State of California
AIR RESOURCES BOARD

Research Screening Committee Meeting
Cal/EPA Headquarters Building
1001 I Street
Conference Room 510, 5th Floor
Sacramento, California 95814
(916) 445-0753

March 28, 2014

9:00 a.m.

ADVANCE AGENDA

I. Approval of Minutes of Previous Meeting:

January 31, 2014 meeting

II. Discussion of a New Research Project:

1) "Aerodynamic GHG Emissions Reduction Assessment of Non 53-foot Trailers Pulled by Heavy-Duty Tractors," University of California, Riverside, $500,000, Proposal No. 2770-278

In order to meet the greenhouse gas (GHG) emission reduction goals specified in California's Global Warming Solutions Act of 2006 (Assembly Bill 32, AB 32), GHG emission reductions are needed from heavy-duty tractors (HDT). The Tractor-Trailer GHG regulation adopted in 2012 was one of the discrete early action measures by the ARB to contribute to the goals of AB 32. The regulation applies to 53-foot or longer box trailers and requires them to be equipped with aerodynamic technologies and low rolling resistance tires, but does not apply to other trailer types. The objective of this project is to investigate potential benefits of extending the regulation to other trailer types (e.g., flatbeds, tankers, etc.) and box trailers shorter than 53 feet. These objectives will be accomplished by: 1) identifying candidate trailer types, and collecting vehicle activity data (e.g., vehicle miles traveled, speed profiles, etc.) for these other trailer types using fleet-owner surveys, engine computer downloads, and on-vehicle data loggers, and 2) by conducting wind tunnel testing and modeling of aerodynamic technologies, and conducting over-the-road emissions testing. Results will support the development of second-generation GHG control measures for HDT trailers.

2) “Evaluation of the Impacts of Emissions Averaging and Flexibility Programs for all Tier 4 Final Off-Road Diesel Engines,” University of California, Riverside, $300,000, Proposal No. 2774-278

California is a participant in the federal Averaging Banking, and Trading (ABT) program and the federal Transition Program for Equipment Manufacturers (TPEM) for criteria pollutant emissions for 2011 and later model-year off-road diesel engines. Both programs are administered at the federal level by the United States Environmental Protection Agency (U.S. EPA), and only national sales data are available. These programs allow higher emitting engines to be sold if these sales are offset by lower emitting engines such that overall fleet-average emissions comply with Tier 4 new engine certification standards. It is possible that a disproportionate number of higher emitting engines may be being sold in California which would have negative impacts on efforts to achieve attainment of ambient air quality standards, and/or could result in public exposure to increased emissions. The objective of this project is to determine the impacts of ABT and TPEM programs on the populations off-road diesel engines sold in California, and if this may have adverse emissions impacts. This will be done using electronic databases, and surveys of California equipment owners. Results will inform ARB policy makers regarding the impacts of these national programs on California's air quality.

3) “Evaluation of the Feasibility, Cost-effectiveness, and Necessity of Equipping Small Off Road Diesel Engines with Advanced PM and/or NO_X Aftertreatment,” University of California, Riverside, $800,000, Proposal No. 2769-278

In 1998, the United States Environmental Protection Agency (U.S. EPA) introduced Tier 1 standards for equipment under 37 kilowatts (kW) (50 hp) and increasingly more stringent Tier 2 and Tier 3 standards for all equipment with phase-in schedules from 2000 to 2008. The Tier 1-3 standards are met through advanced engine design, with no or only limited use of exhaust gas aftertreatment (oxidation catalysts). On May 11, 2004, U.S. EPA signed the final rule introducing Tier 4 emission standards, which are phased-in over the period of 2008-2015. The Tier 4 standards require that emissions of particulate matter (PM) and oxides of nitrogen (NO_X) be further reduced by about 90 percent. Such emission reductions can be achieved through the use of control technologies, including engine modifications and advanced exhaust gas aftertreatment, similar to those used by those meeting the 2007-2010 standards for highway engines. However, off-road diesel engines less than 37 kW are allowed to certify with emissions at higher levels due to the belief that advanced aftertreatment would severely impact the cost of these smaller engines.

Small off-road equipment are estimated to contribute 22 percent of the total NO_X from off-road equipment and 12 percent of total off-road diesel PM emissions. The proposed study will involve the emissions testing of several small off-road diesel engines representing a cross section of applications in the under-37 kW off-road diesel power category using advanced aftertreatment technologies such as diesel particulate filters (DPF), selective catalytic reduction (SCR), exhaust gas

recirculation (EGR) etc. and some will be modified to accommodate operation on alternate fuels, such as natural gas. The research will evaluate the overall emissions impact of this segment of the industry in order to assess the necessity of more stringent standards, and will seek to determine the representativeness of the existing test cycles for these smaller engines. Finally, the investigation will gauge how increasing the cost of control might affect the economic interests of small engine diesel manufacturers, in particular the propensity of consumers to switch from diesel-fueled to gasoline-fueled engines as the relative cost of diesel-fueled engines increases.

The results of this study will be used to determine whether or not small off-road engines less than 37 kW should be subject to more stringent exhaust standards, identify reasonable levels of exhaust control based on costs, and support possible future amendments to the off-road diesel engine regulations.

4) "Reducing Formaldehyde Emissions from Home Central Heating and Air Conditioning Filters," Lawrence Berkeley National Laboratory," $350,000, Proposal No. 2771-278

Formaldehyde is a toxic air contaminant that poses a risk of cancer and other adverse health impacts. Studies have shown that some fiberglass filters used in central heating and air conditioning systems can be sources of formaldehyde. This proposal aims to quantify the indoor contributions of formaldehyde from fiberglass particle filters relative to those from synthetic particle filters, for California homes. The investigators will select at least four types of fiberglass filters that are likely to emit formaldehyde and four types of synthetic filters that, based on prior data, are not expected to have significant emissions, and conduct laboratory testing of formaldehyde emissions across a range of humidity levels, temperatures, and the air velocity passing through filters in typical California homes. The investigators will also estimate the contributions of these filters to indoor formaldehyde concentrations in typical California homes using a mass balance model. It is anticipated that this project will find that use of synthetic particle filters in home central heating and air conditioning systems will result in lower indoor formaldehyde concentrations than use of fiberglass particle filters. This project will help inform decision-makers about whether synthetic particle filters are a part of the solution to reduce indoor formaldehyde exposures.

5) "Protocol Development for Vehicle Emission Toxicity Testing for Particulate Matter," University of California, Davis, $100,000, Proposal No. 2772-278

Toxicological testing of particulate samples is an integral aspect of evaluating possible health effects associated with particulate matter (PM) from new engine technology studies and source specific ambient PM. However, there are a multitude of possible standard operating procedures (SOPs) for sample preparation, each with inherent advantages and disadvantages. This is not surprising since all of these procedures require physical and chemical manipulation of the PM sample during isolation which can affect its inherent toxicological properties. The main objective of this study is to systematically investigate these different SOPs and evaluate which procedures can retain of the

most toxicologically relevant chemical components of the sample for various toxicological assays while producing the fewest toxicological artifacts. The benefit of this investigation is the establishment of a standard SOP for filter PM sample preparation for future toxicological studies. In addition, knowledge gained from this study can be used to evaluate how previously used sample preparation methodologies may have influenced toxicological results in completed studies.

6) "Improving DNDC Modeling Capability to Quantify Mitigation Potential of Nitrous Oxide from California Agricultural Soils," University of New Hampshire, $199,797, Proposal No. 2773-278

Agricultural soils are a major source of nitrous oxide (N_2O), a potent greenhouse gas (GHG) contributing to global warming, in California. Because N_2O is produced in soil by microbial activities which are affected by numerous environmental factors, process-based modeling incorporating site-specific conditions is considered a better approach characterizing N_2O emissions from agricultural crop land. Previous studies have indicated that significant mitigation of N_2O emissions from agricultural soils is possible through various management practices; however, a quantitative tool would be required to estimate emission reductions from these practices. The project will develop and deliver to ARB such a tool by further refining the process-based DNDC (DeNitrification-DeComposition) model based on new N_2O emission data obtained from available mitigation studies and new understanding of N_2O emission mechanisms. The improved capability of quantifying N_2O emission reductions under a variety of management practices will bolster the State's ability to develop greenhouse gas mitigation strategies that are essential for meeting long-term climate change goals set forth by Assembly Bill 32.

III. Discussion of Draft Final Reports:

1) "Central Nervous System Effects of Ambient Particulate Matter: The Role of Oxidative Stress and Inflammation," University of California, Irvine, $309,141, Contract No. 08-306

Numerous epidemiological and toxicological studies have demonstrated that exposure to ambient particulate matter (PM) is associated with increased cardiopulmonary morbidity and mortality; however, little is known about the effects of PM exposure on the central nervous system. The objective of this study was to determine how the biological responses in the brain of genetically modified mice exposed to concentrated ambient fine particulate matter (PM2.5) might depend on the composition of ambient PM emitted from vehicles, power generation, industrial processes and other sources. Mice were exposed in New York City, Sterling Forest, NY, Seattle, WA, East Lansing, MI and Irvine, CA. Exposures were six hours per day, four days per week for 26 weeks (six months). Results of this study suggest that exposure of genetically modified mice to concentrated ambient particles (CAPs) may be associated with inflammatory changes in the brain, and that the sections of the brain that are lower in the signal transducer NF-κB tend to be more susceptible to inflammatory changes. In addition the levels of NF-κB decreased as the animals aged. These results suggest that ambient PM may

produce adverse health outcomes in the brain, which should be taken into consideration when developing future ambient air standards and regulations that will benefit the health of all Californians.

2) "Air Movement as an Energy Efficient Means Toward Occupant Comfort," University of California, Berkeley, $170,000, Contract No. 10-308

In California, heating and cooling in Commercial Buildings consume roughly 34 percent of the built environment's total energy use. Temperature set points and people's comfort zones are typically not fine-tuned to each other. Significant energy is used without increasing or maintaining occupant comfort. Use of fans, large or small for cooling, and foot warmers for heating is thought to increase occupant comfort while allowing higher set points in summer and lower ones in winter. The investigators examined ceiling fans performance in terms of noise and incorporation into the built environment architecture and, primarily, occupant comfort. Comfort can be provided by fans drawing 2 - 8 watts per person, in settings corresponding to ambient conditions of 30°C (86°F) and 60 percent RH (relative humidity). Fans can improve and augment the performance of other energy-efficient technologies, such as radiant cooled ceilings and natural ventilation. The documented energy savings for heating and cooling systems can be substantial (10 - 29 percent). Climate change mitigation policy can make use of fans and other instruments to extract significant energy savings and CO_2 emissions reductions from the built environment.

3) "Construction of a DOAS Instrument for Installation at the California Air Resources Board (ARB) for the Low Level Measurement of Sulfur Dioxide to Investigate the Relation Between Sulfur Dioxide and Sulfate," University of California, Riverside, $90,004, Contract No. 10-312

Sulfur is an important component of combustion and lubricant-derived particles. Sulfate levels in vehicle exhaust particulates can be readily measured, but it is important to understand the relative contribution between combustion and oil-derived particles and conversion rates of sulfur dioxide (SO_2) to sulfate (SO_4). Current instruments are not capable of measuring the very low sulfur dioxide concentrations typical of new vehicles. The objective of this research was to construct, test and provide to ARB's Heavy-Duty Emissions Testing Laboratory a differential optical absorption spectrometer (DOAS) that can measure down to 10 ppbV in real time and determine a mass balance between SO_2 and sulfate. During the testing at CE-CERT, the device has been able to measure down to less than 20 ppbV SO_2 at three times the standard deviation of zero gas response although there is interference when ammonia (NH_3) concentration exceeds 11 ppm. The contractors are supplying an update to the DOAS instrument's software and this may minimize the NH_3 interference. Training for ARB's technical staff will be provided as part of this program so they will be able to properly operate this state-of-the-art instrument independently. This instrument will open testing possibilities for ARB to understand the workings of advanced catalyzed aftertreatment systems and their interactions with the fuel/lube systems, and the potential of those systems to attenuate or produce sulfate particulate matter. This understanding will help ARB understand the impacts of current emission control

policies and guide the development of policies to obtain further reductions.

4) "Improving Regional Biogenic Volatile Organic Compound Emission Estimates Using an Airborne PTRMS EDDY Flux Measurement System," University of California, Berkeley, $400,000, Contract No. 09-339

Current air quality simulations include the role of isoprene and monoterpene chemistry in tropospheric ozone and aerosol production but the magnitude and spatial-temporal distributions of BVOC emissions in California is a complex issue which would benefit from additional data to constrain emissions estimates. Current biogenic VOC emission models predict significant emissions of isoprene from oak woodlands of the Coast Range and the Sierra Nevada mountains, yet there have been few measurements of BVOC fluxes from California landscapes at a larger spatial scale than individual leaves and branches. To create a regional scale BVOC emissions database for validating emissions estimates, during the summer 2011, the principal investigators deployed an airborne Proton Transfer Reaction Mass Spectrometer and Eddy Covariance (PTRMS EC) system over key Californian ecosystems. This project found that airborne basal and model land cover emission factors compare favorably. Eucalyptus and oak woodlands were confirmed as critical isoprene emission areas in the state. In Sierra Nevada oak savanna, agreement between the model and measured flux data is excellent. Generally, average individual ecoregion measured and flux data agree quite well. Isoprene modeling emissions simulations are effective in general and where they differ from airborne data, the issue is likely a combination of discrepancies in the underlying land cover maps, meteorological parameters, or LAI data. This project provides important confirmation of the quality of the biogenic inventory used in ARB's SIP modeling.

IV. Discussion of Other Business:

1) "Using Feedback from Commercial Buildings to Support Energy-Conserving Behavior," University of California, Berkeley, $184,260, Contract No. 10-310