State of California
AIR RESOURCES BOARD

Joint Meeting with the Board and the
Research Screening Committee
To Present the Planned Air Pollution Research
Fiscal Year 2004/2005

Cal/EPA Headquarters Building
1001 I Street
Conference Room 550
Sacramento, California 95814
(916) 445-0753

October 29, 2004
10:00 a.m.

ADVANCE AGENDA

Interagency Proposals

1. "Effects of Ozone and Nitrogen Dioxide Exposure on Cardiovascular Responses in Healthy and Susceptible Humans," University of California, San Francisco, $399,032, Proposal No. 2555-245.

Epidemiology studies indicate that both ozone (O_3) and nitrogen dioxide (NO_2) are associated with increased cardiovascular morbidity and mortality, and with decreased heart rate variability (HRV), a risk factor for adverse cardiovascular outcomes. However, biological mechanisms that could explain air pollution induced cardiovascular effects are unknown. No controlled human exposure studies have investigated the effect of O_3 or NO_2 on HRV. The objective of this project is to investigate several possible mechanisms through which O_3 and NO_2 could alter HRV in healthy and asthmatic humans. The investigation will focus on mediators of airway and systemic inflammation, components of the renin-angiotensin system, and blood coagulability that could plausibly influence HRV. The study will involve healthy and asthmatic subjects (ages 18-55) who will undergo four-hour, intermittent exercise exposures to 0.2 ppm O_3, 0.4 ppm NO_2, and filtered air. The results of this project will help fill a critical data gap: the biological basis for epidemiologic findings that O_3 and NO_2 exposure can induce adverse cardiovascular effects. The results will provide critical support for future reviews of the ambient air quality standards for O_3 and NO_2.

2. “Effects of Wood Smoke Exposure on Cardiopulmonary Pulmonary Responses in Healthy and Susceptible Humans,” University of California, San Francisco, $399,939, Proposal No. 2556-245.

Wood smoke is a major component of air pollution in some areas of California. Epidemiologic data show an association between wood smoke exposure and adverse respiratory health effects, including asthma, as well as an association between particulate and gaseous air pollution and increased cardiovascular morbidity and mortality. However, the biological mechanisms mediating these effects are unknown, as there have been no investigations into biological mechanisms that could explain the cardiopulmonary effects associated with wood smoke exposure in epidemiological studies.

Several plausible mechanisms have been proposed to explain the association of adverse cardiopulmonary outcomes with wood smoke exposure. Reduced heart rate variability (HRV) is a well-known risk factor for cardiovascular morbidity and mortality. Pulmonary and/or systemic inflammation has also been proposed as a plausible mechanism. This project is designed to determine: 1) threshold levels of wood-smoke exposure inducing airway inflammation and HRV responses in humans; 2) the influence of asthma status on wood smoke-induced changes in airway inflammation and HRV; and 3) the biological mechanisms controlling these responses.

The investigation will focus on mediators of airway and systemic inflammation, components of the renin-angiotensin system and coagulability that could plausibly influence HRV and mediate the effects reported in the epidemiologic literature. The study will involve healthy and asthmatic subjects who will undergo 2 hr exposures with intermittent mild exercise to filtered air (control), 150 µg m^{-3} wood smoke, 450 µg m^{-3} wood smoke, and a three serial-day exposure to 150 µg m^{-3} wood smoke. The results of this project will help fill a critical data gap: the biological basis for epidemiologic findings that woodsmoke exposure can induce adverse cardiopulmonary effects. The results will provide critical support for possible future regulatory actions.

3. “The Role of Inhaled Particles in the Pathophysiology of Cardiovascular Disease,” University of California, Irvine, $446,358 Proposal No. 2557-245.

Exposure to levels of particulate matter (PM) found in California has been linked to an increased risk of heart disease. Furthermore, heart disease has been associated with oxidative stress caused by inflammation from exposure to fine and ultrafine particles. Recent epidemiological studies indicate that increases in human morbidity and mortality due to lung cancer, cardiopulmonary disease, and asthma are associated with significantly lower concentrations of fine particles (PM2.5) than those previously thought to affect human health. Ultrafine particles have a high surface area that can carry adsorbed or condensed toxic air

pollutants that have pro-inflammatory effects. Ultrafine PM can deposit effectively in the alveoli, where components can relatively easily pass into the bloodstream.

This proposal will examine the link between particle-induced inflammation and the development of atherosclerosis in normal and atherosclerosis-prone mice, using both fine and ultrafine PM exposures. It will also examine signaling pathways for oxidative stress and inflammation-associated tissue damage to determine the relative importance of these mechanisms in the development or exacerbation of heart disease. Improved understanding of the roles of these mechanisms could lead to ways to prevent or treat heart diseases caused by air pollution.

4. "Determination of the Spatial and Temporal Variability of Size-Resolved PM2.5 Composition in Multiple Regions in California," University of California, San Diego, $678,671, Proposal No. 2558-245.

Many regions in California experience excessive particulate matter levels, as defined by national and state ambient air quality standards, compromising the health of millions of people. A primary goal in helping the development of cost-effective strategies to reduce particulate exposure levels is a scientific understanding of the sources and spatial distributions of particulate matter. This project addresses both of these objectives through field studies of several regions in California that are influenced by excessive particulate levels. To help overcome many of the time- and spatial-resolution difficulties of traditional aerosol measurements, single particle mass spectrometry will be employed, specifically, aerosol time-of-flight mass spectrometry (ATOFMS). This study builds upon and utilizes ATOFMS instrumentation and expertise developed with ARB support. A single particle approach makes possible the identification of unique source marker spectral profiles and allows source apportionment of many important particulate contributors. The ultimate goal of this project is to provide a better understanding of spatial, seasonal, and temporal variability of PM in regions with excessive particulate levels in California.

5. "Particle Phase Peroxides: Concentrations, Sources, Behavior and Health Effects," University of California, Los Angeles, $109,975, Proposal No. 2559-245.

Particulate matter (PM) 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. Recent studies implicate reactive oxygen (ROS) species as the responsible species for much of this toxicity, and the dominant ROS in PM is hydrogen peroxide. Hydrogen peroxide (H_2O_2), a strong oxidizing agent, has been shown to damage lung epithelial cells at levels well below those expected for ambient samples. A recent *in vivo* study showed that hydrogen peroxide in PM produced symptoms associated with respiratory distress, while gas-phase hydrogen peroxide did not. After developing a technique

to quantify peroxide levels in aerosols, UCLA has found that ROS levels are more than 100 times the level that had been predicted. This indicates that PM may be able to continuously generate ROS in aqueous media in lung fluid. This study will determine the sources, prevalence, levels, and behavior of hydrogen peroxide in ambient air.

In this project, UCLA will measure ROS levels in PM from several sites and investigate the relationship between these toxic compounds and source type. Samples will be collected from gasoline exhaust, diesel exhaust, biogenic emissions, wood smoke and soil dust, and photochemically processed air. Size-segregated aerosols will be collected on filters and analyzed for peroxides. UCLA will also carry out laboratory studies to determine the source of peroxides in PM by manipulating ambient PM samples to determine the components that are responsible for ROS. This study will contribute substantially to the understanding of PM toxicity. If this study is successful, it should eventually help ARB to devise control strategies for PM sources that are especially effective in generating ROS and thereby harming human health.

Request for Proposals

6. "Characterization of the Off-Road Equipment Population," RFP. No. 04-315

This project should:

- identify the types of equipment used in California that are powered by internal combustion engines of less than 175 horsepower (hp),
- for those types of equipment, propose a categorization scheme (or affirm an existing scheme) that will facilitate improvement of the emission inventory and regulatory development, and
- characterize the populations in the categories and types by the sizes of engines, the business categories of the owners or users, the geographical locations of use, the seasons of use, and the applications (services) of the equipment.

The project should provide data that can be used to estimate relative numbers of equipment types in various categories, sizes, and uses. However, it is not intended to estimate total counts of equipment.

7. "Health Impacts from Indoor Particulate Matter," RFP No. 04-316.

The objective of the project is to identify and quantify the impacts on human health of PM of indoor origin.

The project goals are:

- To use laboratory approaches in which PM from indoor sources is assessed for its impacts on human or animal cellular activity and response

- To clarify the health impacts of PM from indoor sources using animal studies

The results from this project will begin to provide insight into the type and extent of impacts of indoor PM sources on health. The initial question addressed is whether impacts comparable to those from outdoor PM are seen in laboratory studies using indoor-generated PM. Ultimately, the results may identify whether new epidemiology studies are needed. They may also enable risk reduction approaches to focus more attention on sources most responsible for PM impacts.

Final Reports

8. "Verification of Ship Emission Estimates with Monitoring Measurements to Improve Inventory and Modeling," University of Delaware, $49,901, Contract No. 01-328

Marine vessels are primarily powered by diesel engines and can be a significant source of air pollution in heavily traveled ports along coastlines as well as on a global scale. However, ship emissions have not been addressed in a coherent manner in any existing inventories and methodologies used. This project was intended to reconcile apparent differences between inventories derived from literature emission factors, atmospheric measurement-based predictions, and field observations using the best-practice emission estimation methodologies for two different vessels (Sine Maersk and New Spirit) based on direct monitoring of engine stack emissions (Sine Maersk) and in-plume observations (New Spirit). The results indicate that improved emission inventories are consistent with stack monitoring results but the emission rates derived from in-plume observations result in greater differences with the published emission rates. The methodologies used in this project support the Air Resources Board's (ARB) efforts to establish accurate ship emissions inventories and improved modeling of their impacts.