

**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**

**March 24, 2006  
9:00 a.m.**

**ADVANCE AGENDA**

**Interagency Proposals**

1. "Indoor Environmental Quality and HVAC Survey of Small and Medium Size Commercial Buildings," University of California, Berkeley, \$570,000 Proposal No. 5608-251.

Small and medium commercial buildings (SMCBs), having total floor area less than 50,000 square feet, make up 96% of all commercial buildings in the United States. California's commercial building market is also likely dominated by SMCBs. Unlike larger commercial and public buildings, as well as schools, we have no significant indoor air quality (IAQ) and Heating Ventilation and Air Conditioning (HVAC) data for SMCB available to support "Title 24" California Energy Commission (CEC) building energy efficiency standards regulations. To create this database, SRC and LBNL principal investigators would begin a survey program of the SMCB sector (Phase I). The study staff would use mail and subsequent phone surveys to obtain the necessary HVAC information suggestive of IAQ data. Results from the survey program will provide some of the necessary information for CEC rule-making and for ARB in better understanding IAQ issues in the SMCB sector. The survey will also provide the templates for selection of SMCB participants in the field program (Phase II) that is in its early planning stages. The survey will also help ARB assess indoor air quality and develop health-based guidelines.

2. "Effects of Inhaled Fine Particles on Lung Growth and Lung Disease," University of California, Irvine, \$450,446, Proposal No. 2609-251.

One of the most provocative and potentially important findings from the Children's Health Study (CHS) conducted by the University of Southern California for the ARB was the significant association between reduced lung function growth and exposure to nitrogen dioxide (NO<sub>2</sub>), acid vapor, fine ambient particles and elemental carbon. The cohort of children was followed to 18 years of age, by which age most lung growth is complete. Because the pollutants in ambient air that were associated with the

development of lung function deficits were highly correlated, it was not possible to definitively attribute the health effects to one or more specific pollutants.

These findings from the CHS raise several questions. Among them, does air pollution exposure during childhood and adolescence alter lung development and how, and are any observed deficits permanent?

This proposed study will test a possible hypothesis as to how chronic PM exposures during the period of rapid lung growth could impact lung development. The primary hypothesis is that PM<sub>2.5</sub> exposure will induce oxidative stress that will lead to pulmonary function deficits in rodents exposed from birth to adulthood, and that deficits will persist with subsequent filtered air exposure. The investigators will examine potential molecular mechanisms that could explain the biological basis for PM<sub>2.5</sub> induced developmental effects on the lung, and will compare responses from two sites that have different PM<sub>2.5</sub> concentrations and speciation. These objectives will be addressed using controlled animal exposures (mice) and a mobile exposure system using the Versatile Aerosol Concentration Enrichment System (VACES) particle concentrator that was developed and tested with ARB support.

The results of the study will provide critical data on possible developmental effects of PM exposure during childhood and adolescence and on the potential for PM exposure during childhood to influence development of lung disease later in life. The project addresses a significant research gap that was identified during the recent review of the State ambient air quality standards for PM, and will support the next review of the State PM standards.

### **Contract Amendment**

3. "Measurement Allowance Project," University of California, Riverside, \$202,601, Contract No. 03-345

Verifying in-use compliance from on-road mobile sources is an important element of ensuring that in-use vehicles maintain low emissions over the duration of their useful lives. Beginning in 2007, heavy-duty engine (HDE) manufacturers must demonstrate in-use compliance of their engines by conducting a manufacturer-run in-use compliance program. However, questions have arisen regarding the accuracy and precision of the portable emissions measurement systems (PEMS) that will be used to implement this in-use compliance program. These questions resulted in the signing of a Memorandum of Agreement (MoA) among the ARB, US EPA, and heavy-duty engine companies (as represented by the Engine Manufacturers Association). This MoA specifies a "measurement allowance program" to determine what the accuracy margin should be relative to the laboratory certification test methods as specified in the Code of Federal Regulations (CFR). The redirecting of the ongoing ARB "PEMS project" will reallocate remaining funds to support this measurement allowance program. Specifically, the contractor (CE-CERT) will perform three tasks that will validate the use of PEMS during over-the-road testing BY comparing test data collected using CE-CERT's mobile

emission laboratory (MEL) and PEMS. A statistical Monte Carlo model will be used to evaluate the data and determine whether the PEMS measurement allowance, developed in the laboratory, is adequate for over-the-road testing. The results from this project will support the implementation of the in-use compliance program for HDEs.

### **Interim Report**

4. "Determination of the Spatial and Temporal Variability of Size-Resolved PM 2.5 Composition and Mixing State in Multiple Regions in California," University of California, San Diego, \$678,671, Contract No. 04-336

The primary goals of Phase I of this project were to develop a mobile laboratory and demonstrate the ability to perform source apportionment on ambient particles with ATOFMS data from this laboratory. The success or failure of this phase determines whether or not to proceed with a second phase of the project. The work performed, as outlined in the Phase I Report, meets or exceeds all tasks posed in the work plan. In particular, a mobile laboratory was constructed using an ARB trailer. Sampling ports, electrical conduit, instrument racks and an extensive set of gas and particle phase instruments were installed in the trailer. Portable power generators were purchased and evaluated. These studies show that the exhaust particles are below the cutoff of the ATOFMSs and both characterize influence of NO<sub>x</sub> and CO emissions on gas phase measurements and prescribe methods to minimize these impacts. Two field sampling campaigns were conducted in Riverside as part of a larger Study of Organic Aerosols at Riverside ([SOAR](#)). This work went far beyond the initial task in the proposal and gave highly time resolved source apportionment estimates for particles over two seasons. Further work also demonstrated the ability to scale ATOFMS data to mass measurements using traditional instruments (BAM, TEOM). In summary, all tasks for Phase I were successfully completed and many additional studies were carried out.

### **Final Reports**

5. Phase 1 of "Evaluation of the Heavy-Duty Diesel Engine Not-to-Exceed Regulation," University of California, Riverside, \$400,000, Contract No. 03-345

In-use emissions measurements from mobile sources are needed for both in-use compliance, as well as emissions inventory development purposes, and portable emissions measurement systems (PEMS) offer a means of satisfying this need. The objective of this project was to perform an evaluation of commercially available PEMS that could be used to measure pollutant emissions from in-use diesel engines. A total of eight PEMS were evaluated, two capable of measuring only gaseous emissions, four capable of measuring only PM emissions, and two systems measuring gaseous and PM emissions. These PEMS use a variety of measurement principles and techniques to quantify pollutant emissions. Results were mixed among the various PEMS, and varied by pollutant. For certain PEMS, NO<sub>x</sub> and CO<sub>2</sub> emissions correlated well against the federal reference methods, while THC, CO, and PM emissions, in general, did not correlate as well. The results from this project will aid ARB in addressing programmatic

needs in the areas of in-use compliance, emissions inventory development, and mobile source emissions monitoring.

6. "Indoor Air Chemistry: Cleaning Agents, Ozone and Toxic Air Contaminants," University of California, Berkeley, \$446,865, Contract No. 01-336

The indoor use of certain common cleaning products and air fresheners can cause an increase in indoor concentrations of gaseous and particulate pollutants. When used in occupied spaces, inhalation exposure will result and may lead to adverse health effects. Directly emitted Toxic Air Contaminants (TACs) such as ethylene-based glycol ethers, and non-toxic constituents such as terpenes that can react with ozone to form secondary pollutants, are of particular concern. Objectives of this project were to: 1) identify and quantify primary emissions of TACs from cleaning products, and 2) identify and quantify reaction products when cleaning agents and air fresheners with reactive compounds are exposed to ozone. Product emissions and reactive chemistry were characterized in both a small chamber and a room-sized chamber during simulated cleaning in the presence of ozone. Results indicate that six of 21 products tested contained glycol ethers, with levels ranging from 0.8% to 9.6% by weight. Twelve of the products contained ozone-reactive compounds at levels ranging from 0.2% to 26% by weight. When cleaning products were used in the presence of ozone, investigators observed a high degree of reactive chemistry. Measured products from the terpene-ozone reaction include formaldehyde, ultrafine particulate matter, and hydroxyl radicals. Levels of formaldehyde and secondary organic aerosols were significant when compared to health-based guidelines. An individual's proximity to these pollutants and 2-butoxyethanol in some cleaning scenarios may lead to exposures that warrant consideration for limitations.

7. "Study of Ventilation Practices and Household Characteristics in New California Homes," University of California, Berkeley, \$445,864, Contract No. 03-326

The primary goal of this study was to obtain information on building ventilation practices and satisfaction with indoor air quality (IAQ) among occupants of new single-family homes in California through a mail survey. Investigators conducted a mail survey of a large, stratified-random sample of owner-occupants of new California homes to obtain information pertinent to ventilation practices and IAQ and thermal comfort. The results indicated that occupant opening of windows varies widely, and that occupants in most homes do not open their windows enough to assure adequate outdoor air exchange. Most homes were estimated to have less than the outdoor air exchange rates assumed in state building standards, especially in the winter. The Air Resources Board (ARB) is using the results of this study to design and refine a follow-on field study of ventilation characteristics and exposures to Toxic Air Contaminants in new homes. The California Energy Commission (Commission) will use the study results to assess the impact of current energy efficiency standards on IAQ and comfort and help determine the need for mechanical ventilation systems in new homes.

8. "Responses to Short-term Fluctuations in Particulate Air Pollution in Asthmatic Children: Implications for Asthma Natural History," University of California, Berkeley, \$4,382,926, Contract No. 99-322

The Fresno Asthmatic Children's Environment Study (FACES) was the first project funded through the Vulnerable Populations Research Program, which is designed to study California residents who may be more sensitive to the health impacts of air pollution. FACES was designed to examine the acute and chronic health effects of particulate air pollution, in combination with other ambient air pollutants and bioaerosols, on the natural history of asthma in young children residing in the Fresno County region of California. Both a high prevalence of asthma among an ethnically diverse population and high levels of ambient air pollution, especially PM, have been noted in the Fresno County region. This project was composed of two fully integrated components: an epidemiological health component and an exposure assessment component. The objective of the health component was to collect detailed descriptive data on the subjects, including but not limited to reports of symptoms, daily measures of lung function, and use of asthma medication. The objective of the exposure assessment was to collect detailed air pollution data at centrally located ambient monitors, mobile trailers placed in schools, and in the homes of selected participants to accurately characterize exposure to air pollution. The combination of these data were designed to allow investigators to assess how repeated day-to-day responses to air pollution affect long-term respiratory health and disease in an asthmatic cohort of children living in a high PM region.

The overall study was designed as a 66-month project; however, ARB funded the project in two phases, with funding for the second phase contingent on satisfactory progress during the first phase. The investigators have applied to the National Heart Lung Blood Institute of the NIH for future funding to continue their collection and analysis of FACES health and exposure data. The NHLBI would extend the project through the year 2010. The investigators have received high scores on their application and are confident that they will receive funding. Finally, an augmentation (\$350,000) was approved by the Board in July 2005 to bridge the six month gap in funding between the end of ARB funding and the beginning of NHLBI funding and keep the research team intact. Some additional new analyses would be conducted under the augmentation contract as well.

This report documents the characteristics of the cohort recruited for the project and health outcome measurements. It also documents the ambient pollutant and bioaerosol concentration measurements.

9. "Development and Application of Ambient Aerosol Concentrators to Conduct Health Effects Studies in the Los Angeles Basin," University of California, Los Angeles, \$2,296,598, Contract No. 98-316

Research on the health effects of particulate matter (PM) has been difficult to conduct because of the limited amounts of PM in ambient air that can be delivered to test

animals and people. Therefore, the ARB funded an initial study to develop, construct, and validate transportable inhalation exposure systems that provide concentrated coarse, fine, and ultrafine ambient PM for health studies. The resulting system (Versatile Aerosol Concentration Enrichment System, or VACES) was configured to collect sufficient quantities of size-selected PM for toxicology experiments and for compositional analysis. The University of Southern California (USC) performed most of this work under sub-contract to UCLA. The initial study was extended to use VACES to study rodents exposed at several locations in the South Coast Air Basin (e.g., near freeways), to study humans in clinical settings, and to characterize the chemical, physical, and toxicological properties of ambient PM. The University of California, Irvine (UCI) performed animal work under sub-contract to UCLA. The US EPA contributed additional funds to the Southern California Particle Center and Supersite (which includes UCLA, USC, and UCI) for additional health studies using VACES. Information has been obtained regarding the properties of PM that are especially responsible for their toxic impact. Ultimately, it may be possible for the ARB to develop regulations that target control of the most dangerous PM components, while allowing less stringent control for more innocuous PM components.

10. "A Post Regulatory Evaluation of the Cost and Economic Impact Estimates of Air Pollution Control Regulations," University of California, Riverside, \$149,997, Contract No. 01-335

California law requires the Air Resources Board (ARB) and air quality districts to assess the cost and economic impacts of their regulations on affected businesses and individuals when proposing to adopt or amend any administrative regulation. These estimates tend to differ from those generated by the stakeholders. There is anecdotal evidence that the costs of proposed air pollution regulations are often overestimated or underestimated. This study looked at ten ARB and South Coast Air Quality Management District (SCAQMD) regulations adopted and implemented in the years 1985 through 1998.

The contractor looked at ten regulations. There was data available from both the agencies and stakeholders for an analysis of only eight regulations for the ex ante cost and six regulations for both the ex ante and ex post costs. Of the six, the actual capital cost data were available for only five. For the five regulations where the capital cost data were available, a comparison was made between the estimated and actual capital costs of the regulations. In all these cases the estimated capital costs were similar to the actual capital costs.

A similar comparison was made on the basis of cost per ton reduced for the six regulations. The study indicated that the stakeholders estimated costs and economic impacts are higher than those of the agencies. The agency cost estimates were overestimated somewhat for three cases, similar to the actual costs in two cases, and underestimated for one case. There was also some ex post cost data collected for a 7<sup>th</sup> regulation, but the data was insufficient to conduct a meaningful comparative analysis.

Finally, the contractor provides several recommendations for improving the approach and the process of collection of the actual cost data. The insights gained from this study will help the agencies improve the cost estimates of their proposed regulations.

### **Other Business**

#### 11. "Impact of Reactive Halogen Species on the Air Quality in California Coastal Areas"

The scope of work for this project is being revised to add collection of canisters samples of VOC/halogen reaction products at 2 inland sites during the sampling period. This will provide information about the evolution of halogen reaction products as the airmass moves inland. The total cost of approximately \$35,000 will be split by ARB and CRC.

#### 12. Review of 2006/07 Research Plan Submissions