

UPS CNG TRUCK FLEET

START-UP EXPERIENCE



This is a
Clean Air
Natural Gas Vehicle



Produced for the
U.S. Department
of Energy (DOE) by the
National Renewable Energy
Laboratory (NREL), a
DOE national laboratory

ALTERNATIVE FUEL TRUCK EVALUATION PROJECT

United Parcel Service (UPS) has a strong commitment to the environment, with a long list of environmental initiatives that includes maintenance methods to minimize vehicle emissions, aerodynamic streamlining devices on its tractor-trailer fleet to maximize fuel conservation, retrofitting aircraft for noise reduction, and developing reusable express envelopes. It is no surprise then, that UPS volunteered to participate in a federal program to evaluate the potential benefits of using alternative fuels in commercial fleets, or that managers and staff at two UPS facilities in Connecticut enthusiastically supported the idea.

UPS currently operates 140 Freightliner Custom Chassis compressed natural gas (CNG)-powered vehicles with Cummins B5.9G engines. Fifteen are participating in the Alternative Fuel Truck Evaluation Project being funded by the U.S. Department of Energy's (DOE) Office of Transportation Technologies and the Office of Heavy Vehicle Technologies. DOE's National Renewable Energy Laboratory (NREL) is conducting the study

in collaboration with federal and state agencies and industry partners such as UPS.

UPS's participation in an alternative fuel evaluation is not its first venture into this field—the company is a pioneer in alternative fuels. Since the 1930s, when it began using electric vehicles in New York City, UPS has researched and tested alternative fuels that could reduce vehicle emissions, dependence on fossil fuels, and operating costs.

During the 1970s and 1980s, UPS evaluated methanol-powered vehicles and a stratified-charge engine designed to run on multiple alternative fuels. In the late 1970s, UPS's Canadian subsidiary converted 735 delivery vehicles to propane fuel. In 1989, UPS began testing CNG to assess its viability and benefits.

Today UPS has the largest private fleet of CNG vehicles in the United States—more than 1,000 package delivery vehicles* operate in 16

*UPS calls its package delivery vehicles package cars.

states. UPS also uses propane-powered vehicles in two other countries—850 in Canada and 80 in Mexico. It is reviewing plans to add alternative fuel vehicles (AFVs) in Guadalajara and Monterrey, Mexico. The company expects to launch its first liquefied natural gas (LNG) tractors this year in Ontario, California.

"UPS began using new fuels 15 years ago," said Jerry DiSciullo, vice president of maintenance and engineering at UPS's corporate headquarters in Atlanta, Georgia. "We have tried to keep current on the technologies and to be mindful of the environment and air quality issues."

During the 1980s, UPS evaluated various alternative fuels, found that natural gas had the best characteristics for its operations, and launched its first fleet of 10 CNG vehicles in New

Below: This UPS facility in Hartford, Connecticut, is home to 101 CNG package cars.

Right: The Hartford hub package processing facility is designed to sort tens of thousands of packages per hour.



York City. The vehicles were fueled at the local gas company's CNG facility. During the next 10 years, UPS bought CNG vehicles or retrofitted older vehicles to use CNG.

"We concluded that CNG was the best alternative fuel for our operations, and it had positive environmental qualities," said DiSciullo. "Employees and customers recognized the company for those good neighbor efforts." UPS is also anticipating a cleaner-air future. "We expect to start testing hybrid electric vehicles in 2001," he said.

"We value our leadership role in alternative fuels," said DiSciullo, "and we find that customers and other stakeholders are generally positive." He also said that, because UPS has long been a part of the alternative fuels transformation process, it has direct experience, not just a theoretical response.

Vehicles involved in the project are based in Hartford, Waterbury, and Windsor, Connecticut. The fleet consists of 15 package cars powered by CNG and operating from the Hartford (10) and Waterbury (5) facilities. The three comparison vehicles using diesel fuel are based in Windsor. Delivery routes

in the Waterbury area have more hills than the Hartford and Windsor routes, which adds a terrain factor to the evaluation.

All 15 CNG delivery vehicles are Freightliner Custom Chassis with Grumman Olson bodies, built with Cummins B5.9G engines. This engine was designed for medium-duty truck and bus use and produces ultra-low emissions of nitrogen oxide (NO_x) and particulate matter (PM). All are 1997 model Class 4 vehicles.

Alternative Fuel Truck Evaluation Project



Data collection began in 1999 and was completed in November 2000. Vehicle emissions data were collected at the Hartford, Waterbury, and Windsor facilities by West Virginia University using its portable chassis dynamometer facility.

The corporate commitment to the environment is clearly shared by managers at the three UPS package delivery facilities in the Hartford area. They believe questions such as, "Should we be using cleaner fuels?" or "Can the AFVs perform as well as conventional vehicles?" are being answered every day. The answers are based on their experience with the CNG-powered vehicles they have used since the late 1990s.

"From the beginning of discussions about using cleaner fuels—in 1996—I was psyched," said Steve Mitchell, plant engineer at the UPS facility in Waterbury, referring to the opportunity to use CNG. Having support from the state to encourage switching to cleaner fuels "really sealed the deal," he added.

Accommodating CNG fueling was not a problem at the Waterbury site, Mitchell recalled. "We already had a large central fueling island, so we just added the CNG dispensers alongside

the diesel dispensers." Adequate space was also available for the compressor equipment.

David Hooke, fleet supervisor at the Hartford facility, was also involved at the beginning of UPS's move to CNG. "At the Hartford facility, 101 of our 135 package cars now use CNG; the other 34 are powered by gasoline or diesel."

"These CNG cars roll in and out of here all day and we expect to keep them going for about 20 years," said Tom Robinson, the district automotive fleet manager. Each UPS driver* delivers as many as 500 packages a day, which requires careful planning and teamwork. At each UPS sorting facility, packages are loaded into the delivery vehicles in the same order in which they are to be delivered. The facility is designed to sort tens of thousands of packages per hour.

Mitchell and Hooke agree with the corporate staff in Atlanta that more publicly accessible CNG fueling stations are needed. "That's hurting us because it limits the vehicle's delivery range and adds to the driver's anxiety," Mitchell said. "At the time we installed our CNG fueling station, it was the largest in the area," Robinson added.

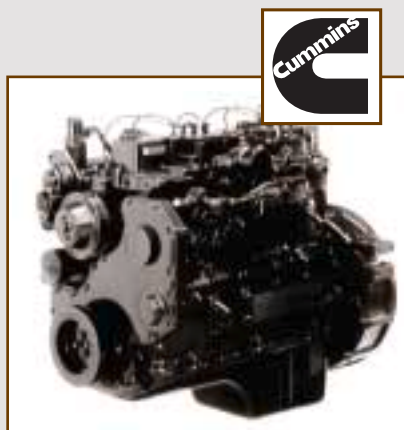
*UPS calls its drivers package car service providers.



United Parcel Service/PIX 09807

Cummins CNG Engine

Model:	B5.9G
Year:	1997
Adapted from:	Diesel B5.9 engine
For:	Medium- and heavy-duty trucks
Emissions:	Ultra-low NO _x , PM levels (Certified to 1998 EPA ultra-low emission vehicle standards)
Rated Power:	195 hp
Peak Torque:	420 lb-ft @ 1600 rpm
Turbocharger:	Yes
Engine size:	359 cubic inches (5.9 liters)
Number of Cylinders:	6
4-Cycle Compression Ratio:	10.5:1



Cummins Engine Company/PIX 03840

First CNG engine with all subsystems (fuel, ignition, air handlers) **engine-mounted**

Delivery Van Freightliner Custom Chassis Components

- FH Model MT45
- Year Manufactured: 1997
- Body Manufacturer: Grumman Olson
- Medium-Duty Frame
- Power Train Options
- Designed to User Needs
- Safety Features



Even with on-site CNG fueling stations and careful route planning at the Hartford and Waterbury facilities, some eventualities cannot be covered. UPS offers an on-call courtesy pickup along the routes, and cannot anticipate the number of calls for this service. So sometimes the vehicles run out of fuel trying to meet this commitment. This can cause major delays and usually a tow to the UPS facility.

Running low on fuel is a concern at both Hartford-area hubs, but it is more likely to occur in Waterbury. The CNG vehicles normally go 80 to 90 miles on a full tank of CNG in Hartford, which has fairly flat terrain. But in Waterbury, the many hilly routes reduce the miles-per-fillup and a car can run low on fuel far from its home base. If a Hartford-based car runs low on CNG near the municipal airport, it can be refueled at the CNG station near Windsor.

The need for more publicly accessible fuel supply stations is a nationwide infrastructure issue for government and private sector leaders committed to promoting the use of alternative fuels.

UPS's Colorful History



United Parcel Service/PIX 09806

This 1935 Walker truck—powered by electricity—was UPS's first alternative fuel package delivery vehicle.

UPS's long and colorful history began in 1907. Seeing the need for a private delivery service, 19-year-old James E. (Jim) Casey borrowed \$100 from a friend and established the American Messenger Company in Seattle, Washington. In those early years, deliveries were made on bicycles.

With the help of a handful of other teenagers, Jim and the company did well because of his strict policies: customer service, reliability, 24-hour service, and low rates. The company's first slogan was "Best Service and Lowest Rates."

The company acquired its first vehicle, a Model T Ford, in 1913 and began daily service in Seattle. Jim initially focused on delivering packages for retail stores. Soon he and his partner were managing a fleet of delivery vehicles. Together they pioneered the concept of consolidated delivery—placing packages addressed to the same neighborhood in the same vehicle.

The company became known as the United Parcel Service and continued to expand operations. By the 1930s, its "Pullman

railroad brown" delivery vans became a common sight in all major West Coast cities and the New York City area. Its first alternative fuel van was a 1935 Walker truck powered by electricity.

UPS is now the world's largest express carrier and package delivery company. It delivers more than 3 billion packages and documents every year to more than 200 countries and territories. The cars are that same brown color today, but more than 80,000 of them now deliver more than 13 million packages and documents each day to 7.9 million regular customers in thousands of cities in the United States and abroad.

UPS's international service can reach more than 4 billion potential customers. The company employs more than 358,000 people worldwide and invests more than \$300 million per year on employee training and learning programs. The company's annual revenues in 2000 were \$29.8 billion.

Alternative Fuel Truck Evaluation Project

The Alternative Fuel Truck Evaluation Project provides a comprehensive comparison between new technology trucks and comparable diesel-powered trucks. Truck fleets considering the use of alternative fuels are expected to be the primary audience for this information. Results from other fleets in the project are available at <http://www.ctts.nrel.gov> and <http://www.afdc.gov>, or by calling the National Alternative Fuels Hotline at 1-800-423-1DOE.

The objectives of the UPS phase of the project are to:

- Collect and analyze data on emissions from the 15 package vehicles using CNG, compared to emissions from three similar vehicles using diesel fuel.
- Evaluate the economic, technical, emissions, and safety factors. Information is obtained by

collecting and comparing data on the operational, maintenance, performance, emissions, and durability of the CNG-powered vehicles and the diesel-powered control vehicles.

Four other commercial fleets are participating in this evaluation project, which began in 1997 and has the objective of comparing performance characteristics of medium- and heavy-duty trucks in commercial fleets powered by various alternative fuels and diesel fuel. Information is being collected on the economic, technical, emissions, performance, durability, and safety factors of these vehicles.

Raley's—A grocery chain in Sacramento, California, which operates Kenworth T800 trucks using LNG fuel and Cummins model L10-300G engines.

Orange County Sanitation District (OCSD)—

A waste hauler in Fountain Valley, California, which operates White/GMC trucks with Caterpillar dual-fuel engines (model 3176B) using CNG and diesel fuel.

Waste Management (WM)—A refuse hauler

in Washington, Pennsylvania, which operates Mack trucks with LNG-fueled Mack engines (model E-7G).

Ralphs Grocery Company—A grocery chain's distribution facility in Riverside, California, which

uses low-sulfur diesel fuel (ARCO ECD™) and particulate filters manufactured by Johnson Matthey and Engelhard.



West Virginia University's transportable heavy-duty vehicle emissions testing laboratory collected data from the UPS test fleet in Hartford and Waterbury.



Kevin Chandler, Battelle/PIX 08644

Kevin Chandler, Battelle/PIX 10072

UPS installed and maintains CNG compressor stations and fueling islands at both its Hartford and Waterbury facilities.

Why Compressed Natural Gas?

CNG is one of several alternative fuels available. Natural gas is abundant and is used to heat homes throughout the United States. It is composed primarily of methane (more than 90%) and other hydrocarbon gases, such as ethane, propane, butane, and pentane. Natural gas is colorless and odorless. An odor is added to natural gas to warn of leaks. CNG used in vehicle engines is stored and used at high pressure—up to 3,600 pounds per square inch.

A natural gas vehicle (NGV) operates on CNG instead of gasoline or diesel fuel. The primary differences between an NGV and a gasoline-powered vehicle are in the on-board fuel storage and

intake systems. NGVs carry their fuel in high-pressure cylinders, which are usually secured to the bottom of the vehicle. From there, the CNG travels along a high-pressure fuel line leading to the engine. A CNG-powered vehicle's mileage in "gasoline gallon equivalent" is about the same as a conventional gasoline vehicle, which can be retrofitted to operate on CNG, but may lose 5%-10% of its power.

CNG fueling stations are few and public access may be limited. Most are operated by natural gas utility companies, some of which allow public access. Increasingly, gasoline service stations are contracting with utilities to install CNG

fueling dispensers. Companies with commercial fleets often install their own CNG fast-fill compressor facilities to ensure access to consistent supplies. *For additional information, see Infrastructure Issues, Incentives.*

UPS converted much of its delivery van fleet in the Hartford area to CNG several years before volunteering to assign 15 of the CNG vehicles to the Alternative Fuel Truck Evaluation Project. Corporate executives, fleet managers, and engineers recalled the lessons they have learned to make the change to alternative fuels easier for other fleets. Despite the challenges, UPS is enthusiastic about using alternative fuels. “Unless somebody tries, we don’t learn these things,” said Jerry DiSciullo. “We have to learn and adapt to make alternative fuels successful by scheduling shorter routes, flatter terrain, and considering seasonal weather factors.”

Lessons Learned

1. Preparations

Determine and solidify the company’s commitment to the environment by evaluating alternative fuels, and consider participating in demonstration or evaluation programs.

Prepare for step-by-step learning. UPS converted vehicles to alternative fuels for 10 years before purchasing new vehicles with alternative fuel engines. “We learned a lot from that early work,” said Jerry DiSciullo.

Research the incentives available from various federal and state sources for purchasing AFVs or retrofitting older vehicles. International companies should examine available incentives in all countries they operate in. “Canada has helped commercial fleets and offers many incentives,” said Larry Flahardy, UPS corporate vice president of fleet maintenance.

Plan ahead to acquire parts and supplies; budget for possible higher costs of replacement parts for alternative fuel engines.

Develop methods to measure the performance and maintenance needs for the AFVs, as well as fuel costs, and compare the data to records for trucks using gasoline or diesel fuel. This will help control operating costs.

Meet with managers to describe the plans and rationale for purchasing or retrofitting vehicles and to gain their support.

Notify employees about the company’s plan to use AFVs and meet with those whose roles or work may be affected.

2. Ongoing Activities

Analyze the required range and routes of the current (and future) alternative fuel fleet and identify locations of publicly available CNG stations in case fuel runs low or unanticipated pickup calls cause the vehicle to exceed its range. However, schedulers should still be careful about where to use the CNG-powered vehicles.

- Assign the right vehicle to the right route so vehicles do not run out of fuel.
- Periodically research outlying areas and arrange for access to public fueling stations.
- Contract for towing services in case vehicles exceed their range and need to be towed to home base.

Integrate alternative fuels information into training programs—including differences in the AFVs for drivers (e.g., range, fuel availability, power)—and for technicians servicing and repairing the new vehicles.

Install on-site fueling facilities and/or share the cost of installation by partnering with a utility, municipality, or nearby company with similar needs. For example, UPS shares a CNG fueling facility in San Ramon, California, with police, fire, and other municipal vehicles. The facility is owned by the local gas company, which leases it to UPS. UPS uses the facility at night, the others use it during the day. Some companies defray the

costs of having an on-site fueling facility by encouraging employees to refill their personal AFVs there.

“Initially—back in 1995—building our own fueling facility was a nightmare,” said DiSciullo, “because there were too many obstacles, too many (regulatory) hurdles and issues to address.” Early issues included confusing permit procedures, unsure local officials, proper protection and safety issues for fuel tanks, how to measure the fuel, required emergency shut-off valves, and training for drivers and mechanics in safe operations. Now CNG stations are located at many UPS hubs, including the Hartford area.

Stay current on evolving technologies, weigh what best fits the company’s future needs, and do a cost-benefit analysis. UPS’s experience has been that most AFVs have a two-year warranty and cost \$15K–\$18K more than diesel-powered medium-duty vehicles.

Identify similar companies participating in alternative fuels demonstration or evaluation projects

and consult them about their experiences.

Check the following Web sites to learn more about demonstration and evaluation programs and participating companies:

http://www.ctts.nrel.gov/heavy_vehicle

<http://www.ott.doe.gov>

<http://www.afdc.doe.gov>

3. Long-Term Strategies

Review the big picture. UPS found that early economies in fuel costs were offset by increases in employee time and mechanical issues. For example, it takes about 3-1/2 minutes to refill fuel tanks with CNG, compared to 10-15 seconds for diesel. CNG vehicles must be filled every night, whereas diesel and gasoline vehicles need refilling every two or three nights.

It takes as long as 30 seconds to start a CNG engine, compared to several seconds for a diesel or gasoline engine, taking more employee time and causing more wear on the starter and battery. There were also unanticipated costs, including durability of the components, costs

of fuel tank certification, new maintenance and service training courses, and added expense for the engine, exhaust, and fuel systems. Another unknown was the longevity of support components. For example, how long will the on-board tank last? Must it be recertified every 10 years?

Provide regular updates to drivers, refuelers, technicians, and others concerned about the difference between the alternative fuel and gasoline or diesel fuel. For example, some UPS drivers initially considered the CNG delivery vehicles sluggish so UPS added 35 horsepower to improve driver acceptance. Fleet managers should periodically seek input from drivers and maintenance personnel about issues or concerns related to the alternative fuel.

Communicate regularly with other stakeholders about the company’s ongoing commitment to cleaner air, planned use of alternative fuels, participation in the test programs or demonstrations, and responses from personnel and customers.

Kevin Chandler, Battelle/PIX 08637



UPS package delivery cars using CNG display their commitment to clean air with this logo on the vehicles.



Kevin Chandler, Battelle/PIX 08645

Infrastructure Issues, Incentives

The lack of publicly accessible CNG refueling stations remains a nationwide issue that deters motorists from purchasing CNG vehicles and is a barrier to the widespread use of CNG by fleet owners.

To ensure an adequate supply, most fleet owners with CNG vehicles—including UPS—construct on-site refueling equipment despite the high cost of installation. Recognizing that high costs are a barrier to increased use of AFVs, federal and state agencies and some vehicle manufacturers are joining forces to defray the costs by offering infrastructure incentives.

The Federal Energy Policy Act of 1992 provides a tax deduction of as much as \$100K per refueling site for businesses. The deduction is available for sites placed in service before January 1, 2005. For additional information about this and other federal incentives, visit http://www.ott.doe.gov/epact/private_fleets.html.

The U.S. Environmental Protection Agency has a voluntary diesel retrofit program to match fleet operators, engine manufacturers, and local governments with providers of technology and resources to help fleets run cleaner. More information is available at <http://www.epa.gov/otaq/retrofit>.

Several automobile manufacturers, including Ford, General Motors, and Honda, offer incentives to install CNG fueling equipment. For example:

- Ford has invested millions of dollars to develop infrastructure and helps fleets and retail owners establish their own fueling stations. In 1999, Ford announced plans



Kevin Chandler, Battelle/PIX 08641

UPS installed fueling stations at both its Hartford and Waterbury sites to ensure a dependable supply of CNG.



United Parcel Service/PIX 07054

Refueling at a CNG station is similar to using gasoline pumps.



United Parcel Service/PIX 07055

to spend at least \$1 million developing retail alternative fuel infrastructure.

- General Motors discounts the retail cost of a CNG fueling device with the purchase of its vehicles.
- Honda offers a CNG fueling device at 50%-100% off the retail price of a Honda CNG Civic (GX). The amount discounted depends on the number of vehicles purchased.

Many local refueling system providers are willing to construct and operate a CNG station in exchange for a guaranteed level of fuel sales over a given period of time (visit http://www.calstart.org/fleets/coopcour_jun99.html).

Connecticut is one of 37 states that offers incentives to companies that purchase AFVs or convert fleets. Details are available at <http://www.calstart.org/>. For example, incentives offered* by Connecticut include:

- Discounted motor fuel tax for those using CNG, \$0.18/gallon compared to the non-discounted rate of \$0.32/gallon.
- Loans to companies to convert older vehicles to alternative fuels.
- Exemption from fuel excise tax for fleets using CNG, LNG, or liquefied petroleum gas (LPG).
- Tax credit of 50% of the cost of converting a vehicle to CNG, LPG, LNG, and electricity.
- Tax credit of 10% of the cost for CNG or electric vehicles' refueling infrastructure or conversion equipment or the cost of an AFV.

- Tax credit for 50% of the construction costs or improvements for filling stations providing CNG, LNG, and LPG.

Canada also motivates companies to use alternative fuels in fleets. "Over the past 10 years, Canada has helped commercial fleets and offered many incentives, such as paying the partial cost of converting vehicles, lowering taxes on alternative fuels compared to gasoline, and promoting public fueling stations," said Larry Flahardy, UPS corporate vice president of maintenance fleet.

Additional information is available at the following Web site: <http://www.fleets.doe.gov>, then click on Incentives and Laws.

Selected Technical Reports and Publications

Battelle, 2001, *Ralphs Grocery EC Diesel Truck Fleet: Start-Up Experience*, National Renewable Energy Laboratory, Golden, CO, NREL/BR-540-29485

Battelle, 2000, *DART's LNG Bus Fleet: Final Results*, National Renewable Energy Laboratory, Golden, CO, NREL/BR-540-28739

Battelle, 2000, *Waste Management's LNG Truck Fleet, Final Data Report*, Battelle, Columbus, OH

Battelle, 2000, *DART's LNG Bus Fleet, Final Data Report*, Battelle, Columbus, OH

Battelle, 2000, *DART's LNG Bus Fleet, Start-Up Experience*, National Renewable Energy Laboratory, Golden, CO, NREL/BR-540-28124

Battelle, 2000, *Raley's LNG Truck Fleet: Final Results*, National Renewable Energy Laboratory, Golden, CO, NREL/BR-540-27678

Battelle, 1999, *Waste Management's LNG Truck Fleet, Start-Up Experience*, National Renewable Energy Laboratory, Golden, CO, NREL/BR-540-26617

Battelle, 1999, *Raley's LNG Truck Site, Final Data Report*, Battelle, Columbus, OH

Chandler, K., Norton, P., Clark, N., 1999, *Interim Results from Alternative Fuel Truck Evaluation Project*, SAE International, Warrendale, PA, SAE Pub. #1999-01-1505

Chandler, K., Norton, P., Clark, N., 1998, *Alternative Fuel Truck Evaluation Project—Design and Preliminary Results*, SAE International, Warrendale, PA, SAE Pub. #981392

Battelle, 1998, *Dual-Fuel Truck Fleet, Start-Up Experience*, National Renewable Energy Laboratory, Golden, CO, NREL/BR-540-25118

Battelle, 1997, *Raley's LNG Truck Fleet, Start-Up Experience*, National Renewable Energy Laboratory, Golden, CO, NREL/BR-540-23402

* Check Web sites or individual states for current information.

The Truck Evaluation Project

NREL has tested and evaluated new fuels and technologies for nearly a decade, and is conducting the DOE Truck Evaluation Project, which includes CNG. Data are being collected and compared on the operations, economic, technical, safety incidents, maintenance, performance, fuel consumption, engine oil consumption, changes, and emissions characteristics of participating fleets. Data from each site are collected for at least 12 months. The results are compared to data from control trucks within the same fleet.

In 1993, NREL began a similar program to evaluate transit bus use. The defined and proven data collection and analysis system from the bus study has been adapted for truck use. The sites in the program have been selected according to the types of trucks and engines, the availability of control vehicles, and each site's interest in participating. Specific criteria must be met, such as vehicle size (medium- and heavy-duty) and number of trucks (at least five).

Two reports are generated for each site. This first is a brief summary of the start-up experience of the project's demonstration of package delivery cars based at the UPS hub in Hartford, Connecticut. The final report is a result of collecting and analyzing 12 months of data from the site. NREL and Battelle (NREL's support contractor for the project), will prepare this report and analysis in the fall of 2001. Data from these programs are available at http://www.ctts.nrel.gov/heavy_vehicle; <http://www.ott.doe.gov>; and <http://www.afdc.doe.gov>. To learn more about this program, its components, CNG vehicles, or incentive programs, contact any of the following individuals:

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For more information and for copies of program reports, visit the Alternative Fuels Data Center at <http://www.afdc.doe.gov>, or call the Alternative Fuels Hotline at 1-800-423-1DOE.

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