

**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
February 27, 2004
8:00 A.M.**

ADVANCE AGENDA

Responses to Request for Proposals

- 1. "Climate Change - Characterization of Black Carbon and Organic Carbon Air Pollution Emissions and Evaluation of Measurement Method," \$450,000, (two proposals received).**

The ARB is required under AB 1493 to adopt regulations that reduce greenhouse gas emissions from motor vehicles. However, particulate emissions are also believed to play a significant role in global warming. Highly absorbing aerosols, such as soot, are so highly efficient as light absorbers that they could result in a net warming of the atmosphere. Aside from the direct warming effect of atmospheric aerosols (which may exceed the accumulated impact of non-CO₂ greenhouse gases), they can reduce rainfall by "burning off" cloud cover, causing further climatic effects. For the purposes of climate change emissions inventories, black carbon is defined as the carbon component of particulate matter that absorbs light. However, this specific component of particulate matter is difficult to measure. Most measurements of light-absorbing carbon are not well related, and consensus on interpretation has not yet been reached for the current suite of available measurement techniques. This project will examine fundamental reasons underlying differences of optical and thermo-optical methods, and will develop reliable emissions factors for use in development of a California emission inventory of climate active carbonaceous particulate matter. This project will result in an improved understanding of the effect of different combustion sources and their particle emissions, in particular black carbon and organic carbon, on air pollution and climate change.

Interagency Proposal

- 2. "Evaluation of Mechanisms of Exhaust Intrusion into School Buses and Feasible Mitigation Measures," University of California, Riverside, \$150,000, Proposal No. 2549-235.**

The recently-completed Children's School Bus Exposure Study (Fitz et al., 2003) was conducted to measure children's exposures during school bus commutes. This study

found intrusion of the bus's exhaust into the bus cabin (after leaving the tailpipe) to be a major contributor to on-board pollutant concentrations. This "self pollution" can lead to high exposures for children with long commutes on older and/or dirtier buses, particularly when the bus windows are closed and ventilation is reduced. However, bus replacement is typically a difficult matter for school districts due to the high cost and relatively long life of school buses. To provide interim measures that may reduce this intrusion phenomenon, a follow-up study was proposed to determine exactly how, where, and when intrusion rates are significant, and investigate potential mitigation methods. Such measures would provide benefits for those students riding under these higher exposure conditions until the older and/or dirtier buses can be replaced.

3. "Evaluation of the Heavy-Duty Diesel Engine Not-To-Exceed Regulation," University of California, Riverside, \$400,000, Proposal No. 2549-236.

Heavy-duty diesel engines/vehicles are substantial contributors to the on-road emissions inventories for NO_x and particulate matter PM. In the 1990s it was found that seven of the largest heavy-duty diesel engine manufacturers violated certification requirements by turning off or defeating emissions control devices during highway operation. As a consequence, in the late 1990s the U.S. EPA and ARB signed consent decrees and settlement agreements, respectively, with these engine companies that required supplemental tests for certification of heavy-duty diesel engines, including the in-use Not-To-Exceed (NTE) test procedure. The NTE regulation requires measurement of in-use NO_x emissions using on-board emissions measurement systems. The NTE requirements are expected to result in compliant in-use heavy-duty diesel engines, but this has not been independently verified by the ARB. On-board measurement systems also have applicability for collecting in-use emissions data for emissions inventory development purposes. The two main objectives of this project are: 1) to evaluate on-vehicle pollutant measurement systems that could be used to satisfy regulatory and/or emissions inventory requirements (requirements that are similar, but not identical), and 2) to utilize these systems for evaluation of the heavy-duty diesel engine in-use emissions NTE regulation. Results from this project would help ARB staff and policy-makers determine how effective the NTE regulation and requirements are in achieving actual in-use emissions reductions from heavy-duty diesel engines in real world operation.

4. "Development of a Micro Air Particulate Analyzer (MicroAPA) for Ubiquitous Deployment in Air Quality Monitoring and Epidemiological Studies," University of California, Davis, \$245,000, Proposal No. 2549-234.

The commercially available instruments for characterizing ambient particulate matter (PM) are not well-suited for widespread deployment by persons who are not highly trained to use them and backed by considerable resources. Undesirable aspects of the existing instruments include high cost, need for laboratory support, poor portability, need for calibration, and need for attendance. This project is intended to develop an affordable, portable, easy-to-use instrument to measure the size distribution of PM smaller than one micron. This would be useful to researchers who study PM near

combustion sources and indoors. The device would also be useful to persons or organizations that need to characterize ambient PM on a fine spatial scale that cannot be provided by the fixed ambient monitoring stations. The investigators would develop a "micro-sensor" to perform as a differential mobility analyzer (DMA), adapt a recently developed particle-charging mechanism, and integrate these functions with commercially available miniaturized ancillary equipment into a device the size of a cell phone. The device would be evaluated against standard particle-size-distribution technologies in the lab and in a pilot field evaluation sampling the ambient air.

Final Reports

5. "Evaluation of Ozone and HNO₃ Vapor Distribution and Effects on Conifer Forests in the Lake Tahoe Basin and Eastern Sierra Nevada," USDA Forest Service, \$29,906, Contract No. 01-334.

A 31-site network of passive samplers was deployed to evaluate the distribution of ambient ozone from the foothills east of Sacramento to sites in the Lake Tahoe Basin. Maps of two-week and whole-season (July-September 2002) average ozone concentrations show that levels are consistently highest at sites 50-60 km west of the Lake. Ozone levels decline steadily from west to east, with the lowest values occurring along the west shore of Lake Tahoe. Between two sites located about 5-10 km west of the Lake (at 7,150-foot elevation) and the west shore of the Lake, a 5-10 ppb decrease in ozone was consistently observed throughout the study period. The distribution of average nitric acid vapor concentrations followed the pattern observed for ambient ozone in the Lake Tahoe Basin. Surveys of ozone injury to ponderosa pine foliage were conducted at 25 sites in the Lake Tahoe Basin. Twenty-three percent of the trees evaluated had symptoms of foliar ozone injury, indicating that only slight injury is occurring to the pines in this area. Data are also presented for studies conducted along transects established in the San Joaquin River Drainage and eastern and southern Sierra Nevada, which may have been affected by emissions from the McNalley fire in Sequoia National Forest in July-August 2002.

6. "Demonstration of Ozone Impacts on Crop Species in the San Joaquin Valley: Open Top Chambers at Kearney Agricultural Center," University of California, Riverside, \$145,301, Contract No. 00-319.

A 10-unit open top chamber facility was established at the Kearney Agricultural Center in Parlier as an exhibit for educating and informing the agricultural community and public-at-large about the harmful effects of air pollution on crops. In 2002 and 2003, a variety of crops were exposed to three ozone treatments (charcoal-filtered air, moderate ozone, and high ozone) to demonstrate the degree to which ozone causes damage to leaves and reduces plant growth. Outreach efforts focused on building relationships with government agencies involved with air pollution control (e.g., Air Resources Board) and the media (e.g., Fresno Bee), and hosting tours of the Center to schools, horticultural groups, etc. A website (<http://airqualityeffects.uckac.edu>) containing information about the open top chamber facility has been established, which also includes a number of

useful links to other air quality information and data, air pollution control agency websites, and information for schoolchildren.

7. "Determination of Elemental Carbon and Organic Carbon Concentrations During the Southern California Children's Health Study 1999-2001," California Institute of Technology, \$55,912, Contract No. 01-309.

As part of the Children's Health Study, fine particles have been measured continuously every 2 weeks at 12 communities in southern California since 1993. Fine particle organic and elemental carbon concentrations have been previously measured for the years 1994-1998; under this contract, these carbon concentrations have been measured for the years 1999-2001. Elemental carbon particle concentrations ranged from 0.05 to 1.74 $\mu\text{g m}^{-3}$ among the communities and the years 1994-2001, while organic carbon concentrations ranged from 1.50 to 17.51 $\mu\text{g m}^{-3}$. Carbon particles account for 24 to 62 percent of the fine particle concentrations among the sites studied. Over the period 1994-1998, there is a pronounced downward trend in fine particle carbon concentrations at the urban sites, followed by an upward trend from 1998 to 2001. These results are important because particles in ambient air are known to be harmful to human health. The information gained from this project will continue to augment the current Children's Health Study database in the area of organic carbon compounds and elemental carbon particles and thus will be directly applicable to the ARB's mandate to protect the health of California's citizens, especially those from sensitive subgroups.

8. "Studies of the Atmospheric Chemistry of Volatile Organic Compounds and of Their Atmospheric Reaction Products," University of California, Riverside, \$299,987, Contract No. 99-330.

One of the most challenging problems in the area of atmospheric chemistry is the accurate description and prediction of secondary pollutants, such as ozone, and secondary organic aerosols and toxic air contaminants. These pollutants are formed through reactions of primary pollutants, e.g. oxides of nitrogen (NO_x) and volatile organic compounds (VOCs), that are emitted directly into the atmosphere. Over three decades of research have produced accurate measurements or at least reliable estimates of the rates and mechanisms of the initial reactions of VOCs with the hydroxyl (OH) radical, nitrate (NO_3) radical, and ozone (O_3). Yet, beyond this initial step, significant uncertainties remain in the chemistry. These gaps in knowledge were addressed by the kinetic and mechanistic studies carried out in this project. The research elucidated the atmospheric chemistry of major classes of organic compounds: alkanes (showing that the major products of long-chain alkanes are 1,4-hydroxycarbonyls and of branched alkanes are carbonyls), a 1,4-hydroxycarbonyl, alkenes, and selected oxygenated organic compounds. In addition, the research investigated nitro-PAH formation (from their PAH precursors) and their presence in the Los Angeles atmosphere. The rate constants and yields determined in this study will help improve the chemical mechanism used in ARB's air quality models and thus will allow the Board to design more technically sound control strategies and regulations.

9. "Collection and Analysis of Weekend/Weekday Activity Data in the South Coast Air Basin," Sonoma Technology Inc., \$389,768, Combined Report, Contract Nos. 00-305 and 00-313.

The objective of this project was to collect activity data in the South Coast Air Basin that would be useful for developing day-of-week inventories of anthropogenic emissions, particularly of ozone precursors. The activity data summarized in this report, will enable better spatial and temporal characterization of the day-of-week differences in emissions of ozone precursors and eventually lead to more accurate emission inventories and more accurate air quality modeling. The contractor used telephone and postcard surveys, various traffic counters, GPS-equipped residential vehicles, and continuous emissions monitoring systems to gather data regarding time-of-day and day-of-week variations in activities during summer. These data, although somewhat limited in space and time, paint a fairly consistent and coherent picture of variations in emissions-related activities. Additional refinements and analysis of these data will eventually lead to a day-specific emissions inventory suitable for more completely assessing the causes of higher ozone concentrations on weekends and for better determining the emission controls that will be necessary to attain healthful air.

10. "Keeping Tahoe Blue Through Atmospheric Assessment: Aircraft and Boat Measurements of Air Quality and Meteorology Near and On Lake Tahoe," University of California, Davis, \$133,382, Contract No. 01-326.

The ARB is actively supporting State and regional planning agencies in their development of the Lake Tahoe Nutrients and Suspended Particle Total Maximum Daily Loading plan for restoring much of Lake Tahoe's amazing water clarity. Initial estimates by water quality researchers of the contributions of various potential nutrient sources to the declining water quality of Lake Tahoe suggested that atmospheric deposition was responsible for significant nitrogen and phosphorus inputs into Lake Tahoe. These estimates need to be refined with additional, and more reliable, methods of estimating atmospheric deposition to ensure that appropriate actions are taken to protect the water clarity of this unique national treasure.

The primary objective of this contract was to make air quality and meteorological measurements aloft with a plane operating in the Tahoe basin and over the western Sierra Nevada. A secondary objective was to employ an instrumented boat during the winter to measure horizontal variations in air pollutants over the Lake.

The aircraft flew on a total of 21 days (more than double the number called for in the contract) and the boat on a total of 6 days (2 overlapping with the aircraft). Although the continuous meteorological and air quality measurements were successful, the program to collect integrated ammonia, nitric acid, and phosphorus samples at two altitudes above the Lake were less successful. In general, the air quality aloft in the Tahoe basin was clean but a few days with potential impacts from outside the basin were identified.

The air quality and meteorological data collected aloft and on the Lake during this study will be used to improve the characterization of meteorological processes aloft in the Tahoe basin and to refine the spatial distribution of materials right above the Lake where deposition to the Lake is very feasible. The information and data from the aircraft/boat program will contribute to refined assessments of atmospheric deposition to the Lake and also help identify the contributing sources.

11. "Development of a Test Method to Measure Stationary and Portable Engine Emissions," West Virginia University Research Corporation, \$248,019, Contract No. 00-316.

Stationary and portable engines are permitted on the basis of certification against emission standards for NO_x and PM according to tests conducted in the laboratory on engine dynamometers. Those tests cannot be repeated on the engines when they are deployed in the field. Thus, regulatory authorities do not have a means to assess the emission performance of in-use engines. Also, the PM measurement method customarily used by enforcement authorities for stationary sources, "Method 5", provides a measure of PM that differs from the measure produced by the laboratory method used to certify engines.

The objectives of this contract were (1) recommendations on suitable instrumentation and protocols for a method for assessing emissions from engines deployed in the field and (2) field evaluations of such a method. The new method would be a screening mechanism to judge the consistency of in-use emissions with certification performance. Also, the method might become the basis for in-use emission limits set as enforceable surrogates for certification limits.

WVU was unable to define a field method precisely. However, WVU makes certain general recommendations about a test method. It recommends that PM be measured by a filter method (possibly a modified Method 5), that NO_x be measured by a Zirconium Oxide sensor preceded by an NO₂ to NO converter, and that the concentration ratio of NO_x to CO₂ measured during the ISO test procedure 8178 be used as a diagnostic measure of the NO_x emission performance of an engine. WVU recommends against attempting to determine brake-specific emissions (i.e., per hp-hour) with the field method for either mechanically or electronically controlled engines. WVU regards the data needed for such a determination as either unavailable or unreliable.

Field trials had not been reported by the time this evaluation was written (although WVU has stated an intent to provide field data before the RSC meeting).

12. "The Impacts of the Air Pollution Control Industry on the California Economy," Environmental Business International, \$116,271, Contract No. 00-312.

The purpose of this study is to provide an economic profile of the California air pollution control (APC) industry and estimate the positive economic impact of air quality

programs. California is a leader in air quality technologies and the California economy has benefited considerably from the APC industry. However, there is no universal definition of the industry and consequently no consensus on its size and impact on the California economy. To assist the contractor in developing a reasonable definition of the industry, the ARB sought technical assistance from a committee of experts in the APC industry, California industry, the air districts, the academic community, and the California Trade and Commerce Agency. After developing a consensus of the definition and structure of the APC industry, the contractor constructed a database of APC companies using a variety of sources. The contractor then surveyed the companies, analyzed and modeled the results into a comprehensive set of statistics on the APC industry in California. The study shows that the industry has grown from \$450 million in revenues in 1970 to \$6.2 billion in 2001, a compounded annual growth rate of 9 percent. During the same period, a total of 29,000 jobs has been created in the industry. The information obtained from this study will assist the board and air districts in their assessment of the positive economic impacts of their proposed regulations; thus performing a more balanced evaluation of overall economic impacts of their air quality programs.

13. "Identification of Target Bioallergens: Frequency of Specific Aeroallergen Sensitization in an Atopic Population in the Sacramento Region," University of California, Davis, \$10,919, Contract No. 01-311.

Airborne allergens from vegetation (bioallergens) can produce allergic reactions, such as asthma and rhinitis, and impose significant costs and discomfort. This retrospective study describes allergic response to a panel of 30 bioallergens in 566 patients living in the Sacramento area. Skin test results and other data from the charts of Kaiser Permanente patients who suffered from asthma and allergic rhinitis were collected and analyzed. The results show that, of the 30 bioallergens tested, grass pollens caused allergic response most frequently, (60+%), while among the tree pollens, olive was the most frequent offender (57%). Allergic response to molds was less common overall, but of the molds tested, *Alternaria*, reportedly released in huge amounts during tomato harvesting season, was the most common allergen (24%). It is not possible to generalize from study results to larger populations, however, grass pollen, olive pollen, and the mold *Alternaria*, are key bioallergens for future studies of allergen interactions in inland California.