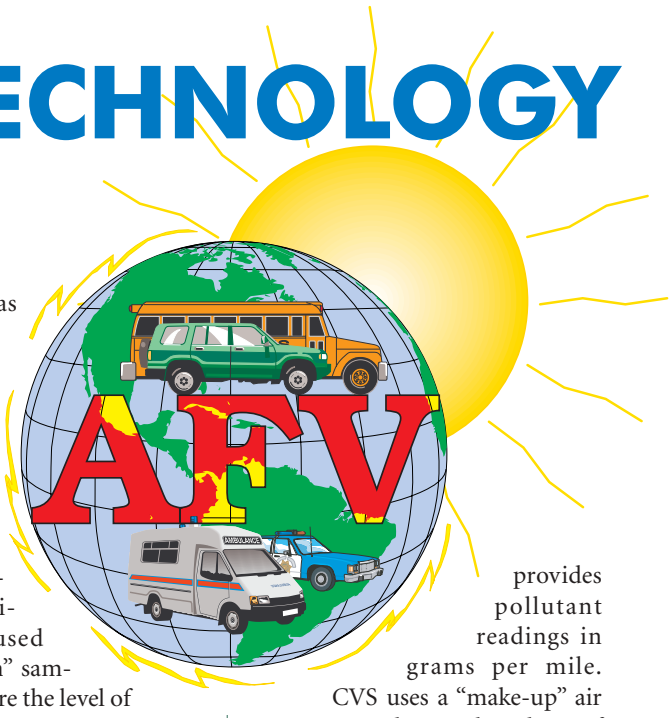
ALTERNATE FUEL TECHNOLOGY

Clean Vehicles/Fuels and Clean Air



Editor's Note: In this installment, author Bob Rodriguez (brodriguez@asecert.org) looks at the impact of cleaner vehicles and cleaner fuels on the air we breathe.

In the previous edition of the *ASE TechNews,* we discussed the opportunities for replacing petroleum with cleaner renewable liquid bio and synthetic fuels produced from a whole variety of plentiful feedstocks including energy crops, forestry waste, newsprint, refuse, landfill gas, vegetable oils and fats, and so on.[1] To be sure, using any of these domestically available alternatives to petroleum bolsters our nation's security and helps fleets comply with the Energy Policy Act enacted by Congress in 1992. But long before EPAct came along, Congress recognized the need for clean air and environmental protection from motor vehicle emissions. In 1970 the Clean Air Act (CAA) was enacted and the EPA was established to address air quality issues. As a result of advancing vehicle technology, today's vehicles are vastly cleaner. But clean fuels also play a role. Let's look closer at how using alternative fuels help us address our environmental concerns.

Clean Air Legislation and Pollutants—A Review

Tightened emissions standards resulted first in evaporative emission control systems and sealed crankcases. A switch to unleaded fuel (no small accomplishment) enabled manufacturers to use catalytic converters, and then came closed loop engine management systems with oxygen sensors, and reformulated gasoline blends. According to Downstream Alternatives: "With the introduction of so-called Tier One vehicles in 1999 hydrocarbon (HC) emissions have been reduced by 98% compared to pre-control era vehicles. Likewise, automotive emissions of oxides of nitrogen (NOx) have been reduced 90% below control pre-levels."[2] Because of California's severe air quality issues, tougher laws enacted there have led the nation; and some northeastern states have adapted tougher-than-federal standards like those in the Golden State. OEs may thus find a given engine package certifies for sale under federal emissions standards, but not for California, et al.[3] According to EPA figures, the average 2000 and 2001 model year vehicle emitted between 27.4 and 36.3 pounds of smog forming pollution (primarily NOx and HC) for every 15,000 miles—about the average driven per year.

Knowledgeable automotive technicians monitor five automotive tailpipe emissions important for air quality: CO, HC, O_2, CO_2 and NO_X. Carbon monoxide (CO) and hydrocarbons (HC) are deadly and were the first to be regulated and measured in the service bay; high readings are the result of partially burned or unburned fuel, respectively. Later, monitoring of O_2 (oxygen) and CO_2 (carbon dioxide) was added to better understand the combustion process; high O_2 means a possible misfire, while increasing CO_2 indicates increased combustion efficiency. Diesels of course are also monitored for particulate matter as small as 2.5 microns (PM2.5). CO_2 is now recognized as a contributing greenhouse gas.

NOx is the greenhouse gas most associated with photochemical smog and ozone. NO_X comes from 1) "area sources" (gas stations, open fires, etc.); 2) "stationary sources" (power plants, boilers, manufacturing, etc.); 3) "off-road mobile sources" (construction, agricultural, ground power, marine equipment, etc.), and 4) "mobile sources" (cars and trucks). NOx is caused by high combustion chamber temperatures (over 3000 degrees), hence the need for relatively lower compression ratios, retarded ignition timing, and EGR systems to reduce nitrous oxide emissions. Environmentalists are also concerned about as-yet unregulated emissions like aldehydes and sulfur dioxide. Emissions standards have tightened with each year's passing and tend to vary according to state and locality, along with how they are to be measured.

Different emissions tests are performed in various state and localities. Some programs may call for simply monitoring emissions with the vehicle unloaded and taking samples at two different engine speeds. This is usually referred to as a two-speed idle (TSI) test. More recently, emissions tests have gone increasingly high-tech to match the more sophisticated technology used in engine control systems. This has brought about the need for dynamometer-based emissions tests, otherwise known as loaded-mode testing. Initially, EPA accepted only the I/M240, an emissions test performed under varying loads and speeds. Eventually, EPA also accepted the ASM (Acceleration Simulation Mode) test, which evaluates emissions with the vehicle at a steady speed and load.

Inasmuch as conditions have changed when measuring emissions, so have the measurement techniques. Historically, automotive technicians have used "concentration" sampling to measure the level of exhaust pollutants, expressed as either a *percentage* or in *parts per million* (1% equates to 10,000 ppm). Concentration sampling is an integral part of emissions programs using the two-speed idle test (TSI) and also the more recent ASM test. A shortfall of the concentration method is that it measures the concentration of pollutants only; it does not account for the difference in exhaust volume between smaller and larger engines. For example, if a 2.0L engine and a 6.0L engine showed the same concentration readings, the 6.0L engine would theoretically produce three times the pollution because it has three times the displacement.

To offset the shortfall of concentration sampling, constant volume sampling (CVS) was adopted, which provides pollutant readings in grams per mile. CVS uses a "make-up" air system to supplement the volume of exhaust from the tailpipe, regardless of engine displacement, so that exhaust volume has no bearing on overall emissions readings. The variance in displacements of smaller versus larger engines is no longer an issue. CVS is an integral part of the I/M240 test performed at centralized testing facilities.

New Vehicle Emissions Certification

Vehicle emissions are monitored and measured by the EPA using a standardized federal test procedure (FTP) on virtually all vehicles sold or brought into the U.S. Evaporative emissions—volatile organic compounds (VOCs)—are measured in a sealed test cell (known as a "shed"), and tailpipe emissions are measured on a dyno using the constant volume sampling (CVS) or "mass" method. CVS measures the relative weight of pollutants in meaningful *grams per mile* during a load mode test. Vehicles must be precisely driven at a variety of speeds and loads following a "trace" designed to simulate real world conditions. Based on these results, vehicles are classified as to their clean air potential (see below).

Vehicle Clean Air Ratings: What's It all About?

Ever tightening emissions standards for on-road vehicles have resulted in EPA compliance timetables with designations like Tier O, Tier One, LEV, ZEV and so forth.[4] (See chart.) Under the National Low Emissions Vehicle (NLEV) program, manufac-

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SULEV Sticker:
Watch for a sticker like this when at the showroom. SULEVs (Super Low Emission Vehicles) offer great fuel economy and are reportedly 75% or more cleaner than ULEVs. Both are much cleaner than most vehicles now on the road.

Toyota Prius: *Gasoline-electric hybrids from Toyota (shown here) and Honda come with continuously variable transmissions and regenerative braking for enhanced fuel economy. Hybrids are among the increasing numbers of SULEVs available. (See "Greenest Vehicles" chart on this page.)*

Emission Standard Programs

Tier 1	The least stringent emission standards
National Low Emission Vehicle Program (NLEV)	A voluntary program to sell cleaner vehicles nationwide. The average emission level must meet LEV, or better, emission standards (see table below).
California	California has special authority under the Clean Air Act to set their own emission standards because of unique air quality problems.
Tier 2	New standards for cars and trucks, to be phased in from 2004 through 2009, that are optional from 2001 to 2003.

Emission Standard Level
(listed from least clean to cleanest)

T1	Tier 1	The least stringent emission standards
TLEV	Transitional Low Emission Vehicle	More stringent than Tier 1 standards for hydrocarbons (HC)
LEV	Low Emission Vehicle	More stringent than TLEV standards for both hydrocarbons (HC) and nitrogen oxides (NOx)
ULEV	Ultra Low Emission Vehicle	More stringent than LEV standards for HC
SULEV	Super Ultra Low Emission Vehicle	Even more stringent standards than ULEV for both HC and NOx
ZEV	Zero Emission Vehicle	The strictest emission standard, permitting no emissions

Source: EPA; *www.epa.gov/autoemissions/about.htm*

The Greenest Vehicles of 2003

Make & Model	Specifications	Emission Standard	MPG: City	MPG: Hwy	Green Score
Honda Insight	1.0L 3, auto CVT[a]	SULEV	57	56	57
Honda Civic GX	1.7L 4, auto CVT [CNG][b]	SULEV*	30	34	53
Toyota RAV4 EV	Electric[c]	ZEV	3.7	2.9	52
Toyota Prius	1.5L 4, auto CVT[a]	SULEV	52	45	52
Honda Civic Hybrid	1.3L 4, auto CVT[a]	SULEV	48	47	51
Honda Civic HX	1.7L 4, manual[a]	ULEV*	36	44	43
Nissan Sentra	1.8L 4, manual[a]	SULEV	28	36	42
Toyota Echo	1.5L 4, manual[a]	LEV*	35	43	42
Toyota Corolla	1.8L 4, manual[a]	ULEV*	32	40	41
Honda Civic	1.7L 4, manual[a]	ULEV*	32	38	40
Ford Focus	2.3L 4, manual	SULEV	25	33	39
Ford Focus Wagon	2.3L 4, manual	SULEV	25	33	39

[a] Configurations of these models with other transmissions and emission standards score nearly as well.
[b] Compressed natural gas (CNG) vehicle fuel economy given in gasoline-equivalent miles per gallon.
[c] Electric vehicle fuel economy given in miles per kilowatt-hour.
* California-certified vehicle available nationwide.

Source: American Council for an Energy-Efficient Economy; *www.greenercars.com*

Part of a continuing series on alternate fuel vehicles and advanced vehicle technology.
If you have comments or questions, contact ASE's Bob Rodriguez at 703-669-6634 or brodriguez@asecert.org.

AUTO TRAINING RESOURCES

Automotive Test Solutions' Circuit Training

Automotive Test Solutions' E-Trainer™ with FAULTMASTER™ technology will help both today's and tomorrow's technicians understand and repair automotive computer systems, ATS says. The E-Trainer is a hands-on automotive electrical training system with light circuits, relay motor circuits and a full engine simulator. It installs or removes faults, failures and problems into or out of all circuits. Simulations of hundreds of faults include power circuit, ground circuit, open circuit, short circuit, battery, charging system, lamp, relay, electric motor, no cranking, no start, OBD II coded drivability, no-code drivability and intermittent drivability faults. Also included are emission and data bus failures, PCM failures, PCM resets, and additional simulated faults, failures and problems.

The E-Trainer is able to give a technician the equivalent of years of experience resulting in a clear and concise understanding of both today's and tomorrow's complicated computer circuitry, notes ATS. E-Trainer prepares techs to diagnose and repair the electronic systems of all of today's automobiles. The beginner and advanced student alike will learn to troubleshoot computer problems.

The E-Trainer comes complete with both Teacher and Student Training Manuals and a RS-232 cable for downloading new updates.

For more information about E-Trainer, phone 1-800-572-6112 or visit **www.AutomotiveTestSolutions.com**.

Bosch Diesel Training Materials

Bosch Diesel Pre-Tech Self Study Training That Works. The Bosch CD-ROM based Pre-Tech Diesel Service Training program is an informational diesel fuel injection course designed for technicians and students. Pre-Tech provides the user with basic diesel theory, pump and governor operation, nozzle and nozzle holder (injector) operation and repair, parts identification, and the use of metrics in the shop. Bosch Pre-Tech provides the information necessary to bring all technicians to a common level of competency and understanding; Pre-Tech can also be used to advance the product knowledge of experienced technicians, and as support materials for courses taught in vocational/technical institutions, Bosch says.

Diesel Fuel Injection Videos. These videos were originally designed to provide reference support for the Bosch network of Authorized Heavy-Duty Diesel Equipment Repair Facilities. Their self-paced, performance oriented approach is suited to either the experienced technician who wishes to upgrade his or her skills or for the apprentice shop technician or trade-vocational student who needs a firm grounding in diesel basics. An overview of all Bosch diesel products is provided, offering students a foundation on which to build their professional career. The videos are designed to be used in concert with the Pre-Tech Diesel Service Training programs.

Bosch offers a wide array of training materials covering automotive electrical, gasoline and diesel fuel injection products.

Check out Bosch's complete ACCESS catalog of training materials at www.boschservice.com/public/accesscat/accesshome.htm or call Robert Bosch Corporation at 800-937-2672.

Natural Gas Vehicle Institute – NGV Safety Training

The three-day NGV Safety Training course is designed for staff who are responsible for driver and technician safety training and/or responsible for cylinder inspections. The course covers all of the key factors to insure safe natural gas vehicle fleet operations, says company officials:

- Safe Driving
- Safe Fueling
- Safe Maintenance
- Detailed Fuel Tank Inspection Procedures

During the first day, attendees will be prepared to train natural gas vehicle drivers in safe driving and fueling. They will also be prepared to train vehicle techs on the safety features of NGV fuel storage and delivery system. Additionally, attendees will receive all the materials and tools needed to conduct both driver and mechanic safety programs.

On the second and third day, attendees will be trained and prepared to conduct cylinder inspections on their organization's NGVs. The training includes hands-on safety inspection of NGV fuel cylinders.

Throughout the course, attendees will have their vehicle safety questions answered; discussions and presentations also included.

For registration information, go online to www.ngvi.com or call the NGV Institute at 800-510-6484 (NGVI).

Wells' *Counter-Point* Newsletter

Wells Manufacturing Corp., Fond du Lac, WI, an original equipment supplier since 1903, is a fully QS-9000 certified manufacturer of ignition and engine management systems components. In November 1997, Wells introduced its *Counter Point*, a quarterly technical newsletter. Today, it is a highly regarded resource of up-to-date information used regularly by nearly 50,000 technicians to solve drivability problems, officials with Wells note.

Each issue contains a feature article, which addresses diagnostic procedures and specific topics critical to today's technician. Some of the subjects covered in the most recent issues include:

- OBDII: An Introduction, Parts One and Two
- OBDII: Diagnostic Strategy Case Study
- OBDII: Oxygen Sensor and Oxygen Sensor Heater Monitors
- OBDII: Catalyst Monitors
- OBDII: Fuel System Fuel Trim

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(To order the Wells binder shown in photo, send a check or money order for $9.95, along with your name and street address to above address. No P.O. boxes, please.)

Alt Fuels

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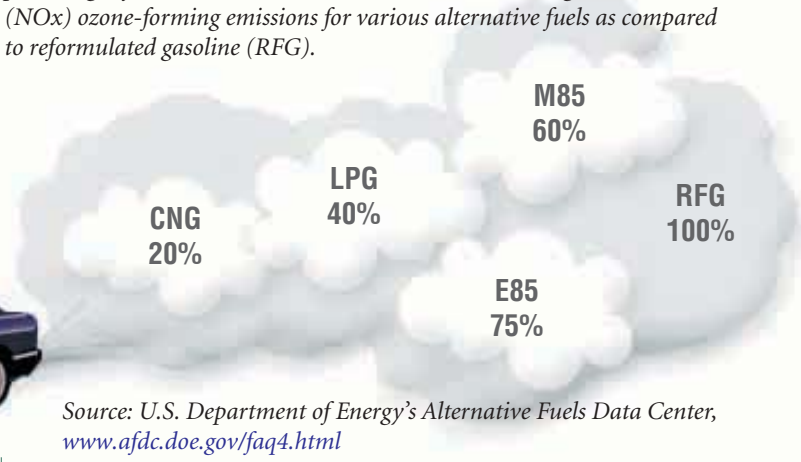
turers may sell a variety of vehicles and average their emission levels; indeed, manufacturers sell flexible-fuel vehicles (an FFV can burn up to 85% ethanol) and apply clean air credits against their more polluting yet popular gas guzzlers.

Vehicles are rated according to vehicle emission standards as LEV, ULEV, SULEV, or ZEV; ratings are based on vehicle year of manufacture, by the maximum allowable amount of VOCs evaporated, and tailpipe emissions. For example, vehicles rated SULEV are ahead of the 2004 schedule and qualify as such because they emit virtually no VOC emissions and very low tailpipe emissions—about 75% less than a ULEV. The gasoline powered 2000 Nissan Sentra CA (clean air) qualifies as SULEV because of its zero evaporative emissions and use of three catalysts. Toyota's gasoline burning Prius qualifies as SULEV because the Atkinson Cycle engine only runs part-time for extremely low grams per mile. A small percentage of zero emission vehicles (ZEVs) are presently mandated in California; ZEVs are principally battery electric vehicles (BEVs) or could be hydrogen fuel cell vehicles (FCVs); even wind and solar powered vehicles might one day be included.

Do alternative fuels offer emissions benefits? This diagram shows the percentage of combined carbon monoxide (CO) and nitrogen oxide (NOx) ozone-forming emissions for various alternative fuels as compared to reformulated gasoline (RFG).



Source: U.S. Department of Energy's Alternative Fuels Data Center, www.afdc.doe.gov/faq4.html

Clean Fuels

Obviously, along with clean/green vehicle technology, cleaner petroleum fuels help to reduce emissions. The EPA regulates the amounts of pollutants (like sulfur) in both gasoline and diesel fuel. In geographical areas where CO and NOx have contributed to "non-attainment" (i.e. where ozone levels exceed EPA limits) these areas have benefited from the use of oxygenated gasoline.[5] Likewise, the use of reformulated gasoline (RFG) has helped certain areas to meet clean air standards.[6] When the Minneapolis-St. Paul area had concerns about rising levels of ozone, officials collaborated with a local fuel supplier to deliver fuel which exceeded present fuel standards: "Our testing has confirmed it to be low-sulfur and low-benzene. When it was introduced in the fall of 1999 (about 6 years ahead of EPA tier II sulfur standards), it represented the first time such a proactive move was made by a fuel supplier and retailer." said Tim Gerlach, Twin Cities Clean Cities Coordinator and Director of Outdoor Air Programs for the American Lung Association of Minnesota.

Alternate fuels burn even cleaner. Despite the cleanest of gasoline or diesel fuel, engines properly outfitted and integrated with alternate fuel systems show a drastic reduction of tailpipe emissions when burning alternate fuels. Honda's literature notes that its Civic GX (a dedicated CNG vehicle) has "the world's cleanest burning internal combustion engine …with an emissions level of just 1/10 the ULEV standard." See the accompanying charts for a better understanding of Vehicle Emission Standards, how alternate fuel emissions compare to RFG, and which vehicles are the cleanest.

Over the years impressive strides towards clean air improvements have been made, thanks to improved vehicles - and clean fuels. More vehicles are being driven more miles however, and clean air problems for major metropolitan areas persist. Each summer cities experience alarming numbers of "code red" ozone-level days when children, the aged, and those with respiratory problems are urged to stay indoors. Thus health, environmental and conservation organizations alike actively support the use of clean fuels and vehicles.[7]

We, as automotive professionals, can partner with these efforts by staying well informed, trained, and equipped to keep today's vehicles running properly for low emissions. Furthermore, we can opt for using cleaner/greener fuels in our vehicles, and promote the clean fuels choice whenever possible to our customers. – *B.R.*

Footnotes:

1. *See Spring 2003* ASE TechNews *for coverage on bio and synthetic fuels.*
2. Changes in Gasoline III Year 2000 Supplemental Update*; Downstream Alternatives Inc., Bremen, Indiana. 800-378-9974; reynoldsatdai@compuserve.com.*
3. *One example: DaimlerChrysler's 3.3 liter Mitsubishi-built engine is federally certified as a flexible-fuel E85 engine for their '98 and newer minivans; however, these applications were not certified for ethanol use in Calif., N.Y., Mass., and Vermont.*
4. *Tables showing the pollution limits for each vehicle type and year of manufacture can by found on the EPA's website. Go to: www.epa.gov/air/caa/title2.html for more information.*
5. *Using high oxygen content methanol-based MTBE and ethanol based ETBE. (MTBE, reportedly linked to ground water contamination, has been banned in California).*
6. *RFG generally contains lower amounts of sulfur, aromatics (esp. benzene), olefins, and reduced vapor pressure (RVP).*
7. *For example, the American Lung Association supports the use of alternate fuels. Go to: www.lungusa.org/air/airout00_alternative.html for more information.*