

**State of California
AIR RESOURCES BOARD**

**Research Screening Committee Meeting
Cal/EPA Headquarters Building
1001 I Street
Conference Room 620
Sacramento, California 95814
(916) 445-0753**

**January 23, 2009
9:00 a.m.**

ADVANCE AGENDA

Interagency Agreement

1. "Environmental Exposures in Early Childhood Education Environments," University of California, Berkeley, \$379,554, Proposal No. 2665-263

Recent studies have shown that early childhood education (ECE) environments (e.g., day care centers) may contain lead, pesticides, and various allergens, but there is little information available on children's exposures to other toxic chemicals in these environments. In the proposed study the contractor will measure volatile organic compounds (VOC), aldehydes, acetone, phthalates, perfluorinated compounds (PFC), several classes of flame retardants and particulate matter (PM) in the indoor air of 40 ECE facilities, and in several outdoor locations near some of the facilities. The flame retardants measured will include polybrominated diphenyl ethers (PBDE), tris phosphate flame retardants, and constituents of Firemaster 550®, a replacement for pentaPBDE which was banned in California beginning in January 2008. The contractor also will measure phthalates, flame retardants, and PFCs in floor dust samples from these facilities. Exposure levels will be estimated and results will be compared to current health benchmarks. Potential exposure sources within the facilities will be assessed via a questionnaire and facility inspection conducted by the contractor. The results from the proposed study will provide valuable exposure data on a number of compounds that are known or suspected reproductive, developmental, or respiratory toxicants, many of which have not been studied in ECE environments.

2. "Neurotoxic Effects of Ambient Particulate Matter: The Role of Oxidative Stress and Inflammation," University of California, Irvine, \$309,141, Proposal No. 2667-263

Numerous epidemiological and toxicological studies have demonstrated that exposure to ambient PM is associated with increased cardiopulmonary morbidity and mortality; however, little is known about the effects of PM exposure on other organ systems. Several animal exposure studies have shown that inhaled particles can be transported to the brain, and that exposure to concentrated ambient particles (CAP) is associated

with increased signaling pathway activity associated with inflammatory responses in the brain, as well as increased levels of biomarkers of oxidative stress and tissue injury. The objectives of the proposed study are to examine the potential for CAPs exposure to induce neurotoxic effects and to determine the role of inflammation and/or oxidative stress in bringing about these effects. Results of this study could provide an improved understanding of mechanisms of PM neurotoxicity and insight into whether ambient aerosol exposure induces neurological effects. Findings from this research could also help determine how specific chemical constituents of the CAP used in this study are associated with health effects. This information could be of value in setting ambient air quality standards and developing air quality regulations to better protect the health of California residents.

3. "Measurement of Diesel Solid Nanoparticle Emissions Using a Catalytic Stripper for Comparison to Europe's PMP Protocol," University of California, Riverside, \$170,000, Proposal No. 2664-263

This project extends the California Air Resources Board's (ARB) recently accomplished Particle Measurement Program (PMP) study (contract 05-320) and other related in-house investigations, which provided critical evaluations of the instruments and sampling methods specified in Europe's PMP measurement protocol. The PMP prescribes regulatory specifications for sampling PM emissions from both gasoline (direct-injection) and diesel vehicles having very low PM mass emissions. The results demonstrated that the PMP protocol yields robust and repeatable measurements of solid particles larger than approximately 23 nanometers (nm) in aerodynamic diameter. However, using the PMP approach, ARB and other investigators have observed high number concentrations of apparently "solid" sub-23 nm particles downstream of the PMP sampling system. In this project, an alternative PMP system using a Catalytic Stripper (CS) for sample conditioning, rather than the evaporation tube or volatile particle remover specified in the PMP method, will be compared to a PMP clone of the reference sampler. The CS has been demonstrated to completely remove volatile compounds such as sulfur and organics and to suppress the formation of nucleating particles. Vehicle emissions tests will involve the University of California, Riverside College of Engineering – Center for Environmental Research and Technology mobile emissions laboratory for over-the-road testing of heavy-duty diesel vehicles equipped with a diesel particle filter meeting the current California emissions standards.

4. "Integrated Physical, Chemical and Optical Measurements of Heavy-Duty Diesel Emissions at NASA AMES Full Scale Wind Tunnel," University of California, Davis, \$419,917, Proposal No. 2673-263

This project characterizes the formation and growth of ultrafine particulates in the emissions from diesel engines under controlled but real-world conditions of dilution. A Class 8 tractor and trailer is operated on a dynamometer over standard driving cycles inside a large wind tunnel. Emissions are measured in the wind tunnel downstream of the vehicle with a variety of equipment including particle counting and sizing instruments, aerosol scattering and absorption coefficient measurements, criteria gas

monitors, and toxic gas samplers. To investigate the development of the plume, the emissions are measured at multiple transverse and axial locations ranging from 0 to 180 feet downwind. The results will be used to evaluate the relationship between emissions measured using conventional constant volume sampling or partial flow sampling systems with emissions experienced under real-world dilution conditions such as near roadways. Measurement of the optical properties of diesel emissions will provide direct evidence for the investigation of climatic impact of diesel particles.

5. "Black Carbon and the Regional Climate of California," University of California, San Diego, \$796,403, Proposal No. 2678-263

In California, warmer temperatures, summer water shortages, and increased wildfires have received increasing attention. To address these environmental issues, ARB has adopted the nation's most sweeping global warming plan (Scoping Plan), outlining for the first time how individuals and businesses will have to meet a landmark 2006 law (AB 32) that made the State of California a leader on curbing the emissions of greenhouse gases. Black carbon (BC), as the main light-absorbing component of soot, has also been recognized as one of the largest contributors to the global warming, and tied to the observed regional climate changes. Reducing the positive radiative forcing of short-lived aerosol species such as BC has been suggested as an attractive control strategy for mitigating climate change. The fundamental goal of this interdisciplinary proposal is to comprehensively assess the radiative forcing BC and its climate impacts in California. The approach consists of both observational data and observationally constrained model assessments. The results of this research project will provide valuable insights on the role of BC aerosols in California's climate, and help to remove impedance to policy-making decisions for mitigating the climate effects of BC emissions.

6. "Assessment of Baseline Nitrous Oxide Emissions in California Cropping Systems," University of California, Davis, \$300,000, Proposal No. 2669-263

Nitrous oxide (N₂O) is a greenhouse gas (GHG) with a global warming potential of 298. It is responsible for about 3 percent of California's GHG inventory. Emissions from agricultural soils represent the main source of N₂O in California, contributing more than 8.2 metric million ton of carbon dioxide (CO₂) equivalent (MMT CO₂E) or 53 percent of total N₂O emissions. Emissions of N₂O from agricultural soils are related to the soil nitrogen (N) content, but are extremely variable both spatially and temporally, reflecting variations of soil conditions such as organic matter content, water content, and temperature. California's current N₂O inventory for agricultural soils uses the Intergovernmental Panel on Climate Change Tier 1 methodology that assumes a default emission factor (EF) of 1 percent for direct N₂O emissions derived from nitrogen sources such as nitrogen fertilizer use and cultivation of N-fixing crops. However, due to California's extremely variable environmental conditions, the EF could change by orders of magnitude. This project is intended to establish baseline N₂O emissions from agricultural soils by monitoring N₂O emissions from five major crops in California. With the passage of AB 32, establishing a more realistic estimate of baseline N₂O emissions from agricultural soils is essential for ARB to develop a mitigation target.

7. "Nocturnal Chemistry in the Urban Boundary Layer of Los Angeles," University of California, Los Angeles, \$289,097, Proposal No. 2674-263

The proposed project is an integral component of the CalNex 2010 Study, a major field campaign planned by ARB and the National Oceanic and Atmospheric Administration (NOAA), that will address important gaps in the understanding of nocturnal chemical and meteorological processes. While the hydroxyl radical dominates daytime chemical processes in the atmosphere, its concentration falls to near zero during nighttime. Its analog, the nitrate radical (NO_3), which is formed predominantly by the reaction of ozone (O_3) with nitrogen dioxide (NO_2), drives chemical reactions during the night. Several key nocturnal processes, however, remain poorly understood. For example, dinitrogen pentoxide, which acts as a storage for NO_3 , is hydrolyzed on water droplets and aerosols to form nitric acid; the rate of this process is highly uncertain and depends on the substrate. An additional challenge in the understanding and description of nocturnal processes is the weak mixing of the atmosphere caused by radiative cooling of the ground at night. This causes stratification in the atmosphere and allows pollutants emitted at ground level to accumulate and form large vertical gradients in concentration. The proposed project will address several important, but poorly understood, areas of nocturnal urban chemistry by conducting field observations during CalNex 2010 of the vertical structure of key nocturnal chemical species at a site near downtown Los Angeles. The expected results from this work are a greatly improved understanding of nocturnal chemistry and meteorology and of its impact on daytime ozone and particle formation in urban atmospheres.

8. "Characterization of the Atmospheric Chemistry in the Southern San Joaquin Valley and an Initial Comparison with Atmospheric Chemistry in the South Coast Air Basin," University of California, Berkeley, \$1,050,000, Proposal No. 2677-263

Ambient concentrations of ozone and $\text{PM}_{2.5}$ have decreased in the South Coast Air Basin (SoCAB). Concentrations of nitrogen species have, to some extent, also responded to emission control measures. However, concentrations of these pollutants in the San Joaquin Valley Air Basin have not responded as well to control measures. This raises a key question: Are these different ambient air quality responses to similar regulatory control strategies a result of different atmospheric chemistry regimes? This research proposal would make detailed (speciated) measurements of reactive oxides of nitrogen and VOCs for at least a 6 week period during summer in the southern San Joaquin Valley in order to fully assess the chemical reactions (e.g., capture several weekends when NO_x concentrations decline by about one-third). The field study would coincide with other CalNex 2010 measurements. These data would be analyzed to characterize the atmospheric chemistry associated with the formation of secondary pollutants during summer in the southern San Joaquin Valley and to assess the performance of chemical mechanisms in air quality models. The results of this and other CalNex 2010 projects will help document any differences in chemical regimes for the formation of secondary pollutants and also guide decisions on how to cost-effectively reduce precursor pollutants to O_3 , $\text{PM}_{2.5}$, and other secondarily-formed pollutants.

9. "SOA Formation: Chamber Study and Model Development," University of California, Riverside, \$474,334, Proposal No. 2671-263

Secondary organic aerosol (SOA) is defined as the organic aerosol component formed in the air from reactive precursors, such as VOCs and NO_x, through atmospheric reactions. SOA contributes significantly to airborne PM, which is of great health, visibility, and climate concern. However, the photochemical processes involved in SOA formation are poorly understood, and the semi-empirical models used to predict SOA formation involve many highly uncertain assumptions. As a result, the SOA formation mechanism implemented in air quality models is primitive, resulting in under-predictions of ambient SOA formation by as much as an order of magnitude. To develop reliable and effective SOA control strategies, air quality models with an improved SOA formation mechanism is needed, which in turn requires a better understanding of SOA formation processes. For this project, well-controlled environmental chamber experiments will be conducted to provide needed input to chemical mechanisms that can predict SOA formation from representative VOCs. In addition, the experimental results and other relevant data will be used to develop and evaluate a model for predicting ambient SOA levels from anthropogenic emissions. This model is essential to developing cost-effective control strategies for fine PM, and would provide a critical step toward identifying feasible and cost-effective VOC control regulations to reduce SOA contributions to fine PM.

10. "Study of In-Use Engine Deterioration in Diesel Off-Road Equipment," University of California, Riverside, \$300,000, Proposal No. 2676-263

Off-road mobile sources powered by diesel engines have become increasingly greater contributors to the mobile source emissions inventories as emissions from on-road diesel engines have been reduced. However the emissions inventories for off-road sources are not as well characterized as on-road sources. One particular need is to be able to quantify emissions deterioration for in-use off-road engines as these engines accumulate hours of operation. The objective this project is quantify engine and emissions deterioration for certain categories of off-road equipment. This objective will be accomplished by administering surveys to collect data to identify engine components that deteriorate as engine hours of operation accumulate, and by collecting emissions data from in-use engines operating in the SoCAB. The results from this project will be used to update and improve ARB's off-road emissions inventory model OFFROAD, and this revised model will provide ARB policy makers with improved emissions estimates for these source categories.

Standard Agreements

11. "Development of an Updated Base Case Ambient VOC Mixture for Assessing Atmospheric Reactivity," University of Texas, \$40,000, Proposal No. 2670-263

Atmospheric organic compounds originate from anthropogenic sources (motor vehicle exhaust, evaporative emissions, and stationary and area sources), and biogenic sources. Most of the anthropogenic emissions have been curbed significantly in the past decades, mainly owing to environmental regulations. As a result, the composition of organic compounds in the atmosphere has changed significantly. The ambient base case VOC mixture that appropriately represents mixtures of reactive VOC in the urban atmosphere is a critical input for scientific and regulatory modeling applications such as the SIP. However, the base VOC mixture was derived in the late 1980s and early 1990s so it is out of date and needs to be updated. This project updates the base VOC mixture by analyzing ambient VOC data collected from various locations in California and other parts of the United States. This should improve our modeling accuracy for air quality control programs and facilitate the effective and efficient control of anthropogenic VOC emissions.

12. "Characterization of Ambient Aerosol Sources and Processes During CalNex 2010 with Aerosol Mass Spectrometry," University of Colorado, Boulder, \$285,000, Proposal No. 2672-263

The proposed research is a key component of the CalNex 2010 Study, a major field campaign planned by ARB and NOAA, that will improve the understanding and characterization of sources and processing of organic aerosols in the SoCAB of California. Recent studies in the eastern portion of the SoCAB have established the importance of SOA (secondary organic aerosol) in summer. Sources of this SOA as well as specific emission sources of the primary organic aerosol (POA), however, remain highly uncertain. The proposed work will address these uncertainties in organic aerosols through deployment during CalNex 2010 of a high-resolution Aerosol Mass Spectrometer (AMS) at a supersite in the Los Angeles area. In conjunction with other gas- and particle-phase measurements from NOAA and other research groups and newly developed mass spectrometric techniques, this research will identify both primary and secondary components of organic aerosol, characterize the sources and chemical properties of these components, and test state-of-the-science SOA models. The project will provide critically needed information on organic aerosols in the South Coast Air Basin - unique, high-resolution AMS data sets and comprehensive POA/SOA analyses; these will better inform policy decisions regarding both climate change and air quality.

13. "Low VOC, Stain Blocking Specialty Primer Coating," California Polytechnic University, \$249,996, Proposal No. 2675-263

Solvents that evaporate from the use of architectural coatings represent a significant portion of California's VOC emissions. A large architectural coating category is Specialty Primers, Sealers, and Undercoaters (SPSU), which are applied to block water-soluble

stains, such as tannins. In 2007, ARB adopted a Suggested Control Measure (SCM) to limit VOC content to 100 grams per liter (g/L) for many types of architectural coatings by 2010. The VOC limit for SPSU is effective in 2012, because effective implementation of that limit can only be accomplished through the development of new low-VOC primer coating options. After reviewing currently available options and researching the science of staining, the contractor will formulate and test SPSU coatings based on low-VOC resins and additives, and new options like nanomaterials. Commercialization of low-VOC primers that perform as well as conventional solvent-borne primers will lead to VOC emissions reductions, resulting in improved air quality.

Draft Final Reports

14. "On-Road Measurement of Light-Duty Gasoline and Heavy-Duty Diesel Vehicle Emission Trends," University of California, Berkeley, \$271,463, Contract No. 05-309

Emissions of PM and O₃ precursors are regulated to protect public health. Nitrogen species are precursors of both PM and O₃ and are also of concern because they can cause (over) nutrification of watersheds and landscapes. In support of sound planning and regulatory decisions, this project documents trends in emission rates of on-road motor vehicles. Changes in rates of emissions from motor vehicles stem from changes in fuel specifications, vehicle technology, emission controls, and fleet characteristics (e.g., distributions of vehicle age, model type, or fuel type). This study characterizes fleet averaged rates of pollutant emissions from light- and heavy-duty vehicle fleets as operated in Caldecott tunnel during summer 2006 and documents the distributions of vehicle ages, types, and operating conditions during the hours of monitoring. Results are compared with similar past studies at Caldecott tunnel to provide trends of emission rates. The method of calculating emissions is a carbon balance approach that is independent of the rate of ventilation of the tunnel and provides emission rate results in units of mass of pollutant emitted per mass of fuel consumed.

15. "Climate Change – Characterization of Black Carbon and Organic Carbon Air Pollution Emissions and Evaluation of Measurement Methods," Desert Research Institute, \$449,997, Contract No. 04-307

PM emissions, which affect the Earth's climate, human health, and visibility, often accompany GHG emissions. While aerosol organic carbon (OC) contributes to cooling through light scattering, black or elemental carbon (EC) absorbs light that leads to global warming. Including the direct and indirect climate effects of BC into global- and regional-scale climate models requires accurate BC emission inventories and conversion factors that translate BC concentration into light absorption coefficients for different wavelengths. The first phase of this study evaluated methods for measuring BC and light absorption. The second phase of the study evaluated global and regional BC inventories and approaches for constructing a BC inventory for California. This study assembled existing profiles into a documented database, which can serve as a starting point for ARB to build on its PM_{2.5} emission inventory effort by coupling relevant source profiles containing BC/EC and OC abundances with its inventory system. This project

has resulted in an improved understanding of the effect of different combustion sources and their particle emissions, in particular BC and OC, on air pollution and climate change.

16. "Improving the Carbon Dioxide Emission Estimates from the Combustion of Fossil Fuels in California and Spatial Disaggregated Estimate of Energy-Related Carbon Dioxide for California," University of California, Berkeley, \$105,000 Contract No. 05-310

Central to any study of climate change is the development of an emission inventory that identifies and quantifies the State's primary anthropogenic sources and sinks of GHG emissions. In 2004, CO₂ emissions from fossil fuel combustion accounted for 80 percent of California GHG emissions. Even though these CO₂ emissions are relatively well characterized in the existing State inventory, significant sources of uncertainties regarding their accuracy still exist. This was a two-Phase research contract. The first part of the final report evaluates CO₂ emissions based on the California Energy Balance Database developed by the Lawrence Berkeley National Laboratory, in terms of what improvements are needed and where uncertainties lie. The estimated uncertainty for total CO₂ emissions ranges between -21 and +37 MMT, or -6 percent and +11 percent of total CO₂ emissions. The second part of this report allocates California's 2004 statewide CO₂ emissions from fuel combustion to the 58 counties in the state, using several different methods, based on the availability of data for each sector. The distribution of emissions by sector varies considerably by county, with on-road motor vehicles dominating most counties, but large stationary sources and rail travel dominating in other counties. Improving the CO₂ emission estimates, finding ways of validating these on a sector-by-sector basis, and providing a validation approach to the statewide GHG emission inventory through disaggregation is an important step in building AB 32 GHG emissions inventory baselines and projections.

17. "Development of an Improved VOC Analysis Method for Architectural Coatings," California Polytechnic State University, \$242,337, Contract No. 04-329

As limits of VOC emissions in regulations for architectural coatings (paints) have become more stringent, the accuracy of test methods used to measure their VOC levels has declined. This is because these test methods only measure the water content and the content of all volatile components (VOC + water), with the VOC content calculated as the difference between these values. With VOC levels in paints declining due to stringent regulatory requirements, the values of the water content and volatile components have become similar. As a result, the difference between two similar numbers has high uncertainty. The contractor developed more precise test methods that are based on direct measurement of the amount of VOC in coatings. They analyzed 67 coatings, representing a wide range of coatings types, using several different methods. Ultimately, they developed five new methods, based on coatings type and target analytes. The development of new test methods for water-borne coatings and for solvent-borne coatings with high levels of VOC-exempt compounds will ensure that

VOC emissions reductions achieved from regulations of paints will continue to be realized as the more stringent limits of the regulations take effect.