State of California
AIR RESOURCES BOARD

RESEARCH PROPOSAL

Resolution 12-39

December 6, 2012

Agenda Item No.: 12-9-4

WHEREAS, the Air Resources Board (ARB or Board) has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2745-275, entitled "Measuring Real-World Emissions from the On-Road Heavy-Duty Truck Fleet," has been submitted by the University of California, Berkeley;

WHEREAS, in accordance with Health and Safety Code section 39705, the Research Screening Committee has reviewed and recommends for funding:

> Proposal Number 2745-275 entitled "Measuring Real-World Emissions from the On-Road Heavy-Duty Truck Fleet," submitted by the University of California, Berkeley, for a total amount not to exceed $450,000.

WHEREAS, the Research Division staff has reviewed Proposal Number 2745-275 and finds that in accordance with Health and Safety Code section 39701, the results from this study will help derive emission factors for individual trucks and develop histograms for individual pollutants. These results will be used to evaluate emissions trends (and therefore the benefits of the Truck and Bus Regulation), unintended consequences (if any), and exhaust aftertreatment durability over time. The investigators will provide tabulated results to ARB staff, including emission rates of individual trucks along with their license plates, engine model year, and aftertreatment attributes matched in ARB's Truck and Bus Registry. ARB staff may use this data to assess the compliance rate of trucks with the requirements of the fleet rule. Research Division staff recommends this proposal for approval.

NOW, THEREFORE, BE IT RESOLVED that the Air Resources Board, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendations of the Research Screening Committee and Research Division staff and approves the following:

> Proposal Number 2745-275 entitled "Measuring Real-World Emissions from the On-Road Heavy-Duty Truck Fleet," submitted by the University of California, Berkeley, for a total amount not to exceed $450,000.

BE IT FURTHER RESOLVED that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the research effort proposed herein, and as described in Attachment A, in an amount not to exceed $450,000.

I hereby certify that the above is a true and correct copy of Resolution 12-39, as adopted by the Air Resources Board.

Tracy Jensen

Tracy Jensen, Clerk of the Board

ATTACHMENT A

"Measuring Real-World Emissions from the On-Road Heavy-Duty Truck Fleet"

Background

ARB Truck and Bus Regulation aims to reduce the emissions of particulate matter (PM) to 0.01 grams per brake horsepower-hour (g/bhp-hr) and oxides of nitrogen (NO_X) to 0.2 g/bhp-hr over the next several years. It's expected that by 2014 most of the California fleet will have diesel PM controls followed by gradual transition to model year (MY) 2010 engines such that by 2023 all the heavy-duty diesel engines operating on California roadways will meet the MY 2010 heavy-duty engine standard using NO_X control. Along with the emission reduction benefits, there may be some unintended consequences of using aftertreatment devices such as an increase in ultrafine particle numbers, ammonia (NH_3) emissions and the nitrogen dioxide (NO_2) to NO_X emission ratio. It is therefore important to measure actual on-road emissions in order to quantity the overall effects of the regulation.

The proposed research will build upon an on-going ARB-funded program to measure emissions at the Port of Oakland and other studies performed at the Caldecott tunnel in recent years. The results of this study will be used to quantify emission factor distributions, identify unintended consequences, investigate the durability and failure rates associated with aftertreatment devices, and establish the net emissions benefits resulting from the Truck and Bus Regulation.

Objective

The objective of this study is to quantify the emission rates of gas- and particle-phase pollutants from a large number of individual in-use, heavy-duty diesel trucks in the San Francisco bay area. This will be done over multiple years during the phase-in of different provisions of ARB's Truck and Bus Regulation where significant decreases in PM and NO_X emissions are expected: (i) 2014, when a significant fraction of the truck fleet will be equipped with diesel particulate filters (DPFs); (ii) 2015, when pre-1994 engines will be replaced with MY 2010 engines; and (iii) 2017, when pre-1996 engines will be replaced with MY 2010 engines, and by which time a significant portion of the fleet will have MY 2010 or newer engines.

Methods

The investigator will measure gases and particles present in the exhaust plumes of at least 1000 individual diesel trucks in each of the three years of the study. At minimum, measurement of carbon dioxide (CO_2), carbon monoxide (CO), nitric oxide (NO), NO_2, NH_3, nitrous oxide (N_2O), PM mass (using a laser photometer) and number, black carbon (BC), and particle size distribution will be performed. NH_3 and N_2O data will be collected only during the last sampling campaign (in 2017). Particle size distribution will be collected based upon instrumentation availability from ARB.

Expected Results
The results from this study will help derive emission factors for individual trucks and develop histograms for individual pollutants. These results will be used to evaluate emissions trends (and therefore the benefits of the Truck and Bus Regulation), unintended consequences (if any), and exhaust aftertreatment durability over time. The investigators will provide tabulated results to ARB staff, including emission rates of individual trucks along with their license plates, engine model year, and aftertreatment attributes matched in ARB's Truck and Bus Registry. ARB staff may use this data to assess the compliance rate of trucks with the requirements of the fleet rule.

Significance to the Board
The data generated from this study will be used to evaluate the effectiveness of ARB's Truck and Bus Regulation in reducing PM and NO_X emissions. The data will also shed light on the durability and deterioration of aftertreatment devices which are being introduced to comply with diesel fleet rules. The study may also help identify any unintended consequences from introduction of aftertreatment devices such as rise in ultrafine particle number concentration, NH_3 emissions, or NO_2 to NO_X emissions ratios.

Contractor:
University of California, Berkeley

Contract Period:
66 months

Principal Investigators (PI):
Dr. Thomas Kirchstetter
Dr. Robert Harley (co-PI)

Contract Amount:
$450,000

Basis for Indirect Cost Rate:
The State and the UC system have agreed to a ten percent indirect cost rate.

Past Experience with the Principal Investigators:
The investigators have been performing on-road measurements in the San Francisco bay area since 1993. They recently sampled at the Port of Oakland in November 2009, June 2010, November 2011 and will do another campaign in the Spring of 2013 for an ARB-funded project. Dr. Thomas Kirchstetter has participated in field experiments at the Caldecott tunnel in 1993 thru 1997, 1999, 2001, 2006, and 2010. Dr. Robert Harley has overseen study design and data analysis for a series of field sampling projects at the Caldecott tunnel between 1994 and 2010, including work for ARB-funded projects. For the proposed research, the investigators will return to the Caldecott tunnel for measurements. ARB staff has a good relationship with the investigators and as noted above, ARB staff have worked on other ARB-funded projects with both the investigators.

Prior Research Division Funding to University of California, Berkeley:

Year	2012	2011	2010
Funding	$ 1,264,264	$ 754,264	$ 801,587

BUDGET SUMMARY

Contractor: University of California, Berkeley

"Measuring Real-World Emissions from the On-Road Heavy-Duty Truck Fleet"

DIRECT COSTS AND BENEFITS			
1.	Labor and Employee Fringe Benefits	$ 348,697	
2.	Subcontractors	$ 0	
3.	Equipment	$ 0	
4.	Travel and Subsistence	$ 6,300	
5.	Electronic Data Processing	$ 0	
6.	Reproduction/Publication	$ 0	
7.	Mail and Phone	$ 0	
8.	Supplies	$ 58,723[1]	
9.	Analyses	$ 0	
10.	Miscellaneous	$ 1,500	
	Total Direct Costs		$ 415,220
INDIRECT COSTS			
1.	Overhead	$ 34,780	
2.	General and Administrative Expenses	$ 0	
3.	Other Indirect Costs	$ 0	
4.	Fee or Profit	$ 0	
	Total Indirect Costs		$ 34,780
TOTAL PROJECT COSTS			**$ 450,000**

[1] Supply costs for sampling and instrumentation are significant, and include two ($800 each) digital video cameras to record traffic, drive-by times and HD truck license plates, calibration gas cylinders (2 zero air @ $500 each; 2 NO,CO,$CO_2$ @ $1000 each, 1 NH_3 @ $650 and, 1 N_20 @ $350), 20 feet conductive 3/8 inch tubing = $205 and Teflon filters @ $409/50pack x 2 packs = $818), electricity generator for research van ($700/campaign x 3 campaigns), equipment rental of a fast CO analyzer (2 months @ $2500/mo), N_2O/CO analyzer (2 month @ $10000/mo), NH_3 analyzer (2 months @ $5000/mo), and annual servicing of fast mobility particle sizer by TSI (3 x $5000).