle fleet consisting of vehicles subject to inspection each year in the biennial program and that are registered in the enhanced program area, as established pursuant to paragraph (1) of subdivision (a) of Section 44003.

(b) (1) The department shall increase the capacity of the program so that the capacity exists to commence, by January 1, 1996, the testing at test-only facilities of that portion of the state vehicle fleet that is subject to inspection and is registered in the enhanced program area, which is sufficient to meet the emission reduction performance standards established by the Environmental Protection Agency in regulations adopted pursuant to the Clean Air Act Amendments of 1990, taking into account the results of the pilot demonstration program established pursuant to Section 44081.6.

(2) Upon increasing the capacity of the program pursuant to paragraph (1), the department shall afford smog check stations that are licensed and certified pursuant to Sections 44014 and 44014.2 the initial opportunity to perform the required inspections. The department shall adopt, by regulation, the requirements to provide that initial opportunity.

(3) If the department determines that there is an insufficient number of licensed test-only smog check stations operating in an enhanced area to meet the increased demand for test-only inspections, the department may increase the capacity of the program by utilizing existing contracts.

(c) The program shall utilize the testing procedures described in Section 44012.

(d) Vehicles that are not diesel-powered in the enhanced program area which are not subjected to the program established by this section may be tested at smog check stations licensed pursuant to Section 44014 that use loaded mode dynamometers. Diesel-powered vehicles in the enhanced program area that are not subjected to the program established by this section may be tested at smog check stations licensed pursuant to Section 44014 using appropriate testing procedures as determined by the department.

(e) (1) The department may implement the program established pursuant to subdivision (a) through a network of privately operated test-only facilities established pursuant to contracts to be awarded pursuant to this section.

(2) The initial contracts awarded pursuant to this section shall terminate not later than seven years from the date that the contracts were executed.

(f) No person shall be a contractor of the department for test-only facilities in all air basins, exclusively, where the enhanced program is in effect unless the department determines, after a public hearing, that there is not more than one qualified contractor. The South Coast Air Basin shall have at least two contractors, and the combined enhanced program area that includes Bakersfield, Fresno, and Sacramento shall have at least two contractors. The department may operate test-only facilities on an interim basis while contractors are being sought.

(g) (1) In awarding contracts under this section, the department shall request bids through the issuance of a request for proposal.

(2) The department shall first determine which bidders are qualified, and then award the contract to the qualified bidder, giving priority to the test cost and convenience to motorists.

(3) The department shall provide a contractual preference, as determined by the department, not to exceed 10 percent of the total proposal evaluation score, based on the following factors:

(A) Up to 5 percent to bidders providing firm commitments to employ businesses that are licensed or otherwise substantially participating in the smog check program after January 1, 1994.

(B) Up to 5 percent to bidders based on the extent to which bidders maximize the potential economic benefit of the smog check program on this state over the term of the contract. That potential economic benefit shall include the percentage of work performed by California-based firms, the potential of the total project workforce who will be California residents, and the percentage of subcontracts that will be awarded to California-based firms.

(4) Any contract executed by the department for the operation of a test-only facility shall expressly require compliance with this chapter and any regulations adopted by the department pursuant to this chapter.

(h) The department shall ensure that there is a sufficient number of test-only facilities, and that they are properly located, to ensure reasonable accessibility and convenience to all persons within an enhanced program area, and that the waiting time for consumers is minimized. The department may operate test-only facilities on an interim basis to ensure convenience to consumers. The department shall specify in the request for proposal the minimum number of test-only facilities that are required for the program. Any contracts initially awarded pursuant to this section shall ensure that the contractors are capable of fulfilling the requirements of subdivision (a).

(i) Any data generated at a test-only facility shall be the property of the state, and shall be fully accessible to the department at any time. The department may set contract specifications for the storage of that data in a central data storage system or facility designated by the department.

(j) The department shall ensure an effective transition to the new program by implementing an effective public education program and may specify in the request for proposal a dollar amount that bidders are required to include in their bids for public education activities, to be implemented pursuant to Section 44070.5.

(k) The department shall ensure the effective management of the test-only facilities and shall specify in the request for proposal that a manager be present during all hours of station operation.

(*l*) The department shall ensure and facilitate the effective transition of employees of businesses that are licensed or otherwise substantially participating in the smog check program and may specify in the request for proposal that test-only facility management be Automotive Service Excellence (ASE) certified, or be certified by a comparable program as determined by the department.

(m) As part of the contracts to be awarded pursuant to subdivision (e), the department may require contractors to perform functions previously undertaken by referee stations throughout the state, as determined by the department, at some or all of the affected stations in enhanced areas, and at additional stations outside enhanced areas only to the extent necessary to provide appropriate access to referee functions.

(n) Notwithstanding any other provision of law, to avoid delays to the program implementation timeline required by this chapter or the Clean Air Act, the Department of General Services, at the request of the department, may exempt contracts awarded pursuant to this section from existing laws, rules, resolutions, or procedures that are otherwise applicable, including, but not limited to, restrictions on awarding contracts for more than three years. The department shall identify any exemptions requested and granted pursuant to this subdivision and report thereon to the Legislature.

(o) The department shall implement the program established in this section only in urbanized areas classified by the Environmental Protection Agency as a serious, severe, or extreme nonattainment area for ozone or a moderate or serious nonattainment area for carbon monoxide with a design value greater than 12.7 ppm, and shall not implement the program in any other area.

(p) If existing smog check stations, in order to participate in the enhanced program, have been required to make additional investments of more than ten thousand dollars ($10,000), the department shall submit recommendations to the Governor and the Legislature for any appropriate mitigation measures.

SEC. 2. Section 44011 of the Health and Safety Code is amended to read:

44011. (a) All motor vehicles powered by internal combustion engines that are registered within an area designated for program coverage shall be required biennially to obtain a certificate of compliance or noncompliance, except for all of the following:

(1) Every motorcycle, and every diesel-powered vehicle, until the department, pursuant to Section 44012, implements test procedures applicable to motorcycles or to diesel-powered vehicles, or both.

(2) Any motor vehicle that has been issued a certificate of compliance or noncompliance or a repair cost waiver upon a change of ownership or initial registration in this state during the preceding six months.

(3) Any motor vehicle manufactured prior to the 1976 model-year.

(4) (A) Except as provided in subparagraph (B), any motor vehicle four or less model-years old.

(B) Beginning January 1, 2005, any motor vehicle six or less model-years old, unless the state board finds that providing an exception for these vehicles will prohibit the state from meeting the requirements of Section 176(c) of the federal Clean Air Act (42 U.S.C. Sec. 7401 et seq.) or the state's commitments with respect to the state implementation plan required by the federal Clean Air Act.

(C) Any motor vehicle excepted by this paragraph shall be subject to testing and to certification requirements as determined by the department, if any of the following apply:

(i) The department determines through remote sensing activities or other means that there is a substantial probability that the vehicle has a tampered emission control system or would fail for other cause a smog check test as specified in Section 44012.

(ii) The vehicle was previously registered outside this state and is undergoing initial registration in this state.

(iii) The vehicle is being registered as a specially constructed vehicle.

(iv) The vehicle has been selected for testing pursuant to Section 44014.7 or any other provision of this chapter authorizing out-of-cycle testing.

(5) In addition to the vehicles exempted pursuant to paragraph (4), any motor vehicle or class of motor vehicles exempted pursuant to subdivision (b) of Section 44024.5. It is the intent of the Legislature that the department, pursuant to the authority granted by this paragraph, exempt at least 15 percent of the lowest emitting motor vehicles from the biennial smog check inspection.

(6) Any motor vehicle that the department determines would present prohibitive inspection or repair problems.

(7) Any vehicle registered to the owner of a fleet licensed pursuant to Section 44020 if the vehicle is garaged exclusively outside the area included in program coverage, and is not primarily operated inside the area included in program coverage.

(b) Vehicles designated for program coverage in enhanced areas shall be required to obtain inspections from appropriate smog check stations operating in enhanced areas.

(c) For purposes of subdivision (a), any collector motor vehicle, as defined in Section 259 of the Vehicle Code, is exempt from those portions of the test required by subdivision (f) of Section 44012 if the collector motor vehicle meets all of the following criteria:

(1) Submission of proof that the motor vehicle is insured as a collector motor vehicle, as shall be required by regulation of the bureau.

(2) The motor vehicle is at least 35 model-years old.

(3) The motor vehicle complies with the exhaust emissions standards for that motor vehicle's class and model-year as prescribed by the department, and the motor vehicle passes a functional inspection of the fuel cap and a visual inspection for liquid fuel leaks.

(d) This section shall remain in effect only until January 1, 2010, and as of that date is repealed.

SEC. 3. Section 44011 is added to the Health and Safety Code, to read:

44011. (a) All motor vehicles powered by internal combustion engines that are registered within an area designated for program coverage shall be required biennially to obtain a certificate of compliance or noncompliance, except for the following:

(1) All motorcycles until the department, pursuant to Section 44012, implements test procedures applicable to motorcycles.

(2) All motor vehicles that have been issued a certificate of compliance or noncompliance or a repair cost waiver upon a change of ownership or initial registration in this state during the preceding six months.

(3) All motor vehicles manufactured prior to the 1976 model-year.

(4) (A) Except as provided in subparagraph (B), all motor vehicles four or less model-years old.

(B) Beginning January 1, 2005, all motor vehicles six or less model-years old, unless the state board finds that providing an exception for these vehicles will prohibit the state from meeting the requirements of Section 176(c) of the federal Clean Air Act (42 U.S.C. Sec. 7401 et seq.) or the state's commitments with respect to the state implementation plan required by the federal Clean Air Act.

(C) All motor vehicles excepted by this paragraph shall be subject to testing and to certification requirements as determined by the department, if any of the following apply:

(i) The department determines through remote sensing activities or other means that there is a substantial probability that the vehicle has a tampered emission control system or would fail for other cause a smog check test as specified in Section 44012.

(ii) The vehicle was previously registered outside this state and is undergoing initial registration in this state.

(iii) The vehicle is being registered as a specially constructed vehicle.

(iv) The vehicle has been selected for testing pursuant to Section 44014.7 or any other provision of this chapter authorizing out-of-cycle testing.

(D) This paragraph does not apply to diesel-powered vehicles.

(5) In addition to the vehicles exempted pursuant to paragraph (4), any motor vehicle or class of motor vehicles exempted pursuant to subdivision (b) of Section 44024.5. It is the intent of the Legislature that the department, pursuant to the authority granted by this paragraph, exempt at least 15 percent of the lowest emitting motor vehicles from the biennial smog check inspection.

(6) All motor vehicles that the department determines would present prohibitive inspection or repair problems.

(7) Any vehicle registered to the owner of a fleet licensed pursuant to Section 44020 if the vehicle is garaged exclusively outside the area included in program coverage, and is not primarily operated inside the area included in program coverage.

(8) (A) All diesel-powered vehicles manufactured prior to the 1998 model-year.

(B) All diesel-powered vehicles that have a gross vehicle weight rating of 8,501 to 10,000 pounds, inclusive, until the department, in consultation with the state board, pursuant to Section 44012, implements test procedures applicable to these vehicles.

(C) All diesel-powered vehicles that have a gross vehicle weight rating from 10,001 pounds to 13,999 pounds, inclusive, until the state board and the Department of Motor Vehicles determine the best method for identifying these vehicles, and until the department, in consultation with the state board, pursuant to Section 44012, implements test procedures applicable to these vehicles.

(D) All diesel-powered vehicles that have a gross vehicle weight rating of 14,000 pounds or greater.

(b) Vehicles designated for program coverage in enhanced areas shall be required to obtain inspections from appropriate smog check stations operating in enhanced areas.

(c) For purposes of subdivision (a), a collector motor vehicle, as defined in Section 259 of the Vehicle Code, is exempt from those portions of the test required by subdivision (f) of Section 44012 if the collector motor vehicle meets all of the following criteria:

(1) Submission of proof that the motor vehicle is insured as a collector motor vehicle, as shall be required by regulation of the bureau.

(2) The motor vehicle is at least 35 model-years old.

(3) The motor vehicle complies with the exhaust emissions standards for that motor vehicle's class and model-year as prescribed by the department, and the motor vehicle passes a functional inspection of the fuel cap and a visual inspection for liquid fuel leaks.

(d) This section shall become operative on January 1, 2010.

SEC. 4. Section 44012 of the Health and Safety Code is amended to read:

44012. The test at the smog check stations shall be performed in accordance with procedures prescribed by the department, pursuant to Section 44013, and shall require, at a minimum, for all vehicles that are not diesel-powered, loaded mode dynamometer testing in enhanced areas, and two-speed testing in all other program areas. The department shall ensure all of the following:

(a) Emission control systems required by state and federal law are reducing excess emissions in accordance with the standards adopted pursuant to subdivisions (a) and (c) of Section 44013.

(b) Motor vehicles are preconditioned to ensure representative and stabilized operation of the vehicle's emission control system.

(c) For other than diesel-powered vehicles, the vehicle's exhaust emissions of hydrocarbons, carbon monoxide, carbon dioxide, and oxides of nitrogen in an idle mode or loaded mode are tested in accordance with procedures prescribed by the department. In determining how loaded mode and evaporative emissions testing shall be conducted, the department shall ensure that the emission reduction targets for the enhanced program are met.

(d) For other than diesel-powered vehicles, the vehicle's fuel evaporative system and crankcase ventilation system are tested to reduce any nonexhaust sources of volatile organic compound emissions, in accordance with procedures prescribed by the department.

(e) For diesel-powered vehicles, if the department determines that the inclusion of those vehicles is technologically and economically feasible, a visual inspection is made of emission control devices and the vehicle's exhaust emissions are tested in accordance with procedures prescribed by the department, that may include, but are not limited to, on-board diagnostic testing. The test may include testing of emissions of any or all of the pollutants specified in subdivision (c) and, upon the adoption of applicable standards, measurement of emissions of smoke or particulates, or both.

(f) A visual or functional check is made of emission control devices specified by the department, including the catalytic converter in those instances in which the department determines it to be necessary to meet the findings of Section 44001. The visual or functional check shall be performed in accordance with procedures prescribed by the department.

(g) A determination as to whether the motor vehicle complies with the emission standards for that vehicle's class and model-year as prescribed by the department.

(h) The test procedures may authorize smog check stations to refuse the testing of a vehicle that would be unsafe to test, or that cannot physically be inspected, as specified by the department by regulation. The refusal to test a vehicle for those reasons shall not excuse or exempt the vehicle from compliance with all applicable requirements of this chapter.

(i) This section shall remain in effect only until January 1, 2010, and as of that date is repealed.

SEC. 5. Section 44012 is added to the Health and Safety Code, to read:

44012. The test at the smog check stations shall be performed in accordance with procedures prescribed by the department, pursuant to Section 44013, and shall require, at a minimum, for all vehicles that are not diesel-powered, loaded mode dynamometer testing in enhanced areas, and two-speed testing in all other program areas. The department shall ensure all of the following:

(a) Emission control systems required by state and federal law are reducing excess emissions in accordance with the standards adopted pursuant to subdivisions (a) and (c) of Section 44013.

(b) Motor vehicles are preconditioned to ensure representative and stabilized operation of the vehicle's emission control system.

(c) For other than diesel-powered vehicles, the vehicle's exhaust emissions of hydrocarbons, carbon monoxide, carbon dioxide, and oxides of nitrogen in an idle mode or loaded mode are tested in accordance with procedures prescribed by the department. In determining how loaded mode and evaporative emissions testing shall be conducted, the department shall ensure that the emission reduction targets for the enhanced program are met.

(d) For other than diesel-powered vehicles, the vehicle's fuel evaporative system and crankcase ventilation system are tested to reduce any nonexhaust sources of volatile organic compound emissions, in accordance with procedures prescribed by the department.

(e) For diesel-powered vehicles, a visual inspection is made of emission control devices and the vehicle's exhaust emissions are tested in accordance with procedures prescribed by the department, that may include, but are not limited to, on-board diagnostic testing. The test may include testing of emissions of any or all of the pollutants specified in subdivision (c) and, upon the adoption of applicable standards, measurement of emissions of smoke or particulates, or both.

(f) A visual or functional check is made of emission control devices specified by the department, including the catalytic converter in those instances in which the department determines it to be necessary to meet the findings of Section 44001. The visual or functional check shall be performed in accordance with procedures prescribed by the department.

(g) A determination as to whether the motor vehicle complies with the emission standards for that vehicle's class and model-year as prescribed by the department.

(h) The test procedures may authorize smog check stations to refuse the testing of a vehicle that would be unsafe to test, or that cannot physically be inspected, as specified by the department by regulation. The refusal to test a vehicle for those reasons shall not excuse or exempt the vehicle from compliance with all applicable requirements of this chapter.

(i) This section shall become operative on January 1, 2010.

SEC. 6. No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because the only costs that may be incurred by a local agency or school district will be incurred because this act creates a new crime or infraction, eliminates a crime or infraction, or changes the penalty for a crime or infraction, within the meaning of Section 17556 of the Government Code, or changes the definition of a crime within the meaning of Section 6 of Article XIII B of the California Constitution.

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APPENDIX B

Proposed Regulation Order

PROPOSED AMENDMENTS TO THE PERIODIC SMOKE INSPECTIONS OF HEAVY-DUTY DIESEL-POWERED VEHICLES

Amend section 2190, 2191, and 2194, title 13, chapter 3.6, California Code of Regulations to read as follows:

(Note: The proposed amendments to the existing regulation are shown in underline to indicate proposed additions)

§ 2190. Vehicles Subject to the Periodic Smoke Inspection Requirements.

These regulations shall be applicable, operative July 1, 1998, as follows:

(a) Except as provided in subsections (b), (c), (d), (e), (f) and (g), the requirements of this chapter apply to all heavy-duty diesel-powered vehicles with gross vehicle weight ratings greater than 6,000 pounds which operate on the streets or highways within the State of California.

(b) through (f) [No Change]

(g) Diesel vehicles 1998 model year and newer with weights of 6000 to 14,000 pounds GVWR during years which the vehicle has been noticed for a California Smog Check, are excluded from performing a PSIP test, but must maintain a record of a passing Smog Check Vehicle Inspection Report in lieu of the PSIP test record.

Note: Authority cited: Sections 39600, 39601 and 43701(a), Health and Safety Code. Reference: Sections 39002, 39003, 39010, 39033, 43000, 43018, 43701(a), 44010.5, 44011, 44011.6, and 44012, Health and Safety Code.

§ 2191. Definitions.

(a) The definitions of this section supplement and are governed by the definitions set forth in Chapter 2 (commencing with Section 39010), Part 1, Division 26 of the Health and Safety Code. The provisions of this chapter shall also be governed by the definitions set forth in section 2180.1, Title 13, California Code of Regulations including the following modifications:

(1) "Fleet" means any group of 2 or more heavy-duty diesel-powered vehicles which are owned or operated by the same agency or entity.

(2) "Test opacity" means the opacity of smoke from a vehicle when measured in accordance section 2193(e).

(3) "Vehicle Inspection Report" means documentation issued by a licensed Bureau of Automotive Repair Smog Check Station.

Note: Authority cited: Section 39600, 39601 and 43701(a), Health and Safety Code. Reference: Sections 39002, 39003, 39010, 39033, 43000, 43018, 43701(a), 44010.5, 44011, 44011.6, and 44012, Health and Safety Code.

§ 2194. Record Keeping Requirements.

(a) The owner of a vehicle subject to the requirements of this chapter shall record the following information when performing the smoke opacity testing:

(1) through (11) [No Change]

(12) For vehicles that have failed the smoke test and have been repaired, the vehicle repair information specified in section 2186(a), Title 13, California Code of Regulations.

(13) During years in which 1998 and newer model year vehicles of 6000 to 14,000 pounds GVWR are required to perform a Smog Check, the vehicle owner shall provide a passing Smog check Vehicle Inspection Report in place of the PSIP record.

Note: Authority cited: Sections 39600, 39601 and 43701, Health and Safety Code. Reference: Sections 39002, 39003, 39033, 43000, 43018, 43701, 44010.5, 44011, 44011.6, and 44012, Health and Safety Code.