



Advanced Technology Vehicles in Service

Advanced Vehicle Testing Activity
FreedomCAR & Vehicle Technologies Program
U.S. Department of Energy



LNG Heavy-Duty Trucks

Norcal Waste Systems, Inc.

SAN FRANCISCO'S NORCAL WASTE SYSTEMS, INC., has been recycling solid waste since 1921—long before it was required or fashionable. Given that sense of environmental responsibility, it's no surprise that Norcal is now adding alternative fuel trucks to its fleet. Norcal is the parent company of three California waste companies: Sunset Scavenger, Golden Gate Disposal & Recycling, and Sanitary Fill Company. Norcal began testing alternative fuel systems in 1994 and is recognized as a pioneer in using compressed natural gas to power a recycling truck.

These days, when drivers of Norcal's long-haul trucks say "fill'er up," they are talking about clean-burning liquefied natural gas (LNG). It is considered an alternative fuel because it displaces petroleum. It also emits fewer toxic pollutants than diesel or gasoline. "We are committed to implementing the best environmental solutions possible, both in recycling and clean-air technologies," said Mike Sangiacomo, Norcal's president and CEO. "We are truly committed to helping communities grow and improve their collection, disposal, and recycling programs."

NORCAL OPENED THE BAY AREA'S FIRST LNG STATION

in March 2002. The station currently serves 14 new LNG long-haul waste transfer trucks already in service at Sanitary Fill, and will fuel 24 additional LNG trucks when they arrive. Including the 14 trucks already in service, the company will purchase a total of 38 LNG long-haul trucks. Nine are expected to begin operation in early 2003, and 15 more will be requested when regional transportation grants become available.

The 38 long-haul trucks represent more than 10% of Norcal's San Francisco fleet of collection and transfer trucks. The 14 LNG trucks currently at Sanitary Fill transport more than 2,200 tons of garbage and recyclables a day. Once all the trucks are in place, the benefits from reduced pollution will be equivalent to taking 2,200 cars off the road.



Over the past four years, Norcal—in partnership with the City and County of San Francisco Clean Air Program and the San Francisco Clean Cities Coalition—used about \$3 million from the Bay Area Air Quality Management District's Transportation Fund for Clean Air to help pay for the trucks.

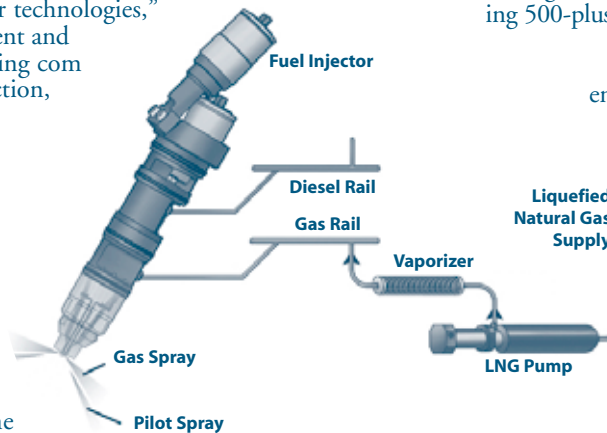
THE TRUCKS ARE EQUIPPED WITH CUMMINS WESTPORT'S ISXG HEAVY-DUTY ENGINE.

Cummins Westport Inc. is a joint venture company formed by Cummins Inc. and Westport Innovations Inc. to bring natural gas engines to market. Westport Innovations is an alternative fuel engine technology company that developed the High-Pressure Direct Injection (HPDI™) system and other natural gas technologies; Cummins is a veteran diesel engine manufacturer that provides the compression ignition engines with technology for heavy-duty applications.

The ISXG engine is capable of generating 500-plus horsepower (hp).

In 2001, the California Air Resources Board (CARB) certified the prototype engines for achieving oxides of nitrogen (NO_x) levels of no more than 2.5 grams per brake horsepower hour (bhp-hr).

Cummins Westport executives say their new engine provides diesel-like performance and reliability and has cleaner emissions. They also report that the engine provides the highest horsepower and power-to-weight ratio in its class and can pull the heaviest loads up the steepest hills at the same speeds as the diesel vehicles.



Westport's HPDI™ System

LNG FUEL AND HPDI™ SYSTEMS POWER THE FLEET.

LNG is natural gas that has been liquefied by a cryogenic process. Because of its high octane rating, natural gas works well in spark-ignited internal combustion engines but on its own is not well suited for compression-ignited engines.

Compression ignition is achieved by dispensing a small amount of diesel fuel into the ISXG engine, along with natural gas (both at high pressure). This fuel combination is accomplished by the HPDI™ system, a pressurized injector technology that fits like a diesel fuel injector and delivers the two fuels. A small amount of diesel is used as a pilot to assist in ignition, and a large amount of natural gas is used to provide power to the engine. Currently, ISXG uses just 6% diesel fuel on an energy basis.

Norcal's fleet manager Bennie Anselmo says the results have been positive: "The trucks have been equipped with the Cummins Westport ISXG engine and will allow us the same performance level obtained using diesel." The drivers confirm that there are no noticeable performance differences between the new LNG fuel and diesel.



THE U.S. DEPARTMENT OF ENERGY'S ADVANCED VEHICLE TESTING ACTIVITY (AVTA), formerly the Fields Operations Program, is evaluating the first 14 prototype LNG trucks at Norcal and Sanitary Fill and plans to assess the nine additional trucks when they arrive in 2003. These nine units are early production versions of Cummins Westport's engine and

Truck: Peterbilt 378 (Day Cab)	
Model Year	2001, 2002
Wheelbase	194 in.
GVWR/GCWR	46,000/80,000 lbs.
Curb Weight	16,340 lbs.
Service	Waste transfer to landfill (110-120 miles round trip)
Engine: Cummins Westport ISXG	
Rating	400 hp @1,800 rpm 1,450 ft.-lbs. @ 1,200 rpm
Displacement	14.9 L
Ignition	Compression ignition with HPDI™
Fuels: LNG and Diesel	
Storage	LNG: 75 gal.* Diesel: 50 gal.
Range	200 to 250 miles
Emissions Results**	
NO _x	2.19 g/bhp-hr
NMHC	0.19 g/bhp-hr
CO	1.94 g/bhp-hr
PM	0.029 g/bhp-hr
* Two of the LNG trucks have 110 gal. of on-board LNG storage.	
** 2001 ISXG emissions FTP results for CARB.	

fuel system. The system combines HPDI™ with cooled exhaust gas recirculation (EGR) technology to further reduce emissions—to half of the 2004 NO_x regulated limits.

The evaluation will document the development process and the progress of this new technology. The AVTA will collect information on operations, maintenance, performance, and emissions to develop comprehensive, unbiased evaluations. NREL's Fleet Test & Evaluation Team supports the AVTA in evaluating fleets of alternative fuel trucks and buses. Several evaluations are planned to start within the next year. Visit www.ott.doe.gov/otulfield_ops for more information.

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Advanced Vehicle Testing Activity: www.ott.doe.gov/otulfield_ops

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