



# Technical Highlights

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## Clean Fuel Options for Heavy-Duty Diesel Trucks and Buses

*The pollution emitted by diesel engines contributes greatly to our nation's air quality problems. Even with more stringent heavy-duty highway engine standards set to take effect in 2004 and 2007, existing trucks and buses will continue to emit large amounts of nitrogen oxides (NO<sub>x</sub>) and particulate matter (PM), both of which contribute to serious public health problems in the United States. Fortunately, there are several techniques and technologies designed to reduce diesel pollution from existing engines. Using cleaner fuels is one way existing trucks and buses can be upgraded (or "retrofitted") to pollute less. In addition to using cleaner fuel, a retrofitted engine can be fitted with a device designed to reduce pollution for increased effectiveness. This fact sheet discusses some clean fuel options.*

### **Pollution from Diesel Engines**

Heavy-duty trucks and buses account for about one-third of NO<sub>x</sub> emissions and one-quarter of PM emissions from mobile sources. In some urban areas, the contribution is even greater. The fine particles in diesel exhaust (known as particulate matter) can penetrate deep into the lungs and pose serious health risks including aggravated asthma, lung damage, and other serious health problems. In addition, diesel exhaust is a likely human carcinogen. Children are more susceptible to air pollution than healthy adults because their respiratory systems are still developing and they have a faster breathing rate.

Diesel exhaust also has environmental impacts. PM from diesel engines contribute to haze, which restricts visibility. In addition, diesel exhaust contributes to ozone formation (a component of smog), acid rain, and global climate change.

## **Major Clean Fuel Options**

### **Ultra-Low Sulfur Diesel**

The primary purpose of Ultra-Low Sulfur Diesel (ULSD) is to enable or improve the performance of aftertreatment technologies such as a particulate matter (PM) filter. The combination of a PM filter and ULSD can reduce emissions of PM by 90 percent. The quantity of emissions reductions from the use of ULSD alone will vary depending on the application, level of sulfur reduction, and other fuel characteristics of the replacement fuel (e.g., cetane number, aromatics, PNA). Some case studies suggest that the use of ULSD alone can reduce emissions of PM between 5 and 9 percent. While ULSD-only emission reductions for PM are relatively modest on a per-vehicle basis compared to aftertreatment retrofit, the emission reductions can be significant if an entire fleet is fueled with ULSD.

ULSD will be available nationwide in June 2006, but currently is available in certain parts of the country. The price differential between ULSD and regular diesel fuel varies by location but currently ranges between 8 and 25 cents more per gallon. In 2006, when ULSD is available nationwide, the cost differential will be much less.

### **Compressed Natural Gas**

Compressed Natural Gas (CNG) is a gaseous fuel that is a mixture of hydrocarbons, mainly methane, and is produced either from gas wells or in conjunction with crude oil production. The majority of natural gas consumed in the United States comes from sources within North America. Increased use of fuel produced in North America helps reduce our reliance on oil from overseas, which is good for our nation's energy security.

When purchasing new school buses, one option to consider is buses that run on CNG and have been fitted with an oxidation catalyst to reduce pollution. Vehicles powered by natural gas perform just like vehicles powered by diesel fuel, but natural gas buses emit 70 to 90 percent less PM than an unmodified diesel bus. CNG buses may have higher formaldehyde, hydrocarbon, and ultra-fine PM emissions than diesel engines using ULSD and a PM filter. Adding a catalyst to a CNG bus will help further reduce emissions.

Overall the cost of natural gas and diesel fuel are very similar, but in some areas of the country, natural gas fuel may be more economical. However, a new compressed natural gas school bus costs at least \$30,000 more than a new diesel school bus (currently, only the largest school buses - Type D - are available with CNG engines). Since it is a gaseous fuel, it must be stored and handled differently than more traditional liquid fuels like diesel or gasoline. Therefore, CNG buses require special refueling facilities as well as special maintenance facilities.

### **Other Clean Fuel Options**

#### **Biodiesel**

Biodiesel is a domestically produced, renewable fuel that can be manufactured from new and used vegetable oils and animal fats. Biodiesel is safe, biodegradable, and reduces air pollutants such as PM, carbon monoxide (CO), hydrocarbons (HC) and air toxics. However, NO<sub>x</sub> emissions increase with the concentration of biodiesel in the fuel. Some biodiesel produces more NO<sub>x</sub> than others, and some additives have shown promise in modifying the increases.

Blends of 20 percent biodiesel with 80 percent petroleum diesel (B20) can be used in unmodified diesel engines. B20 reduces emissions of PM by about 10 percent. However, B20 also increases NO<sub>x</sub> emissions by approximately 2 percent. The B20 blend costs about 15 to 30 cents per gallon more than regular diesel fuel.

Biodiesel can be used in its pure form (B100), but may require certain engine modifications to avoid maintenance and performance problems. Pure blends of biodiesel may not be suitable for cold climates. B100 reduces emissions of PM by roughly 40 percent and costs about 75 cents to \$1.50 more than regular diesel fuel.

#### **Emulsified Diesel**

Emulsified diesel is a blended mixture of diesel fuel, water, and other additives that reduces emissions of PM as well as NO<sub>x</sub>. Emulsified diesel can be used in any diesel engine, but the addition of water reduces the energy content of the fuel, so some reduction in power and fuel economy can be expected.

Emulsified fuel will stay mixed for a fairly long time. However, if a vehicle sits dormant for months at a time the water can settle out of the fuel and possibly cause problems. Therefore school buses may want to phase out the use of the fuel towards the end of the school year and then

reintroduce it in the fall. EPA data demonstrate a reduction in NO<sub>x</sub> emissions of 5 to 30 percent and a reduction in PM of 20 to 50 percent. Emulsified diesel costs roughly 20 cents more per gallon than regular diesel fuel.

## **For More Information**

For more information on these topics, please visit these EPA Web sites:

- Voluntary Diesel Retrofit Program: [www.epa.gov/otaq/retrofit](http://www.epa.gov/otaq/retrofit)
- Clean School Bus USA – Basic Information on Retrofit Options: [www.epa.gov/otaq/schoolbus/retrofit.htm](http://www.epa.gov/otaq/schoolbus/retrofit.htm)
- Alternative Fuels: [www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm](http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm)
- Clean Diesel Independent Review Panel: [www.epa.gov/air/caaac/clean\\_diesel.html](http://www.epa.gov/air/caaac/clean_diesel.html)
- Health Assessment Document for Diesel Engine Exhaust: <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060>

You can also contact the Office of Transportation and Air Quality library for document information at:

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