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

January 11, 2008
9:00 a.m.

ADVANCE AGENDA

Responses to Requests for Proposals

1. "Developing a California Inventory for Ozone Depleting Substances and Hydrofluorocarbon Banks and Emissions from Foams," RFP No. 07-312

    a. Caleb Management Services, Ltd.
    $349,758, Proposal No. 2656-259

    b. ICF Consulting Services, LLC
    $348,877, Proposal No. 2655-259

With the passage of the California Global Warming Solutions Act of 2006 (AB 32), the California Air Resources Board (ARB) is charged with developing and implementing mitigation strategies to enable the State of California to reach its goal of carbon dioxide-equivalent (CO_2E) greenhouse gas (GHG) emission reductions to 1990 levels by 2020. As a starting point, the Climate Action Team report, which was developed by several agencies through a stakeholder process, identified a suite of strategies for reducing the six Kyoto pollutants (i.e., CO_2, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons, and sulfur hexafluoride). Other efforts, including the development of early actions under AB 32, have revealed additional opportunities to reduce emissions of GHGs, and it has become apparent to ARB staff that significant high-global warming potential (GWP) GHG emissions reductions are possible, particularly if ozone depleting substances are considered.

The purpose of the proposed research is to generate a California-specific, bottom-up, high-GWP foam blowing agent inventory through the quantification of emissions rates (during production and use), application growth rates, chemical substitution rates, banks, and end-of-life disposal emissions (if applicable) for each high-GWP blowing agent in each selected application.

The results of this study will ultimately help ARB refine CO_2E GHG emissions control strategies currently being developed, in terms of costs/benefits. The study will also help

to identify as well as prioritize new mitigation opportunities, so that those presenting the greatest benefits receive the most attention. Such strategies would not only reduce GHG emissions but in some cases would provide co-benefits by mitigating emissions of substances that cause stratospheric ozone depletion.

Lastly, the results of this study will provide the basis for the materials flow portion of the end-of-life (EOL) lifecycle analysis model, to be developed in the near future. The quantities as well as the spatial and age distributions of foams in California will be a critical input to determine the most cost-effective way to deal with these materials at EOL.

2. "The California Climate Change Industry: the Current Market and Prospect for Growth in the Global Economy," RFP No. 07-315

    a. Environmental Business International, Inc.
    $196,211, Proposal No. 2646-258

    b. TIAX, LLC
    $189,973, Proposal No. 2647-258

AB 32 requires ARB to adopt regulations to reduce greenhouse gas emissions while considering benefits to the California economy. Climate change regulations may impose costs on businesses. However, they are likely to provide significant economic opportunities. Business complaints of regulatory costs, if unchallenged, could hamper our efforts to reduce greenhouse gas emissions.

Aware of changing public attitudes, a growing number of businesses have begun to invest in the emerging climate change industry. The current and future regulations would further stimulate demand in the industry. The expected expansion of the industry will increase jobs, profits and exports. This study will evaluate these benefits and identify market drivers that can enhance them. It will also assess improvements in business and energy indicators.

The results of this study will provide the Board with data on the positive impacts of climate change regulations that could be used along with the regulatory costs in evaluating how climate change regulations may affect the California economy.

Interagency Proposals

3. "Expansion of the NYSERDA Evaluation of On-Board Real-Time Particulate Emissions Measurement Technologies Program," Southern Research Institute, $102,722, Proposal No. 2650-259

Over the past decade a number of instruments have been developed that are capable of quantifying particulate matter emissions in real-time (i.e., on a second-by-second basis). These instruments, by virtue of their fast response times and increased sensitivity compared to traditional filter-based methods, offer the potential to provide

superior performance compared to filter-based methods. However, these real-time instruments often use different operating principles and this tends to produce different results. It has been a number of years since an instrument evaluation was performed, and the state of the art has been advancing since then. Hence, it is necessary to evaluate current instruments to gauge their performance against the filter-based reference method. This proposal will expand a large study funded by the New York State Energy Research and Development Authority (NYSERDA) to include additional vehicles and fuels. The results from this project will aid ARB staff in determining which instruments are appropriate for specific tasks (e.g., inspection and maintenance, or emissions monitoring, etc.).

4. "Source Apportionment of Carbonaceous Aerosols Using Integrated Multi-Variant and Source Tracer Techniques and a Unique Molecular Marker Data Set," University of Wisconsin, Madison, $409,962.71, Proposal No. 2651-259

Organic carbon and elemental carbon (OCEC) are important contributors to fine particle concentrations throughout the State of California. There is a great need to apply tools that can provide a more definitive understanding of the impact of gasoline-powered vehicles, diesel engines, biogenic-derived secondary organic aerosol and anthropogenic-derived secondary organic aerosol in California to develop effective particulate matter control strategies and to support health and climate-forcing studies. Of equal significance is the need to develop a platform that can be used to compare different source apportionment tools and to provide a framework for assessing the accuracy and stability of such source apportionment tools.

The proposed project can be divided into two major thrusts: measurements and data analysis. The measurement thrust of the project would be to generate a year long time series of hourly PM2.5 OCEC measurements, daily PM2.5 molecular marker measurements, and daily bulk PM2.5 measurements of water soluble organic carbon, water soluble potassium and ultrafine particle number. The data analysis thrust of the project involves the applications of parallel source apportionment methods including molecular marker chemical mass balance modeling, molecular marker positive matrix factorization modeling, molecular marker iterative confirmatory factor analysis modeling, as well as statistical analysis to identify trends in day-of-the-week, time-of-day, and plume analysis to ascertain the strengths and weaknesses of these complementary models.

5. "Environmental Chamber Studies of Ozone Impacts of Coatings Volatile Organic Compounds," University of California, Riverside, $200,041, Proposal No. 2652-259

When coatings are applied, solvents are emitted that contain volatile organic compounds (VOCs) that contribute to ozone formation. ARB staff is considering the feasibility of reactivity-based VOC control strategies for architectural coatings, which allow industrial users of VOC source categories to determine the extent of allowable emissions based on the reactivity of the VOCs in their solvents. Data from experiments conducted in environmental chambers are necessary for the determination of reactivity values. These experiments determine, under controlled, simulated atmospheric

conditions, the extent to which the VOCs produced oxidize break-down products that are important for ozone formation. However, past chamber work does not adequately characterize the production of VOC oxidation products. Therefore, a modified chamber is needed to adequately evaluate their ozone impact.

For the proposed study, the University of California, Riverside environmental chamber will be modified in order to obtain better correlations with atmospheric reactivity. Subsequently, selected VOCs used in architectural coatings will be tested to obtain more reliable estimates of their ozone impacts. The outcome of the proposed study is expected to help ARB develop strategies that should lead to less ozone formation and exposure, with the lowest possible expense by the affected industry.

6. "Characterization of Toxicity as a Function of Volatility of Ultrafine PM Emissions from Compressed Natural Gas Vehicles", West Virginia University, $349,996, Proposal No. 2653-259

Exhaust emissions from vehicles include both semi-volatile and non-volatile particles. Depending on vehicle type, age and ambient conditions, between 70-90 percent of the particles by number and 10-30 percent of the mass may consist of semi-volatile material that will partially or completely evaporate upon heating. Some emission control technologies effectively remove the non-volatile fraction of particles, but can increase the number of semi-volatile particles. Semi-volatile particles dominate a commuter's exposure to particle number while commuting. It would therefore be very useful to know whether the semi-volatile material is more or less toxic than the non-volatile particles. ARB, in collaboration with the University of Southern California (USC), the University of Los Angeles, and the South Coast Air Quality Management District, is currently conducting a study to investigate the characteristics of PM fractions, and their implications for exposure and health impacts: "Physicochemical and toxicological assessment of the semi-volatile and non-volatile fractions of PM from heavy and light-duty vehicles operating with and without emissions control technologies."

The proposed one-year project serves to expand the aforementioned study to include heavy duty Compressed Natural Gas (CNG) fueled engines. The inclusion of these technologies is of high interest because CNG is one of the available low-emission options in the Diesel Risk Reduction Plan, yet uncontrolled emissions from heavy duty CNG engines also contain toxic gases such as formaldehyde, 1,3-butadiene and benzene, high numbers of ultrafine particles, and mutagenic particles. Due to constraints of time and budget, CNG buses were omitted from the ongoing ARB study. The proposed study adds evaluation of heavy-duty CNG engines to the matrix of engines and fuels being investigated in the ongoing study. Full funding for the project is provided by the California Energy Commission. The vehicle testing and sample collection will be done by West Virginia University using their portable heavy duty chassis dynamometer stationed at the University of California, Riverside. USC will participate in this study to analyze for the same toxicity metrics as in the current ARB study.

7. “ARCTAS-California 2008: An Airborne Mission to Investigate California Air Quality,” University of California, Irvine, $400,000, Proposal No. 2654-259

Understanding of emission sources and atmospheric transport and transformations is foundational to development of effective emission control plans for traditional air pollutant and climate change species. To improve this understanding it is important to obtain complementary suites of measurements for multiple pollutants including precursor emissions and intermediate and final reaction products at locations both offshore and over land. Most aircraft platforms available to past air quality studies have been limited by available power or payload to carrying relatively few types of instruments and have had relatively restricted geographic range. This study would take advantage of two advanced research aircraft supplied by NASA to obtain more extensive measurements than previously possible. The cost is low relative to the measurement capabilities because these aircraft are already funded for sophisticated instrumentation by multiple principal investigators in preparation for studies of transport and transformation of pollutants in the arctic in 2008. The aircraft with all research personnel and infrastructure can be made available for one week during summer 2008 for use on California specific missions. The advantages to ARB include the range and speed of the aircraft, greater instrument payloads than normally available, high levels of expertise already funded by NASA, integration of multiple observations on two aircraft, quality assurance comparisons between these and other research platforms, and integration of aircraft observations with satellite observations. The separately funded research infrastructure provides a unique opportunity for a highly leveraged opportunity for application of these measurement capabilities to questions of specific interest to California.

8. “Systemic Platelet Activation in Mice Exposed to Fine Particulate Matter,” University of California, Davis, $112,282, Proposal No. 2657-259

Epidemiologic studies suggest that the majority of air pollution-related adverse health impacts, particularly cardiovascular effects, are associated with particulate matter. However, biological mechanisms identified to date do not fully explain these associations. Several recently published studies suggest that the vascular endothelium and blood platelets may be involved in mediating particulate matter-related cardiovascular effects. The objective of this “proof of concept” proposal is to investigate the potential for carbonaceous ultrafine particles (UFP), with and without polycyclic aromatic hydrocarbon or iron, to alter pulmonary vascular endothelial function and up-regulate platelet function, thereby promoting blood coagulation and thrombus formation. The results of this study will help to determine the direction of future research. If the hypothesis is validated with the proposed generated atmosphere, the next logical step would be to examine the same endpoints in animals exposed to concentrated ambient particles, and then in human studies. If the hypothesis is not validated, the results will provide information that will contribute to development of a revised hypothesis for subsequent investigations. The ambient air quality standards for particulate matter are based on statistical associations between particulate matter and health endpoints, with little supporting biological data. The results of the proposed study will help to address

the critical lack of mechanistic data to support the biological validity of the observed epidemiologic associations.

9. “In-vehicle Air Pollution Exposure Measurement and Modeling,” University of California, Irvine, $500,000, Proposal No. 2643-257

In-vehicle exposures to vehicle-related pollutants are frequently high, due to a vehicle's proximity to relatively undiluted emissions from other vehicles, the typically rapid air exchange rate inside vehicles, and the average 95 minutes per day spent in the in-vehicle microenvironment. In-vehicle pollutant concentrations of UFPs and VOCs have been found to be up to 10 times higher than ambient levels. Nonsmoking residents of Los Angeles (LA) can receive up to 50 percent of their daily UFP and black carbon exposure from their time spent in vehicles. Furthermore, commuting times in the LA area are predicted to double by 2020 due to population growth, making it even more important to develop models that can estimate the impact of increased vehicle-related exposures. These exposure models can be incorporated into health effect models to determine the effect of vehicle related pollution.

In the proposed study, investigators will collect in-vehicle air pollution data in Southern California and use the data to develop and validate in-vehicle exposure models. The investigators postulate that the models could be used to incorporate estimated in-vehicle exposures into health effects models and epidemiological studies. The results from the current project are considered essential to future health studies that will link in-vehicle exposure to health outcomes. The findings of this study will provide information that can be used in ARB’s evaluations of air quality and mobile source emission measurements and controls.

Draft Final Reports

10. “Measurement Allowance Project - On-Road Validation,” University of California, Riverside, $400,000, Contract No. 03-345

In 2006, ARB adopted a new in-use compliance regulation and test procedures for heavy-duty diesel engines that requires the use of on-vehicle portable emissions measurement systems (PEMS) to measure pollutant emissions. These PEMS are not expected to be as accurate or precise as laboratory-grade emissions analyzers, and hence ARB, the United States Environmental Protection Agency, and the Engine Manufacturers Association agreed to a research program to quantify the magnitude of this "measurement allowance" (i.e., the difference between the PEMS results and laboratory instruments results). This measurement allowance program used engine and environmental testing, statistical modeling, and model validation of three different measurement methods to develop the measurement allowances for gaseous emissions (nitrogen oxide, Non Methane Hydrocarbons, and carbon monoxide). The work performed as part of this contract concerned the validation of the Monte Carlo model that was used to develop the measurement allowances. Two sets of measurement allowances were developed, one set for engine model years 2007-09, and the second set for 2010 and subsequent model years. The implementation of the in-use compliance

program for heavy-duty diesel engines will act to ensure that these engines remain in compliance with their certification standards throughout their useful lives.

11. "Development and Demonstration of an Aerosol Tracer Technique Based on Neutron Activation Analysis for Studying Cyclical Deposition and Resuspension of Aerosol-Associated Toxic Compounds," University of California, Los Angeles, $83,875, Contract No. 04-345

Large primary particles emitted as fugitive material from roads, industrial facilities, etc. have large settling velocities and thus do not travel far from the original 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 was to test the application of a rare-earth tracer methodology to quantitatively track large particle transport by cyclic suspension, deposition, and resuspension. The results are that the tracer method worked as designed, but the low density of tracer in the field experiments and high background concentration of the tracer elements in ambient surface dust and components of experimental equipment limited quantitative evaluation to samples with relatively high tracer concentrations. Thus, the loss of tracer from test surfaces, a measure of resuspension, could be measured reliably, but the more dilute down-wind samples (to measure redeposition) were problematic to quantify. The use of different tracers for different particle sizes was also deemed a success, and, although subject to the same quantification limitations, there was qualitative demonstration that small particles are more mobile than larger ones. Additional significant findings are that rough surfaces (e.g. asphalt paving) sequester much of the applied test material, so that it is held against resuspension or retrieval by vacuuming, and that loss of test material from both asphalt and concrete test areas was largely independent of wind speed. The partial success of this experiment shows that resuspension is an important removal mechanism for large particles from roads or similar surfaces, but also demonstrated that modeling this behavior will require additional research to better understand the factors that control resuspension.

12. "Nighttime Chemistry: Observations of NO_3 and N_2O_5," University of California, Berkeley, $122,778, Contract No. 04-335

Nighttime chemical reactions between nitrates (from ozone and nitrogen dioxide (NO_2) photochemistry) and nitrogen dioxide (from direct emissions and nitric oxide (NO) photochemistry) form N_2O_5 and further reactions produce nitric acid (HNO_3). Nitric acid combined with ammonia to form ammonium nitrate that essentially removes emitted nitrogen oxides (NO and NO_2) species from the troposphere. However, N_2O_5 may also dissociate forming NO_2, which would continue to participate in nighttime aerosol reactions. At the start of this project, there were no current field measurements for nighttime N_2O_5 and HNO_3 that would reliably support California's PM2.5 simulations. These simulations are the regulatory tools for compliance demonstration required for PM2.5 and other PM state implementation plans (SIP). As part of this project the University of California, Berkeley (UCB) staff upgraded the prototype laser induced

fluorescence instrument that has successfully measured ambient concentrations of nitric acid and N_2O_5 to achieve 15 to 25 parts per trillion volume sensitivity. UCB staff conducted two biweekly measurement campaigns at Blodgett Forest station and one at a farm near Bakersfield. The data produced as a result of this project can serve as inputs and as validation tools for PM simulations. These measurements improve ARB's PM modeling efforts and thus improve the SIPs based on PM modeling.

13. "Traffic Pollution and Children's Health: Refining Estimates of Exposure for the East Bay Children's Respiratory Health Study," Office of Environmental Health Hazard Assessment, $ 215,855, Contract No. 03-327

Traffic emissions are the major source of air pollution in urban areas, with higher concentrations of traffic pollutants near busy roads. The investigators evaluated links between living near areas of high traffic and risks of adverse respiratory outcomes, including current asthma and bronchitis symptoms in the previous 12 months of exposure using data collected for the East Bay Children's Respiratory Health Study. To estimate exposures to traffic pollutants, the investigators used geographic-information systems methods to estimate measures of traffic density near the home and correlated these traffic measures with measured traffic pollutant concentrations. The investigators also developed a validated land use regression model to estimate pollutant concentrations at the residence. In health analyses, consistent positive associations were observed between residential proximity to traffic or modeled NO_2 exposures and risks of current asthma. These analyses took into account individual level risk factors such as family history, home environmental factors, and socio-demographic factors, and school indoor air quality factors. Those living within 75 m of freeways were at highest risk. The findings in this current study signify that, even in urban areas with good regional air quality, exposures to air pollution from nearby traffic may be associated with risks to children's respiratory health.