Technology Committee Bulletin

September 28, 1999
(revised January 31, 2008)

How Safe are Natural Gas Vehicles?

Natural gas is an environmentally clean, plentiful, low-cost, domestically produced fuel for motor vehicles. But is it a safe fuel?

Any motor vehicle fuel can be dangerous if handled improperly. Fuels contain energy which must be released by burning. Gasoline is a potentially dangerous fuel, but, over time, we have learned to use it safely. The same is true of natural gas. Natural gas safely generates our electricity, heats our homes and cooks our meals. But, like gasoline, natural gas must be understood and respected to be used safely.

Natural gas is a naturally occurring fuel which requires very little processing before use. Chemically it normally consists of over 90% methane with smaller amounts of ethane, propane, butane, carbon dioxide and other trace gases. The high methane content gives natural gas its high octane rating (120-130) and clean-burning characteristics, allowing high engine efficiency and low emissions.

As with all vehicle fuels, natural gas can be used safely if simple, common sense procedures are followed. In fact, natural gas has safety advantages compared to gasoline and diesel: it is non-toxic, and has no potential for ground or water contamination in the event of a fuel release. An odorant is added to provide a distinctive and intentionally disagreeable smell which is easy to recognize. The odor is detectable at one-fifth of the gas' lower flammability limit.

Natural gas vehicles have an excellent safety record for two primary reasons: the properties of the fuel itself and the integrity of the natural gas vehicle and its fuel delivery system.

Natural gas has a very limited range of flammability – it will not burn in concentrations below about 5% or above about 15% when mixed with air. Gasoline and diesel burn at much lower concentrations and ignite at lower temperatures. Although it takes very little energy to ignite a flammable mixture of air and natural gas, gasoline, or diesel, natural gas burns at a somewhat lower temperature.

Property	Natural Gas	Gasoline	Diesel
Flammability Limits (volume % in air)	5-15	1.4-7.6	0.6-5.5
Autoignition Temperature (°F)	842	572	446
Minimum Ignition Energy in Air (10^{-6} BTU)	0.27	0.23	0.23
Peak Flame Temperature (°F)	3423	3591	3729

Source: Murphy, Michael J., *Properties of Alternative Fuels*, Federal Transit Administration, 1994

From the gas field to the vehicle's engine, natural gas requires very little processing to make it suitable for use as a fuel. Gasoline and diesel must be processed from crude oil in large and complex oil refineries. After water vapor, sulfur and heavy hydrocarbons are removed, natural gas flows by pipeline (the safest way to transport energy) directly to the fueling station where it is compressed for use. Alternatively it may be liquefied at cryogenic temperatures on site or at a central facility and delivered by truck. Gasoline and diesel are delivered to fueling stations by tank trucks over the highway.

At a compressed natural gas fueling station the gas is compressed before being provided to vehicles at 3000 to 3600 pounds per square inch (psi). Stations can deliver a "fast fill" to vehicles in minutes or, using a "slow fill" strategy, in a few hours to overnight.

Although the use of high storage pressures might appear dangerous, compression, storage and fueling of natural gas vehicles meet stringent industry and government safety standards. Remember that high-pressure gases are used safely every day in industrial and medical applications.

Natural gas powered vehicles are designed and built to be safe both in normal operation and in crashes. New natural gas vehicles are subjected to the same federal government crash tests as other vehicles. Natural gas vehicle fuel systems must meet Federal Motor Vehicle Safety Standards 303 and 304. Natural gas cylinders are much thicker and stronger than gasoline or diesel tanks. Cylinders are designed not to rupture when fully fueled over six times a day, 365 days a year, far beyond what they will see in service. Industry standards test them far beyond normal environmental and service damage risks. Cylinders must even withstand a bonfire test and penetration by a 30-caliber bullet without rupture!

No matter what the fuel, fueling stations, indoor parking structures and repair garages must be built to ensure high levels of safety. Requirements for facilities handling natural gas and natural gas vehicles may differ from those for gasoline or diesel vehicles. For example, leaking diesel and gasoline form puddles on the floor. Natural gas normally rises toward the ceiling and disperses. Therefore the danger of fire would be greatest near the floor for liquid fuels and near the ceiling for natural gas.

Time has proven natural gas vehicles to be safe in actual operation. Based on a survey of 8,331 natural gas utility, school, municipal and business fleet vehicles (NGVs) that traveled 178.3 million miles:

- The NGV fleet vehicle injury rate was 37% lower than the gasoline fleet vehicle rate.
- There were no fatalities compared with 1.28 deaths per 100 million miles for gasoline fleet vehicles

- The collision rate for NGV fleet vehicles was 31% lower than the rate for gasoline fleet vehicles
- The fleet of 8,331 NGVs was involved in seven fire incidents, only one of which was directly attributable to failure of the natural gas fuel system.

Natural gas vehicles were first commercialized after World War II in Italy. There are now over seven million in use worldwide. Natural gas vehicles have been used in the US since the early 1980s, with over 90,000 in use today. Yet there has been only one fatality in the US caused by an NGV fueling system failure in all that time.

Even more important than statistics is the confidence that natural gas vehicle users feel. One in five new transit buses are natural gas powered, with about 10,000 transit buses and community shuttles in service. Police in Rocky Hill, CT report "the safety record of the (NGV) cars has been excellent." The Department of Energy states that "after rigorous testing… (the King County, Washington police) found their… (compressed natural gas) cars to be as safe and reliable as conventional vehicles"

Not only are transit agencies and police using natural gas vehicles, more and more school buses are now powered by natural gas. In 1996 the Department of Energy worked with a major school bus supplier to develop "an ultra-safe and low-emission" natural gas powered school bus. School buses from that manufacturer and others, using that engine (or other natural-gas engines), are in widespread use today.

How do natural gas vehicles behave in crashes? The strength of the natural gas cylinders and fuel system generally avoids any leakage or fire. For example an accident involving a CNG-powered pick-up…proved to be a testimonial to the safety of CNG tanks. As reported in the May 1995 edition of *Automotive Fleet*:

> When the 1992 CNG pick-up was broadsided in Midland, Texas, the most vulnerable part of the fueling system bore the brunt of the hit. While the force drove an imprint of the tank safety valve into the side of the truck, the CNG tanks did not rupture, and driver Jimmy Oden walked away.

And in a tragic 1998 accident, a stopped bi-fueled Honda (a vehicle which could run on either natural gas or gasoline) was impacted by another vehicle moving at nearly 100 mph and a fire fed by gasoline broke out. The 50-liter natural gas fuel tank was intact and remained secured in its support brackets. (Reported in a June 1998 BC Gas press release).

Nationwide Insurance, in looking at the safety of natural gas buses in a fleet, concluded as long ago as 1992 that "…the natural gas powered vehicles will be the safest vehicles in your fleet and (we) have no reservations about insuring them." (Palmer, Pat, *Nationwide Insurance*, letter to Kenneth E. Bauman Bus, Inc., September 10, 1992)

In summary, technical data, appropriate safety regulations and years of experience show natural gas vehicles to be as safe as, or safer than, conventionally fueled vehicles.