STATE OF CALIFORNIA
AIR RESOURCES BOARD

MEETING OF THE

RESEARCH SCREENING COMMITTEE

December 2, 2011
9:00 a.m.

Air Resources Board
Research Division
Cal/EPA Building
1001 I Street
Sacramento, CA 95814
(916) 445-0753

State of California
AIR RESOURCES BOARD

Research Screening Committee Meeting
Cal/EPA Headquarters Building
1001 I Street
Conference Room 550, 5th floor
Sacramento, California 95814
(916) 445-0753

December 2, 2011
9:00 a.m.

AGENDA

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

October 28, 2011
9:00 a.m.

MINUTES

RSC Members in Attendance

Harold Cota
Steven Japar – via teleconference
Daniel Costa – via teleconference
Chung Liu
Irva Hertz-Picciotto
Suzanne Paulson
Tracy Thatcher
Forman Williams

The Research Screening Committee (RSC or Committee) convened the meeting at 9:10 a.m. The minutes of the June 9, 2011 meeting were approved.

Draft Final Reports

1. "Spatiotemporal Analysis of Air Pollution and Mortality in California Based on the American Cancer Society Cohort," University of California, Berkeley, $749,974, Contract No. 06-332

   Written comments were submitted by the close of business on October 26 by members of the public: Frederick W. Lipfert, James E. Enstrom, Matthew A. Malkan, William B. Grant, Gordon J. Fulks, William Matt Briggs, John D. Dunn, and Norman R. "Skip" Brown. There were seven public commenters who read from or summarized the letters from Malkan, Dunn, Lipfert, Briggs, Brown and Enstrom. After the public comment period, the Committee proceeded to discuss the draft final report. There were a number of questions from the Committee regarding the methods described in the draft final report. There was an extensive discussion on the findings of all-cause mortality and mortality from cardiovascular (CVD) and

ischemic heart disease (IHD). The Committee pointed out that there is a comprehensive body of literature that supports the association between PM2.5 and CVD and IHD. In addition, the Committee recognized that from a health perspective, the association between PM2.5 exposure and CVD and IHD was biologically more plausible than for all-cause (which includes deaths unrelated to PM2.5 exposure, such as accidental deaths). Furthermore, all the models showed CVD and IHD associations with PM2.5, whereas only the most refined model showed an effect from PM2.5 on all-cause death. Therefore, the Committee felt that the report should emphasize the CVD and IHD results, in the "conclusions" and "abstract" sections of the report, consistent with the results in the body of this report. Overall, the Committee believed that the report used state-of-the-art techniques, and presented an extensive amount of work, and provided the best estimates possible for PM2.5 exposure and health outcomes in California.

Motion: Move to accept subject to the restating or clarifying of the all-cause effect from PM2.5 exposure.

The Committee approved the report.

2. "Assessing Near-Field Exposures from Distributed Residential Wood Smoke Combustion Sources," California Polytechnic State University, San Luis Obispo, $320,286, Contract No. 07-308

   Motion: Move to accept subject to the inclusion of comments from staff and the Committee.

   The Committee approved the report.

3. "Physicochemical and Toxicological Assessment of the Semi-Volatile and Non-Volatile Fractions of PM from Heavy-Duty Vehicles Operating with and without Emissions Control Technologies," University of Southern California, $677,950, Contract No. 05-308

   The Committee noted that the dithiothreitol (DTT) and reactive oxygen species (ROS) tests do not meet the reader's expectation generated by the word "toxicological" in the title, and suggested that a different word be used in future reporting.

   Motion: Move to accept subject to the inclusion of comments from staff and the Committee.

   The Committee approved the report.

4. "Reducing Emissions of Volatile Organic Compounds from Agricultural Soil Fumigation: Comparing Emission Estimates Using Simplified Methodology," United States Department of Agriculture, $150,000, Contract No. 07-332

The Committee requested that the principal investigator modify the Abstract and Executive Summary to make them more readable to a non-technical audience. There are too many abbreviations and it's difficult to follow without checking nomenclature. The Committee also requested descriptions, equations, and specific references for the Hydrus and Solute models on page 14 be included.

Motion: Move to accept subject to the inclusion of comments from staff and the Committee.

The Committee approved the report.

5. "Using Pb and Sr Isotopes to Assess Asian Aerosol Impacts in Urban and Interior California," University of California, Berkeley, $80,806, Contract No. 07-318

The Committee requested the following clarifications and corrections to the report.

- Add some discussion of the long-term or seasonal average values to the Summary and Conclusions sections. The Committee stated that noting only the single high peak was insufficient, and did not fully represent the monitoring effort in the project.
- Explain the link between Asian lead (Pb) and sources of interest in the Executive Summary, Introduction and Conclusions. Specifically address the anthropogenic and combustion links to Pb in the Asian plume as distinct from the dust.
- Page 2: Add a discussion of Pb uncertainty to match the style and content of the strontium (Sr) uncertainty discussion.
- Page 8: Add a brief discussion (just a couple of paragraphs) of the seasonality of trans-Pacific transport to coastal California. The plots show a strong seasonal difference in Pb transport to Chabot.
- Pages 19-20: Recalculate and expand the text to explain the computation in more detail. The calculations discussed and the data in Figure 11 are unclear. A Committee member, working from the figure, was unable to duplicate the results.
- Elaborate the basis for the Pb/PM2.5 ratio used to estimate total Asian PM at Chabot.
- Adjust the number of significant figures used in numbers in the text and tables to better fit with the degree of precision in the overall project (i.e. the Pb concentrations and the ratios among elements all vary in the samples, so the very high precision suggested in some numbers is inappropriate to describe the general characteristics of the Asian plume or its contribution at Chabot).
- Review the text for spelling and grammatical errors.

Motion: Move to accept subject to the inclusion of comments from staff and the Committee.

The Committee approved the report.

6. “Developing a California Inventory for Industrial Applications of Perfluorocarbons, Sulfur Hexafluoride, Hydrofluorocarbons, Nitrogen Trifluoride, Hydrofluoroethers and Ozone Depleting Substances,” Institute for Research and Technical Assistance, $199,840, Contract No. 07-313

   The Committee requested a clarification on the comparison of the estimates of halons used in fire protection in this study, and estimates from a trade association.

   Motion: Move to accept subject to the inclusion of comments from staff and the Committee.

   The Committee approved the report.

7. "Lifecycle Analysis of High-Global Warming Potential Greenhouse Gas Destruction,” ICF International, $297,766, Contract No. 07-330

   Motion: Move to accept subject to the inclusion of comments from staff and the Committee.

   The Committee approved the report.

New Research Projects

8. “Black Carbon and the Regional Climate of California,” University of California, San Diego, $24,080, Contract No. 08-323

   The Committee expressed general support for the proposal. Staff explained that the first set of results, from an existing ARB-funded study, have led to a major finding that diesel particulate matter control policies, as implemented by California, have resulted in a reduction of atmospheric black carbon (BC) by 50 percent. This supplemental study can provide an additional unique data set for understanding the BC radiative forcing, from an observational perspective, and to validate model predictions of BC climate forcing.

   Motion: Move to accept subject to the inclusion of comments from staff and the Committee.

   The Committee approved the proposal.

9. “Investigate the Durability of Diesel Engine Emissions Control,” $300,000, RFP No. 11-309

   The Committee requested explanation of how the proposed level of funding would be adequate to support a six year program. Staff explained that the six year program actually consists of three short sampling campaigns that occur once every other year.

   The Committee asked how staff thought the sampling might be conducted. Staff replied that at least two methods exist. One is to capture individual truck exhaust

plumes as the trucks drive under a roadway overpass. A second is to capture exhaust as the trucks accelerate through a purpose-built shed at a controlled location, such as a weigh station.

The Committee asked if it would be possible to assess project performance after each sampling campaign, and if performance did not meet expectations, to then cancel the remainder of the project and withdraw the remaining funds. Staff answered in the affirmative.

The Committee asked why six years and three campaigns were chosen rather than four years and two campaigns. Staff answered that the longer time period allows for collecting more data and more time for aftertreatments to degrade or fail. This is an important consideration because the frequency of occurrence or aftertreatment failures is expected to be small.

Motion: Move to accept subject to the inclusion of comments from staff and the Committee.

The Committee approved the RFP.

10. "Emissions of Potent Greenhouse Gases from Appliance and Building Waste in Landfills," $250,000, RFP No. 11-308

Staff noted that a UC group is planning on submitting a full proposal for the research, and this request for proposal (RFP) will only go forward if the UC proposal is deemed non-responsive. The Committee asked if the Cal Poly San Luis Obispo Global Waste Research Institute had responded with a pre-proposal, which it had not. The Committee requested that Cal Poly San Luis Obispo be personally contacted to see if they had received the research proposal solicitation, and if not, to allow them to submit a proposal before the RFP is opened up.

The Committee wanted to know if landfills were a much larger source of emissions than generally accepted, especially for methane emissions. Staff responded that, while methane emissions in California landfills were controlled through comprehensive regulation requirements, the emissions from the high-global warming potential greenhouse gases, such as those in foam, are currently not known.

Motion: Move to accept subject to the inclusion of comments from staff and the Committee.

The Committee approved the RFP.

Other Business

11. Annual Research Plan

Staff presented an update on the research plan for FY 2011-12, which was circulated to RSC members on September 9 for comment. The plan was approved by the Board on September 22 and the 23 research concepts delineated in the plan

are being into full proposals. The first half of the proposals will come to the December 2 RSC meeting for review, and the second set will be reviewed at the February 17, 2012 RSC meeting. Contracts will be in place by the end of FY 2011-12.

The Committee asked why the process was different this year. In previous years, the Committee had been offered the opportunity to review and/or comment on the full set of research concept submissions. Staff indicated that this year's planning process responded to Board requests to consider long-term strategic goals (2030, 2050), to focus research on direct support of mission-critical issues, and to emphasize internally generated research concepts developed in conjunction with partner divisions. In response to Committee question regarding the number of external submissions and how many were ultimately accepted, staff reported that there were approximately 185 submissions received in response to our public solicitation. Approximately 12 to 15 of those made the final cut. The remaining concepts are on track to be developed into full proposals through a solicitation to California's public universities.

The meeting adjourned at 12:00 p.m.

DISCUSSION OF A NEW RESEARCH PROJECT
ITEM NO: 1
DATE: December 2, 2011
PROPOSAL NO.: 2733-272

STAFF EVALUATION OF A RESEARCH PROPOSAL

TITLE:	Reducing In-Home Exposure to Air Pollution
PRIME CONTRACTOR:	Lawrence Berkeley National Laboratory
SUBCONTRACTOR:	Residential HVAC Contractor; $41,600
PRINCIPAL INVESTIGATORS:	Brett C. Singer, Ph.D. Iain S. Walker, Ph.D.
TOTAL AMOUNT:	$1,249,994 + $51,000 = $1,300,994
CONTRACT TYPE:	Standard Agreement
CONTRACT TERM:	36 Months

For further information, please contact Peggy Jenkins at (916) 323-1504.

I. SUMMARY

New California homes are now required to have mechanical ventilation systems, many of which do not filter the incoming polluted air. The increase in the number of new homes built near major roadways may elevate the public's indoor exposure to high levels of ambient particulates, especially ultrafine particles (UFPs); and ozone continues to be a major pollutant in urban areas. Employing high efficiency filtration in homes can be a very effective mitigation tool in reducing such exposure. The objective of this study is to measure the effectiveness and energy use of combinations of mechanical ventilation and filtration systems in order to identify compatible low-energy systems that are most effective at reducing indoor exposures to indoor, and incoming outdoor, pollutants. Specifically, the investigators plan to: 1) identify and evaluate up to 15 current and new systems, and select seven of the most promising systems to be compared to one reference or baseline system; 2) identify and prepare a test home near a major roadway with high ambient ozone and PM2.5 levels in which the experimental measurements will be conducted; and 3) evaluate the in-situ performance of system

combinations operating over a period, including several weekdays and one weekend day, during a warm, spring/summer season and a cool, fall/winter season. The results of this study will identify combinations of mechanical ventilation and filtration systems that are both health-protective and energy-efficient that can be specified for new homes and homes of people with severe asthma or other respiratory conditions.

II. TECHNICAL SUMMARY

Objective

The objective of this study is to measure the effectiveness and energy use of combinations of mechanical ventilation and filtration systems in order to identify compatible low-energy systems that are most effective at reducing indoor exposures to indoor, and incoming outdoor, pollutants.

Background

In part to address indoor air quality issues, new California homes are now required to have mechanical ventilation under California's Energy Efficiency Standards for Residential Buildings [Title 24, Section 150(o)]. Some of these systems include filtration, but the most economical (and widely used) low energy systems do not filter the incoming air or filter it poorly. Since new construction often occurs near busy roadways and new land use policies, including the Sustainable Communities and Climate Protection Act of 2008 (SB 375), encourage infill developments in urban areas, potential mitigation strategies that reduce exposure to incoming ambient pollutants beyond ARB's land use planning setback guidelines need to be identified. Such a strategy may include different combinations of mechanical ventilation systems coupled with high efficiency filtration technologies deployed in new and existing construction.

Studies have shown that high efficiency filtration (MERV 13-16) can be very effective in reducing particles indoors, but few residential heating, ventilating, and air conditioning (HVAC) systems incorporate such filtration. In addition, there is often a varying energy cost associated with high energy filtration, especially for those paired with central mechanical ventilation systems. Effective methods of filtration of ozone and VOCs for residences are also desirable, but options are limited (yet growing) for the residential market. This proposed study will identify the most energy efficient and health-protective

combinations of mechanical ventilation coupled with the most effective filtration technology that is readily available or soon to enter the residential market.

Ambient pollution entering the home environment, where people spend a substantial amount of time, remains a major health concern. Particle removal is the highest priority because of their diverse number of sources and their association with serious adverse health impacts including increased asthma, cardiovascular disease, and premature deaths. UFPs are especially elevated near roadways, and traffic emission studies have shown a strong association of busy roadways with such adverse impacts. Although much attenuation occurs in new homes when windows are closed, indoor ozone exposure still carries a health concern, because it remains the ambient pollutant that most often exceeds federal and state air quality standards. Opening windows and use of some mechanical ventilation systems potentially increases the amount of ozone entering homes, and may lead to a chronic exposure to elevated ozone. Thus, further reduction of ozone exposure also needs to be explored.

Proposal Summary

This project will focus on identifying and testing filtration technologies best suited for ambient particulate removal, especially PM2.5 and UFPs, and secondarily on ozone, indoor particles, and nitrogen dioxide removal. The investigators propose to complete four tasks in order to meet the project's objective.

Task 1 includes holding a kick-off meeting at ARB, forming a small technical advisory committee in consultation with ARB, and submittal of all required reports.

Task 2, the first technical task, will consist of identifying, evaluating, and selecting systems for study that are compatible with California's climate and building practices, and with current and expected Title 24 building code requirements. Such systems will utilize current or soon-to-be available ventilation and pollutant removal technologies. This detailed scoping assessment will be conducted in consultation with ARB, the technical advisory committee, and HVAC filtration and ventilation manufacturers and installers. A single reference or baseline system common in California and approximately 10 to 15 promising combinations of ventilation and filtration systems will undergo detailed review and evaluation including possible modeling by LBNL. Of the

identified system combinations, seven will be selected for in-use evaluation in Task 4. These proposed combinations may be integrated with, or operate independently of, the specific heating and cooling components of the HVAC system. The selected pollutant removal technologies will primarily focus on the potential removal effectiveness of ambient fine and ultrafine airborne particles and ozone, followed by a secondary focus on removing indoor particles. Nitrogen dioxide removal will be measured as a low-cost opportunity in addition to the experimental assessment.

Additionally, in Task 2 the investigators will generate a detailed experimental plan, comprised of a test matrix, detailed monitoring plan, and refined schedule. The central measure of effectiveness will be the ratio of indoor to outdoor pollutant concentrations (I/O) for each test system for comparison to the reference system. The I/O ratio indicates the overall effectiveness of pollutant removal resulting from all factors, including building related removal (e.g., deposition on walls and surfaces in leakage pathways). ARB must approve the experimental plan devised under Task 2 before field work may begin.

In Task 3, the investigators will select and prepare the test home and deploy analytical equipment according to the specifications of the experimental plan devised under Task 2. The test home should meet several criteria, including a construction date of 2006 or later, and an existing HVAC system that meets the requirements for the reference system and can easily accommodate the seven test system combinations. The home should be unoccupied for the duration of experiments; compatible with the experimental schedule; located in an area with elevated ambient UFP, PM2.5 and ozone levels; and located within 300 meters of a major freeway that includes heavy-duty diesel traffic.

Task 4 entails executing the experimental plan, once the test home is prepared, in order to evaluate the in-situ performance of each system combination. Specifically, the investigators will utilize two sets of air quality monitors to continuously measure and estimate the following pollutants, at a minimum, at one indoor and one outdoor location for each system configuration: total particle number concentrations down to 10 µm, with size-resolved bins to 2.5 µm, the volume and mass of fine particulate matter, UFPs, ozone, nitrogen dioxide, and black carbon. The approved monitoring plan will specify the measurement locations to characterize the enhanced pollutant removal performance

of each tested system. Monitoring will also include recording HVAC system operation time and energy consumption, indoor and outdoor temperature and humidity, other metrics of component performance (e.g. pressure drop across the filter), and the average daily ventilation rate. In addition, for each system configuration, the investigators will evaluate performance for indoor pollutants by conducting controlled experiments involving scripted pollutant generation activities. The effect of building-related pollutant removal processes will also be ascertained using the concentration rebound method developed by LBNL researchers. This method allows determination of size-resolved particle removal efficiency during infiltration and indoor deposition. The preliminary plan is to operate and monitor the performance of each system for a period of at least five week days and one weekend day during at least two seasons. If funds are available, the investigators will attempt to incorporate additional operation and monitoring periods to evaluate the performance of one or two systems equipped with aged (used) filters. Finally, the data will be compiled, reviewed, and reported to ARB.

III. STAFF COMMENTS

Early versions of the proposal were distributed to California Energy Commission (CEC) staff members for comment. Staff provided comments on the draft and the investigators refined their proposal accordingly. Subsequent to completion of the proposal, staff further requested that LBNL monitor and measure VOC concentrations when the ozone filters are tested; LBNL has agreed to do so, at an additional cost of $51,000.

Staff requested a reduction of indirect costs where feasible. LBNL is requesting a waiver for the Federal Administrative Charge (Participant's Value Contribution) of $37,499 from the Department of Energy. This amount is not shown in the budget and is expected to be waived.

Staff recognizes LBNL's high overhead rate, but has negotiated the best rate and has requested a reduction of indirect costs where feasible. LBNL has requested a waiver for the Federal Administrative Charge (Participant's Value Contribution) of $37,499 from the Department of Energy. This amount is not shown in the budget and is expected to be waived. Staff believes the total cost is appropriate given the full value that will accrue to the State. Drs. Singer and Walker and other LBNL scientists assigned to this project are nationally recognized experts in the fields of mechanical ventilation, filtration, and

indoor air quality, thereby bringing key expertise to this project. Additionally, both Drs. Singer and Walker are currently serving as PIs on related projects funded by the CEC that will provide useful baseline information for this project.

IV. STAFF RECOMMENDATION

Staff recommends the Research Screening Committee approve this proposal for a total amount not to exceed $1,249,994 + $51,000 = $1,300,994, subject to any changes and additions specified by the Committee.

DISCUSSION OF A NEW RESEARCH PROJECT
ITEM NO: 2
DATE: December 2, 2011
PROPOSAL NO.: 2730-272

STAFF EVALUATION OF A RESEARCH PROPOSAL

TITLE:	Reducing Air Pollution Exposure in Passenger Vehicles and School Buses
CONTRACTOR:	University of California, Los Angeles
PRINCIPAL INVESTIGATOR:	Yifang Zhu, Ph.D.
TOTAL AMOUNT:	$150,000
CONTRACT TYPE:	Interagency Agreement
CONTRACT TERM:	30 Months

For further information, please contact Peggy Jenkins at (916) 323-1504.

I. SUMMARY

Exposure to roadway-related particulate matter (PM) has been linked to respiratory and cardiovascular diseases. A significant percentage of the daily exposure to this pollution has been demonstrated to occur while commuting between home and work or school. While substantial progress has been made in reducing on-road emissions by tightening vehicle emission standards and retrofitting trucks and buses, exposure to commuters is still of concern due to their proximity to the sources of this pollution. The investigators will assess the effectiveness of high efficiency (HEPA) filters in cars and school buses to mitigate roadway exposures of commuters. In-cabin particulate levels will be tested in 12 cars driven under three in-cabin filter schemes, including: 1) no passenger-cabin filters, 2) passenger-cabin filters provided by the manufacturer, and 3) HEPA passenger-cabin filters. In-cabin particulate levels in buses will be tested with and without in-cabin HEPA filters. Results from these studies will provide the Air Resources Board (ARB) with a detailed understanding of the extent to which passenger cabin filters can mitigate exposures to roadway pollution at a relatively low cost.

II. TECHNICAL SUMMARY

Objective

The general objective of this study is to explore the application of HEPA filtration to reduce exposure to in-cabin fine and ultrafine particles. This study will provide data that can be used by ARB for future in-cabin air pollution exposure reduction guidelines and by the vehicle manufacturers to improve filtration in cars and buses. The specific objectives are to:

1. Determine the extent to which HEPA filters can reduce fine and ultrafine particle levels inside the passenger cabin of vehicles.
2. Identify important factors affecting the performance of HEPA filters in passenger vehicles.
3. Determine the extent to which installing a HEPA filter in the air conditioning system or operating a HEPA filter based air purifier can reduce fine and ultrafine particle levels inside of school buses.
4. Identify important factors affecting the performance of HEPA filters and air purifiers inside of school buses.

Background

Research has shown that exposure to traffic-emitted particulates can be associated with adverse health effects such as asthma, cardiovascular disease and even death. And while this exposure is significant and has been linked to important health concerns, few studies have investigated specific methods to reduce in-cabin particle exposures to commuters.

Cabin air filters are becoming standard equipment in new automobiles to clean outside and re-circulated air as it enters the cabin of the vehicle. In studies testing the efficiency of commercial passenger cabin filters, a large range of filtration efficiency was observed. The large variation among filters suggests that a higher efficiency cabin filter, a HEPA filter, may dramatically reduce the penetration of fine and ultrafine particles into the cabin. The few earlier reports on the use of HEPA filters in automobiles achieved dramatic reductions when the in-cabin air was re-circulated and no outside air was brought into the cabin. However, since new reports are now warning about the dangers of long-term re-circulation of cabin air and the build-up of carbon dioxide (CO_2), studies to investigate filtered ventilation of outside air need to be undertaken.

In contrast to passenger vehicles, school buses are usually not equipped with replaceable cabin filters. This is especially true for older buses with no built-in mechanical ventilation systems. In newer buses with air conditioning systems, a low efficiency filter (i.e. <MERV 5) is usually installed to remove larger particles before the air reaches the blower fan and the evaporator. This filter could be replaced by a HEPA filter to reduce roadway particles in the cabin of school buses. Alternatively, the cabin air could be filtered while being re-circulated through a built-in ventilation system capable of re-circulation, if available on the bus, or through a portable air purifier placed in the cabin. All of these approaches would enable high efficiency filtration to be tested as a mitigation approach that could be incorporated into bus ventilation design in the future.

Proposal Summary

In this proposal, high efficiency filters or air purifiers will be tested for their ability to reduce passenger cabin exposure to fine and ultrafine particles in automobiles and buses. In automobiles, low efficiency, factory-installed passenger cabin filters will be replaced with HEPA filters, and cabin particle numbers and size distribution will be monitored using real-time instruments: two Water-based Condensation Particle Counters (TSI, model 3785), and a DustTrak photometer with a PM2.5 inlet impactor (TSI, model 8520). Other measurements that will be made include carbon monoxide (CO) and CO_2 concentrations using two Q-Trak indoor air quality monitors (TSI, model 8550), and meteorological parameters and traffic activity. In all experiments, outside air values will be measured to generate a ratio of inside to outside particle values. Vehicles will be tested with no filter, with the factory-installed filter, and with a HEPA filter to determine the benefit of high efficiency filtration.

In southern California, small cabin vehicles (passenger cars and pickups) account for 63 percent of the total fleet and large cabin vehicles (SUVs and vans) account for 37 percent. Therefore, eight small cabin vehicles and four large cabin vehicles will be selected to reflect the southern California vehicle fleet. Automobile ventilation in these experiments will be set to “fan-on” and “recirculation-off” (vent-open) settings to direct outside air through the cabin ventilation systems where it can be filtered. The cars will be driven on freeways and city streets since roadway pollutants vary between road

conditions, and will be driven at two different speeds since air exchange rates in vehicles are dependent on their speed.

The investigator has access to newer buses with air conditioning systems, where a HEPA filter can be placed. Thus, in four buses, HEPA filters will be installed in the air conditioning system and particulate numbers and sizes will be measured as described above, plus two Scanning Mobility Particle Sizers (TSI model 3936) will be used to measure fine and ultrafine particle size distribution. Windows and doors will be closed during the tests, except when doors open for short periods to pick up or drop off students, and in a small number of tests with windows open a couple of inches. Additionally, as a "proof of concept" experiment, the investigators will test two buses with a portable HEPA-based air purifier in the cabin and measure the ability of the air purifier to reduce passenger cabin particulate matter (PM) levels. All bus experiments will consist of approximately two hours of transit picking up students and dropping them off at school or home.

III. STAFF COMMENTS

ARB staff reviewed the first draft of the proposal and provided comments to the investigators. Staff asked the investigator to revise the proposal based on a number of comments, including those summarized as follows:

1) Discuss the rationale and need for specific aspects of the study design, including the importance of the vent being open to minimize the build-up of CO_2 in the cabin. Discuss how this research examines different solutions for reducing on-roadway exposure than those addressed in current ARB regulations, such as the ARB diesel truck rule. And discuss why previous studies on the efficacy of filtration have been mixed and how those studies differ from this proposal.
2) Refer to the bus portion of the project as a pilot level effort (since only a few buses will be tested), and explain why the air conditioning system in the bus was chosen to place the filter and not another source of air circulation/ventilation, such as the ventilation or heating system. Explain how a commercial HEPA filters would work in a bus air conditioning unit.
3) Use a wider range of more recent models of automobiles (eliminate the oldest vehicles planned for testing), and try to obtain other makes and models of buses to test as well.

The investigator agreed to revise the proposal accordingly based on staff's questions and recommendations. Subsequent to receipt of the revised proposal, staff also requested addition of black carbon measurements where feasible. Dr. Zhu agreed to do so provided that ARB can loan one aethalometer.

Dr. Zhu has extensive experience in vehicle filtration as well as measuring particles and other pollutants in vehicles. She has published extensively in this area. Staff is confident that Dr. Zhu will provide a high quality effort within the time and budget proposed.

IV. STAFF RECOMMENDATION

Staff recommends the Research Screening Committee approve this proposal for a total amount not to exceed $150,000, subject to any changes and additions specified by the Committee.

DISCUSSION OF A NEW RESEARCH PROJECT
ITEM NO: 3
DATE: December 2, 2011
PROPOSAL NO.: 2731-272

STAFF EVALUATION OF A RESEARCH PROPOSAL

TITLE:	Modeling the Formation and Evolution of Secondary Organic Aerosol during CalNex 2010
CONTRACTOR:	University of Colorado, Boulder
PRINCIPAL INVESTIGATOR:	Jose-Luis Jimenez, Ph.D.
TOTAL AMOUNT:	$350,000
CONTRACT TYPE:	Interagency Agreement
CONTRACT TERM:	36 months

For further information, you may contact Dr. Eileen McCauley at (916) 323-1534.

I. SUMMARY

Organic aerosols (OA), and specifically secondary organic aerosols (SOA) formed from oxidation of gaseous precursors, constitute a large fraction of the submicron particulate mass and are responsible for significant health and climate effects. Despite their importance, a substantial gap remains between model predictions and field measurements of SOA concentrations, with predictions typically too small by a factor of two to three. The objective of the proposed research is to improve modeling of the concentration, composition and evolution of SOA in California by using measurements from the CalNex 2010 field study to optimize and constrain state-of-the-art SOA models. The improvements to SOA models will be based on a wide variety of measurements that were taken during the largest field study of atmospheric processes over California – CalNex 2010. These include high-resolution time-of-flight Aerosol Mass Spectrometer (HR-ToF-AMS) measurements of aerosol composition taken by the Jimenez Group and supporting measurements of aerosol precursors and other species taken by other research groups at the Pasadena supersite. By employing multi-group data sets, the research team effectively leverages several million dollars' worth of data collection and

analysis work from the CalNex 2010 campaign. State-of-the-art SOA models will be run using SOA precursor and oxidant data as inputs to provide predictions for the concentration, composition and volatility of SOA at the field site; the resulting predictions will be compared against experimentally determined SOA characteristics. Parameters within the models will then be adjusted to provide the best description of the data. Given the scope and the sophistication of the gas-phase and particle-phase measurements carried out during CalNex 2010, the proposed research will test and constrain SOA models at a level of detail that has not been possible before. Results from this work will be used to help identify sources of SOA and improve models that quantitatively predict the evolution of SOA; these improvements will aid in the development of effective strategies to reduce SOA pollution in California and in predictions of future climate change.

II. TECHNICAL SUMMARY

Objective

The objective of the project is to improve models for sources, composition and evolution of OAs in California. This will be accomplished through evaluations of a variety of state-of-the-science SOA models with AMS and supporting measurements taken during the CalNex 2010 field study and adjustments to the parameters in these models to improve their accuracy.

Background

The ability of regulators to develop effective control strategies for particulate matter rests on their skill to accurately predict effects of alternative emission control scenarios on ambient air quality. For OAs, and especially SOA, this skill is compromised by the poor performance of current SOA models in predicting the sources, evolution and concentrations of SOA. In general, traditional 3-D photochemical models that use estimates of SOA formation from oxidation of volatile organic compounds (VOC) precursors greatly underestimate observed ambient OA concentrations, typically by a factor of two to three. To treat this deficiency, several recent SOA models, for example the Robinson model, have incorporated a refined description of volatility of organic compounds – the volatility basis set (VBS). Although this addition to air quality models for the eastern United States and Mexico City areas improves agreement with ambient measurements, large uncertainties remain in how such an approach should be

implemented in 3-D regional photochemistry aerosol models. For example, primary- semi- and intermediate-volatility organic compounds (P-S/IVOC) are only indirectly constrained by such models and are currently not included in emission inventories. The rates of photochemical aging and overall reaction mechanisms for the P-S/IVOC are also ill understood and constrained. Inclusion of improved characterization of aging will likely require expansion of the VBS methodology to a 2-D VBS description, in which the O:C ratio is included along with volatility classes.

Important steps in updating and improving OA models for California were taken by the Jimenez Group during the CalNex LA 2010 field campaign, where they deployed a HR-AMS system and complementary instrumentation (Thermal Denuder and Potential Aerosol Mass (PAM) instruments) to the Pasadena site in order to better characterize ambient aerosols. In addition to the Jimenez Group's instruments, approximately 70 additional instruments were deployed by other groups at the site, making this one of the largest studies of aerosols and their precursors ever carried out in California. These measurements included: OA mass, carbon content (O:C ratio), and composition (division of OA into hydrocarbon-like organic aerosols – HOA – and one or more components of oxygenated organic aerosol – OOA); volatility characterization (saturation mass concentrations) with the Thermal Denuder; potential yields of SOA from OA precursors with the Potential Aerosol Mass instrument; and concentrations of several SOA precursors from various instruments from other groups. These data will form the constraints from which OA modeling improvements will be based. In this context, the Jimenez Group and collaborators are uniquely distinguished by their possession of both the necessary chemical and volatility data as well as the required expertise with state-of-the art SOA models.

Proposal Summary

The proposed project may be divided into five tasks. 1) A pseudo-Lagrangian box model will be developed for the Pasadena site that incorporates state-of-the-science SOA formation estimates from VOCs and P-S/IVOCs. Several different descriptions of SOA formation will be tested; these simulations will include the 2-D VBS (a basis set comprised of volatility bins and O:C ratios combined with empirically-derived rates to estimate formation of SOA mass). Air parcels will be started over the Pacific Ocean and transported inland over the L.A. basin, undergo chemical processing, emission and

dilution for several hours, and arrive in Pasadena in the afternoon. The results from these simulations will be compared with many CalNex field measurements, which will act as constraints for model parameters. 2) 3-D modeling of the Los Angeles region will be carried out using the WRF/Chem community model v. 3.3 with a nested 4 km grid domain. For this work, a less computationally intensive 1-D VBS approach will be used to describe SOA formation. The performance of the VBS model will be evaluated through comparisons of simulations with CalNex measurements; parameters will be adjusted to address the most important discrepancies. 3) The potential SOA measured in different air masses with the PAM instrument will be compared with model estimates of total SOA formation predicted from measured precursors; both the Lagrangian and 3-D regional models will be utilized. 4) Analysis of the HR-AMS data set from the Pasadena site will be performed using 3-D Positive Matrix Factorization software; this factorization utilizes particle size or volatility as the third dimension in addition to time and mass spectra components. This extended analysis will provide better characterization of the OA classes (OOA and HOA) for the Pasadena site and correspondingly better constraints on SOA formation. This work should yield further insights into OA apportionments. 5) Lastly, the impact of different emission reductions on OA and PM2.5 concentrations will be explored using the most accurate models (as developed through tasks 1-4) in sensitivity studies.

III. STAFF COMMENTS

ARB staff reviewed this proposal and think the research will significantly improve modeling of the composition, sources and processing of OAs in the South Coast Air Basin and other urban areas of California. Prof. Jimenez is widely recognized as one of the premiere aerosol scientists in the world and as a leader in Aerosol Mass Spectrometer analysis.

Several limitations of the AMS measurements and data analysis techniques should be noted. These may help provide a context for interpreting uncertainties in such work.

- Each mass spectrum collected by the AMS is generated by an ensemble of particles and species, which makes identification of individual species components virtually impossible; instead, broader chemical classes are distinguished. In addition, AMS spectra for specific compounds are similar, but

not identical, to those standard electron-impact databases. This discrepancy is caused by thermal decomposition and increased fragmentation of molecules during vaporization in the AMS instrument.

- Conversion of measurements from a Thermodenuder saturation vapor pressure bins (VBS) involves many assumptions and estimates of parameters, such as the enthalpy of vaporization. These introduce uncertainties into the resulting VBS description of OAs.

- PAM is a relatively new instrument developed by the Brune group at Pennsylvania State University; its performance and measurement characteristics are not well understood. An important consideration is whether aerosol yields in the PAM chamber are similar to those under ambient conditions. These questions should be addressed in the current ARB project 08-319, which will analyze some PAM data from CalNex. In addition, the Jimenez group received a CIRES Innovative Research Program grant to measure SOA yields within PAM for a variety of precursors (especially P-S/IVOCs).

- Several caveats accompany any application of PMF to datasets, and in particular to AMS mass spectra measurements. First, all source profiles are assumed constant, which precludes evolution of profiles across the dataset (e.g. increased oxidation of specific source emissions). Second, the modeler must identify the number of factors in a solution that "best" explains the data. This step is subjective and depends critically on the knowledge and skill of the user and may vary with the particular application. Finally, PMF does not provide unique solutions for the factorization; instead, physically relevant solutions must be chosen, sometimes through choices of model parameters (rotation, number of components, constraints). This step introduces further complexity into the interpretation of results.

IV. STAFF RECOMMENDATION

Staff recommends the Research Screening Committee approve this proposal for a total amount not to exceed $350,000, subject to any changes and additions specified by the Committee.

DISCUSSION OF A NEW RESEARCH PROJECT
ITEM NO: 4
DATE: December 2, 2011
PROPOSAL NO.: 2729-272

STAFF EVALUATION OF A RESEARCH PROPOSAL

TITLE:	Long Range Transport of Air Pollutants into California
CONTRACTOR:	University of California, Davis
PRINCIPAL INVESTIGATOR:	Anthony Wexler, Ph.D.
TOTAL AMOUNT:	$506,084
CONTRACT TYPE:	Interagency Agreement
CONTRACT TERM:	36 Months

For further information, please contact Dr. Eileen McCauley at (916) 323-1534.

I. SUMMARY

Wind patterns in the Northern Hemisphere typically carry pollutants across the Pacific Ocean from Asia to North America. The natural and anthropogenic emissions in Asia contribute to the background concentrations of air pollutants in the air masses crossing California. This baseline in pollutant concentrations has been increasing and, with limited prospects for reductions in Asian emissions in the short-term, more stringent control efforts on emission sources in California will be needed if all health-based ambient air quality standards are to be attained. Most of what we know about Asian transport is from short-term intermittent measurements and modeling studies. To more fully characterize air quality, particularly when ozone ambient air quality standards are exceeded, this project will make continuous measurements of ozone as well as size and composition measurements of particulate matter (PM) for two years during the extended summer season (March-October) at two remote monitoring sites. The measurements will include chemical markers previously shown to be indicative of emission sources over which the air mass has passed. The measurements and data analysis associated with this project will refine the contributions of Asian transport to air quality in northern

California. This information is critical for ensuring that emission control efforts are sufficient to achieve ambient air quality standards and to avoid federal sanctions. In addition, the data will help define policy-relevant background (PRB) ozone concentrations in California. These results will help identify the need for international emission reductions, which would avoid the imposition of additional control programs on California's businesses and residents.

II. TECHNICAL SUMMARY

Objective

The transport of pollutants from the growing Asian economic region increases background concentrations of air pollution arriving in California and thus inhibits the ability of current emission control programs in California to meet ambient air quality standards. The objective of this project is to establish a small monitoring network to quantify and characterize the variable ozone and particulate pollution arriving in northern California from over the Pacific Ocean.

Background

Wind patterns in the Northern Hemisphere typically carry pollutants from Asia to North America during a 1-2 week journey across the Pacific Ocean. Previous air quality field studies, primarily making air quality measurements aloft (e.g., ICTC2K2, ARCTAS-CARB, and CalNex 2010), have all shown Asian pollution arriving over California. Recent research indicates that these natural and anthropogenic emissions (e.g., dust storms, rapidly growing economies in China and India) are increasing the background concentrations of air pollutants (e.g., ozone, PM2.5) in the air masses arriving at and crossing California. Analyses of particulate matter (PM) samples indicate widespread and persistent Asian PM in clean rural areas of the state. An analysis of ozone measurements aloft collected once per week using ozonesondes on the northern coast of California noted occasions when the concentrations were as high as 70 percent of the ozone measured at surface sites in the northern Sacramento Valley on the following day.

The pollutant concentrations associated with long-range transport may contribute to exceedances of State and Federal ozone air quality standards. A California-specific field study is needed to understand and quantify the present impacts of transport on ozone

standards attainment in northern California. This increasing baseline in observed ambient air quality concentrations and the limited prospect for reduced Asian emissions in the short-term means that more stringent control efforts on emission sources in California will be needed, if all health-based ambient air quality standards are to be attained.

Most of what we know about Asian transport is from short-term intermittent field studies. Because this information is incomplete and does not capture all the pertinent days, it cannot adequately characterize the variations in baseline concentrations. Thus, the current control measures in the State Implementation Plans for ozone (and possibly PM2.5) do not accurately account for this pollution source and its variable impact on local air quality. A better understanding of the contribution of this long-range transport of pollutants (i.e., by means of continuous air quality measurements) and additional analyses regarding its range of impacts on air quality in California is needed to adequately characterize the contribution of long-range transport to exceedances and near-exceedances of ambient air quality standards. Thus, by conducting continuous monitoring, this project would expand upon the more episodic nature of previous research. This project would better characterize the frequency and variability in not only the long-range transport of pollutants, but also various other potential sources. In addition, the impacts of long-range transport and other sources on local air quality, particularly when it is poor, can be more accurately evaluated.

Proposal Summary

This project would make continuous measurements of ozone and selected tracer gases (e.g., CO, CO_2, H_2O) as well as make size and composition measurements of PM during the extended summer seasons (March-October) of 2013 and 2014. The objective is to more fully characterize the air quality, especially when pollutant concentrations are high (e.g., exceedances and near-exceedances of ambient air quality standards), when a variety of causes (e.g., Asian transport, stratospheric intrusions, forest fires, and regional anthropogenic and biogenic emissions) can be significant factors. ARB-sponsored research has previously identified specific tracers for Asian PM (e.g., CO, CO_2, Pb, PM size and composition, pollutant ratios), detectable even in some urban areas of California. PM tracers will be measured with a Rotating Drum Impactor (RDI) aerosol instrument that samples PM in eight different size bins on a short

time-frame (e.g., 3 hours). The filter strips are analyzed for elemental composition by x-ray fluorescence (XRF). Laboratory work is currently underway to expand analytical capabilities to detect additional compounds via other analytical techniques, such as inductively coupled plasma mass spectrometry. The chemical markers in the PM measurements can be indicative of the emission sources over which the air mass has passed. A continuous measurement program like the one proposed in this project would be a significant enhancement beyond previous intermittent sampling programs and would enable Asian air masses to be routinely identified and the frequency and magnitude of their contribution to air quality and exceedances of ambient air quality standards to be more precisely characterized for northern California. This information is critical for ensuring that emission control efforts are sufficient to achieve ambient air quality standards and to avoid federal sanctions. In addition, the ozone data will help define policy-relevant background (PRB) concentrations in California. This is an important policy tool for placing more responsibility on the federal government to work for international emission reductions and for avoiding the imposition of extra control programs on California's businesses and residents.

Two of the three RDI sites would be located in the Coastal Range at locations minimally impacted by local and regional pollution sources (i.e., Cahto Peak, located about 12 miles from the coast and 25 miles NE of Fort Bragg at 4200 feet above sea level (ASL), and Chews Ridge, SW of Monterey, at ~5050' ASL). The proposed interior (northern Central Valley) site is Tuscan Butte, located about 10 miles NE of Red Bluff at 1870' ASL and is more likely to be impacted by regional pollution sources (e.g., fires, Sacramento Valley emissions). The inland site needs to be free of local pollution sources because fresh NOX emissions will temporarily suppress ozone concentrations via titration ($NO + O_3 \rightarrow NO_2 + O_2$) and potentially skew the data analysis and interpretations. The temporal and compositional characterization provided by the RDI monitoring program at air quality facilities in the Coastal Range and the Central Valley will enhance the identification of emission sources associated with long-range transport. The bulk of the measurements and transport analysis will feature the Cahto Peak and Tuscan Butte site pair in northern California as both sites will also have CO, CO_2, and H_2O measurements (in addition, Tuscan Butte will monitor CH_4 and N_2O) to support the air parcel source characterization with the RDI PM data.

This transport assessment will be enhanced by utilizing data anticipated from ongoing monitoring programs (e.g., routine air quality and meteorological monitoring programs operated by ARB, National Atmospheric and Oceanic Administration (NOAA), and local districts, ozonesonde releases at Trinidad Head, ozone and meteorological measurements on instrumented towers near the coast and south of Sacramento). The similarly instrumented Chews Ridge site is funded under a different contract (with the San Joaquin Valley Air Pollution Control District) and data collected there will be contrasted with those at the Cahto Peak site to provide some characterization of the spatial variations that occur as Pacific air masses come onshore. Collaborative data from Trinidad Head will provide additional spatial characterization of ozone concentrations along the north coast of California.

The ozone and aerosol data will be summarized and analyzed but can also be compared with predictions from global pollution models. These comparisons would be conducted to validate transport modeling from both chemical and source attribution perspectives. If the long-range transport model characterizes current conditions well, it could be used to track and predict how increasing Asian emissions will likely impact future air quality in California.

III. STAFF COMMENTS

Staff and the potential contractor have consulted with several groups regarding specific project objectives, needs, and potential enhancements to the proposed monitoring project. The investigator has agreed to upgrade the monitoring site at Cahto Peak to ensure that “data for record” are collected according to ARB’s standard procedures. Scientists from different groups (ARB, NOAA, NASA, local districts) with expertise in a variety of research areas are working together to benefit from the synergies that will occur from coordinated research planning for the summers of 2013 and 2014. Their comments, suggestions, and review of a draft proposal have resulted in this proposal seeking RSC approval. On-going discussions and coordination of future monitoring efforts will result in joint research efforts that will benefit air quality planners and guide policy-makers at local, state, and national levels.

The current proposal includes data summarization and basic analysis but does not include detailed technical analysis (e.g., modeling). The on-going discussions among potential collaborators assume that staff of the Research Division (RD) will contribute most of the data analysis for characterization of source contributions. The basic data analysis product at this time is the characterization of the frequency and magnitude of ozone impacts from various emission source types. NASA is interested in contributing some aircraft flights and NOAA is interested in providing some meteorological support (i.e., radar wind profilers) and releasing some ozonesondes. The PI is currently pursuing a collaborator with expertise in global and regional modeling to estimate future air quality impacts under various potential scenarios. Once the various complementary efforts are confirmed, the PI will developed a more detailed data analysis plan regarding what can be done with the integrated data sets and what analyses each of the collaborators has committed to performing. Professor Wexler has been a professor for 20 years and is an expert in aerosols. He is currently applying for a $10 million grant from the National Science Foundation to establish a long-term monitoring network on the West Coast to better characterize and quantify the impacts of Asian transport and to document trends.

IV. STAFF RECOMMENDATION

Staff recommends the Research Screening Committee approve this proposal for a total amount not to exceed $506,084, subject to any changes and additions specified by the Committee.

DISCUSSION OF A NEW RESEARCH PROJECT
ITEM NO.: 5
DATE: December 2, 2011
PROPOSAL NO.: 2724-272

STAFF EVALUATION OF A RESEARCH PROPOSAL

TITLE:	Atmospheric Measurement and Inverse Modeling to Improve Greenhouse Gas Emission Estimates
PRIME CONTRACTOR:	Lawrence Berkeley National Laboratory
SUBCONTRACTORS:	California Institute of Technology; $55,029; University of California, Riverside; $48,507
PRINCIPAL INVESTIGATOR:	Marc Fischer, Ph.D.
TOTAL AMOUNT:	$680,000
CONTRACT TYPE:	Standard Agreement
CONTRACT TERM:	36 Months

For further information, you may contact Elizabeth Scheehle at (916) 324-0621.

I. SUMMARY

Assembly Bill 32 (Global Warming Solutions Act of 2006, AB 32) requirements make it necessary for the Air Resources Board (ARB) to develop and evaluate a greenhouse gas (GHG) emissions inventory for California. Some of the current inventory estimates of GHGs are uncertain, especially methane (CH_4) and nitrous oxide (N_2O). Atmospheric GHG measurements from tall towers, when combined with inverse modeling estimation techniques, have the potential to independently quantify GHG emissions. The research proposed here constitutes a focused effort to evaluate California's GHG emissions inventory.

The proposed project is divided into three tasks: 1) continue to collect a long-term dataset of GHG and carbon monoxide (CO) measurements from the tall tower near Walnut Grove, California, adding continuous N_2O measurements to the existing measurement suite, and compiling a one-year measurement record for inverse

modeling; 2) expand the ARB GHG research measurement network to a new tower site in the Riverside/San Bernardino area, capturing GHG and CO emissions from the entire South Coast Air Basin (SoCAB), and compile a one-year measurement record for inverse modeling; 3) apply inverse modeling to include the new Riverside/San Bernardino measurement site and the full suite of measured GHG and CO in order to evaluate the inverse modeling methodology using ARB's independently confirmed CO emissions inventory and to evaluate ARB's GHG emissions inventory.

II. TECHNICAL SUMMARY

Objective

The proposed effort will lay the groundwork to evaluate and improve ARB's GHG emissions inventory, which is used to inform emission reduction efforts and to evaluate progress towards meeting California's target of achieving the 1990 level of GHG emissions by 2020. The major objectives of the project are to: 1) continue and extend GHG and CO measurements at existing Lawrence Berkeley National Lab (LBNL) measurement sites, 2) implement a new measurement site that covers GHG and CO emissions from SoCAB, and 3) apply inverse modeling to estimate GHG and CO emissions from the major emission regions of California.

Background

Current inventory estimates of California's GHG emissions are based on a combination of techniques that may not accurately represent California's GHG emissions. Independent estimates of GHG emissions are necessary to ensure that ARB meets its AB 32 requirements and has an accurate inventory on which to base the agency's regulations and evaluate their impact.

The proposed inverse modeling method, which estimates GHG fluxes from in-situ GHG measurements and windfields, can provide an independent estimate of GHG emissions. This approach has been widely applied at both global and regional scales. In general, the components of inverse modeling are GHG concentration measurements, an atmospheric transport model (including chemistry for global simulations), *a priori* GHG emission estimates, and a statistical technique to minimize differences between measured and predicted GHG concentrations. This proposed project will apply the inverse modeling method to estimate CO emissions using the measurements collected

from this monitoring network. CO has been widely used as a tracer for urban emissions and can be used to evaluate the inverse modeling methodology with ARB's CO emissions inventory that has already been independently confirmed by tunnel studies and fuel-based inventories.

In collaboration with National Oceanic and Atmospheric Administration (NOAA), the LBNL has been conducting tall-tower GHG measurements and inverse modeling for the California Energy Commission (CEC) and ARB. In 2007, LBNL started the CEC-supported California Greenhouse Gas Emissions Measurement (CALGEM) project for CH_4 and other non-CO_2 GHG emissions. From 2007 to the present, measurements of many of the important long-lived GHGs (CO_2, CH_4, N_2O, and high-global warming potential gases) have been made at towers in San Francisco (Mt. Sutro) and the Sacramento Delta area (Walnut Grove). In addition to the main GHG species, air samples from Walnut Grove are being analyzed for radiocarbon $^{14}CO_2$ which serves as a tracer of locally emitted fossil fuel CO_2.

Of particular relevance to the current proposal, LBNL has been active in developing and applying the inverse modeling method to estimate CH_4 emissions from a sub-region of California using tower-based CH_4 measurements. LBNL has carried out inverse modeling analyses using measured CH_4 data at Walnut Grove and showed that CH_4 emissions from central California are about 50 percent higher than emission inventory estimates. Being able to extend the analysis in time and location will allow ARB to determine the reasons for the discrepancies as well as identify other potential uncertainties.

Proposal Summary

This proposed research project will enable ARB to: 1) continue measurements of a suite of GHGs (CO_2, CH_4, N_2O, and high-global warming potential gases) and CO at the CALGEM sites and integrate them into the ARB network, 2) expand the ARB measurement network to comprehensively sample GHG and CO emission sources in the SoCAB, and 3) conduct comprehensive inverse modeling to quantify California's GHG and CO emissions. The product of this work will be a rigorously defensible evaluation of selected GHG emission inventories and a measurement and modeling system capable of continuing those estimates into the future.

III. STAFF COMMENTS

Feedback from ARB staff was shared with the proposed principal investigator and modifications to the proposal were implemented to the satisfaction of staff. In general, reviewer comments focused on details of the sampling plan and the proposed inverse modeling analyses. Agreement was reached between ARB and the principal investigator to collect data and conduct inverse modeling for at least one year. This approach will allow direct comparison between ARB's GHG and CO emission inventory and modeled emission estimates. As a result, this project will generate spatially disaggregated CO emissions that can be compared to the existing CO emission inventory as a check on the inverse modeling methodology. The project has the potential to identify under- or over-estimated GHG emission regions and source types. ARB staff will then be able to utilize the results to improve the GHG emissions inventory.

Dr. Marc Fischer is well known for his extensive experience in the measurement and modeling of GHG emissions. Additionally, this research project will utilize the supercomputing power facility at LBNL for inverse modeling runs.

IV. STAFF RECOMMENDATION

Staff recommends the Research Screening Committee approve this proposal for a total amount not to exceed $680,000, subject to any changes and additions specified by the Committee.

DISCUSSION OF A NEW RESEARCH PROJECT
ITEM NO: 6
DATE: December 2, 2011
PROPOSAL NO.: 2732-272

STAFF EVALUATION OF A RESEARCH PROPOSAL

TITLE:	Source Speciation of Central Valley GHG Emissions using In-Situ Measurements of Volatile Organic Compounds
CONTRACTOR:	University of California, Berkeley
PRINCIPAL INVESTIGATORS:	Allen H. Goldstein, Ph.D. Mark Fischer
TOTAL AMOUNT:	$360,000
CONTRACT TYPE:	Interagency Agreement
CONTRACT TERM:	36 Months

For further information, please contact Dr. Eileen McCauley at (916) 323-1534.

I. SUMMARY

Accurate and precise greenhouse gas (GHG) emission inventories for all source categories are essential to determine their mitigation potential and to apportion the required GHG emission reductions. The Air Resources Board's (ARB) GHG emission inventories have gone through a number of evaluation and validation exercises. Nevertheless, peer-reviewed literature and ARB-supported research recommends further improvements, particularly to the methane (CH_4) and nitrous oxide (N_2O) inventories. Many GHG emission sources also emit volatile organic compound (VOC) species which can help to identify the source. Using a proton transfer reaction mass spectrometer (PTR-MS), this study would add speciated VOC measurements to the measurement program at a tall tower in Walnut Grove. Using speciated VOCs, this study would develop detailed GHG source profiles and test their use in more robust inverse estimation and modeling for GHG emission inventory evaluation and validation.

II. TECHNICAL SUMMARY

Objective

This project is intended to evaluate and demonstrate the use of VOCs as source tracers for non-CO_2 GHGs; thus providing a new tool to potentially validate GHG emission inventories in California. Specific project objectives are to deploy a PTR-MS at five elevations from close to ground to roughly above 500 meters to measure speciated VOCs strongly related to emission sources that also emit CH_4 and N_2O. Using these relationships, the project would provide estimation of CH_4 and N_2O emissions from these sources and, given the right meteorological conditions, the project would support inverse modeling of these emission inventories.

Background

The Climate Change Solutions Act of 2006 (AB 32) requires reduction of California's GHG emissions. Building and testing GHG inventories has been the subject of significant effort even before AB 32 through research at the California Energy Commission, ARB and academia. Prior research by the co-principal investigator (co-PI) in this study has predicted variations in atmospheric GHG concentration due to fossil fuel emissions and terrestrial ecosystem exchange. One method to apportion different sources requires measurement of multiple species that can serve as source tracers and an extensive set of aloft measurements. However, such data are not common. Aside from Walnut Grove Tower, Mount Wilson, Sutro Tower, and a few developing sites, California has few continuous multiple GHG measurement sites.

Using inverse emission estimates, prior research by the co-PI to estimate source contributions to non-CO_2 GHG emissions has used observations made from a tall tower at Walnut Grove. The tower provides samples at multiple heights representing different geographic extents for continuous CO_2, CH_4, CO, and ^{222}Rn and daily flask sampling (analyzed daily for CO_2, CO, CH_4, N_2O, SF_6, and periodically for broad suite of halo carbons and isotopes of CO_2, and CH_4). Continuous N_2O measurements may also be added. Inverse emission estimates rely on accurately measured GHG mixing ratios to determine local-to-regional enhancements above background levels; these estimates require a clear understanding of local and regional meteorology combined with detailed meteorological modeling including long-distance and multi-height trajectory analysis.

Proposal Summary
The project has five tasks:

1. Recognizing the strong association of some speciated VOCs with GHG emissions such as nonanal with rice cultivation (CH_4 and N_2O), hydrogen sulfide with manure management and landfills (CH_4), and acetonitrile with biomass burning (N_2O), begin to develop emission inventory profiles for these GHG sources that include not only CH_4 or N_2O but also a likely set of strongly associated speciated VOCs.

2. Optimize a PTR-MS, which was deployed at the Walnut Grove tower for a pilot study, for improved sensitivity, precision, stability, remote control, and data access. In particular, use the pilot study data to improve detection efficiency for VOC species critical to particularly important sources.

3. Collect a year's worth of data in the form of 10-minute segment measurements per each hour per each elevation and combine them with other co-located continuous and semi-continuous data such as ozone and meteorological parameters.

4. Using data analysis techniques, (e.g. cluster and factor analysis, source receptor simulations) partition GHG emissions using speciated VOCs as a tracer of various emissions inventory source strengths and begin to build GHG emissions profiles with a larger number of elements (additional dimensionality will be helpful for source receptor analysis).

5. When and where meteorological parameters and analysis permit, begin to conduct inverse modeling using these newly developed profiles to estimate strength of these emissions and compare them with those available in official GHG emission inventories. Provide a final report with the analysis and modeling results and communicate this report to ARB.

III. STAFF COMMENTS

ARB staff notes that many VOC species, for example acetonitrile, that are strongly associated with a particular emission source (biomass burning in this case) can also be associated with other sources (refineries, pharmaceuticals, and photographic film). Further, it is not clear whether the level of precision and accuracy for VOC species to contribute significantly to current inverse modeling findings may be within the capabilities of the PTR-MS data protocols; ethanol, for example, is difficult to measure with PTR-MS. Other additional data elements such as less abundant isotopic CH_4 and N_2O species concentrations have been used to add capability to GHG emission inventory assessments; no other speciated VOC efforts have been tried before this study. On the other hand, extensive VOC species profiles for most emission source categories exist and should aid profile building and testing. Source receptor analysis using VOC speciation is also a standard of existing data analysis techniques for ozone and particulate matter purposes.

Over the last fifteen years, Professor Goldstein has been the key principal investigator for work on biogenic emission inventories in California, for the CalNex field study, for work on new aerosol and speciated VOC instruments and much else. In the last seven years, Dr. Fischer has been the key principal investigator for inverse modeling of the Walnut Grove tower, Sutro tower, and Mount Wilson datasets to understand important deficits of ARB greenhouse gas emission inventories and was a key participant in the CalNex field study.

IV. STAFF RECOMMENDATION

Staff recommends the Research Screening Committee approve this proposal for a total amount not to exceed $360,000, subject to any changes and additions specified by the Committee.

DISCUSSION OF A NEW RESEARCH PROJECT
ITEM NO: 7
DATE: December 2, 2011
PROPOSAL NO.: 2727-272

STAFF EVALUATION OF A RESEARCH PROPOSAL

TITLE:	Development of a New Methodology to Characterize Truck Body Types along California Freeways
CONTRACTOR:	University of California, Irvine
PRINCIPAL INVESTIGATOR:	Stephen G Ritchie, Ph.D.
TOTAL AMOUNT:	$350,000
CONTRACT TYPE:	Interagency Agreement
CONTRACT TERM:	24 Months

For further information, please contact Jonathan Taylor at (916) 445-8699.

I. SUMMARY

Inductive loop detector (ILD) systems are widely deployed in major freeway corridors in the United States to collect traffic data. However, the current systems only provide the number of vehicles and occupancy data. These systems are unable to characterize the traffic composition such as the percentage of trucks and buses, which is a critical input for emissions estimation. Recently, University of California, Irvine (UCI) under contract with ARB developed a California Vehicle Activity Database (CalVAD) to estimate highway vehicle miles traveled (VMT), average speed, heavy-duty truck VMT and heavy-duty truck weight. However, these enhancements do not provide information on truck body classification and the relationship between body size and weight characteristics that influence emissions from the truck fleet. Therefore, this study proposes to develop and implement an improved data collection methodology that will provide body type classification for trucks traveling on the California freeway system. This project includes development of a truck body classification model that will use

classifications similar to the classifications in the Vehicle Inventory Use Survey (VIUS)[1]. The results from the proposed study are expected to differentiate between freight and non-freight trucks both spatially and temporally. The results of this study can be used to estimate the proportion of long haul and short haul trips in major corridors. This will lead to improvements in emission inventory models to predict the effectiveness of various emissions control program. Further, the information from this study will also be used to calibrate and validate the statewide freight-forecasting model and will help inform freight models under development by metropolitan planning organizations (MPOs). Ultimately, the results from this study will help to develop strategies to reduce emissions from California's goods movement.

II. TECHNICAL SUMMARY

Objective

The main objective of this study is to develop a truck body classification model using inductive loop signature data. The second objective is to deploy a pilot program to collect ILD signature data at two Weigh-in Motion (WIM) stations using the advanced detector cards. The third objective is to evaluate the performance of the developed model by deploying advanced detector cards to an additional 8 to 10 stations.

Background

In California, on-road trucks are significant sources of criteria and greenhouse gas (GHG) emissions. Emissions estimation is complicated by the large number of trucks registered in other states that move goods into and out of California. Both state and federal agencies are investing billions of dollars to reduce goods movement emissions. However, the existing system for measuring truck activity does not provide enough detail to develop control strategies to mitigate emissions from goods movement in the future. Therefore, there is an increasing need to have more accurate truck activity and body type information.

Currently truck activity data is collected using the Vehicle Detection Station (VDS) and WIM sites in operation across California. VDS stations (more than 13,000) are widely installed in the California freeway system to measure traffic volume and vehicle

[1] VIUS provides data on the physical and operational characteristics of the nation's private and commercial truck population.

occupancy every 30 seconds. This provides estimates of truck counts but does not provide detailed truck classification. On the other hand, sparsely located WIM stations (about 106) collects gross vehicle weight, individual axle weights, vehicle speed, overall vehicle length, axle spacing, and vehicle classification, in real time from the traffic stream. A key element of the WIM system is that the data are generated continuously. The vehicle weight is measured by plates or piezo sensors embedded in the pavement. Speeds and vehicle lengths are measured using inductive loops that are placed before and after each weight sensor. However, both VDS and WIM do not provide information regarding body type of trucks and commodity flow. This information is critical for goods movement studies and freight forecasting models.

Proposal Summary

Researchers at UCI propose to develop a truck body type classification model using inductive loop signature and axle configuration data. This study is divided into three phases. In phase I, a body type classification model will be developed using data collected at the San Onofre VDS station (located between Los Angeles and San Diego) to establish proof-of-concept. The model will be validated based on ground-truth data and rigorous statistical analysis. The model will distinguish between truck and non-truck vehicles and provide detailed body classification similar to VIUS classification. In addition, this phase will explore the hardware requirements to install advanced detector cards at WIM stations to collect signature data without compromising the existing data collection system. In phase II, two or more WIM stations will be selected and advanced detector cards will be deployed to collect wide variations of signature data that were not captured in phase I (e.g., agricultural and logging trucks). The model developed in phase I will be refined and recalibrated using additional information such as axle spacing and weight to identify the body type and improve the accuracy. Further, the research team will explore statistical techniques to back-cast truck body classifications and truck movements to previous years. In phase III, more VDS and WIM stations will be identified with the support of California Department of Transportation (Caltrans) to deploy advanced detector cards to test the reliability and accuracy of the classification model.

III. STAFF COMMENTS

This project will address the body type data gap in quantifying the criteria and GHG emissions from trucks and fill a critical research need in goods movement studies. The draft proposal was reviewed by staff at ARB and at Caltrans. Comments were integrated into the revised project proposal and there are no remaining concerns or issues regarding the work proposed. Staff from ARB and Caltrans endorses this project and feel that it will benefit the state since it improves the emissions inventory and data for freight forecasting models. Moreover, it is a cost-effective approach for truck activity data collection.

Professor Stephen Ritchie, the Principal Investigator, has conducted similar work in the past for Caltrans. He has extensively published and is a recognized expert in the field of Intelligent Transportation Systems. Study results will help ARB, Caltrans, MPOs and other state agencies design programs to reduce truck emissions and improve fuel efficiencies. Ultimately, the project will advance California's efforts for meeting the goals of the goods movement emission reduction program and AB 32.

IV. STAFF RECOMMENDATIONS

Staff recommends the Research Screening Committee approve this proposal for a total amount not to exceed $350,000, subject to any changes and additions specified by the Committee.

DISCUSSION OFA NEW RESEARCH PROJECT
ITEM NO: 8
DATE: December 2, 2011
PROPOSAL NO.: 2728-272

STAFF EVALUATION OF A RESEARCH PROPOSAL

TITLE:	Evaluating Mitigation Options of Nitrous Oxide Emissions in California Cropping Systems
CONTRACTOR:	University of California, Davis
PRINCIPAL INVESTIGATORS:	Martin Burger, Ph.D. William R. Horwath, Ph.D. Johan Six, Ph.D.
TOTAL AMOUNT:	$400,000
CONTRACT TYPE:	Interagency Agreement
CONTRACT TERM:	36 Months

For further information, please contact Dr. Dongmin Luo at (916) 324-8496

I. SUMMARY

The agricultural sector is the largest contributor of nitrous oxide (N_2O), a potent greenhouse gas (GHG), both globally and in California, accounting for about 60 percent of anthropogenic N_2O emissions. Since N_2O is produced in soil through microbial processes involving nitrogen (N) compounds, its emissions from agricultural soils are closely related to soil nitrogen content, but highly variable due to numerous environmental factors that govern microbial activities. Therefore, crop management practices that affect microbial activities in soil would also affect N_2O emissions. This project will identify and quantify the N_2O emission reduction potential from alternative management practices for five important crops in California: grapes, almonds, lettuce, tomatoes, and corn. The proposed alternative management practices will include: use of alternative nitrogen fertilizers, use of nitrification and urease inhibitors, fertigation via subsurface drip irrigation (SDI), changing cover crops, organic farming, and conservative tillage. This project is expected to provide data needed for the development of potential agricultural offset protocols pursuant to AB 32.

II. TECHNICAL SUMMARY

Objective

The purpose of this project is to identify alternative management practices that can reduce N_2O emissions from five important California crops: grapes, almonds, lettuce, tomatoes, and corn. Specific objectives are to: 1) identify experimental sites and establish standard and alternative management practices for the crops, 2) measure N_2O fluxes and estimate emission differences between the standard and alternative management practices, 3) characterize key variables controlling N_2O emissions, and 4) measure crop yields to evaluate yield-based N_2O emission factors and cost-effectiveness.

Background

Agricultural soils are a significant source of anthropogenic N_2O that contributes to climate change. Because production of N_2O in soil is driven by soil microorganisms, the N_2O emission flux from soil is dependent on numerous environmental factors that affect microbial activities. The complex interactions of microbiological processes and soil conditions, e.g., soil nitrogen content, soil water content, organic carbon availability, and temperature, control N_2O dynamics in the soil and thus its emission fluxes. Therefore, agricultural management practices which are intended to manipulate the above soil factors for the benefit of crop production will affect N_2O emissions.

This project is the second phase of the N_2O research program that was initiated in 2007 as part of the AB 32 Scoping Plan. The first phase, to be completed in 2012-2013, has been characterizing baseline N_2O emissions from major California cropping systems under conventional management practices. The proposed project will evaluate the effects of alternative management practices on N_2O emissions from five of the major cropping systems.

Management options, such as use of nitrification inhibitors, conservation tillage, and fertigation, have been effective in mitigating N_2O or overall GHG emissions from agricultural soils, but their impacts have not been examined under California-specific conditions. This project is intended to investigate selected management options for important California crops that are considered to have the best potential to reduce N_2O

emissions, and to be feasible both technically and economically. The study will provide information critically needed for the development of agricultural offset protocols.

Proposal Summary

The project will consist of the following five technical tasks:

1) Select experimental sites and establish experimental treatments

   Experimental sites will be selected in main production areas for the crops. Soil type, soil stratification, and depth to water table (DWT) will be examined to ensure the representativeness of these test sites. Soil management history and availability of grower's collaboration will also be considered. Both conventional and alternative management practices will be established for each of the five crops.

2) Monitor N_2O fluxes

   N_2O emissions data will be collected for two years at a frequency that matches the expected emission fluxes. Diurnal fluctuations will be characterized through short-term, detailed time-series measurements of N_2O fluxes.

3) Calculate annual N_2O emissions and emission reduction potentials

   The measured N_2O flux data will be used to calculate annual N_2O emissions for each practice. Statistical analysis will be carried out to assess the significance of emission differences between conventional and alternative management practices, and the N_2O emission reduction potential will be calculated.

4) Measure crop yields and calculate N use efficiency.

   Crop yield and total biomass will be measured at harvest to evaluate economics of the management options and calculate N fertilizer use efficiency. The production of biomass reflects the amount of carbon dioxide (CO_2) fixation, although CO_2 emissions will not be monitored.

5) Evaluate effects of environmental variables on N_2O emissions.

   Key environmental variables include soil N availability, soil water content as water-filled pore space (WFPS), soil organic carbon content, bulk density, and soil and air temperatures. These variables will be measured concurrently with N_2O monitoring and evaluated for their impact on N_2O emissions.

III. STAFF COMMENTS

This proposal was developed in close consultation with ARB staff by a team of scientists who have been involved in research projects assessing baseline N_2O emissions from California cropping systems. The research concept presented in ARB's FY 2011-12 Annual Research Plan, as well as an earlier version of the proposal, were shared with the California Energy Commission, the California Department of Food and Agriculture, and a large group of environmental and industry stakeholders. ARB staff received extensive feedback on the selection of the crops and mitigation options. The crops and management options selected for this project are consistent with input from the stakeholder's suggestions, although we were unable to cover all of suggested crops and management options due to limited funding. Their suggestions may be pursued in the future if additional funds become available. The principal investigators are actively working with stakeholders to seek more funds to cover additional management practices including organic farming operations for lettuce and corn.

The University of California, Davis research team has a solid track record in research involving nitrogen geochemical cycling in agricultural ecosystems. The principal investigator for this project, Dr. Martin Burger, is currently the project manager for the three ARB-funded investigations dealing with baseline N_2O and NO_X emissions from California cropping systems. The co-principal investigators, Drs. William Horwath and Johan Six, are the principal investigators for several N_2O projects, funded by ARB, other state agencies, and other entities. This project will provide California-specific data on best management practices that reduce N_2O emissions from important California crops, and inform the development of potential agricultural offset protocols. The N_2O emission data collected from the project will also be used to calibrate and validate geochemical models, such as DNDC (DeNitrification-DeComposition), to improve their applicability to California cropping systems.

IV. STAFF RECOMMENDATION

Staff recommends that the Research Screening Committee approve this proposal for a total amount not to exceed $400,000, subject to any changes and additions specified by the Committee.

DISCUSSION OF A NEW RESEARCH PROJECT
ITEM NO.: 9
DATE: December 2, 2011
PROPOSAL NO.: 2726-272

STAFF EVALUATION OF A RESEARCH PROPOSAL

TITLE:	Assessment of the Emissions and Energy Impacts of Biomass and Biogas Use in California
PRIME CONTRACTOR:	University of California, Irvine; $144,997
SUBCONTRACTOR:	University of California, Davis; $25,000
PRINCIPAL INVESTIGATORS:	Donald Dabdub, Ph.D. Jacob Brouwer, Ph.D.
TOTAL AMOUNT:	$169,997
CONTRACT TYPE:	Interagency Agreement
CONTRACT TERM:	24 Months

For further information, please contact Dr. Dongmin Luo at (916) 324-8496.

I. SUMMARY

ARB has adopted regulations to promote renewable electric power and renewable transportation fuels through the Renewable Electricity and the Low Carbon Fuel Standards. Increased use of biomass and biogas can lead to reduced emissions of criteria pollutants and greenhouse gases (GHG). Sewage digester gas, landfill gas, and biomass resources can be used to generate electricity and heat, and to provide renewable gaseous or liquid fuels for stationary and vehicular applications. This study will quantify the emissions from various fuel paths that utilize biomass and biogas, and determine the potential to exploit emerging resources, focusing on the South Coast Air Basin (SoCAB) and the San Joaquin Valley (SJV). This study will use the resulting data as input into air quality modeling to determine the overall air quality impacts and GHG emissions of the projected biomass and biogas infrastructure. The results will provide a

scientific basis to evaluate the potential air quality co-benefits of biomass and biogas use.

II. TECHNICAL SUMMARY

Objective

The objectives are to analyze biomass and biogas resources and their integration into local fuel infrastructure in both urban and rural/agricultural environments, to determine the associated emissions of GHGs and criteria pollutants, and to evaluate the potential air quality co-benefits of biomass and biogas use. Specific objectives include:

1. Analysis of biomass and biogas resources, and prediction of their integration into urban and rural environments,
2. Determination of resulting GHG and criteria pollutant emissions, and
3. Determination of resulting air quality impacts (ozone and particulate matter).

Background

Biomass and biogas resources have the potential to provide a significant portion of the energy requirements in California while reducing GHG emissions and also addressing air quality and waste disposal issues. Historically, most biogas energy has been derived from digester gas and landfill gas, and most biomass energy has been derived from wood and forest residues. However, additional sources are increasingly being used to generate electricity and renewable fuels: municipal solid waste, digestion of new waste streams such as dairy waste and food processing waste, and gasification of wastewater residues such as sludge. Biogas from digestion and from gasification of waste streams has the potential to provide added net energy benefits because the feedstock is already available and usually requires costs for removal or disposal that can be averted. Using the biomass and biogas fuels in a natural gas driven energy conversion device reduces the need for conventional fuel and contributes to energy sustainability while reducing emissions of GHGs and criteria pollutants.

Proposal Summary

The University of California, Irvine (UCI) will evaluate the potential and constraints of carbon-neutral electricity and vehicle fuel (hydrogen, biogas) supply, based upon regional renewable bio-resources. To provide a range of renewable bio-resources, UCI will focus on two distinct regions: the mostly urban SoCAB, and the mostly rural and agricultural SJV. The proposal describes four technical tasks that together involve the

analysis of biomass resources and their integration into local fuel infrastructure in the SoCAB and the SJV, the determination of net emissions of GHGs and criteria pollutants, and the determination of resulting air quality impacts. Each task is briefly described below.

Task 1: Analysis of biomass and biogas resources in the SoCAB

This task consists of three sub-tasks. For sub-task 1.1, the California Biomass Collaborative will provide up-to-date information on biomass/biogas resources and facilities. Sub-task 1.2 involves evaluation of the potential and constraints of carbon-neutral electricity and vehicle fuel supply, based upon renewable bio-resources in the SoCAB. These include wastewater treatment and landfill gas, green waste, and agricultural and dairy waste. UCI will quantify the available bioenergy sources and estimate their potential hydrogen and biogas generation capacity. This includes evaluation of dedicated single-purpose plants, such as direct biogas combustion or biogas reformation, to determine the optimal bioenergy strategy. Sub-task 1.3 will analyze the resulting infrastructure to calculate projected emissions outputs and resource consumption for several biomass and biogas technology deployments. UCI will provide emissions and resource results for scenarios that include electricity generation and renewable methane and hydrogen generation, delivery, and dispensing technologies, and the carbon impact based on life cycle analysis. Geographic Information System (GIS) tools will be used to allocate the biomass/biogas-based infrastructure.

Task 2: Analysis of biomass and biogas resources in the SJV

This task will be conducted similarly to task 1, except the focus will be on the SJV. GIS tools will be used to determine plausible infrastructure deployment, including optimal location of large co-digestion plants and small distributed biomass plants. Scenarios favoring the direct use of biogas will be developed and evaluated, including compressing, liquefying, and injecting gas into the transmission system.

Task 3: Determine GHG and pollutant emissions

Sub-task 3.1 involves the use of UCI's Preferred Combination Assessment (PCA) model to integrate the biomass and biogas technology combinations and their emission factors into infrastructure scenarios on a life cycle basis. This will include GHG analyses

that consider resource availability and type of feedstock. ARB certification process information, and data provided by the California Biomass Collaborative (CBC), will be used to obtain emission factors for biomass and biogas technologies. Sub-task 3.2 consists of the development of spatially- and temporally-resolved emissions fields associated with each biomass/biogas implementation scenario. Both baseline emissions inventories and biomass/biogas implementation scenario emissions inventories will be developed for a future year (e.g., 2020), for use in regional air quality models.

Task 4: Determine air quality impacts

This task involves the allocation of emissions for each biomass/biogas implementation scenario, by air basin, and their entry into the Community Multiscale Air Quality (CMAQ) model to obtain levels of ozone and particulate matter in the SoCAB and SJV air basins.

III. STAFF COMMENTS

UCI submitted a research concept and subsequently a draft proposal, which were reviewed by staff from the California Energy Commission (CEC) and ARB. CEC staff suggested that UCI contact the CBC at the University of California, Davis, which led to the proposed subcontract for this project. The CBC coordinates California's research and technology development in bioenergy and biomass, so this subcontract will ensure the availability of the latest information on biomass technological developments and projections. Dr. Dabdub, a professor in UCI's Advanced Power and Energy Program, has successfully completed several ARB-funded research contracts. Dr. Brouwer, Associate Director of UCI's Advanced Power and Energy Program and UCI's National Fuel Cell Research Center, has conducted research in air quality and GHG impacts of future energy technologies.

IV. STAFF RECOMMENDATION

Staff recommends the Research Screening Committee approve this proposal for a total amount not to exceed $169,997, subject to any changes and additions specified by the Committee.

REVIEW OF A DRAFT FINAL REPORT
ITEM NO.: 1
DATE: December 2, 2011
CONTRACT NO.: 07-309
Link to Report

STAFF EVALUATION OF A DRAFT FINAL REPORT

TITLE:	Is Disparity in Asthma among Californians due to Higher Pollution Exposures, Greater Vulnerability, or Both?
CONTRACTOR:	University of California, Los Angeles
PRINCIPAL INVESTIGATOR:	Ying-Ying Meng,DrPH
TOTAL AMOUNT:	$299,794
CONTRACT TYPE:	Interagency Agreement
CONTRACT TERM:	24 months

For further information, please contact Dr. Barbara Weller at (916) 324-4816.

I. SUMMARY

The California Health Interview Survey (CHIS) is a population-based random-digit dial telephone survey conducted in California every two years since 2001 and directed by the University of California, Los Angeles (UCLA) Center for Health Policy Research. According to analysis of the CHIS 2003 data, 4.5 million Californians suffer from asthma and an additional 3.4 million Californians suffer from asthma-like symptoms. Previous studies have indicated that children, the elderly, racial/ethnic minorities, and low-income Californians suffer disproportionately from asthma and asthma-like symptoms. Studies have also indicated that some sub-populations are more affected by pollutants due to increased vulnerability or increased exposures. Data from the CHIS project was used to examine air pollution susceptibility in vulnerable populations and to provide information on whether the disproportionate burden of asthma or asthma-like symptoms among low socioeconomic status (SES) individuals is related to greater pollutant exposures, greater vulnerabilities, or both. Using Geographic Information System (GIS) software, CHIS 2003 respondents' residential addresses were linked to air pollution data for O_3,

PM10, PM2.5, and NO_2 from the nearest air monitoring stations. Annual pollutant averages and days exceeding air quality standards were calculated. Traffic density and residential distance to roadways were also determined. Higher exposures were found for lower income groups and racial/ethnic minorities (Latino, African Americans and Asian/Pacific Islander/Other) for NO_2, PM10, and PM2.5. The study found associations between pollutant exposures and increased asthma outcomes among adults and children. The results suggested that some racial/ethnic populations (Latino, African Americans and Asian/Pacific Islander/other) and low-income groups had greater levels of adverse asthma outcomes with similar increases in air pollution exposures compared to higher income reference groups (white). Overall, the results of this study found that some lower income and minority groups are more impacted by air pollution due to higher exposures and in addition, certain lower income and minority groups are more vulnerable to the effects of air pollution exposures than other groups.

II. TECHNICAL SUMMARY

Objective

Linking existing air pollutant data from ambient monitors, traffic data, and CHIS 2003 data, this study tested the following hypotheses: 1) Vulnerable sub-populations in California (e.g., racial/ethnic minorities and low-income individuals) have higher exposures to air pollution; 2) Individuals with asthma or asthma-like symptoms exposed to higher levels of air pollution are more likely to report adverse health outcomes; 3) Air pollution exposures, low SES, and certain vulnerability factors exert independent adverse effects on individuals with asthma or asthma-like symptoms; and 4) The effects of vulnerability factors, such as access to health care, will result in more adverse asthma outcomes in vulnerable sub-populations exposed to higher levels of air pollution.

Background

Despite major advances in the development of anti-inflammatory medications in the last two decades, children, the elderly, racial/ethnic minorities, and low-income Californians suffer disproportionately from asthma and asthma-like symptoms. CHIS data provides population-based information which can be used to examine the association between exposure to air pollution and adverse respiratory health outcomes while also

incorporating SES, disease management, and risk factors such as smoking, obesity, and access to care.

Project Summary

To investigate the effects of air pollution on those with asthma and asthma-like symptoms in California and to identify potentially vulnerable subgroups, a cross-sectional study was conducted linking CHIS 2003 questionnaire data to existing air pollutant and traffic data. Three populations were included in the analyses: respondents with lifetime asthma (N=5,620 adults and 1,889 children), those with current asthma (N=3,587 adults and 1,224 children), and those not diagnosed with asthma that experienced asthma-like symptoms (N=4,413 adults and 1,109). Respondents living in their current neighborhood for less than nine months were excluded. Using GIS software, the respondents' residential addresses were linked to criteria pollutants (O_3, PM10, PM2.5, and NO_2) from the nearest air monitoring stations. Annual pollutant averages for the 12-month period prior to respondents' interview dates were calculated. Exceedance frequencies (e.g., number of days or hours above the standards) for these pollutants were also calculated. Traffic density and distance to roadways as proxies for traffic exposure based on residential address were calculated. The investigators performed statistical analyses to examine associations between air pollution and asthma outcomes and additional analyses were performed to evaluate increased vulnerability to pollutants among sub-populations. Pollutant-outcome models were adjusted for several potential confounders related to vulnerability, such as smoking, obesity, heart disease, and having a usual source of health care.

The investigators found disparities in exposure to air pollutants that related to low income and certain race/ethnicities among Californians with current asthma. In general, higher exposures were consistently observed for lower income groups and racial/ethnic minorities (Latino, African Americans and Asian/Pacific Islander/Other) for NO_2, PM10, and PM2.5. In contrast, annual average O_3 exposure was generally lower or about the same in these groups compared to the corresponding reference groups. Similar exposure disparities were observed for respondents with asthma-like symptoms. Associations with annual pollutant averages were seen for all asthma outcomes, mostly among adult respondents. They also observed associations with the number of days exceeding federal or state standards for O_3 and PM. In respondents not diagnosed with

asthma, some associations were seen between asthma-like symptoms and annual air pollutant averages and exceedance measures. The study was able to detect a few associations for traffic density and distance to roadway measures with asthma and asthma-like symptoms. Pollutant associations remained after adjusting for several potential confounders in the analyses. Associations were found for race/ethnicity and household federal poverty level with annual average pollutant exposures for NO_2 and PM10, suggesting that certain racial/ethnic (Latino, African American and Asian/Pacific Islander/other) and low-income groups have greater levels of adverse asthma outcomes with similar increases in air pollution exposures compared to higher income reference groups (white). Overall, the results of this study found that some lower income and minority groups are more impacted by air pollution due to higher exposures and in addition, certain lower income and minority groups are more vulnerable to the effects of air pollution exposures than other groups.

III. STAFF COMMENTS

Staff comments on the first draft of the report were sent to the investigators for their consideration, and they have addressed all the staff's concerns in the current version of the report.

IV. STAFF RECOMMENDATION

Staff recommends that the RSC accept this draft final report, subject to inclusion of appropriate additions and revisions in response to the staff comments and any changes and additions specified by the Committee.

REVIEW OF A DRAFT FINAL REPORT
ITEM NO.: 2
DATE: December 2, 2011
CONTRACT NO.: 07-322
Link to Report

STAFF EVALUATION OF A DRAFT FINAL REPORT

TITLE:	Retail Climate Change Mitigation: Life-Cycle Emission and Energy Efficiency Labels and Standards
CONTRACTOR:	University of California, Berkeley
PRINCIPAL INVESTIGATOR:	Arpad Horvath, Ph.D.
TOTAL AMOUNT:	$265,144
CONTRACT TYPE:	Interagency Agreement
CONTRACT TERM:	54 Months

For further information, please contact Fereidun Feizollahi at (916) 323-1509.

I. SUMMARY

Air Resources Board (ARB) is at the forefront of reducing greenhouse gas (GHG) emissions from a wide range of sources. Estimates are that up to 67 percent of the annual GHG "footprint" of the average United States consumer is attributable to the purchase, use, and disposal of retail products. The emissions associated with their manufacture, use, and disposal may represent an untapped source of potential GHG emissions reductions. The contractor developed a model to estimate total lifecycle GHG emission for 22 retail products sold in California.

The completed research provides ARB with:

- A comprehensive emission multi-regional input-output (MRIO) lifecycle analysis (LCA) model that characterizes the embedded GHG emissions of retail products sold in California.
- An estimate of lifecycle GHG emissions reductions technically attainable for 22 retail products.

- An assessment and analysis of the emissions reduction from a labeling and a standards program if applied to these 22 products.

II. TECHNICAL SUMMARY

Objective

For a workable labeling program, individual companies would need to estimate the embedded GHG emissions for each product labeled. The creation of a model to estimate total lifecycle GHG emissions for retail products will help the State pursue this source of GHG emissions. The purpose of this research is to develop an analytical framework (model) to assess the potential lifecycle GHG emissions reductions that could occur through the use of a GHG emissions label and standards program for retail products sold in California.

Background

The manufacturing, use, and disposal of retail products in the United States account for as much as 67 percent of the annual GHG emissions. As such, retail products may represent a large, untapped source of potential GHG emissions reductions for the State. The development of a model to assess lifecycle GHG emissions for retail products and the impact of labels and standards on GHG emissions reductions could help the State pursue this source of GHG emissions.

Labels and standards could also provide manufacturers with significant incentives for minimizing the lifecycle GHG emissions of retail products sold in California. This research addressed two critical needs:

1. The need for analytical methods to quantify lifecycle GHG emissions of policies, such as product labeling and standards.
2. The need to assess the emissions reductions that are likely to occur in California due to the policies.

This research provides ARB with a framework -- to assess the potential impact of labeling and product standards for retail products on GHG emissions reductions in California.

For the 22 products considered in this study, it was found that energy-using devices and animal-based food items offered the greatest potential reductions among the products considered. In terms of the estimated potential GHG emissions reductions, 10 of the 22 products considered accounted for 90 percent of the estimated reduction potential. Of these 10, four were energy-using devices (refrigerator, water heater, flat panel TV, and desktop PC control unit) and four were animal-based food items (beef, milk, cheese, and chicken). The total technical potential for lifecycle GHG emissions savings for the 22 products was estimated at 29 MMT CO_2e over the period 2011-2015. Restaurants — the only commercial sector expenditure considered in this study — were estimated to be the number one emitter of lifecycle GHG emissions and also ranked number one in terms of estimated GHG emissions reductions potential. The implication of these results is that the service sectors might hold large potential for GHG emissions reductions.

The results also suggest that the MRIO LCA model could provide the State with valuable screening capabilities for identifying products and services that hold the greatest potential for in-state emissions reductions under lifecycle GHG emissions policy initiatives.

Project Summary

The research centered on the following four (4) components:

1. <u>Develop model to estimate LCA GHG emissions</u>

The contractor developed the MRIO LCA model that includes 426 industrial sectors in the California economy. This model allows ARB staff to model the embedded GHG emissions in 426 different product and service sectors in the State. In addition, the model estimates embedded GHG emissions that occur both inside and outside California, but within the U.S., and outside of the U.S. This provides ARB with a means to estimate the GHG emissions “leakage” associated with various policy options. Using the MRIO model for reference, ARB selected 22 products for full LCA. They are:

22 Retail Products for Life-Cycle Analysis

1. Masonry cement	9. Chicken	17. Refrigerator
2. Paint	10. Cheese	18. Men's dress shirt
3. Canned tomatoes	11. Milk	19. CFL light bulb
4. Bread	12. Soft drink	20. Restaurant
5. Tortillas	13. Paper towel	21. Wooden cabinet
6. Beer	14. Personal computer	22. Hot water heater
7. Wine	15. Hard disc drive	
8. Beef	16. Flat panel TV	

These products are expected to represent a significant fraction of the annual lifecycle GHG emissions associated with retail products manufactured and consumed in California.

2. Estimate lifecycle GHG emissions reductions attainable for retail products sold in California

For each of the 22 products identified above, the lifecycle GHG emissions associated with a feasible *"low carbon technical potential (TP)"* scenario of the product were estimated. The *low carbon TP* scenario of a product represents the technically feasible minimum lifecycle GHG emissions that are currently realistic for a given product, and is meant to approximate the "best in class" product that may appear on the market in response to a California lifecycle GHG emissions labeling and/or standards program.

3. Analyze policy scenarios for retail product labeling and standard programs in California

This research analyzed five policy scenarios over a five-year projection period (2011-2015). The five (5) policy scenarios are:

1. A *"business as usual"* scenario, which projected the growth in average annual lifecycle GHG emissions of the selected 22 products based on current trends in California population growth and retail product consumption.
2. A *"low carbon TP"* scenario, which estimates the annual lifecycle GHG emissions of the selected 22 products, assuming that 100 percent of purchased products will be of the "low-GHG" variety (as described in Task 2 above). The difference between the *"business as usual"* and *"low carbon TP"* scenarios provides ARB with an estimate of the maximum achievable GHG emissions reductions potential if labels and/or standards programs were implemented in California and achieved full impact.
3. A *"stock turnover constrained TP"* scenario, which considers that durable goods (e.g., appliances) will likely only be replaced as they reach the end of their useful life, and therefore limit the pace at which low-carbon versions of durable goods can be deployed over the projection period.
4. A *"benchmark market uptake"* scenario, which estimates natural market uptake of the low-carbon versions of the 22 products if such products displayed carbon labels, based on benchmarking to market uptake rates of ENERGY STAR-labeled products.
5. A *"lifecycle product standards"* scenario, which estimates the achievable GHG emissions reductions by product if maximum lifecycle emissions standards were implemented by California for each of the 22 products.

4. Recommendations and Final Report

The contractor provided recommendations for future work to make improvements in the analytical framework and to fill-in data gaps. The final report describes the methods, assumptions, data, and results associated with each of the five (5) scenarios outlined above. The report also describes the model and data requirements and includes a

user's guide and Excel MRIO model which will enable staff to run the MRIO LCA emissions model in-house.

III. STAFF COMMENTS

This study was the first attempt by ARB to quantify LCA GHG emissions from retail products consumed in California. Although the methodology will not permit comparison of a carbon footprint between like products of different brands (because the method/data is input-output based), the research has improved and expanded ARB's understanding of input-output GHG lifecycle analytical methods and data requirements and their limitations. The research shows the disaggregation of emissions between California, out of California but within the U.S., and outside the U.S.

The researchers who maintain the Cool California model (http://coolcalifornia.org/) have used the updated MRIO model from this research to enhance the GHG emissions estimates provided on the Cool California web link.

In Appendix E: Product Data Derivations, Table E-4, p.135 describes the energy use requirements to refrigerate beef; however, the use assumptions do not include the energy requirement to cook the beef. The analysis needs to include energy use for cooking beef and chicken.

Staff have requested slight changes to references, pagination, text, and metrics in the draft final report.

IV. STAFF RECOMMENDATIONS

Staff recommends the Research Screening Committee accept this draft final report, subject to inclusion of appropriate additions and revisions in response to the staff comments and any changes and additions indicated by the Committee.

REVIEW OF A DRAFT FINAL REPORT
ITEM NO.: 3
DATE: December 2, 2011
CONTRACT NO.: 09-366
Link to Report

STAFF EVALUATION OF A DRAFT FINAL REPORT

TITLE:	SF_6 Replacement Evaluation in Magnesium Sand and Investment Casting
CONTRACTOR:	California State Polytechnic University, Pomona
PRINCIPAL INVESTIGATOR:	Victor Okhuysen, Ph.D.
TOTAL AMOUNT:	$49,995
CONTRACT TYPE:	Interagency Agreement
CONTRACT TERM:	18 Months

For further information, please contact Elizabeth Scheehle at (916) 324-0621.

I. SUMMARY

Molten magnesium rapidly oxidizes upon exposure to the atmosphere, hindering the magnesium casting process and resulting in high product scrap rates. In current casting practice, sulfur hexafluoride (SF_6) is used as a cover gas to prevent exposure of the molten metal to air. Unfortunately, SF_6 has an extremely high global warming potential (GWP) and, per the state's efforts under the Global Warming Solutions Act of 2006 (AB 32), a low GWP replacement is desired. This project's objective was to select and utilize a viable alternative in normal casting operations to determine viability as a replacement for SF_6. The most viable candidate is a fluorinated ketone called Novec 612, manufactured by 3M Corporation. Several California magnesium foundries used Novec 612 in their sand and investment casting production work and evaluated the products produced. The product quality and scrap rates were comparable to those achieved using conventional SF_6 cover gas, indicating that Novec 612 is technically capable of meeting industry needs while greatly reducing the industry's climate change impact and helping Air Resources Board (ARB) and California to meet their climate change emission reduction goals. Cost analysis was not a major goal of this project, but

data indicate that operational costs for using Novec 612 relative to SF_6 range from a benefit to a significant cost penalty depending on the type of process and gas prices.

II. TECHNICAL SUMMARY

Objective

This project was undertaken as a basic feasibility test to evaluate a replacement for SF_6 as a cover gas in the magnesium casting industry. Economic impacts were estimated as a secondary aspect of the project. No attempts were made to optimize the process to improve yield or minimize cost.

Background

Magnesium sand and investment casting requires a protective gas due to the very high reactivity of molten magnesium with atmospheric oxygen. Over the last few decades, the protective cover gas of choice has been SF_6. However, SF_6 is a very powerful greenhouse gas with a GWP of 23,900 due to its high infrared absorption and long life in the atmosphere. For these reasons, a replacement technology is sought. Ideally, a new cover gas that has the advantages of SF_6 – molten metal protection, mold gas purging, non-toxicity, non-flammability, ease of use, and reasonable cost – can be found.

Cover gases consist of an active gas and a carrier agent such as CO_2. The gas blends are used in three distinct functions: to cover the molten metal in the furnace during melting, to cover the molten metal during transportation and pouring, and lastly to purge the mold of atmospheric air with cover gas. Molten magnesium forms an oxide layer that is brittle and cracks and thus is permeable to further oxidation with atmospheric oxygen. Since magnesium oxidation is a very powerful exothermic reaction, if left unchecked the reaction will continue very violently. The cover gas reacts with the exposed liquid surface of the magnesium and thus limits the oxidation and violent reactions.

Fluorinated ketones, specifically Novec 612 have been explored for some applications as a replacement for SF_6. Novec 612 is being successfully used as a cover gas for ingot casting and die casting of magnesium. In addition, it is non-toxic, non-flammable, and has a greenhouse warming potential (GWP) of approximately one due to its short lifetime in the environment. There are significant differences between sand and

investment casting and die and ingot casting. The first one is higher casting temperatures used in sand and investment casting which cause the Novec 612 to break down much faster. Thus, it is possible that the Novec 612 will not survive long enough to successfully protect the metal. The second difference is significantly higher exposure to the open atmosphere by the metal during melting and pouring than in the other processes. Thus, it will be necessary to use much higher levels of cover gas in sand casting than in die casting and ingot casting, greatly affecting the economics of the process.

The main objective of the project is to evaluate the possibility and implications of switching SF_6 with Novec 612 for sand and investment magnesium casting.

Project Summary

The experiment was designed to incorporate the various methods of magnesium melting and pouring in dry and green sand and investment casting as practiced in California. The intent was to change the existing processes as little as possible in order to use Novec 612 as a replacement.

Novec 612 was used to protect during metal melting, pouring and mold flushing, and in combination with flux use according to existing practice. The Novec 612 cover gas was produced by equipment provided by the gas vendor. In melting, Novec 612 was used as a cover gas in conjunction with a covered crucible with a distribution manifold. These crucibles were also used to pour the molten metal into the molds. A second method was used where the metal was melted under a cover of flux. Then the flux was removed and the gas was used to cover the metal during pour in a crucible without a lid. The third method used flux to protect the metal in the furnace and during pour, and the gas was used only to flush the mold.

As part of normal production runs, 39 molds were poured and 66 castings were produced for both sand casting and investment casting processes. The pour weight per mold ranged from 4.5 Kg (10 lbs) to 163 Kg (360 lbs). The alloys used included AZ91and AZ91E (alloyed with aluminum and zinc) and ZE41 (alloyed with zinc, zirconium and rhenium) which due to containing rare earth elements are more

susceptible to cover gas related defects. Castings were then processed and evaluated using standard methods.

All molding methods, both alloys, and all casting weights could be successfully poured with Novec 612 as cover gas. The only defective castings were due to lack of proper cover gas due to an assignable cause that would be expected to produce the same problems with SF_6. These defects could be eliminated with a higher gas flow rate than the test equipment could provide.

Economic comparisons were based on a range of costs of SF_6 over recent years (a low of $13.20 per kg to a high of $44 per kg, with a current value of $25.50 per kg), the current price of Novec 612 ($49.50 per kg), and 3 values covering a range of estimated costs for the Novec 612 cover gas producing equipment ($55,000, $75,000 and $100,000). Gas consumption values for SF_6 were based on facility purchase records for the past year. Gas consumption values for Novec 612 were based on flow rates measured during the test periods.

Depending on the actual melting and molding processes used, annual operational costs based on gas cost alone ranged from a significant cost increase to moderate savings. However, any potential gas cost savings would be overshadowed by the procurement costs for the Novec 612 generation equipment.

In summary, this project indicated that Novec 612 is a technically viable alternative to SF_6 as a cover gas for magnesium sand and investment casting in California, providing protection and casting quality comparable to those of SF_6. Estimates of economic impacts indicate that cost impacts could be substantial, however, further research to optimize foundry procedures, including reducing gas consumption during the individual melting, transport and pouring, and mold flushing stages, could reduce this impact significantly.

III. STAFF COMMENTS

Electronic copies of preliminary draft final reports were provided for review and comment to ARB staff and the principal investigator also made early drafts available to the participating facilities to ensure exclusion of proprietary or otherwise sensitive

material. ARB staff also provided a copy to the Novec 612 vendor for comment. Where appropriate, any comments received were incorporated into the report by the author. This study met the contract requirements and provides new information regarding a potential reduced-GWP replacement cover gas for the California magnesium casting industry.

IV. STAFF RECOMMENDATIONS

Staff recommends the Research Screening Committee accept this draft final report, subject to inclusion of appropriate revisions in response to the staff comments and any changes and additions specified by the Committee.