State of California
AIR RESOURCES BOARD

Evaluating Technologies and Methods to Lower Nitrogen Oxide Emissions from Heavy-Duty Vehicles

RESEARCH PROPOSAL

Resolution 13-27

June 27, 2013

Agenda Item No.: 13-6-1

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 2767-276, entitled "Evaluating Technologies and Methods to Lower Nitrogen Oxide Emissions from Heavy-Duty Vehicles," has been submitted by Southwest Research Institute; and

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

> Proposal Number 2767-276 entitled "Evaluating Technologies and Methods to Lower Nitrogen Oxide Emissions from Heavy-Duty Vehicles," submitted by the Southwest Research Institute, for a total amount not to exceed $1,599,744.

WHEREAS, the Research Division staff has reviewed Proposal Number 2767-276 and finds that in accordance with Health and Safety Code section 39701, this project will provide critical information on the feasibility of achieving NO_X emissions lower than the current engine standard for two heavy-duty engines: one natural gas engine with three way catalysts, and one diesel engine with selective catalytic reduction. The information will help ARB to develop future air quality plans.

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 2767-276 entitled "Evaluating Technologies and Methods to Lower Nitrogen Oxide Emissions from Heavy-Duty Vehicles," submitted by the Southwest Research Institute not to exceed $1,599,744.

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 $1,599,744.

I hereby certify that the above is a true and correct copy of Resolution 13-27, as adopted by the Air Resources Board.

Tracy Jensen

Tracy Jensen, Clerk of the Board

ATTACHMENT A

"Evaluating Technologies and Methods to Lower Nitrogen Oxide Emissions from Heavy-Duty Vehicles"

Background

The 2010 nitrogen oxides (NO_X) emission standard for heavy-duty engines establishes a limit for NO_X emissions of 0.20 grams per brake horsepower-hour (g/bhp-hr). Nevertheless, it is projected that even when the entire on-road fleet of heavy-duty vehicles operating in California is compliant with the 2010 emission standards, upcoming National Ambient Air Quality Standards (NAAQS) requirements for PM2.5 and ozone cannot be achieved in California without further significant reductions in NO_X emissions from the heavy duty fleet. The main technologies employed by diesel and natural gas engine manufacturers to meet the 2010 NO_X engine standard are selective catalytic reduction (SCR) and three way catalysts (TWC), respectively. Both of these technologies are relatively new in heavy-duty truck applications, and manufacturers of SCR systems, TWCs, and heavy-duty engines are still optimizing their systems to achieve the required reductions in the most efficient and cost-effective manner. As these technologies mature, there should be opportunities to reduce NO_X emissions below the level required by the 2010 NO_X standards.

Objective

The objective of this research is to obtain the maximum NO_X reduction possible from heavy-duty diesel and natural gas engines through the combination of engine tuning practices, thermal management strategies, and aftertreatment strategies, while continuing to meet all applicable standards for hydrocarbons, non-methane hydrocarbons, carbon monoxide, and PM, without incurring a greenhouse gas (GHG) penalty, and consistent with a technological path to meeting the upcoming United States Environmental Protection Agency (U.S. EPA) requirements for GHG emissions from heavy-duty vehicles. The target NO_X emission rate for this project is 0.02 g/bhp-hr, which is a 90 percent reduction from the current standard.

Methods

The contractor shall first refine a research plan identifying engine test cycles, specific engines to be tested, and aftertreatment technologies for consideration in the screening and final demonstration efforts. They shall then characterize two stock engines, one for diesel and another for natural gas, using reference laboratory equipment and procedures following Title 40, Code of Federal Regulations, Part 1065 (40 CFR 1065), determine stock engine characteristics for colds starts, hot starts, normal operation, and low-load-low-temperature operation, and determine possible engine control strategies. Based on the identified engine performance and possible engine control strategies, the contractor shall select aftertreatment technologies and engine control strategies for screening using low-cost exhaust emission sources and test benches, and identify candidate engine-aftertreatment systems for on-engine demonstration. Finally, the contractor shall perform engine dynamometer tests following 40 CFR 1065 for selected aftertreatment technologies to demonstrate low NO_X emissions over the heavy-duty

Federal Test Procedure, a low-load-low-temperature cycle such as World Harmonized Transient Cycle, and the extended idle test cycles.

Expected Results
The feasibility of achieving NO_X emissions lower than the current engine standard will provide information for technical consideration during future development of rules with low emission limits for new engines. The deliverables of this project include a final report detailing methods, NO_X emissions reduction strategies, summary data tables, findings from the research, as well as the final dataset in spreadsheet or database format consisting of second-by-second test data from the demonstration testing, data tables reporting integrated emissions and other key parameters from each individual test, and tables summarizing overall test results.

Significance to the Board
This project will provide critical information on the feasibility of achieving NO_X emissions lower than the current engine standard for two heavy-duty engines: one natural gas engine with TWC, and one diesel engine with SCR. The information will help ARB to develop future air quality plans.

Contractor:
Southwest Research Institute

Contract Period:
36 months

Principal Investigators:
Cynthia C. Webb, M.S.
Chris Sharp
James Chiu, M.S.
Darius Mehta, M.S.

Contract Amount:
$1,599,744

Basis for Indirect Cost Rate:
The Southwest Research Institute proposal was received using a competitive bid process in which the cost proposal is rated. Therefore, the indirect cost rate of 138 percent of 'Labor' and 'Fringe Benefits' plus 3.78 percent of 'Materials and Supplies' is accepted as proposed.

Past Experience with the Principal Investigators:
Southwest Research Institute is one of the most distinguished research groups with experience in fuels, lubrication oil, engines, emissions, and advanced after treatment systems. They have provided research and development services to ARB, U.S. EPA, Department of Energy, private companies, and others. Their prior experience with ARB has included studies of emissions from locomotives, light-duty gasoline vehicles, methanol-fueled vehicles, off-road engines, and heavy-duty diesel engines.

Prior Research Division Funding to the Southwest Research Institute:

Year	2012	2011	2010
Funding	$ 0	$ 0	$ 0

BUDGET SUMMARY

Southwest Research Institute

"Evaluating Technologies and Methods to Lower Nitrogen Oxide Emissions from Heavy-Duty Vehicles"

DIRECT COSTS AND BENEFITS			
1.	Labor and Employee Fringe Benefits	$ 579,877	
2.	Subcontractors	$ 0	
3.	Equipment	$ 0	
4.	Travel and Subsistence	$ 5,250	
5.	Electronic Data Processing	$ 0	
6.	Reproduction/Publication	$ 0	
7.	Mail and Phone	$ 0	
8.	Supplies	$ 106,661[1]	
9.	Analyses	$ 0	
10.	Miscellaneous	$ 0	
	Total Direct Costs		$ 691,788
INDIRECT COSTS			
1.	Overhead, General and Administrative Expenses and Material Handling	$ 804,453	
2.	Fee or Profit	$ 103,503	
	Total Indirect Costs		$ 907,956
TOTAL PROJECT COSTS			**$1,599,744**

[1] Supplies for vehicle testing tasks include fuel, span gases, exhaust tubing, clamps, thermocouples, stainless and Teflon sample tubing, and various other necessary materials.