SCAQMD HDV In-Use Emissions Testing Program

Lead Program Sponsor
South Coast Air Quality Management District (SCAQMD), West Virginia University, University of California, Riverside and California Air Resources Board (CARB)

Co-Participants
Port of Long Beach, Port of Los Angeles

Background

The Ports joined an existing SCAQMD research program to conduct in-use emissions testing for class 8 diesel- and LNG-fueled trucks, and if needed, to evaluate emission-reduction potential of retrofit technology on existing and new on-road heavy-duty engines. The original project scope was budgeted at a total $1,701,156. The University of California, Riverside (UCR) and West Virginia University (WVU) were selected by competitive bid to conduct this emissions testing program jointly with SCAQMD. The TAP funding for this project covered program enhancements to include emissions testing of additional drayage trucks utilizing a newly developed port drive test cycle specifically derived from in-use drayage operation. The TAP provided $306,552 in co-funding to test six additional heavy-duty drayage vehicles using the Ports' drive test cycle, bringing the total project budget to $2,007,708.

Project Objectives

The objectives of the project included: in-use emissions testing of heavy-duty natural gas and diesel vehicles to verify emissions standards and the emission-reduction potential of engine or aftertreatment technology to reduce regulated emissions over time; measurement of ammonia and formaldehyde emissions from heavy-duty vehicles; the effectiveness of oxidation catalysts or alternative technologies to reduce these emissions; the assessment of the emission-reduction potential of exhaust gas recirculation (EGR) to reduce PM and NOx emissions from diesel engines; and the impact of using water in-lieu of urea or no reductant for SCR technology. To achieve these objectives, the project included on-road heavy-duty vehicles used in transit, school bus, refuse, and goods movement applications and powered by engines fueled with natural gas, propane, diesel, and combination of diesel and natural gas fuels.

Technology Description

The vehicles were evaluated across 66 different test configurations. The engines were categorized into eight groups including natural gas engines with three-way catalysts, high pressure direct injection (HPDI) engines with EGR and DPF with or without SCR technology, propane and diesel school bus engines, propane engines certified at or below 0.2 g NOx, diesel engines certified at 1.2 g NOx, diesel engines certified above 0.2 g NOx without SCR technology, and diesel engines certified at or below 0.2 g NOx with SCR technology. In addition, WVU utilized its Transportable Emissions Measurement System (TEMS) and Horiba Portable Emissions Measurement System (PEMS) to measure in-use emissions from a U.S. EPA 2010 compliant heavy-duty diesel truck loaded to approximately 70,000 pounds, while driven from Morgantown WV to Riverside CA. WVU continuously tracked all not-to-exceed events, and measured total and non-methane hydrocarbon, NOx, CO, CO2, NO2, nitric oxide, nitrous oxide, PM, and ammonia emissions.

Results

Emissions testing for the following 24 project vehicles was completed as part of this project:

- Three natural gas-fueled drayage vehicles (one CNG & two LNG)
- One LNG-fueled refuse vehicle
- One CNG-fueled transit bus
- Four High Performance Direct Injection natural gas vehicles (dual-fuel LNG & diesel)
- Two school buses (one propane and one diesel)
- One propane-fueled drayage truck
- Eight diesel-fueled drayage trucks
- Four diesel fueled refuse vehicles

Nine of the test vehicles were evaluated by WVU, eleven were evaluated by UCR, and four were evaluated by both contractors to review the correlation of results between the two laboratories. All testing was completed and the final reports from each contractor (WVU and UCR) are available from SCAQMD staff. In general, emissions testing results indicated that while emissions were within expected limits, the in-use testing results were significantly higher than original certification level of the project truck engines. Also, natural gas trucks were found to emit less NOx as compared to diesel trucks since the SCR units on the diesel engines were not performing at optimal efficiency when at temperatures below 250 degrees centigrade. When the SCR units were not operational, diesel engine emissions were found to be as much as ten times higher than from natural gas engines. The PM emissions from all technology vehicle types were close to the detection limits of the measurement system (i.e., very low). Diesel vehicles employing high-EGR strategy resulted in frequent DPF regeneration events which contributed to momentary high PM mass emissions. Whereas, the PM emissions from the soot free combustion of natural gas were similar in magnitude to DPF-equipped diesel. It should also be noted that natural gas engines equipped with three-way catalysts were able to achieve low PM emissions without the use of a DPF. Another significant result of this test program was that ammonia emissions were found to be significant for the natural gas-fueled vehicles.

Benefits

The project helped characterize in-use emissions from port drayage truck operation, providing an improved understanding of the in-use emissions that result from implementation of advanced technologies.

Project Costs

The Ports contributed $306,552 in co-funding to this project for the additional port-specific testing, bringing the total project budget to $2,007,708. CARB also provided an in-kind services contribution to support the project, which included quantification of criteria pollutant emissions using a portable emission measurement system, collection and analysis of exhaust gases for N2O emissions, data analysis, and interpretation of emissions test results and measurements.

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