NATURAL GAS

HEAVY-DUTY VEHICLE EMISSION TESTING

FreedomCAR

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Evaluating the Emission Reduction Benefits of WMATA Natural Gas Buses

PROJECT IMPACT

This project demonstrated the emission reduction performance of natural gas transit buses versus conventional diesel counterparts: the natural gas buses had 53% lower oxides of nitrogen (NO_X), 85% lower total particulate matter (TPM), and 89% lower carbon monoxide (CO). It is anticipated that these advantages will encourage more extensive use of natural gas buses in U.S. cities as transit agencies seek ways to meet stricter emission mandates. Full replacement of conventionally fueled U.S. transit buses with natural gas buses could displace the equivalent of more than 600 million gallons of petroleum-based fuels annually and result in substantial air quality benefits.

Advantages of WMATA natural gas transit buses:

- 53% lower NO_x
- 85% lower TPM
- 89% lower CO

PROJECT GOALS

This project was part of the U.S. Department of Energy's (DOE's) FreedomCAR and Vehicle Technologies (FCVT) Program. One of the goals of the FCVT Program is to develop and deploy advanced transportation technologies that reduce the nation's use of imported oil and improve air quality. The goal of this project was to demonstrate the emission performance of natural gas transit buses. The project was performed in cooperation with DOE's Clean Cities Program, which supports partnerships that deploy clean-burning alternative fuel vehicles and build associated fueling infrastructure.

WMATA'S NEED FOR CLEANER BUSES

The Washington Metropolitan Area Transit Authority (WMATA) serves the public transportation needs of metropolitan Washington, DC, including Northern Virginia and Southern Maryland. More than 1.7 million commuters ride WMATA's rail cars and buses daily, and many of the area's tourists ride the system as well. WMATA serves 348 bus routes with 1,433 buses, including 164 that run on compressed natural gas (CNG, Figure 1).

The Washington, DC metropolitan area has air quality challenges. The U.S. Environmental Protection Agency (EPA) classifies it as a "severe" ozone nonattainment area, even though there are no significant stationary sources of air pollution. The air pollution is primarily due to motor vehicle emissions.

To help alleviate this air pollution, the Washington, DC City Council, the WMATA Board of Directors, and WMATA officials developed a plan in 2001 to convert much of the WMATA bus fleet from diesel to CNG. Under this plan, WMATA will purchase CNG buses and modify fueling and maintenance facilities to accommodate CNG buses, whenever reasonably possible (subject to ongoing vehicle availability and funding).

EMISSION TESTING OF WMATA'S CNG BUSES

The Clean Cities Program worked closely with WMATA during the CNG planning process, and DOE is interested in the effects of the conversion to CNG buses, including real-world emission performance. In July 2002, DOE and its National Renewable Energy Laboratory (NREL) evaluated the emissions of new WMATA CNG buses and comparable diesel buses using a heavy-duty chassis dynamometer.

Test Vehicles

Five CNG and four diesel buses were randomly selected from the fleet of available buses. Of the four diesel buses, two had low mileage (2,290 and 5,000 miles) and two had more than 100,000 miles. This difference in mileage had a negligible effect on test results; emissions data from the low-mileage and high-mileage diesel buses were similar. All of the natural gas buses had between 1,900 and 2,600 miles. Test vehicle specifications are shown in Table 1.

Figure 1. Natural gas transit buses at WMATA's Bladensburg fueling facility. WMATA operates 164 CNG-powered buses to reduce air pollution in the Washington, DC metropolitan area. Leslie Eudy, NREL/PIX 12293

Table 1. Test Vehicles

	CNG Buses	LSD Buses
Manufacturer	New Flyer	Orion
Model Year	2001	2000
GVWR (lb)	40,600	42,540
Odometer, each bus (mi)	1,900	2,290
	2,400	5,000
	2,500	105,000
	2,600	112,900
	2,600	
Engine	Cummins Westport C-Gas Plus	Detroit Diesel Series 50
Displacement (L)	8.3	8.5
Rated HP	280	320

GVWR—gross vehicle weight rating; LSD—low sulfur diesel.

The CNG vehicles tested were model year 2001, 40-foot, low-floor New Flyer buses. They were equipped with Cummins Westport 8.3-L C-Gas Plus CNG engines and an oxidation catalyst.

The diesel vehicles tested were model year 2000, 40-foot, low-floor Orion buses. They were equipped with Detroit Diesel Series 50 engines and an oxidation catalyst, and they used diesel fuel with a sulfur content of approximately 19 parts per million.

Test Equipment and Procedures

The vehicles were tested at WMATA's facility in Landover, MD on West Virginia University's Transportable Heavy-Duty Vehicle Emission Testing Laboratory. The laboratory is uniquely configured using driveshafts to connect each drive axle to individual dynamometers to avoid tire slippage experienced on the more typically used dynamometer rolls. Exhaust gases are collected and analyzed on site to determine regulated emission rates using instruments made by Rosemount Analytical and Varian.

The emission testing laboratory can be programmed with various driving cycles to simulate different types of vehicle operation. The driver matches the vehicle's operation to the speed and acceleration of the programmed test cycle using a display inside the vehicle. For the WMATA testing, the Central Business District (CBD) cycle was used, which simulates the stop-and-go operation of transit buses being operated in congested urban areas.

Each test bus was run, without stopping, through four consecutive CBD cycles on the dynamometer. The first cycle was a warm-up cycle; the cumulative emissions from the final three cycles were collected and measured. Measured emissions included total hydrocarbons (THC), non-methane hydrocarbons (NMHC), CO, carbon dioxide (CO_2), NO_x, and TPM.

Results and Conclusions

Figure 2 shows the emission results for the CNG and diesel buses. On average, the CNG buses reduced emission of NO_x by 53%, TPM by 85%, and CO by 89% compared with the diesel buses. Overall, the Cummins Westport 8.3-L C-Gas Plus engine reduced these measured emissions significantly in this transit bus application compared with model year 2000 diesel buses.

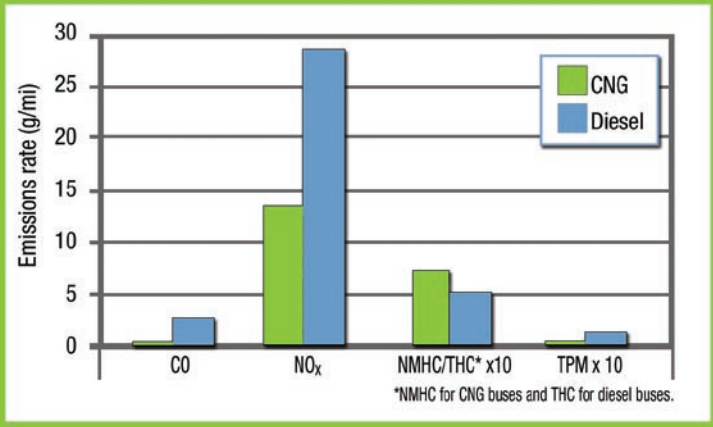

Figure 2. Average chassis dynamometer emissions of natural gas and diesel buses.

NEXT STEPS

During the 2003 model year, WMATA will re-power some of its older diesel buses to incorporate new diesel engines equipped with exhaust gas recirculation designed to meet the October 2002 requirements of the EPA Diesel Engine Consent Decree. NREL will use this unique opportunity to evaluate the emissions performance of the latest diesel engines compared with the latest CNG engines in transit buses.

Because of the interest in California and nationwide to consider regulating currently unregulated emissions, NREL also plans to measure toxic emissions such as 1,3-butadiene and benzene from CNG and diesel WMATA buses. The regulated and unregulated emission testing is planned for 2003.

FOR FURTHER INFORMATION, CONTACT

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