

**State of California
AIR RESOURCES BOARD**

**Research Screening Committee Meeting
Cal/EPA Headquarters Building
1001 I Street
Conference Room 510
Sacramento, California 95814
(916) 445-0753**

**March 13, 2009
9:00 a.m.**

ADVANCE AGENDA

Draft Final Report

1. "Determination of Reactive Oxygen Species Activity in PM and Enhanced Exposure Assessment for the NIH, NIEHS Study Entitled 'Ultrafine Particulate Matter and Cardiorespiratory Health,' University of California, Irvine, \$676,814, Contract No. 03-329

A large study was initiated by the National Institute of Environmental Health Sciences (NIEHS) to investigate the nature and mechanisms of air pollution impacts on elderly people with cardiovascular disease. In this study, sixty-four elderly people with doctor-diagnosed cardiovascular disease who lived in residential retirement facilities were observed over two six-week periods for changes in blood pressure and heart electrical activity and blood borne biomarkers of injury or inflammation. The Air Resources Board (ARB), with co-sponsorship from the South Coast Air Quality Management District (SCAQMD), augmented this study with the objective of enhancing the exposure assessment activities with expanded indoor and outdoor air monitoring. ARB also supported *in vitro* studies of the oxidative chemistry of particles that are thought to influence particle toxicity and also supported statistical analyses to explore the association between the blood biomarkers and pollutants. The results of the health study sponsored by the NIEHS are not complete, but important findings have been reported on several aspects of the ARB supported components. Results show that indoor particulate matter (PM) exposures experienced by residents of the retirement homes were most strongly associated with outdoor sources, especially by pollutants emitted by traffic. Changes in factors related to inflammatory processes and blood cell function, as well as hourly fluctuations in blood pressure and electrical activity of the heart, were associated with combustion-generated air pollution such as organic, elemental, and black carbon. Ultrafine particle numbers (UFP) were associated with the blood biomarkers and blood pressure changes, but they were not predictive of cardiac electrical activity changes. Fine particle (PM_{2.5}) mass was less likely than the more specific combustion-generated components to show evidence of possible harm. This

suggests that regulatory activities should be more specifically focused on UFP than on PM2.5 to protect the elderly.

Interagency Agreements

2. "Personal, Indoor, and Outdoor Particulate Air Pollution and Heart Rate Variability in Elderly Subjects with Coronary Artery Disease," University of California, Irvine, \$235,000, Proposal No. 2666-264

Findings in cohort and time series studies suggest that PM2.5 air pollution is associated with increases in cardiovascular hospitalization and mortality. Individuals at greatest risk include elderly individuals with pre-existing cardiovascular disease or other diseases that place them at high risk for myocardial infarction or stroke. NIEHS has sponsored a major health assessment study to determine how the elderly are harmed by exposures to PM in four sites in the Los Angeles area. These areas were selected to assess the health effects near to and far from traffic. ARB and SCAQMD co-funded an extension of this study to conduct extensive monitoring of personal, indoor, and outdoor pollutant levels to refine the relationships between exposure and cardiovascular health outcomes. The proposed study would build upon that study to more fully investigate how one factor of cardiovascular impact, heart rate variability (HRV), is impacted by fine and ultrafine PM exposure. Examination of HRV data could provide more information regarding the nature of risks that the elderly experience and how mortality may be driven by environmental exposures to ultrafine PM. This study would be funded by ARB and SCAQMD if approved by both Boards.

3. "Central Nervous System Effects of Ambient Particulate Matter: The Role of Oxidative Stress and Inflammation," University of California, Irvine, \$309,141, Proposal No. 2667-264

Numerous epidemiological and toxicological studies have demonstrated that exposure to ambient PM is associated with increased cardiopulmonary morbidity and mortality; however, little is known about the effects of PM exposure on other organ systems. Several animal exposure studies have shown that inhaled particles can be transported to the brain, and that exposure to concentrated ambient particles (CAP) is associated with increased signaling pathway activity associated with inflammatory responses in the brain, as well as increased levels of biomarkers of oxidative stress and tissue injury. The objectives of the proposed study, as stated in this revised proposal, are to examine the potential for CAPs exposure to induce adverse effects on the central nervous system (CNS) and to determine the role of inflammation and/or oxidative stress in bringing about these effects. Results of this study could provide an improved understanding of mechanisms of PM action on the CNS and insight into whether ambient aerosol exposure induces neurological effects. Findings from this research could also help determine how specific chemical constituents of the aerosol are associated with health effects. This information could be of value in setting ambient air quality standards and developing air quality regulations to better protect the health of California residents.

4. "SOA Formation: Chamber Study and Model Development," University of California, Riverside, \$474,334, Proposal No. 2671-264

Secondary organic aerosol (SOA) is defined as the organic aerosol component formed in the air from reactive precursors, such as volatile organic compounds (VOC) and NO_x, through atmospheric reactions. In the summer, SOA may account for a significant fraction of atmospheric PM, which is of great health, visibility, and climate concern. However, the photochemical processes involved in SOA formation are poorly understood, and air quality models used to predict SOA formation involve many highly uncertain assumptions. To develop reliable and effective SOA control strategies, improved mechanisms to predict SOA concentration in air quality models are needed. For this project, well-controlled environmental chamber experiments will be conducted to provide needed input to chemical mechanisms that can predict SOA formation from representative VOCs. Together with other relevant chamber data, a hybrid SOA chemical mechanism based on the well-known SAPRC gas-phase chemical mechanism will be developed and evaluated. The outcome of this project is expected to contribute scientifically to the informed decision of developing feasible and cost-effective emission regulations.

5. "A Field Experiment to Assess the Impact of Information Provision on Household Electricity Consumption," University of California, Los Angeles, \$173,934, Proposal No.2679-264

Residential energy consumption accounts for a substantial portion (14 percent in 2002-2004) of California's greenhouse gas (GHG) emissions, and the Board's recently-approved Scoping Plan identifies voluntary actions as well as residential energy efficiency as key components of the State's strategy to meet a 2020 GHG emissions goal equal to the 1990 baseline. To meet the 2050 goal of 80 percent reductions in GHG emissions, dramatic shifts in the ways residential consumers of goods, energy, and services choose and use technologies will be necessary. Thus, both near-term and 2050 GHG emissions targets require substantial behavioral changes. Historically, behavioral change measures have received relatively little support as an energy management strategy, due largely to lack of information regarding their effectiveness as well as inadequate means of evaluating outreach programs, the effects of which may reach beyond direct program participants via peer-to-peer networking. The proposed study addresses these gaps by: (a) probing the impact and cost-effectiveness of programs designed to reduce residential energy consumption; and (b) probing the role of peer-to-peer communication in motivating energy conservation behaviors to be undertaken by non-participants in the outreach program. The proposed study involves a randomized trial of three household interventions that target reduced residential consumptions through provision of information on (i) relationships between appliance use and electricity consumption; (ii) how the tiered electricity pricing system works; and (iii) potential savings associated with energy efficiency investments. Analyses will gauge whether and to what extent the interventions succeed in reducing residential electricity consumption, which of the three information treatments is most effective, and what, if

any, spillover effects occur among peers identified by participants. Study results may help ARB, utilities, and/or other stakeholders design and evaluate programs to reduce residential electricity consumption.

Draft Final Reports

6. "Particulate Phase Peroxides: Concentrations, Sources, Behavior, and Self-Effect," University of California, Los Angeles, \$109,975, Contract No. 04-319

Particulate matter has been associated with significant adverse health outcomes, but it is difficult to devise cost-effective control strategies without a better understanding of the cause of PM toxicity. Scientists believe that ROS are responsible for much of this toxicity, and the dominant ROS in PM is hydrogen peroxide (H₂O₂). This study explored the sources, levels, and behavior of H₂O₂ in ambient air. The University of California, Los Angeles (UCLA) measured H₂O₂ levels in PM from several sites, and investigated the relationship between these toxic compounds and source type. Samples were also collected from diesel exhaust and photochemically processed air. Size-segregated aerosols were collected on filters and analyzed for peroxides. UCLA also carried out laboratory studies to help determine the source of peroxides in PM. UCLA found that H₂O₂ levels in aerosols are more than 100 times the level that had been predicted. This indicates that PM may be able to continuously generate H₂O₂ in aqueous media such as lung fluid. The results obtained from this study contribute meaningfully to the understanding of PM toxicity. Follow-up studies should eventually help ARB to devise control strategies for PM sources that are especially effective in generating H₂O₂ and thereby harming human health.

7. "Harbor Community Monitoring Study – Saturation Monitoring," Desert Research Institute, \$515,674, Contract No. 05-304

Residents in the greater Wilmington area live near major pollution sources, including one of the world's largest port complexes, oil refineries, busy roadways, and industrial/commercial facilities, such as railyards, electrical power generating plant, and paint shops. Previous modeling of diesel PM emissions identified the ports area and goods movement corridors as areas with enhanced concentrations of air pollution and cancer risks. The primary objective of this project was to use simple instruments (passive samplers and mini-volume PM_{2.5} samplers) to cost-effectively measure the intra-community distribution of selected pollutants (primarily toxic air contaminants and PM_{2.5}). The project results indicate that the passive samplers, due to their good measurement precision over their week-long sampling period, could be a useful tool for characterizing persistent intra-community variations in air pollution. However, the accuracy of the passive sampler measurements might not be adequate for assessing compliance with ambient air quality standards or comparing with chronic reference exposure levels. The study results indicate a strong influence from major roadways and that the network of roadways likely results in an elevated regional background of pollutant concentrations associated with mobile sources. PM_{2.5} mass concentrations, on the other hand, were relatively similar across the study area. Although the Harbor

Community Monitoring Study measurements confirm some direct impact from local pollution sources, the air quality in the area is not significantly different than in other regions of the air basin, due in part to the routine on-shore flow of cleaner air.

8. "Development of an In-Field Diesel PM Compliance Method for Stationary and Portable CI Engines," University of California, Riverside, \$299,893, Contract No. 04-330

The Air Resources Board has identified diesel exhaust PM as a toxic air contaminant and has implemented a number of regulations and programs to reduce PM emissions from different categories of diesel engines. One such regulation, the Airborne Toxic Control Measure (ATCM) for stationary diesel engines requires the control of PM emissions from sources such as emergency/standby and prime generators and air compressors. The ACTM includes a compliance option that requires in-use stationary diesel engines with a PM emission level of greater than of 0.01 g/bhp-hr be equipped with a diesel particulate filter (DPF) which obtains an 85 percent reduction in PM. This ATCM, while adopted by ARB, requires local air districts and the regulatory agencies that are responsible for permitting stationary diesel engines within their jurisdictions, to implement and enforce the ATCM. The ATCM does not establish ongoing compliance testing requirements. As such, it is left to each District's discretion to determine the appropriate approach for ensuring on-going compliance with the ATCM emission standards. The method currently used by the districts to ensure on-going compliance is ARB Method 5. This method is time consuming and costly to perform, and so air districts have asked the ARB for less costly alternatives to Method 5. The objective of this project was to develop and demonstrate a "simplified field test method" (SFTM) that could be used as an alternative to Method 5 in many instances. It is intended to be a screening test targeted at high PM emitting engines that would be indicative of DPF failures. The contractor developed such a SFTM and demonstrated it on a variety of stationary and portable diesel engines. The results indicate that the SFTM measurements, determined at a single mode (one engine speed and load point), can correlate with the laboratory reference method results, a weighted average over 5 modes, within about a +12 to -25 percent accuracy. The results from this project will assist local air districts with the implementation of the ARB regulation to reduce PM emissions from stationary and portable diesel engines.

9. "Dairy Operations: An Evaluation and Comparison of Baseline and Potential Mitigation Practices for Emissions Reductions in the San Joaquin Valley," California State University Fresno Foundation, \$249,980, Contract No. 04-343

The San Joaquin Valley (SJV) of California continues to struggle to meet the ambient air quality standards for ozone. In order to reduce ozone formation within the SJV reductions of ozone precursors are needed. Dairy operations are abundant within the SJV and are assumed to be a large source of ozone precursors known as reactive organic gases (ROG). However, data on specific compounds and dairy management practices relevant to California do not exist. Emissions of ROGs were characterized at six dairies within the SJV using flux chamber and upwind-downwind canister sampling

with accompanying gas chromatography-mass spectrometry analysis, in addition to real-time characterization using an Innova photoacoustic gas analyzer. It was observed that operations related to the preparation and distribution of feed materials had the greatest emissions of ROG. Manure management operations were found to be of lesser magnitude than previously assumed. Anticipated seasonal effects on emission strength were less significant than expected, with only open lot emissions showing temperature dependence. The emission flux data from this contract will be combined with additional data being collected in collaboration with Dr. William Salas (University of New Hampshire) and Dr. Frank Mitloehner (University of California, Davis) and used to update the emission factors for dairy operations within California. Accurate emissions factors for dairy operations are needed as these facilities must be permitted within the SJV and need to be accurately considered in California's emission inventory.

Interim Report

10. "Source Oriented Toxicity of Ambient Aerosol – Interim Report on Task 1," University of California, Davis, \$838,934, Contract No. 06-331

Ambient PM has been linked with increased morbidity and mortality, yet the reasons are unclear. Ambient PM derives from a wide range of sources and experiences a range of atmospheric processes that may alter its toxicity. Direct exposures of animals to emissions neglects atmospheric photochemistry that may enhance toxicity, while exposure to PM combines the effect of many sources so does not elucidate which source contributes to the toxicity. This study uses a single-particle mass spectrometer to selectively direct ambient particles into each of several bins, based upon their source type. This interim report describes the proof-of-concept for this technique. Specifically, this interim report summarizes the data obtained and concludes that (1) Fresno air is quite heterogeneous and (2) the proposed instrumentation and sampling equipment can respond sufficiently quickly to the temporal variations, which address concerns raised during the review of the proposal. Approval of this report will authorize the subsequent toxicological phase of this study, as follows. The bin contents will be instilled into rodents that will be studied for several possible toxic endpoints. The result will be relative toxicity indices for particles derived from each source category. This would help ARB to develop PM control strategies that focus on sources based on the relative toxicities of their PM emissions.