

Liquefied Natural Gas (LNG) Yard Tractor Project

Technology Manufacturer

Kalmar Industries
Cummins Engine Company

Co-Participants

Port of Long Beach, U.S. EPA Region 9, Long Beach Container Terminal, CALSTART

Project Objective

To investigate the technical and commercial feasibility of reducing emissions from yard tractors, the Port of Long Beach, in partnership with the U.S. EPA, funded the demonstration of yard tractors equipped with low-emission liquefied natural gas (LNG) engines.

Technology Description

The project was divided into three phases. The first phase focused on development of LNG yard tractor specifications, procurement, and installation of temporary LNG refueling.

Phase 2 included operation of the LNG yard tractors at a marine terminal for a period of eight months. Demonstration commenced in June 2006 and was completed in January 2007. During this time, data were collected on the performance of the LNG yard tractors compared to a group of baseline diesel vehicles. Emissions testing was also conducted at the conclusion of the second phase.

The third phase of the project was the development of a business case assessment to determine the cost-effectiveness and return on investment of using LNG equipment as opposed to diesel.



The project team consisted of the Port of Long Beach, U.S. EPA Region 9, Sound Energy Solutions, CALSTART, and Long Beach Container Terminal (LBCT). LBCT volunteered to test the LNG yard tractors in their container terminal operations during the eight-month evaluation period.

A total of three LNG yard tractors were deployed for performance testing and evaluation. Specifications for the LNG yard tractors were based on the Ottawa Commando 50 4x2 off-road terminal tractor performance specifications.

The LNG engine specified for the demonstration was the model year 2005 Cummins C Gas Plus 8.3 liter natural gas engine, rated at 250 hp and certified to the CARB on-road Optional NO_x standard.

Eight diesel yard tractors were selected from LBCT's fleet to serve as the baseline yard tractor group for comparative purposes. The baseline vehicles were equipped with various off-road diesel engines, ranging from model year 2001 to 2003 Cummins 8.3 liter 6CT engines rated at 205-215 hp and certified at Tier 1 or Tier 2, to model year 2005 Cummins 5.9 liter ISB engines

certified to the on-road emissions standard. All baseline diesel engines were equipped with diesel oxidation catalysts and closed crankcase ventilation to reduce particulate matter emissions. Data was collected on the baseline yard tractor group in parallel with the LNG tractors under similar operating conditions.

Results

Data collection was performed for quantitative parameters, such as fuel consumption and exhaust emissions, as well as qualitative attributes, such as operator perceptions of vehicle drivability. With respect to fuel economy, the LNG yard tractors used approximately 30% more fuel, on a diesel equivalent gallon basis, as compared to the average for baseline diesel vehicles. This result is consistent with expectations for the relative efficiency of a spark-ignited natural gas engine compared to a compression-ignited diesel engine.

Operator acceptance was assessed via surveys given to all LNG yard tractor drivers. Drivers were asked to rate the LNG yard tractor as “better”, “same”, or “worse” in key performance areas compared to a typical diesel tractor. The areas covered by the survey included maneuverability, pulling power, acceleration, shifting, steering, in-cab visibility, ride comfort, etc.

Based on the driver surveys, 97% of the drivers found the LNG yard tractors to have the same or better performance compared to the diesel tractors; 67% of the drivers rated the LNG tractors as having superior performance in general. The project final report is available on the TAP website.

Benefits

During emissions testing, the lowest NO_x and PM emissions were produced by the 2005 on-road diesel engine-equipped tractor and the 2005 LNG tractor, respectively. NO_x emissions from the LNG yard tractor were approximately 21% higher than NO_x emissions from the on-road diesel engine equipped with a diesel oxidation catalyst and closed crankcase ventilation system.

Project Costs

The total project cost was \$425,000. Funding included \$350,000 from the Port of Long Beach TAP Program and a \$75,000 contribution from U.S. EPA Region 9.

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