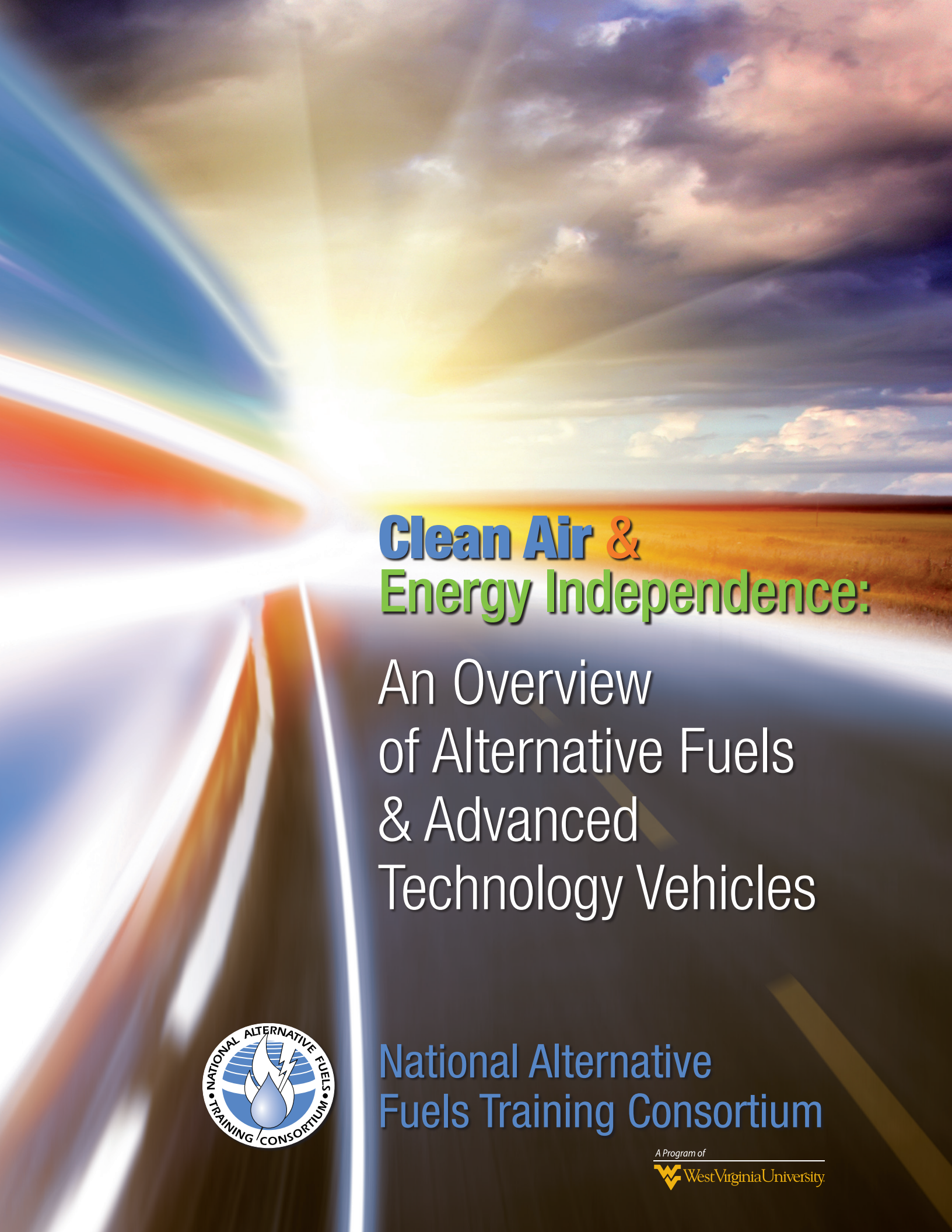

Clean Air & Energy Independence:

An Overview of Alternative Fuels & Advanced Technology Vehicles

National Alternative Fuels Training Consortium

A Program of

West Virginia University

Notes

(twisting force) to the drive wheels in order for the vehicle to start moving and accelerate to the desired speed with maximum efficiency.

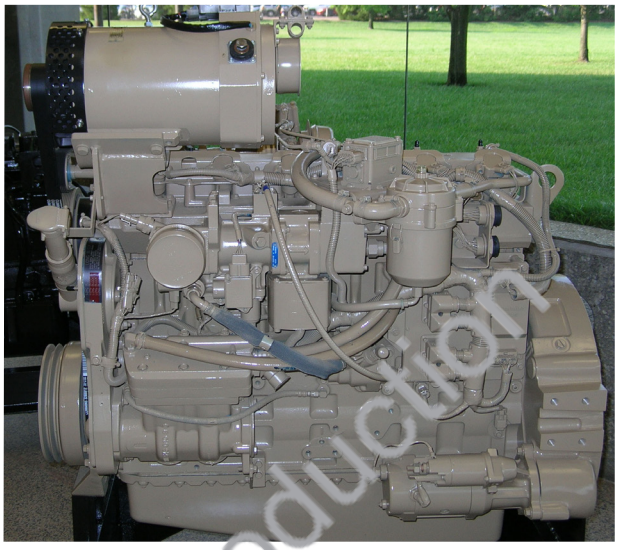

Figure 4-7: *Natural gas engine.*
Photo courtesy of Cummins Engine company & NREL.

The drive train in an NGV is made up of the brakes and the differentials. The brakes slow down or stop the vehicle and the differentials act as the final gear reduction in the vehicle, transmitting power to the wheels and allowing the vehicle to be steered.

Unlike the fuel storage system in a conventional vehicle that consists of a single fuel tank, the fuel storage system in a dedicated NGV consists of one or more pressurized cylindrical tanks that are attached to the top, rear, or undercarriage of the vehicle (see Figure 4-8). A bifuel NGV also has a gasoline tank and a conventional fuel system.

Differences with Natural Gas Vehicles

Although natural gas vehicles have components similar to those of conventional vehicles, several of these components require modification in order for the engine to run efficiently and effectively on natural gas. The main differences in natural gas vehicles are the fuel compression ratio and the fuel management system (see Figure 4-9).

Figure 4-8: *CNG tank.*

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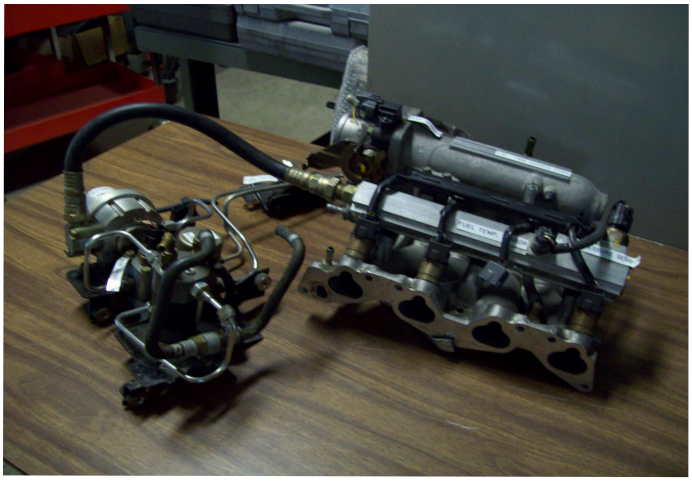

Figure 4-9: *Fuel management system–Photo courtesy of. NAFTC*

CNG

Natural gas enters the vehicle via the fuel receptacle and flows into high-pressure cylinders. When the engine requires natural gas, the fuel leaves the cylinders and passes through a master manual shutoff valve (a safety device).

The fuel then travels through a high-pressure fuel line to a pressure regulator that reduces storage pressure to the fuel system's working pressure. Next, the natural gas goes through an electronically controlled solenoid valve, which enables the gas to pass into the gas mixer or fuel injectors. Natural gas now gets mixed with air and flows down the intake or fuel-injectors. Lastly, it enters the engine combustion chamber, where it is burned to produce power (see Figure 4-10).

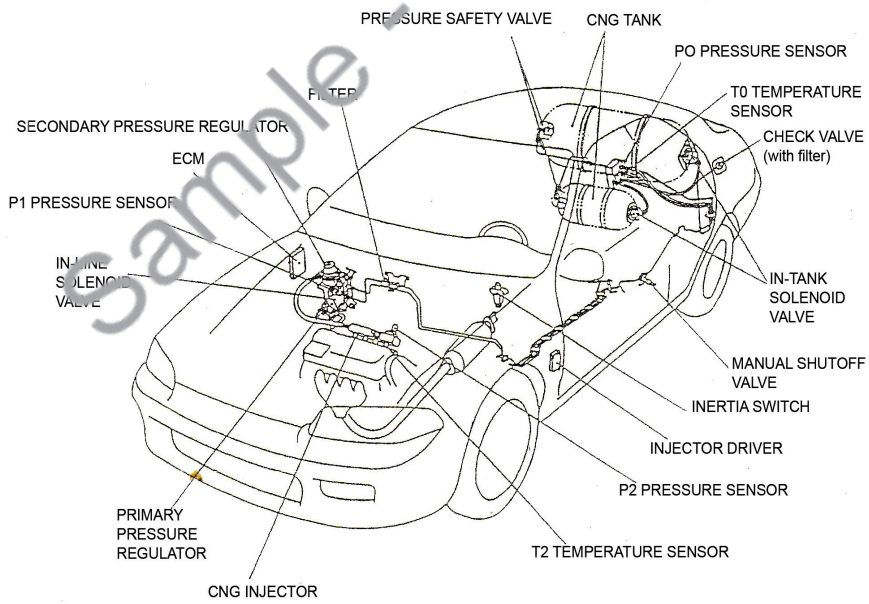

Figure 4-10: *CNG vehicle fuel system–Photo courtesy of NAFTC*

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companies may have objections (not to mention the taxing authorities who are not able to collect road-use taxes on this fuel). No such option exists for LNG.

- The **lower energy content** of natural gas—it takes 124 cubic feet of CNG to equal the amount of energy in one gallon of gasoline—results in natural gas vehicles having a limited range, compared to conventional vehicles. Extra storage tanks can be added to the vehicle to remedy this problem, but the additional weight of the storage tanks may displace some of the payload capacity.
- Trunk space is also limited in NGVs. The fuel storage system in a natural gas vehicle consists of one or more tanks or dewars that are larger than the fuel tank in a conventional vehicle. They are installed inside the vehicle's trunk for safety.
- Purchase prices for natural gas vehicles tend to be higher than for conventional vehicles. Federal and state incentives may defray some of the increased costs, but consumers still have to pay the higher purchase price up front.
- In addition, if commercial CNG/LNG vehicle maintenance facilities are not readily available, fleets using natural gas vehicles may have to purchase service and diagnostic equipment as well.
- CNG cylinders must be visually inspected every three years or 36,000 miles (LNG dewars do not have to be inspected unless they are involved in an accident).
- CNG is stored at high pressure. Rapid release of CNG can be a safety hazard. LNG is stored at cryogenic temperatures. If it comes into contact with skin, severe frostbite ("cryogenic burns") can result.
- Because LNG is a cryogenic substance, it will vaporize rapidly if allowed to warm up. If uncontrolled warming occurs, an explosion could result.
- CNG is highly flammable and must not be allowed to concentrate in an enclosed space. LNG is not flammable until it evaporates into CNG, which happens very quickly.

Notes

- Lastly, natural gas is not a **renewable** energy source. Similar to the situation with other fossil fuels, the supply of natural gas will eventually run out.

Natural Gas Vehicles and the Environment

Natural gas is the cleanest of all hydrocarbon fuels, therefore offering great benefits for the environment. The combustion of natural gas produces carbon dioxide and water vapor. In contrast, coal and oil have a higher **carbon ratio** (they contain more atoms of carbon for each atom of hydrogen), and they also contain sulfur.

The burning of fossil fuels has led to several environmental issues, such as global warming, smog, and acid rain.

- Carbon dioxide is a major contributor to "greenhouse gases" that are believed to be responsible for **global warming**. The combustion of natural gas produces almost 30 percent less carbon dioxide than oil and approximately 45 percent less than coal. Compared to other fossil fuels, the use of natural gas as an alternative fuel can lessen the emission of greenhouse gases in the United States.
- **Smog** is caused by the chemical reaction between carbon monoxide, oxides of nitrogen, volatile organic compounds, and ultraviolet radiation produced by the sun. This is why smog is generally worse in cities that have a high percentage of clear, sunny days. Natural gas usage does not play a significant role in smog formation, because natural gas vehicles emit low levels of oxides of nitrogen and practically no particulate matter. Using natural gas in areas of poor air quality can help combat the detrimental effects of smog.
- **Acid rain** that plagues much of the eastern United States is responsible for damaging crops, forests, wildlife populations, buildings, and causing respiratory illnesses. The reaction of sulfur dioxide and oxides of nitrogen with water vapor in the presence of sunlight, leads to the formation of acidic compounds in the air. Since natural gas vehicles emit hardly any sulfur dioxide and a decreased amount of oxides of nitrogen, the use of natural gas does not contribute to formation of acid rain.