

Using CNG Trucks in National Parks



Produced for the U.S. Department of Energy by the National Renewable Energy Laboratory, in cooperation with Battelle

The U.S. Department of Interior (DOI) has made a long-standing commitment to reducing dependency on petroleum in its motor vehicle fleet.

DOI's 32,000-vehicle fleet includes more than 300 alternative fuel vehicles (AFVs) across the nation in about 25 states and more than 75 locations. Approximately 80 percent of DOI's AFVs are designed to use an alcohol-based fuel (primarily methanol or ethanol/gasoline blend); 15 percent use either natural gas or propane. Electricity or biodiesel fuel the remaining 5 percent of the AFVs.

DOI has been working with other federal agencies and industry, including vehicle manufacturers

and fuel suppliers, to establish clean transportation zones for demonstrating alternative fuel technologies.

These partnerships, which include the U.S. Department of Energy (DOE) and the U.S. Department of Transportation, allow vehicle, fueling, and infrastructure cost sharing and also provide "hands-on" support for DOI's alternative fuel vehicles.

DOI has successfully implemented cleaner burning alternative fuel transit vehicles, such as electric trams, to

relieve traffic congestion and help to protect the park systems' natural resources and historic sites. DOI

now operates electric mass transit vehicles at the Patuxent National Wildlife Visitor Center, Back Bay National Wildlife Refuge, Golden Gate National Recreational Area, and Yosemite and Grand Canyon National Parks.

Alternative Fuels Coordinator Robert Jarcho recognizes the significance of replacing the fleet's diesel-fueled heavy-duty trucks with AFVs. ("Heavy duty" refers to any truck with a gross vehicle weight of at least 8,501 pounds.) "Implementing alternative fuels in heavy-duty vehicles really contributes to emissions reductions — this is the frontier for alternative fuels," he explains.

On November 15, 1997, the National Park Service (NPS) introduced the first of several alternative fuel heavy trucks into its fleet in the Washington, D.C., area.

Federal Government Leads the Way for Alternative Fuel Use

"... the use of alternative fueled motor vehicles will, in many applications, reduce the Nation's dependence on oil, and may create jobs by providing an economic stimulus for domestic industry, and may improve the Nation's air quality by reducing pollutants in the atmosphere. . . . The purpose of this order is to ensure that the Federal Government exercises leadership in the use of alternative fueled vehicles."

**President William J. Clinton
Executive Order 13031
December 1996**



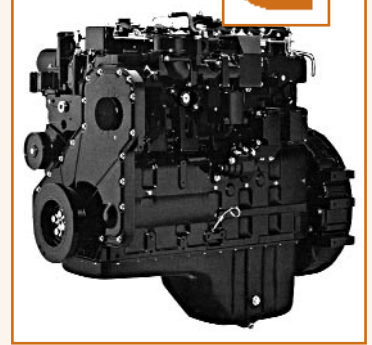
Specifications of the CNG Refuse Hauler at Central

- Crane Carrier Low Entry Tilt (LET) chassis
- Rear loading trash packer with a 2.3 cubic yard capacity hopper
- 4 x 2 transmission
- 33,000 lb GVW
- Fully equipped to operate on CNG
- Full engine and chassis warranty
- 250 hp heavy-duty engine
- Emissions certification
- CNG tank capacity of 4,500 scf @ 3,000 psi
- Range of ~100 miles



Cummins C8.3G Engine

Fuel:	CNG
Displacement:	505 in ³ , 8.3 L
Horsepower:	250 hp @ 2400 rpm
Torque Peak:	750 lb-ft @ 1400 rpm
Size:	44.3-in. length 29.2-in. width 42.0-in. height
Weight:	1330 lb
Emissions: with catalyst	1.8 NO _x g/bhp-hr 0.6 NMHC g/bhp-hr 0.9 CO g/bhp-hr 0.02 PM g/bhp-hr
Compression Ratio:	10.5:1
Fuel System:	Electronic control
Throttle Control:	Drive-by-wire
Configuration:	In-line, 6 cylinder
Air Intake:	Water-cooled turbocharger
Warranty:	2 years/100,000 miles



NMHC=nonmethane hydrocarbons
CO=carbon monoxide
NO_x=oxides of nitrogen
PM=particulate matter

The Crane Carrier refuse hauler, using a Cummins C8.3G engine fueled by compressed natural gas (CNG), is part of the Washington, D.C., NPS fleet and operates in the National Capital Region’s National Capital Parks–Central area.

NPS and DOI are working with DOE to implement alternative fuels in heavy trucks to attain goals of environmental sustainability and efficient operation. This report outlines the steps required to put CNG trucks in operation in the NPS fleet.

Getting Started

DOI decided to demonstrate the heavy-duty vehicles at an NPS site that would be particularly visible: “We wanted to make sure that the public recognized the efforts being made at the federal level to use environmentally friendly technologies

within the national parks,” said Charles Borders of the NPS National Capital Region. “But, more importantly, the park service *wanted* to do this — it is an integral part of being a good steward.”

The first step in implementing the vehicles into the fleet was to determine the fleet’s operating requirements. DOI, DOE, and NPS — assisted by Battelle, the project’s technical contractor — assessed the vehicles’ operating range and the number of miles or hours required for normal operations. The team also determined how often the vehicles would be fueled (e.g., daily or every other day).

The trash packers in the National Capital Parks–Central operate 7 days a week, 8 hours each day. In addition to the continuous operations within the parks (averaging 30 miles per day), the trash packers make daily trips to a dump site, which is a 70-mile round trip. The vehicle needed to meet the driving range (~100 miles each day), horsepower (~250 hp), and torque requirements.

Candidate fuels (and therefore engines) for the project included methanol, ethanol, natural gas, propane, biodiesel blends, and electricity. With technical support from Battelle, the project team assessed each fuel’s ability to meet the NPS requirements and developed specifications for the desired vehicle.

Through the General Services Administration (GSA), DOI ordered a new refuse hauler, powered by CNG, from a Crane Carrier Corporation dealer, with delivery in November 1997.

The refuse hauler uses a Cummins C8.3G dedicated natural gas engine, which is reported to have one of the lowest cost-of-operation of any engine in its class, along with one of the highest power-to-weight ratios. The ignition system on the C8.3G features coil-on-plug technology with multiple spark discharge, which eliminates spark plug wires, reducing system maintenance and increasing spark plug life. Cummins developed the C8.3G engine for 32,000- to 66,000-lb regional-haul

applications such as pickup and delivery vehicles and urban trucks, as well as for on/off highway applications such as refuse and dump trucks. This engine is now available in ratings up to 275 hp with 750 or 660 lb-ft peak torque. This engine is certified to the U.S. Environmental Protection Agency (EPA) ultra-low emissions vehicle (ULEV) standard and to the EPA low emissions vehicle (LEV) standard (without catalytic converter).

Factors for Success

The NPS has been operating the refuse hauler for more than 5 months. Based on their experiences with the start-up of CNG operations in the National Capital Parks—Central, Robert Jarcho, Charles Borders, and Facility Manager Sean Kennealy offered the following lessons learned for other fleet operators.

Find a project champion.

Success of an alternative fuel project depends on the commitment of a champion at all levels of the organization — someone committed to making it happen. Bob Jarcho has provided the ongoing energy for the NPS project, and he has discovered that having regional champions — such as Charles Borders and Sean Kennealy — makes the process of introducing new technologies into the field much easier.

Know what's available as well as what you need.

Information about alternative fuel vehicles is available to support your decision-making process. Determining the vehicle specifications is essential, but you need to know what the engine and vehicle manufacturers have to offer.

Expanding the GSA heavy-duty alternative fuel vehicle list is crucial to the successful implementation of AFVs in the federal fleet.

Consider infrastructure needs when selecting the fuel.

NPS had an existing CNG compressor station and fuel dispenser at the East Potomac Park Maintenance Yard that provided fuel for the NPS light-duty fleet. The facility's 39 cfm compressor, 18,000 ft³ gas storage tank, 2 gal/min dispenser, and NGV-1 fitting met the fueling requirements of the light-duty fleet. However, as NPS discovered, fueling heavy-duty vehicles requires a faster throughput. Washington Gas Company, which provides the CNG and maintains

the station, upgraded the dispenser and delivery tubing to meet the heavy-duty vehicle fueling requirements. Although changes were needed, having the facilities in place

was beneficial financially. In addition, the personnel already had a working familiarity with the fuel and the dispenser.

Storage space is an important consideration in choosing a fuel. A CNG fueling system requires a compressor system, a fuel management system, a natural gas service, and a physical structure to ensure safety. The fueling site also needs to be located for ease of use as well as safe operation.

Establish a reliable support network.

Finding solutions to problems quickly will make or break a technology project. As Jarcho points out, the comfort level of using alternative fuels can be an issue. Conventionally fueled vehicles have problems too, but the operations and maintenance personnel generally know how to solve them. With the new vehicles, however, they may not be able to diagnose problems or may be hesitant to repair them. The external support required must be available in order to move quickly on problems.

An important consideration when selecting the vehicle is easy access to warranty service. Because the fuel may not be available near the warranty provider, you must consider the travel time and distance involved if the warranty provider does not offer on-site service.

Jarcho praises the exceptional support



that Washington Gas Company has provided in addressing the start-up problems associated with the fueling station. Slow fuel-fill times were restricting the vehicle's integration into the fleet, and Washington Gas quickly diagnosed and corrected the problem. Installing a new dispenser and replacing existing piping significantly improved the fill time and increased the operators' confidence in using the vehicles.

Purchase new vehicles.

Fleet operators have the option of purchasing new vehicles or repowering existing fleet vehicles with new engines and retrofitting fuel systems. Many factors drive the choice, such as funding and vehicle downtime.

DOI initially sought to repower a refuse hauler along with purchasing a new one. However, repowering a single vehicle was option, as industrial providers did not respond to DOI's request for the service.

Fleet operators choosing to repower vehicles should carefully consider the number of vehicles to be refitted with an alternative fuel engine, the projected life of the vehicles (does it make sense to put a new engine in the vehicle?), and the availability of a certified service provider. The provider needs to be certified by the original equipment manufacturer to ensure warranty coverage.

DOI recommends that fleet operators purchase new equipment for two primary reasons: new equipment instills more confidence in operators, and securing warranty service for newly purchased vehicles is easier.

Ensure a seamless contracting mechanism.

New equipment can present start-up issues with engine and vehicle operations. For new operators, however, determining the source of a problem can be difficult. As Kennealy points out, having a single point

of contact would make it easier for the operations and maintenance personnel — rather than trying to determine if the vehicle has an engine problem, or a chassis problem, or a CNG tank problem. New technology can make the most confident maintenance personnel hesitant.

Invest in education.

Crane Carrier and Washington Gas Company have

ment to environmental stewardship.

"It is such a great opportunity to show the public what we are doing," Kennealy said. "You see that truck out on the Mall, and there is no diesel chatter, no belching smoke, no diesel smell." NPS personnel in the field are the true ambassadors of the program, and the more they know, the more they can share.

What Next?

DOI hopes to operate propane-powered trucks at three sites around Washington, D.C., if suitable engines can be purchased in 1998. Other national parks across the country also may join the program. The trucks will be used in normal maintenance and cleanup operations at the parks, such as picking up trash and debris, plowing snow, and delivering repair materials and equipment.

When asked if DOI will continue with similar programs, Jarcho responds enthusiastically. "Absolutely," he said. "The success of this program gives us hope that more heavy-duty vehicles will be used. This is a real milestone — the more it happens, the more it *can* happen. The technology just keeps getting better and better."



provided CNG fuel system training for NPS personnel to ensure safe handling and operation. In addition to overcoming problems that arise from handling new materials, personnel need to learn about the fuels to overcome uncertainties that make them tentative.

As Borders indicates, this program also provides other educational opportunities: educating NPS personnel about why an alternative fuel program matters and educating the public about all of the NPS environmental initiatives. NPS has several programs in place, including recycling and composting. The alternative fuel program is part of the NPS commit-

Natural Gas is an Abundant, Environmentally Friendly Fuel

Natural gas is found in abundant supplies in the United States. It is composed primarily of methane (more than 90 percent) and other hydrocarbon gases such as ethane, propane, butane, and pentane. Natural gas is odorized to provide a warning of its presence. Compressed natural gas is stored and used at high pressure — up to 25 MPa (3,600 psi).



Chassis dynamometer emissions testing results obtained through NREL's Alternative Fuel Transit Bus Evaluation Program indicate that CNG vehicles have the potential to reduce particulate matter and oxides of nitrogen (NO_x) significantly.

Assessment of Fuels for NPS Heavy-Duty Vehicles

Methanol and **ethanol** are clean-burning fuels that generally emit lower levels of particulate matter and NO_x than diesel fuel. Methanol and ethanol are produced from natural gas (methanol) or corn (ethanol). These fuels have a much lower energy density than diesel fuel, which translates to a higher fuel cost and reduced range for the same volume of fuel. When engines were being chosen for this project, no methanol or ethanol engines were available from original equipment manufacturers (OEMs).

Natural gas (NG), composed primarily of methane, is a fuel that can produce very low levels of particulate matter and lower levels of NO_x than diesel when burned. NG can be stored on a vehicle as either a compressed gas (usually at 3,000 or 3,600 psi) or a cryogenic liquid (LNG). Heavy-duty natural gas engines are available from several OEMs. The technology offers appropriate horsepower, torque, and fueling features, and is available for a refuse hauler. The driving range is adequate for the NPS application. The team selected CNG rather than LNG because of the availability and proximity of the fuel station provided by Washington Gas.

Propane can also produce low levels of particulate matter and lower levels of NO_x than diesel when burned. Propane is an effective fuel that may be implemented in dump trucks operating at other sites (George Washington Memorial Parkway, Shenandoah National Park, and Patuxent National Wildlife Refuge) if existing trucks can be repowered with suitable propane engines.

Electric vehicle technology does not yet support the range and horsepower requirements of the heavy vehicles being evaluated in this project.



Committed Project Participants Ensure Success in Implementing CNG in the NPS Heavy Truck Fleet

The **U. S. Department of Energy** (DOE) sponsored and funded the evaluation program. DOE's mission is "to foster a secure and reliable energy system that is environmentally and economically sustainable . . . and to support continued United States leadership in science and technology."

The mission of DOE's **Office of Transportation Technologies** (OTT) is to develop and promote user acceptance of advanced transportation vehicles and alternative fuel technologies that will reduce oil import requirements, and reduce criteria pollutant emissions and greenhouse gases.

As DOE's field manager, the **National Renewable Energy Laboratory** (NREL) implements alternative fuel demonstrations to provide unbiased, fuel-neutral information on the performance, cost, and emissions characteristics of heavy-duty alternative fuel vehicles.

The **Department of Interior** (DOI), one of the project sponsors, is committed "to advancing scientific research and monitoring to improve our understanding of the interactions of natural and human systems and to reduce the impacts of hazards caused by natural processes and human actions . . . and to providing useful scientific information for sound resource decision making."

The **National Park Service** (NPS), as part of DOI, promotes and regulates the use and conservation of the nation's more than 83 million acres of national parks. NPS maintains and operates the evaluation program's first alternative fuel vehicle.

Washington Gas Company, the primary natural gas supplier for residential and commercial users in the metropolitan Washington, D.C., area, provides fuel for the evaluation program's vehicles. Washington Gas also has provided technical support for safe fueling operations.

Battelle, a research organization with particular expertise in alternative fuel demonstration and evaluation programs, is providing technical support to DOI and NPS in purchasing and operating the heavy-duty vehicles.



Recommended Resources

These resources — available from the Alternative Fuels Data Center (<http://www.afdc.doe.gov>) — offer a great place to start in understanding how you can implement alternative fuels in a vehicle fleet:

- **Heavy Vehicle and Engine Resource Guide** provides a summary of available engines and vehicles and identifies manufacturers and points of contact.
- **Natural Gas Resource Guide** provides a summary of contacts, associates, databases, funding and incentive contacts, periodicals, safety standards, tank and manufacturing testing standards, and vehicle manufacturer contacts.
- **Running Refuse Haulers on Compressed Natural Gas** is a case study of New York City's successful operation of six CNG-fueled refuse haulers.
- **Raley's LNG Truck Fleet: Start-Up Experience** is a case study of the experiences of a California grocery store chain that successfully incorporated eight heavy-duty alternative fuel vehicles into its fleet.
- **Hennepin County's Experience with Heavy-Duty Ethanol Vehicles** describes the 3-year field test of two heavy-duty snowplow/road maintenance trucks fueled by ethanol in Hennepin County (Minnesota).
- **The Ethanol Heavy-Duty Truck Fleet Demonstration Project** and **Running Line-Haul Trucks on Ethanol** summarize Archer Daniel Midland's experiences in operating the first ethanol-powered, heavy-duty, over-the-road truck fleet.

If you want to know more about the NPS program or about alternative fuel vehicles, contact any of the following:

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

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