State of California
AIR RESOURCES BOARD

Research Screening Committee Meeting

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

April 19, 2004
9:00 a.m.

ADVANCE AGENDA

Responses to Request for Proposals

1. "Analysis of Building Characteristics and Indoor Environmental Quality in California Classrooms," Request for Proposal 03-328.

- Westat, Rockville, Maryland, $116,780, Proposal No. 2550-239.

- Illinois Institute of Technology, Chicago, Illinois, $115,495, Proposal No. 2550-241.

The Air Resources Board (ARB) and the Department of Health Services (DHS) recently conducted a study to assess environmental health conditions in California's portable classrooms, as required by California Health and Safety Code Section 39619.6. A great deal of new data were collected for the Portable Classrooms Study (PCS). However, detailed analyses of some of these data were not funded in the initial study. The objective of this project is to further analyze variables on ventilation and other energy-related factors and examine their relationship to indoor air quality and other environmental characteristics in classrooms. In addition, the association of pollutant levels with a school's socioeconomic indicators will be examined. The ARB needs further analyses of the PCS data to help refine specific recommendations to schools and guide further activities for preventing indoor environmental quality (IEQ) problems in schools. The California Energy Commission (CEC) is interested in further analysis of the PCS data in order to obtain information needed for revising their building energy efficiency standards for schools; the CEC is providing the major funding for this effort. The results of this study will be used to improve energy efficiency and IEQ in California schools through revised building standards and improved guidance to California schools.

Sole Source Proposal

2. "Spatial and Temporal Characterization of Fine Particulate Matter Mass Concentrations in California Using Actual and Surrogate Fine Mass Measurements From 1980-2002," Envair, $34,915, Proposal No. 2550-242.

The relationship between short-term exposure to ambient air pollution and exacerbation of preexisting illness and mortality in susceptible individuals has been well established. However, understanding of the association between long-term exposure to air pollution and morbidity and mortality is less well defined. ARB is currently funding two epidemiological studies, which will investigate long-term exposure to particulate matter (PM). "Air Pollution and Cardiovascular Disease in the California Teachers' Study Cohort" is using an existing data set to study whether long-term exposure to PM (PM10 and PM2.5) air pollution or to any of several gaseous pollutants is associated with cardiovascular and cardiopulmonary disease incidence or mortality. "A Pilot Study to Quantify Health Benefits of Incremental Improvements in Air Quality" is intended to determine if it is possible to quantify measurable improvements in health that are related to declining air pollutant levels in the South Coast Air Basin (SoCAB). Investigators in both studies need a reliable long-term record of ambient fine PM mass concentrations, to be used along with data on other air pollutants and contributing factors. The purpose of this project is to develop estimates of monthly-average fine PM mass concentrations and their uncertainties in California for the period from 1988 through 2002 and in the SoCAB from 1980 through 2002. Developing a reliable historical record of fine PM mass concentrations necessitates combining data from different monitoring programs and accounting for differences in measurement methods and accuracy. This project will result in a very valuable comparison of fine PM measurements and several possible surrogates for PM2.5 measurements. The final product of this study will be of use to all health studies, which need to estimate exposure to fine PM from available historical data and will improve ARB's analysis of long-term PM2.5 concentration trends.

Final Reports

3. "Epidemiologic Investigation to Identify Chronic Effects of Ambient Pollutants in Southern California," University of Southern California, $10,025,483, Contract 94-331. Board Approval 1/26/95.

For the past decade, there has been a concern that California's ambient air quality standards do not adequately protect Californians from the impacts of long-term exposure to air pollutants. This need was addressed by an assessment of lung development in about 6000 school-age children exposed to ozone, nitrogen dioxide, particulate matter, and vapor-phase acids in southern California. Children were selected for study because they are especially vulnerable to air

pollution because their lungs are still growing and developing and their breathing rates are higher than adults. The findings demonstrated an association among nitrogen dioxide, vapor-phase acids, and particulate matter and significant chronic deficits in lung function among adolescent children. The findings also demonstrated an effect of ozone on new onset asthma. Study data showed that new cases of asthma are much more likely to occur in high ozone communities, especially among those children who exercise regularly at elevated levels. The results also showed that short-term changes in ozone were associated with a substantial increase in school absences from both upper and lower respiratory illness. Most of these associations extend to pollution levels below current ambient air quality standards and may exert significant health effects. Taken as a whole, these results should provide scientific support for aggressive and accelerated efforts to achieve clean air for our children to breathe.

4. **"Effects of Nitrogen Dioxide on Airway Inflammatory Responses in Allergic Asthmatic Subjects," University of California, San Francisco, $248,127, Contract No. 00-337. Board Approval 6/28/01.**

Epidemiological studies and data from several controlled human exposure studies suggest that exposure to ambient nitrogen dioxide (NO_2) at levels at or below both Federal and State air quality standards might be associated with worsening of asthma and enhancement of allergic inflammation in the lungs of asthmatics. Concern that the current California ambient air quality standard for NO_2 might not adequately protect the state's asthmatic population led to development of this study, which investigated whether asthmatics exposed to high ambient levels of NO_2, with and without subsequent inhaled allergen challenge, developed increased airway inflammation. The results suggest that while most of the asthmatic subjects studied did not develop enhanced airway inflammation in response to allergen challenge after exposure to NO_2 under the exposure conditions used, there was a sub-set of the group that did. In addition, under the exposure conditions used, NO_2 exposure by itself did not cause either bronchoconstriction or non-specific airway inflammation.

5. **"Mechanisms of Particulate Toxicity: Health Effects in Susceptible Humans," University of California, San Francisco, $409,937, Contract No. 99-314. Board Approval 12/10/99.**

This draft final report describes the UC San Francisco component of a multi-campus (UCSF, UCD and UCI) collaborative research effort designed to continue systematic investigation of the biological mechanisms of particulate matter (PM) toxicity. The project focused on two PM components, ammonium nitrate and carbon, substances that comprise a significant fraction of the PM in ambient air in California. This human clinical exposure study examined the effects of laboratory-generated particles (ammonium nitrate and carbon) on airway inflammation, immune cell function, and pulmonary and cardiovascular function in asthmatic adults. There were two experiments: (1) comparison of

responses to exposure to filtered air (FA), particles alone, and a mixture of particles and ozone (O_3); and (2) comparison of responses to a single day particle exposure to responses after three consecutive days of particle exposure. Pulmonary inflammation was assessed using fiberoptic bronchoscopy with bronchoalveolar lavage (BAL) and airway biopsies. The lavage fluid and biopsy tissue were analyzed for cellular and biochemical markers of airway inflammation. Symptoms and cardiopulmonary function, including spirometry and heart rate variability, were also monitored to assess exposure-mediated changes in function. The major particle-related finding of the project was the decrements in pulmonary function following both the single and consecutive day exposure protocols, which were not accompanied by physiologically significant alteration in any endpoint related to airway inflammation, or by a change in heart rate variability. In contrast, combined exposure to particles and O_3 induced both mild airway inflammation and decrements in pulmonary function, as well as a decrease in heart rate variability.

6. **"Mechanisms of Particulate Toxicity: Effects On the Respiratory System of Sensitive Animals And Asthmatic Humans," University of California, Davis, $567,529, Contract No. 99-315. Board Approval 12/10/99.**

Exposure to airborne particulate matter (PM) has been associated with several adverse health effects, including an increase in the number and severity of asthma attacks. UC Davis participated in a three-campus collaborative research effort (with UC San Francisco and UC Irvine) to investigate how PM causes adverse health effects. The three groups used similar tissue sample collection, biological assays, and exposure conditions: a laboratory-generated PM mixture of ammonium nitrate and elemental carbon. UCD studied rats that were sensitized to ovalbumin (egg white) prior to PM exposure, in order to develop an animal model that physiologically mimics asthmatic conditions found in humans. The PM exposures in these rats led to effects such as altered airway epithelial cells and increased airway inflammation. UCD also assayed cellular endpoints in human lung tissue samples obtained from asthmatics exposed to PM at UCSF. UCD found that PM exposure led to detectable changes in levels of cytokine expression, which help generate immune response. This could be a factor in how PM causes adverse health effects. This collaborative approach to animal and humans testing has helped to elucidate the impact and potential mechanisms of action of major PM components on the respiratory system.

7. **"Mechanisms of Particulate Toxicity Systemic Effects in Sensitive Animal Models and Susceptible Humans," University of California, Irvine, $231,982, Contract No. 99-316. Board Approval 12/10/99.**

In older people with pre-existing heart and/or lung disease, exposure to airborne particulate matter (PM) has been linked to premature death. UC Irvine participated in a three-campus research effort (with UC San Francisco and UC Davis) to investigate how PM causes a range of health effects. The three groups

used similar exposure conditions, tissue sample collection, and assays. UCI studied the effects of PM exposure in senescent (elderly) rats, using a laboratory-generated mixture of ammonium nitrate and elemental carbon (carbon black). UCI found that the senescent rats exhibited changes in blood pressure and heart rate variability that are consistent with an adverse effect of PM on the heart. UCI also helped install the PM atmosphere generation process at UCSF, and analyzed tissue samples collected during the human clinical exposures at UCSF. UCI found that humans and rats, exposed under similar conditions, both exhibited increased activation of macrophages. This collaborative approach to animal and human testing has helped to elucidate potential mechanisms of action of airborne PM on the cardio-respiratory system. This research may be useful in developing appropriate controls that target especially harmful PM emissions.

8. "Improvement of Emissions Inventories for Industrial Coatings and Thinning and Cleaning Solvents," MACTEC, $274,456, Contract No. 00-314. Board Approval 12/7/00.

The project was conducted to update and augment the inputs to the emission inventory calculations of ROG and TOG from (1) the application of industrial coatings, (2) the use of solvents for thinning those coatings and for cleaning of application equipment, and (3) the use of solvents for thinning and clean-up of architectural coatings. The contractor was required to conduct surveys to collect this information. The response rates to the surveys of industrial coating manufacturers and the users of the coatings were very poor. Therefore, only limited estimates for the amounts used and the compositions of those products were possible. Responses to the surveys of painters and home owners were adequate to allow all the objectives for solvents and for architectural coatings. Methods for spatial allocation and periodic updates were developed only for emissions from commercial painters. The results will be applied to improving emission inputs to photochemical modeling.

9. "Heterogeneous NOx Chemistry in Polluted Urban Atmospheres: Implications for the Formation of Particles and Ozone and Control Strategy Development," University of California, Irvine, $600,003, Contract No. 00-323. Board Approval 2/22/01.

Nitrogen oxides react in the atmosphere to form ozone, particles and other pollutants. While the gas phase chemistry of these compounds is well understood, their reactions on surfaces (i.e., particles, buildings) have not been studied to the same extent. In this research, heterogeneous reactions of the oxides of nitrogen were studied using a variety of spectroscopic methods. A major advance was the development of a new chamber that allows simultaneous measurements of gas and surface species, using long-path FTIR and attenuated total reflectance, respectively. The reactions studied included the heterogeneous hydrolysis of nitrogen dioxide (NO_2) to form nitrous acid (HONO) and surface

adsorbed nitric acid (HNO_3), the decomposition of HONO to produce nitric oxide (NO) and NO_2, the “renoxification” reaction of adsorbed HNO_3 with NO to produce NO_2, and the effects of light on the production of HONO from surface adsorbed HNO_3. A thin layer of water provided the reaction substrate and was characterized by the droplet contact angle, surface topography, and water uptake. In studies of HONO decomposition on surfaces, it was found that HONO competes with water for surface sites and that water displaces HONO that was previously adsorbed onto the walls into the gas phase. Preliminary airshed modeling indicate that the heterogeneous renoxification reaction of HNO_3 causes an increase in ozone concentrations and that the shape of the ozone isopleths (in VOC-NOx plane) may change shape compared to models without this additional chemistry. In total, the laboratory studies carried out for this project provide the most comprehensive set of kinetic and mechanistic data to date for reactions of oxides of nitrogen on surfaces. This type of information is critical in order to accurately predict the effect of NOx controls on PM and ozone levels.

10. "Development and Evaluation of a Gas-Phase Atmospheric Reaction Mechanism for Low NOx Conditions," University of California, Riverside, $79,884, Contract No. 01-305. Board Approval 9/20/01.

The gas phase chemical mechanism is a critical component in air quality simulation models used in State Implementation Plan development. SAPRC-99, developed by Dr. William Carter at the University of California, Riverside, is considered a state-of-the-science mechanism and has been extensively used in many regulatory and research applications. For example, it was recently employed to update the reactivity scales used in ARB’s aerosol coatings regulations. However, this mechanism was developed and evaluated for high NOx conditions typical of urban areas so questions have arisen as to its performance under low NOx conditions found in rural and remote areas. This project evaluated the accuracy of the SAPRC-99 chemical mechanism for prediction of photochemical smog formation under low NOx conditions. Model predictions were compared to data collected in three different environmental chambers. The results indicate that the SAPRC-99 mechanism performs well under low NOx conditions for simple chemical systems and ambient surrogate ROG-NOx experiments with high ROG/NOx ratios. However, significant problems were identified with ambient simulations at low ROG/NOx ratios and with the current aromatic mechanisms. The results of this project have improved our understanding of atmospheric chemistry in rural and remote areas, allowing more accurate air quality simulation when modeling low NOx conditions, and will thus lead to more scientifically sound control plans and strategies.

11. "Quantitative Analysis of Aerosol Time-of-Flight Mass Spectrometry Data Using YAADA," Arizona State University, $50,281, Contract No. 01-338. Board Approval 3/21/02.

Researchers are now able to measure the size and composition of single aerosol particles using instruments like the Aerosol Time-of-Flight Mass Spectrometer (ATOFMS). This instrument collects complete mass spectra for individual particles at a rate of approximately one per second. Thus very large data sets (approximately 200 MB/day) can be collected during a multi-day, multi-instrument experiment. These data sets are too large for *ad hoc* data analysis techniques. The objective of this research project was to develop and test a quantification module for the existing program, YAADA, which allows users to perform quantitative comparisons of ATOFMS and reference sampler data. This goal was accomplished by comparison of ATOFMS data and collocated impactor measurements of aerosol mass to determine particle detection efficiencies for the modified ATOFMS design used in a study in Bakersfield. It also compared ATOFMS data with collocated impactor measurements of aerosol carbon to determine chemical sensitivity of ATOFMS instruments for organic and elemental carbon. The resulting software allows for improved analysis of the ATOFMS data collected under other ARB contracts. Quantitative aerosol measurements are needed to better understand the sources, transformations, and fate of ambient particles in order to understand the effects of particulate matter on global climate, human health, and regional visibility.

12. "Detailed Characterization of Indoor and Personal Particulate Matter Concentrations," Harvard University, $599,145, Contract No. 00-302. Board Approval 12/8/00.

Previous studies of human exposure to particulate matter (PM) have shown that the relationship between ambient concentrations and human exposures is very complex. The overall objective of this study was to characterize the relationships among personal, indoor, and outdoor fine particulate (PM2.5) exposures for 17 healthy subjects living in metropolitan Los Angeles. Low-flow samplers were used to measure daily average concurrent personal, indoor, and outdoor mass concentrations of PM2.5, as well as continuous PM2.5, elemental carbon (EC), and nitrate for each subject over seven consecutive days in the Summer 2000 - Winter 2001 period. Continuous monitors were used to measure diurnal variations in size-resolved particle counts, black carbon (BC), nitrate, and home air exchange rates. Daily diaries of subject and household activities were also collected. This project was co-funded by the U.S. Environmental Protection Agency. The investigators found that indoor PM2.5 was the largest contributor to personal PM2.5 levels, accounting for 65-100% of daily personal PM2.5, on average. Significant individual and diurnal variations in all PM measurements, air exchange rates, and PM-generating activities such as cooking and cleaning were also observed.

13. "Children's Microenvironmental and Personal Pollutant Exposures for SB25 with NAPS Health Status Survey," University of California, Los Angeles, $399,464, Contract No. 00-338. Board Approval 6/28/01.

The Children's Environmental Health Protection Act (Senate Bill 25, Escutia, 1999) required the ARB to conduct enhanced neighborhood monitoring in six communities in California in order to determine if the current statewide monitoring network is adequate for estimating children's exposures to air pollutants. The primary objective of this project was to conduct indoor, outdoor, and personal monitoring at one school each in three of those communities during the 2001-2002 school year to help determine whether the current ambient monitoring system adequately reflects children's exposures to air pollutants. Investigators completed a total of 13 weeks of monitoring, distributed among the three schools. Monitoring at each school was conducted in five locations: three classrooms per school, one outdoor location at the school, and indoors at one student's residence. Monitoring included PM2.5 and PM10, elemental carbon/organic carbon (EC/OC), volatile organic compounds (VOCs), aldehydes, and carbon monoxide (CO). Personal VOC measurements were successfully obtained for 72 students. Health questionnaires were completed by 205 students to determine the incidence of asthma, hay fever, and eczema. In general, pollutant levels were higher indoors than outdoors. No clearcut trends were offered regarding personal pollutant concentrations relative to concentrations measured indoors and outdoors. For formaldehyde, concentrations were greater indoors than outdoors. The results of this study provide further information of relative indoor/outdoor relationships for selected pollutants.