

**State of California
AIR RESOURCES BOARD**

**Research Screening Committee Meeting
Cal/EPA Headquarters Building
1001 I Street
Conference Room 510
Sacramento, California 95814
(916) 445-0753**

**February 25, 2010
9:00 a.m.**

ADVANCE AGENDA

Interagency Proposal

1. "Identifying Determinants of Very Low Energy Consumption Rates Observed in some California Households," University of California, Davis, \$94,911, Proposal No. 2694-267

Household energy consumption makes up a substantial portion of California's greenhouse gas (GHG) emissions, 14 percent in 2002-2004. Voluntary actions as well as residential energy efficiency have been identified by the Assembly Bill 32 Scoping Plan as key components of the State's strategy to meet a 2020 GHG emissions goal equal to the 1990 baseline. To meet the 2050 goal of 80 percent reductions in GHG emissions, dramatic shifts in the ways residential consumers of goods, energy, and services choose and use technologies will be necessary. Thus, both near-term and longer term GHG emissions targets require substantial behavioral changes. Historically, behavioral change measures have received relatively little support as an energy management strategy, and uncertainty regarding viable scenarios for very low energy consumption in 2050 prevails. The proposed research addresses both of these critical gaps by offering concrete examples of how California households live with relatively little energy, what motivates households to consume less than the norm, and what factors can be leveraged to induce other households to consume less energy. Of particular importance is that the strategies unveiled by this research are practicable within the current constellation of social, technological, and institutional constraints.

Draft Final Reports

2. "Air Pollution and Environmental Justice, Integrating Indicators of Cumulative Impact and Socio-Economic Vulnerability into Regulatory Decision Making," University of California, Santa Cruz, \$691,922, Contract No. 04-308

Attempts to deal with issues of environmental justice (EJ) in air quality regulation have been hampered by difficulties in characterizing air quality on a neighborhood scale and identifying neighborhoods that, for socioeconomic reasons, may be

especially vulnerable to further burdens. The objective of this research contract was to develop an approach to addressing environmental justice issues of relevance to air pollution regulation in California. The study results indicate that environmental disparities do exist, even when controls are introduced for spatial dependence, and that linguistic isolation is an important and novel explanatory variable. The results also found that ambient air pollution is associated with lower birth weight and preterm birth, but that effect modification by area and individual-level measures of race and socio-economic status is not statistically significant. The researchers developed a screening method that provides a relative rank of neighborhoods within regions based on EJ concerns. This method was used to evaluate potential EJ concerns related to siting decisions, which may be useful for future regulatory assessments. The Environmental Justice Screening Method can provide an important first step to guide decision-making regarding further research, community outreach, and regulatory strategies to better address environmental justice concerns related to air pollution impacts across diverse communities in California.

3. "Indoor Environmental Quality and HVAC Survey of Small and Medium Size Commercial Buildings," University of California, Berkeley, \$557,986, Contract No. 05-347

There is virtually no research on how heating, ventilation, and air conditioning (HVAC) systems in California's small and medium commercial buildings (SMCB) (total floor area between 1000 and 50,000 square feet) operate. Since HVAC is the primary energy consuming activity in most of these buildings with ventilation key variable affecting indoor environmental quality, this information is of great interest to the Air Resources Board (ARB) Indoor Air Quality program, and the California Energy Commission (CEC) Title 24 energy efficiency program. Statistically valid representative telephone survey for building and mail survey for HVAC characteristics were used to collect relevant details on ventilation and indoor environmental quality in small and medium-sized commercial buildings. Candidates for the second phase (a field study) were selected from the phone survey. The telephone survey collected 476 samples; the more detailed HVAC survey collected a total of 71 samples (included partially completed returns). Depending upon the amount of ventilation supplied, the components are present for SMCBs to have very poor indoor environments. As expected, most building owners and operators did not know much about their ventilation delivery system. For example, one out of every five buildings overheats or overcools. The positive effects of Title 24 on energy conservation in California, however, leave an uncertain picture of ventilation and indoor air as most occupants and/or owners also seem largely unaware of their HVAC equipment. This report provides data on an important class of buildings in California and will help ARB and CEC to decide on next steps.

4. "ARCTAS-California 2008: An Airborne Mission to Investigate CA Air Quality," University of California, Irvine, \$400,000, Contract No. 07-335

This project allowed ARB to leverage the National Aeronautics and Space Administration's (NASA) planned efforts in support of the International Polar Year by having NASA research aircraft deployed for multiple days in California. The data

collected will improve our understanding of emission sources and atmospheric transport and transformations in California. NASA's extremely sophisticated instrumentation allowed the collection of complementary measurements for multiple pollutants including precursor emissions, and intermediate and final reaction products at locations both offshore and over land.

5. "Light Duty Gasoline PM: Characterization of High Emitters and Valuation of Repairs for Emission Reduction-Phase 3," University of California, Riverside, \$249,826, Contract No. 05-323

Light-duty gasoline vehicles (LDGV) are currently estimated to emit a large fraction of on-road mobile source particulate matter (PM) emissions. With the continuing reduction in diesel PM emissions required by recent diesel regulations, PM emissions from LDGVs, will contribute an even larger fraction. This study is part of a multi-agency cooperative effort involving ARB, South Coast Air Quality Management District (SCAQMD), Foundation for California Community Colleges, and the Bureau of Automotive Repair. Phase I of the study screened the performance of Remote Sensing Devices (RSD) equipment and real-time PM monitors; a report on the results of Phase I was approved by the Committee in December of 2007. Phase II of the study uses RSD data to characterize the distribution of LDGV PM emissions among the in-use fleet, and will be reported separately by SCAQMD. The current report describes Phase III of the study which evaluates means to identify high PM emitters among the in-use fleet and evaluates the potential costs and benefits of repair and other emission reduction strategies. The methods evaluated include a regional RSD monitoring network, and a number of real time PM monitoring instruments.

6. "Process-Based Farm Emission Model for Estimating Volatile Organic Compound Emissions from California Dairies," University of California, Davis, \$299,191, Contract No. 05-344

Dairies in the San Joaquin Valley are significant sources of volatile organic compound (VOC) emissions but considerable uncertainty remains regarding the identities and amounts of the chemicals emitted. The current emission estimates rely primarily on nominal emission factors, which do not consider emission variations due to differing management practices at dairy farms. The study provided VOC emission data collected from dairy feed silages, animal housing, and manure storage using laboratory incubation and environmental chamber experiments. The results indicate that ethanol and volatile fatty acids are the primary VOC species generated from dairy farms. Emission rates of VOCs were influenced by temperature, wind speed, and total solids levels. Under laboratory conditions, kinetics of ethanol emissions from feed silages can be approximated by a first-order equation, but are more complex from manure sources. The study developed a series of mathematical models to describe VOC emissions from different components of dairy operation, which are now being integrated into a windows-based computer modeling software for dairy emissions. The software will be a valuable tool for ARB to improve the VOC inventory from California dairy farms.

7. "Reducing Emissions of Volatile Organic Compounds (VOCs) from Agricultural Soil Fumigation," University of California, Riverside, \$200,000, Contract No. 05-351

Under the ozone State Implementation Plan, the California Department of Pesticide Regulation is required to develop regulations mandating 12-20 percent VOC emission reductions from 1990 levels for fumigant pesticides in nonattainment areas. However, enormous uncertainties exist in both the estimates of baseline VOC emissions and reductions achievable from available emissions control strategies. This project measured emissions of 1,3-dichloropropene (1,3-D) and chloropicrin from pesticide fumigants Telone II and Telone C-35 in the field under five soil fumigation practices, four of which were intended as emission-reduction strategies: 1) intermittent sprinkler irrigation following fumigation; 2) soil amendment with composted green waste; 3) deep injection; and 4) soil amendment with the fertilizer ammonium thiosulfate. Results of the study indicated that Strategies 1 and 2 were most effective, reducing the emission rate of 1,3-D by 50 percent and 80 percent, respectively, compared to the conventional practice. Strategies 3 and 4 were less effective, reducing the emission rate of 1,3-D by only 20 percent. The emission rates of chloropicrin in all cases were very low (<2 percent), possibly due to rapid soil degradation. Based on these and other published results, Strategy 1 is recommended as a viable practice for reducing VOC emissions from fumigant pesticides.

8. "Differences in Inflammatory Responses to Exposures of Concentrated Ambient Particles in Susceptible Volunteers," University of California, Los Angeles, \$629,920, Contract No. 05-341

Animal, cellular, and human studies have shown that short-term exposure to PM can cause airway inflammation. Human studies that have directly tested short-term PM exposure on human subjects have reported only modest changes in disease markers likely because of the great variability in responses observed. A few studies have shown marked significant changes occurring but only in some subjects. Thus, it became important to study individuals with risk factors identified as having a likelihood of increased susceptibility or responsiveness to PM. Based on available data the two most prominent "susceptibility factors" (Glutathione-S-transferase mutation 1(GSTM1) null genotype and asthma) were selected for this study. A study with thirty (10 mild-moderate asthmatic GSTM1 null, 10 mild-moderate asthmatic GSTM1 present, and 10 healthy GSTM1 present) subjects was conducted where subjects served as their own control. The subjects were exposed to particle mass concentrations of 200 $\mu\text{g}/\text{m}^3$ to determine the short-term effects of concentrated ambient particles (CAP) exposure in individuals likely to be at risk for adverse effects. Outcome measures included symptom scores, physiologic measures as well as serum, sputum, and nasal lavage samples for inflammatory biomarkers. Overall, a few endpoints supported the hypothesis of increased airway inflammation with CAPs exposure. However, the results did not demonstrate an effect of asthma or GSTM1 status on the inflammatory response to CAPs. Future studies are needed to investigate susceptible populations impacted by PM exposure which might allow

future air quality regulations to protect the health of subpopulations at significantly greater risk.

9. "Characterization and Improvement of the Versatile Aerosol Concentration Enrichment System," University of California, Davis, \$123,848, Contract No. 04-332

The Versatile Aerosol Concentration Enrichment System (VACES) forms a critical component of current ARB-funded research on the adverse health effects caused by particulate matter. VACES allows researchers to study such effects on animal models by concentrating ambient particles. This technology is based on inducing particles to grow by water condensation, concentrating the droplets with a virtual impactor, and then drying the particles back to their original size. This method has been documented to preserve many particle properties, such as size, bulk chemistry, indicators of single-particle composition, and particle morphology. In this project, further experimental assessment on VACES was performed. The enrichment factor (EF) of VACES was measured as a function of ambient conditions and operating parameters; gas and particle phase concentration artifacts for the high volatility and high solubility compounds were investigated. A strong depletion for gaseous nitric acid - nearly an order of magnitude - and of hydrogen peroxide was observed. Based on these and other engineering issues documented in the first part of this project, an improved Versatile Aerosol Concentration Enrichment System (iVACES) was developed and tested at the University of California, Davis. In laboratory tests, the EF of iVACES under different ambient conditions and operating parameters varies between two and ten in typical northern California climate conditions during summer-fall seasons, which depends on the combined effects of ambient conditions (temperature and relative humidity) and operational parameters. Further improvements to VACES were suggested as follow-on work.

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

Many regions in California experience excessive PM levels, as defined by State and national ambient air quality standards, compromising the health of millions of people. A primary goal in helping the development of cost-effective strategies to reduce particulate exposure levels is a scientific understanding of the sources and spatial distributions of PM. This project made significant contributions to these questions through several field studies in California. In this work, investigators utilized aerosol time-of-flight mass spectrometry (ATOFMS) on both stationary and mobile platforms, in conjunction with many supplemental particle and gas measurements, to characterize temporal, spatial, and source contribution variations of aerosols. A second focus of the project, to provide mass concentration data from ATOFMS measurements, has also been achieved through various particle scaling approaches. Finally, significant advances in the apportionment of single particles to sources have been made through the development of a source signature library, including secondary aerosol markers, and improvements in data analysis techniques. Overall, the project greatly furthers the understanding of spatial,

seasonal, and temporal variability of PM in regions with excessive particulate levels in California.

11. "An Investigation of Offshore Ship Emissions of CO, NO_x and SO_x from Shoreline Measurements and a Survey of Vessel Operations," University of California, Davis, \$49,560, Contract No. 06-333

Emissions from ships have the potential to substantially influence air quality in and downwind of coastal regions. This contract attempted a multi-pronged approach to provide information on ship activity and emissions offshore of Bodega Bay. Trace level monitoring of carbon monoxide (CO) and sulfur dioxide (SO₂) were major components of this project and were to be combined with ship activity information (survey and global positioning system) to better estimate ship emissions. These results were then to be compared with an existing "bottom-up" estimate of ship emissions to provide constraints and guidance for future research. The results from this project were to be valuable for the central California air quality planning efforts as air quality modeling results are sensitive to background and initial concentrations of pollutants on the upwind side of the modeling domain. Unfortunately, problems with the trace level instruments and extreme reluctance on the part of boat owners/operators to participate in the survey severely compromised the utility of the study results. Additional efforts to collect pertinent data also met with difficulties and the project failed to achieve its objectives.

- 12 "Emissions of HFC-134a in Auto Dismantling and Recycling," Foundation for California Community Colleges, \$159,578, Contract No. 06-334

HFC-134a, a potent GHG with a global warming potential 1,300, has been the universal refrigerant used in automotive air conditioning (AC) since the mid- 1990s. Knowingly venting HFC-134a during dismantling of vehicles at their end of useful lives is prohibited by a United States Environmental Protection Agency. ARB proposed to strictly enforce this federal regulation. However, the HFC-134a emissions inventory associated with this source is unknown; the potential benefit from an enforcement measure is also unknown. This project aimed at and succeeded in providing an estimate of the remaining HFC-134a in vehicles at dismantlers, based on California Department of Motor Vehicles data, and field sampling at dismantler sites across the State. The results show that during 2000 to 2008, around 8.5 million vehicles were classified as end of life vehicles, about 2.1 million of which were assumed to have used, based on model year, HFC-134a instead of R-12, the older generation refrigerant, in the AC. Sixty-nine percent of these vehicles were handled by licensed dismantlers. From the sample population of more than 2000 vehicles, an average of 220 grams of HFC-134a, or 26 percent of nominal charge, remained in the AC of the dismantled vehicles. Therefore, an average of 35 metric tons of HFC-134a remains in the dismantling vehicles every year. This is equivalent to 0.05 million metric ton CO₂ equivalent per year of GHG emissions.