State of California
AIR RESOURCES BOARD

Research Screening Committee Meeting
Cal/EPA Headquarters Building
1001 I Street
Conference Room 540
Sacramento, California 95814
(916) 445-0753

February 28, 2005
9:00 a.m.

ADVANCE AGENDA

Responses to Requests for Proposals

1. "Ventilation and Indoor Air Quality in New Homes," RFP No 04-310
   a) ADM Associates, Inc., $1,099,543.89, Proposal No. 2577-547
   b) Air Quality Sciences-Building Consulting, Inc., $1,196,615, Proposal No. 2576-247
   c) Indoor Environmental Engineering, $1,042,935, Proposal No. 2575-247
   d) Westat, $1,158,409, Proposal No. 2578-247

Concerns have been raised regarding whether households in new California homes use windows, doors, exhaust fans, and other mechanical ventilation devices enough to remove indoor air pollutants and excess moisture. The proposed field study will obtain information on ventilation characteristics and indoor air quality (IAQ) in new, single-family detached homes in at least two seasons and two regions of California. The relationship between ventilation characteristics and IAQ will be analyzed to examine the adequacy of ventilation in new homes. The California Energy Commission (Commission) will use this information to revise their energy efficiency design standards for new single-family homes. The ARB will use the information to update and improve its indoor exposure estimates to toxic air contaminants and other indoor air pollutants, and to develop recommendations for improving IAQ in new homes. The Commission is funding this project.

Interagency Proposals

2. "Development and Demonstration of an Aerosol Tracer Technique Based on Neutron Activation Analysis for Studying Cyclical Deposition and Resuspension of Aerosol-Associated Toxic Contaminants," University of California, Los Angeles, $87,704, Proposal No. 2579-247.

Many contaminants found in aerosols have adverse effects on human health through inhalation, and, when deposited, on the health of aquatic and terrestrial ecosystems. Large primary particles emitted as fugitive material from roads, industrial facilities, etc. have large settling velocities and thus do not travel far from the point of emission, however chemicals associated with such sources are widely distributed in surficial dust in urban environments. Little is known about the transport processes that move these materials, but it is suspected that cyclic resuspension and transport can spread pollutants across the urban landscape. The objective of this research is to test tracer-based field methods to quantify large particle transport by cyclic suspension, deposition, and resuspension. The expected results consist of both a quantitative evaluation of the capabilities of the methods and preliminary data on the rates of particle movement by cyclic entrainment. Successful completion of this research will enable ARB to better understand the spread of toxic materials at facility and neighborhood scales and will facilitate improved regulation of fugitive materials.

3. "Changes in 'Background' Ozone from Very Long Range Transport and Stratospheric Ozone," University of California, San Diego, $410,231, Proposal No. 2580-247

Absent anthropogenic sources, ambient ozone concentrations in California would not be zero. Controls on California emissions are unable to improve air quality to a level below that of the global background. Background ozone in California is believed to be a combination of locally produced natural ozone due to natural precursor emissions, stratospheric down-mixing, and intercontinental transport of anthropogenic ozone from Asia. As California moves toward attainment of ozone standards it will become increasingly important to understand the contributions of these background ozone sources to ambient ozone concentrations. The focus of this project is to establish the frequency, amount, and uncertainty of exogenous ozone currently affecting California.

4. "Assessment of the Health Impacts of Particulate Matter from Indoor Sources," University of California Davis, $399,555, Proposal No.2581-247

Exposure to ambient particulate matter (PM) in California contributes to thousands of premature deaths and serious adverse health impacts such as cardiovascular and respiratory diseases. Indoor sources can result in elevated indoor PM concentrations, and several toxic components have been detected in PM from indoor sources. The proportion of PM exposure due to indoor sources

would be even greater for infants and the elderly, who spend more time indoors. Also, people tend to be near indoor sources such as cooking stoves and wood stoves, which tends to increase the resulting exposure. Consequently, PM of indoor origin may have a significant health impact. Therefore, the ARB is interested in investigating the potential health impacts of PM from key indoor sources to determine whether reductions in indoor PM emissions are needed to more effectively reduce PM exposure and risk.

The objective of this study is to determine the potential impact of PM of indoor origin on human health, using chemical and biological assays. This study should enable the ARB to understand the relative toxicity of major indoor PM sources. It should also provide insight into the types of chemicals responsible for their toxicity.

5. "The Collection and Development of Exhaust Speciation Profiles from Modern Commercial Jet Aircraft Engines," University of Missouri, $259,966.12, Proposal No. 2565-246.

Airport traffic is expanding, yet accurate, up-to-date information on the exhaust speciation profiles of both total organic gases (TOG) and particulate matter (PM) from modern commercial jet aircraft using current fuels is scarce. The lack of such chemical source profiles makes it almost impossible to produce accurate statewide inventories and Environmental Impact Report (EIR) efforts in regions heavily affected by commercial jet aircraft. The objective of this project is to develop TOG and PM speciation profiles for engines used in newer Boeing 737-type commercial aircraft burning Jet A/A-1 turbine fuel using the latest analytical equipment. This will be accomplished by collecting exhaust samples at the exhaust exit plane of an engine run over a modified US EPA Landing and Take-Off (LTO) cycle on a parked aircraft. The samples will be analyzed to determine PM and gaseous chemical composition and PM particle size and number information. Successful completion of this project will facilitate informed decision-making and accurate modeling of commercial jet engine exhaust emissions for inventories and ozone estimation as well as detailed chemical speciation/source apportionment to assist in health risk assessments during the EIR process for airport expansion projects.

6. "Dairy Operations: An Evaluation and Comparison of Baseline and Potential Mitigation Practices for Emissions Reduction in the San Joaquin Valley," California State University, Fresno, $249,980, Proposal No. 2582-247

Dairies are a significant source of Reactive Organic Gas (ROG) and ammonia emissions in the San Joaquin Valley. Due to the lack of experimental data, accurate quantification of these emissions has been, at best, difficult. Also, there is currently very little scientific information available to determine the most effective and feasible methods to reduce emissions from dairies. This project is designed to improve the state of the knowledge. It will yield data needed to

improve current estimates of baseline emission rates and to estimate the emission reductions that are achievable with available control technologies such as covered lagoons and digesters. The proposed approach includes conducting field monitoring at five to eight California dairies to measure atmospheric levels of the pollutants of interest. The data from the field monitoring will then be used with dispersion modeling to estimate emission rates. The tested dairies will include three to five dairies using different types of emission mitigation strategies and two to four dairies using no emission mitigation strategies. The data collected at these dairies will allow the ARB staff to improve current emission estimates from diaries and the potential emission reductions that can be achieved by existing mitigation techniques. This information is needed to support the State Implementation Plan (SIP) and will be useful in assessing the need and feasibility of future regulatory strategies for dairies. Furthermore, the results of this project will add to the existing database from research sponsored by the dairy industry.

Contract Augmentation/Interim Report

7. "Hourly, In-Situ Quantification of Organic Aerosol Marker Compounds," University of California, Berkeley, $269,330, Contract No. 03-324 (Augment by $100,000)

Regulatory efforts to attain fine particulate matter (PM2.5) standards require improvements in our knowledge of the factors controlling the concentration, size and chemical composition of PM2.5. While many advances have been made in measuring and modeling the inorganic ionic species that are found in PM2.5, much less is known about the organic fraction. Yet organic matter is a major constituent of airborne particles, comprising 20-40% of the PM2.5 mass in many regions. Quantitative knowledge of the composition of PM2.5 organic matter is key to tracing its sources and understanding its formation and transformation processes. The objective of this work is to identify the origins of PM2.5 organic matter within a region in California that is currently out of compliance with PM air quality standards.

This research project has two phases. The objective of Phase I, the subject of this interim report, was to demonstrate the ability of the UCB instrument to measure atmospheric PM2.5 samples with separation and identification of organic compounds at the molecular level. For Phase I, UCB was contracted (less than $10,000) to prepare a brief written report providing evidence that the new instrumentation is ready for field measurements in California. Phase II will commence after the RSC concurs with the feasibility of field measurements with this instrument and gives approval for continuation of project funding. The Phase I interim report indicates that the new in-situ thermal desorption aerosol GC/MS-FID sampling approach can provide time-resolution not possible through filter sampling, while avoiding many of the well-documented artifact complications associated with filter collection and sample storage and transport. The

continuation of this research will provide useful new data of immediate value for air quality attainment strategies for the Central Valley and the development of the State Implementation Plan for PM.

Final Reports

8. Deployment and Operation of the Scanning Mobility Particle Sizers (SMPS) and Low Temperature Tapered Element Oscillating Microbalance (TEOM) in the Children Health Study Communities," University of Southern California, $74,679, Contract No. 01-300

Results from the Southern California Children's Health Study (CHS) suggest that exposure to increased particle levels leads to retarded lung function growth and other adverse health consequences in children. In 2001 the ARB established the world's most extensive network of ultrafine particle monitoring as part of the CHS. The particle count monitors deployed provide data on the total number of ultrafine particles. In this project scanning mobility particle sizers (SMPSs) were deployed to measure ultrafine particle size distributions at the twelve CHS sites and at the Los Angeles Supersite Portable Instrumentation Unit at the University of Southern California. The addition of size distribution data to the total particle count data provides information about the sources and behavior of these important particles. Two SMPS systems were available and were circulated through the CHS monitoring stations with an effort made to capture summer and winter data at each site. The results indicate great spatial heterogeneity of ultrafine particles and temporal heterogeneity on diurnal and seasonal time scales. The results also indicate correlation with co-pollutants in limited conditions only. This was unexpected, stronger correlations with co-pollutants were expected at the time the proposal was written.

The second part of the project made use of tapered element oscillating microbalance (TEOM) samplers designed to operate at near ambient temperature. The standard PM10 measurement devices used by the CHS (standard TEOMs operating in the EPA equivalent method configuration) are known to under-report particle mass. The EPA equivalent method for TEOMs specifies that they operate at 50 degrees Centigrade to minimize the contribution of water vapor to particle mass measurements, however, this elevated temperature can cause the loss of volatile components of the particulate matter. The data is then corrected using a factor calculated from collocated hivol measurements of PM10 or hivol measurements from the nearest similar site. The data from the new TEOMs will be used by the CHS investigators to recalculate their correction factors for data from the existing TEOMs.

9. "Global Radiative Effect of Particulate Black Carbon," California Institute of Technology, $164,592, Contract No. 02-322

Assembly Bill 1493 requires the Air Resources Board to develop and adopt regulations that achieve the maximum feasible reduction of greenhouse gases emitted by passenger vehicles and light-duty trucks and other noncommercial vehicles. While carbon dioxide (CO_2) is the predominant greenhouse gas, black carbon (BC) particles also exert a climatic warming influence. To evaluate potential measures to abate the effect of California emissions of greenhouse gases and particulate matter on climate, it is necessary to determine the current magnitude of the BC effect relative to other impacts. The primary objective of this research project was to obtain an estimate of the climatic effect of black carbon emissions from the State of California. Given such an estimate, one can then proceed to compare the relative climatic effects of CO_2 and BC emitted in California. This research project provides information needed when considering CO_2 and BC abatement policies to reduce climate effects.

The present report focuses on global climatic effects of BC, and, based on an estimate of the percentage of global BC emissions attributable to California, extrapolates that effect to California emissions alone. Since BC particulate matter tends to mix with other particulate material in the atmosphere, the radiative effect of BC was considered in conjunction with that of other aerosol species, namely, sulfate, nitrate, ammonium, and primary organic aerosol. Direct radiative forcings of anthropogenic BC, primary organic aerosols, sulfate, nitrate, and ammonium and indirect forcing of anthropogenic sulfate aerosol at the top of the atmosphere and at the surface were estimated using the Goddard Institute for Space Studies General Circulation Model II-Prime for the years 2000, 2025, 2050, 2075, and 2100. The results indicate that as sulfur dioxide emissions slowly decline, anthropogenic BC is predicted to become an increasingly important contributor to total direct radiative forcing over the next one hundred years, if BC emissions are not curtailed.

10. “Alternatives to Automotive Consumer Products that Use Volatile Organic Compounds (VOC) and/or Chlorinated Organic Compound Solvents", Institute for Research and Technical Assistance, $189,966, Contract No. 01-317

Volatile Organic Compound (VOC) emissions from the use of aerosol automotive parts cleaners purchased by consumers are a significant contribution to total statewide VOC emissions. The ARB has adopted regulations that limit the VOC content of these cleaners, and substantial emissions reductions have been achieved. However, additional reductions from the use of automotive parts cleaners by consumers are necessary. These reductions will be achieved through the use of cleaners with lower, or near-zero-percent VOC content. Water-based cleaners are emerging as one of the alternatives to solvent-based cleaners for automotive parts cleaning products. There are currently few aerosol, water-based automotive parts cleaners on the market that are available to

consumers. More field testing of water-based cleaners is needed to fully demonstrate their technological feasibility before further regulatory development to reduce emissions. The purpose of this project was to perform the testing necessary to demonstrate the emissions reduction potential of near-zero VOC content aerosol automotive parts cleaners.

To assist the principal investigator in the project, a Technical Review Committee (TRC) was formed consisting of representatives of the aerosol cleaner industry, water-based cleaner industry, and government regulatory agencies. The committee reviewed the principal investigators' work at various junctures and provided input on the project direction.

The first step in the process was to identify existing, commercial water-based cleaners. These cleaners were then tested in both aerosol (if available) and non-aerosol form to evaluate their cleaning capability on automotive parts in a laboratory setting. These initial tests served as screening tests to identify the best-performing existing water-based cleaners. The cleaners that performed best in these preliminary screening tests were then tested again. However, in the second round of screening tests, all of the water-based cleaners were packaged in aerosol containers. The aerosolized cleaners were tested in the laboratory on automotive parts following the protocols of the prior screening tests with one addition. In the second round of screening tests, the cleaning ability of the aerosolized water-based cleaners was compared to the performance of common solvent-based cleaners. For these tests, small quantities of the aerosolized cleaners were given to automotive repair facilities for use by personnel performing automotive repairs who could test the cleaning capability of the cleaners during actual repair work.

Cleaners that performed well relative to their solvent-based counterparts in the screening tests were then tested in aerosol form in a more extensive field test program at automotive repair facilities. In the field tests, the cleaning performance of the water-based cleaners was evaluated relative to the solvent-based cleaners that were usually used at the automotive repair facilities. The potential for using alternative propellants was also evaluated. Finally, the cost and toxicity of the near-zero cleaners was evaluated.

From the field testing of the cleaners at the automotive repair facilities, eight water-based cleaners were identified that performed well in engine degreasing applications. The VOC contents of these cleaners were approximately 10 percent. For carburetor and fuel injection system cleaning applications, the Institute for Research and Technical Assistance (IRTA) developed two non water-based cleaners with near-zero VOC content. This was necessary due to the potential problems of introducing water into the automotive fuel system. These cleaners were three blends of soy methyl esters (soy) and acetone. Acetone is an "exempt" VOC due to its low photochemical reactivity, while soy is exempt due to its high boiling point. Three water-based cleaners and two

soy/acetone blends were found to perform well for brake cleaning and general purpose degreasing. The VOC content of these products ranged from zero percent to 10 percent. Carbon dioxide was found to perform well as a propellant when used with soy/acetone, but further research would be needed to determine if problems related to rust don't arise when it is used in water-based products. The raw material costs for the near-zero VOC content cleaners were found to be somewhat higher than for the solvent-based cleaners. The toxicity for the near-zero VOC cleaners was found to be lower than existing organic solvent-based products.

The program demonstrated the technological feasibility of water-based aerosol automotive parts cleaners as well as the feasibility of using exempt solvents for the same purpose. The use of these cleaners has potential for achieving additional VOC emissions reductions from the category of automotive parts cleaners.

11. "Evaluation of Atmospheric Impacts of Selected Coatings VOC Emissions", University of California, Riverside, $300,086, Contract No. 00-333

Because emissions from architectural coatings are an important component of the stationary source volatile organic compounds' (VOC) inventory, the California Air Resources Board (ARB) approved a mass-based Suggested Control Measure for VOCs in architectural coatings in June 2000. In the meantime, staff was also directed to evaluate the feasibility of reactivity-based regulations for architectural coatings as an alternative to mass-based regulations for added cost-effectiveness and flexibility. However, there are several issues regarding the feasibility of reactivity-based regulations, including the uncertainties associated with the reactivity of VOCs in architectural coatings. This project was intended to reduce uncertainties in ozone reactivity estimates for selected major types of coatings VOCs. Environmental chamber experiments were carried out at atmospherically representative conditions to evaluate the abilities of mechanisms of these selected VOCs to predict their atmospheric ozone impacts. It is concluded that the current SAPRC-99 mechanism simulates the results of the experiments with Texanol® and the primarily alkane petroleum distillate solvents reasonable well but the model did not correctly predict the effect of ozone formation and other aspects for aromatic 100 and synthetic isoparaffinic alkanes (ASTM-3C1). In addition, bin assignment analysis of compositional data from different solvents and further development of a direct reactivity measurement method were conducted. As a result of this project, updated reactivity estimates were derived for these selected coating VOCs and their associated uncertainties were reduced. We believe that the outcome of this project has significantly helped improve our understanding of reactivity uncertainties associated with architectural coatings VOCs, which is critical regarding the feasibility of a reactivity-based control strategy for architectural coatings.

12. “Source Characterization and Source Apportionment Studies Using Aerosol Time-of-Flight Mass Spectrometry,” University of California, San Diego, $333,790, Contract No. 00-331

This research characterized particles from mobile sources as a function of different driving conditions and performed the first single-particle apportionment of ambient particles to gasoline and diesel vehicle sources. In these studies, single particle mass spectrometry, specifically aerosol time-of-flight mass spectrometery or ATOFMS, was used to continuously measure both aerodynamic sizes and the chemical compositions of single particles. Source studies of gasoline and diesel powered vehicles were conducted using chassis dynamometers and driving cycles that reflect different real-world driving conditions. In total 13 heavy-heavy duty diesel and 28 light-duty gasoline vehicles were tested, which were representative of typical on-road vehicles. Evaluation of the applicability of source profiles that were developed from these tests was performed for two ambient studies, inside a tunnel and near a roadway. Both of these comparisons gave high match rates with the new source profiles and provided support for direct classification of particles (with a neural net, ART-2a) near sources. Apportionment of particles was carried out for the near-roadway study. This work demonstrates the usefulness of single particle techniques in ambient apportionment studies and contributes towards its use in more complicated environments that contain many sources and aged particles.

13. ”Keeping Tahoe Blue through Identifying Nitrogen Transport to Lake Tahoe: Additional Ambient Air Nitrogen Species Measurements University of California, Berkeley, $175,036, Contract No. 01-327

To protect Lake Tahoe’s clarity, the Tahoe Regional Planning Agency (TRPA) has determined that it is necessary to understand and reduce enrichment of nutrients including nitrogen and phosphorous to the lake. In developing a Total Maximum Daily Loading (TMDL) profile for establishing a new water quality standard at Tahoe, the regional water quality agency, Lahontan, has also made a similar determination. Through dry and wet deposition, atmospheric nitrogen oxides including NO_X, nitric acid and organic nitrates may contribute to increases in the nitrogen available as a nutrient in the Lake. Nutrient loading is believed responsible for loss of Lake clarity. Sources of atmospheric nitrogen oxides may include emissions from combustion, bacterial modification of fertilizers and natural bacterial emissions from the Sacramento Valley and the Bay Area that are transported to the Tahoe Basin, and direct emissions within the Basin from vehicles and home wood burning as well as natural sources.

As part of the Lake Tahoe Atmospheric Deposition Study (LTADS 2003) and to understand the contribution of regional atmospheric sources to enrichment of nitrogen in the Lake, UC Berkeley (UCB) measured ambient concentrations of nitric acid, nitrogen dioxide, and two separate classes of organic nitrates: total peroxy nitrates (such as PAN), and total organic nitrates at Lake Tahoe using a

state-of-the-art thermal dissociation laser -induced fluorescence (LIF) instrument. These measurements were co-located with ARB measurements of meteorology, O_3, and total nitrogen species (NO_Y) at the Big Hill site.

Studying winter conditions at Big Hill, UCB investigators concluded that total reactive nitrogen concentrations are generally low, net flow at the surface is downhill, and the urban plume rarely reaches the western rim of Tahoe Basin. Individual small scale burn events along the western slope may generate nitric acid concentrations that can reach the Tahoe Basin, but such burn events are rare and too dispersed over time and space to contribute a substantial part of the Tahoe Basin atmospheric loading. Combining analyses at Big Hill, with simulations of data collected at Granite Bay, Blodgett Forest, and Big Hill on a direct line of air parcel transport from the Sacramento valley to the Tahoe Basin, UCB investigators concluded that Sacramento was the dominant source of reactive nitrogen in the region. However, the plume rarely reached Tahoe. Deposition was also fast enough that by the time the plume approached western edges of the Tahoe Basin, very little nitric acid remained within it. Moreover, Big Hill nitric acid data show effects of air masses that arrived from urban areas other than those to the west of the Tahoe Basin. Finally, organic nitrate concentrations are relatively high within the Sacramento plume but their contribution to nitrogen deposition is currently poorly understood. UCB and ARB analyses suggest that air parcel transport does not significantly contribute to reactive nitrogen and nitric acid concentrations at the Tahoe Basin.