



# Clean Vehicle Solutions (Asia) Limited

“Cleaner Air for a Healthier Future”

## GLOSSARY

### **Additives**

Chemicals added to fuel in very small quantities to improve and maintain fuel quality and/or to lower emissions.

### **Adsorption –**

A process that occurs when a gas or liquid solute accumulates on the surface of a solid or, more rarely, a liquid (adsorbent), forming a molecular or atomic film (the adsorbate).

### **After-cooling / Inter-cooling**

Cooling the engine intake air after the turbocharger and prior to introduction into the cylinder After-cooling increases engine power and lowers NO<sub>x</sub> emissions

### **After-treatment Devices**

Devices which remove pollutants from exhaust gases after the gas leaves combustion chamber (e.g., catalytic converters or diesel particulate filters). The term "exhaust gas after-treatment" is considered derogatory by the emission control industry, but there is no consensus on the use of such alternatives as "post-combustion treatment" or "exhaust emission control".

### **Air Quality Management District (AQMD)**

Administrative districts organized in California to control air pollution. Nationwide in the U.S., AQMDs are parallel to the areas designated for classification against the National Ambient Air Quality Standards (NAAQS). Generally, AQMDs and their national parallel encompass multiple jurisdictions and closely follow the definition of Consolidated Metropolitan Statistical Areas and Metropolitan Statistical Areas.

### **Air Toxics**

Toxic air pollutants, as classified by pertinent regulations Examples of substances classified as air toxics by the US Clean Air Act include acetaldehyde, benzene, 1, 3-butadiene, formaldehyde, and polycyclic organic matter (POM). California air toxics regulations also classify diesel exhaust particulates as a toxic air contaminant.

### **Alternative Fuel**

Fuel other than petroleum diesel or gasoline

### **ANG (Adsorbed Natural Gas)**

Natural gas stored in a nanoporous material (usually carbon derived) at lower pressure than compressed natural gas. The advantage of ANG is that the fuel can be stored at a higher density.

### **Articulated Pistons**

Two-piece pistons incorporating an entirely separate piston crown or dome with a separate skirt, and linking the two together with the piston pin. Many 1994 and later engines incorporate steel crown/Aluminium skirt articulated pistons.

### **Bar –**

A unit of pressure Atmospheric air pressure is often given in millibars where "standard" sea level pressure is defined as 1013.25 mbar (hPa).

### **Bi-Fuelled Vehicle**

A vehicle with two separated fuel systems designed to run on either conventional fuel or an alternative fuel using only one fuel at a time.

### **Biodiesel**

The mono alkyl esters of long chain fatty acids derived from renewable lipid feed stocks, such as vegetable oils and animal fats, for use in compression ignition (diesel) engines. Manufactured by transesterification of the organic feedstock by methanol

### **Brake Mean Effective Pressure (BMEP)**



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The work accomplished during one engine cycle divided by the engine swept volume. It is essentially the engine torque normalized by the engine displacement. The word "brake" denotes the actual torque/power available at the engine flywheel as measured on a dynamometer. Thus, BMEP is a measure of the useful power output of the engine.

### Brake Specific Fuel Consumption (BSFC)

BSFC is the ratio of the engine fuel consumption to the engine power output (as measured at the flywheel). BSFC has units of grams of fuel per kilowatt-hour (g/kWh) or pounds mass of fuel per brake horsepower-hour (lb/bhp/hr). BSFC is a measure of engine efficiency.

### Carbon Dioxide (CO<sub>2</sub>)

A colourless, odourless, non-toxic gas. It is one of main products of fossil-fuel combustion. Carbon dioxide is a greenhouse gas that contributes to the potential for global warming.

### Carbon Monoxide (CO)

A colourless, odourless and toxic gas. It blocks the lungs' ability to obtain oxygen. CO is produced by incomplete combustion of fossil fuels and is a major part of air pollution. Compression ignition (diesel) engines generate significantly lower CO emissions than spark ignited engines.

### Carcinogens

Substances known to cause cancer

### Catalyst

A substance which influences the rate of a chemical reaction but is not one of the original reactants or final products, i.e. it is not consumed or altered in the reaction. Catalysts are used in many processes in the chemical and petroleum industries. Emission control catalysts are used to promote reactions that change exhaust pollutants from internal combustion engines into harmless substances.

### Cetane Index

A calculated value, derived from fuel density and volatility, giving an approximation to Cetane number.

### Cetane Number

A measure of ignition quality of diesel fuel. The higher the Cetane number the easier the fuel ignites when injected into an engine. Cetane number is determined by an engine test using two reference fuel blends of known Cetane numbers. The reference fuels are prepared by blending normal Cetane (n-hexadecane), having a value of 100, with heptamethyl nonane, having a value of 15.

### CFR (Cooperative Fuel Research) Engine

A single cylinder, overhead valve, variable compression ratio engine used for measuring octane or Cetane quality

### Clean Air Act (CAA)

In the USA the fundamental legislation is to control air pollution. The original Clean Air Act was signed in 1963. The law set emissions standards for stationary sources, such as factories and power plants. Criteria pollutants included lead, ozone, CO, SO<sub>2</sub>, NO<sub>x</sub> and PM, as well as air toxics. The CAA was amended several times, most recently in 1990. The Amendments of 1970 introduced motor vehicle emission standards for automobiles and trucks.

### Clean-Fuel Vehicle (CFV)

A vehicle that has been certified to meet clean-fuel standards of the Clean Air Act Amendments of 1990

### Cloud Point (CP)

A measure of the ability of a diesel fuel to operate under cold weather conditions Defined as the temperature at which wax first becomes visible when diesel fuel is cooled under standardized test conditions (ASTM D2500)

### CNG

(Compressed Natural Gas) - CNG is produced by compressing natural gas, predominantly composed of methane (CH<sub>4</sub>), to pressure of 200 bars. Stored and distributed in hard containers, usually cylinders, it is an environmentally clean alternative to gasoline (petrol) or diesel fuel.

### Cold Filter Plugging Point (CFPP)



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A measure of the ability of a diesel fuel to operate under cold weather conditions Defined as the lowest temperature at which diesel fuel will pass through a fine wire mesh screen of the test apparatus

## Common Rail Injection

A diesel fuel injection system employing a common pressure accumulator, called the rail, which is mounted along the engine block. The rail is fed by a high pressure fuel pump. The injectors, which are fed from the common rail, are activated by solenoid valves. The solenoid valves and the fuel pump are electronically controlled. In the common rail injection system the injection pressure is independent from engine speed and load. Therefore, the injection parameters can be freely controlled. Usually a pilot injection is introduced, which allows for reductions in engine noise and NOx emissions.

## Compressed Natural Gas (CNG)

Natural gas compressed to a volume and density that is practical as a portable fuel supply.

## Compression Ignition (CI)

The form of ignition that initiates combustion in a diesel engine the rapid compression of air within the cylinders generates the heat required to ignite the fuel as it is injected.

## Conversion

(Of a Standard Vehicle to NGV) - The process of converting a gasoline powered vehicle to an NGV is simple, inexpensive and requires a minimum of time. Although converting a diesel powered vehicle to NGV is a bit more complicated, it is also simple and inexpensive. Both gasoline and diesel powered vehicles can be converted to operate on natural gas only, or to become dual-system (gas or diesel and CNG) vehicles.

## Converted Vehicle

A vehicle, originally designed to operate on gasoline or diesel that has been modified or altered to operate on an alternative fuel.

## Cordierite

A ceramic material of the formula  $2MgO-2Al_2O_3-5SiO_2$  which is used for automotive flow-through catalyst substrates and ceramic wall-flow diesel filters

## Dedicated Vehicle

A vehicle designed to operate solely on one alternative fuel, as opposed to a converted vehicle which was later altered to use an alternative fuel.

## Diesel Oxidation Catalyst (DOC)

Catalyst promoting oxidation processes in diesel exhaust. Usually designed to reduce emissions of the organic fraction of diesel particulates, gas-phase hydrocarbons, and carbon monoxide

## Diesel Particulate Filter (DPF)

A device which physically captures diesel particulates preventing their discharge from the tailpipe Collected particulates need to be removed from the filter, usually by continuous or periodic oxidation in a process called "regeneration".

## Diesel Particulate Matter (DPM)

Sub-micron size particles found in diesel exhaust. Most emission regulations specify DPM measurement methods in which particulates are sampled on filters from cooled exhaust gas. The cooling causes condensation of vapours in the gas sampling train. Thus, the DPM is composed of both solid and liquid particles and is generally classified into three fractions: (1) inorganic carbon (soot), (2) organic fraction (often referred to as SOF or VOF), and (3) sulphate fraction (hydrated sulphuric acid).

## Dimethyl Ether (DME)

The simplest ether  $CH_3-O-CH_3$  can be manufactured from natural gas or from a renewable organic feedstock. DME is a prospective alternative diesel fuel.

## Direct Injection (DI)

In diesel engines with direct injection the combustion chamber is not divided and fuel is injected directly to the cylinder.



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## Dual-Fuel Vehicle

A vehicle designed to operate on a combination of alternative fuel, such as compressed natural gas (CNG) or liquefied petroleum gas (LPG), and conventional fuel, such as diesel or gasoline. These vehicles have two separate fuel systems, which inject both fuels simultaneously into the engine combustion chamber.

## Electronic Control Module (ECM)

A microprocessor that determines the beginning and end of each injection cycle on every cylinder. The ECM determines both fuel metering and injection timing in response to such parameters as engine crankshaft position and rpm, engine coolant and intake air temperature, and absolute intake air boost pressure.

## Elemental Carbon (EC)

Inorganic carbon, as opposed to carbon in organic compounds, sometimes used as a surrogate measure for diesel particulate matter, especially in occupational health environments. Elemental carbon usually accounts for 40-60% of the total DPM mass.

## Emission Credit Trading

A program administered by the Environmental Protection Agency under which low polluters are awarded credits which may be traded on a regulated market and purchased by polluters who are in non-compliance for emissions until compliance can be achieved.

## EV

Electric vehicle

## Evaporative Emissions

Hydrocarbon vapours that escape from a fuel storage tank or a vehicle fuel tank or vehicle fuel system.

## Flash Point

The temperature at which a combustible liquid gives off just enough vapour to produce a vapour/air mixture that will ignite when a flame is applied. The flash point is measured in a standardized apparatus using standard test methods, such as ASTM D93 or ISO 2719.

## Flexible-Fuelled Vehicle

A vehicle with the ability to operate on alternative fuels, 100 percent petroleum-based fuels, or a mixture of alternative fuel and petroleum-based fuels.

## Fossil Fuel

Any naturally occurring organic fuel formed in the Earth's crust, such as petroleum, coal and natural gas.

## Fuel cycle

The processes involved in extracting a fuel in its native form, converting it to a useful product, transporting it to market, and consuming it at its final destination.

## Geometric Surface Area (GSA)

In monolith catalyst substrates, the total channel surface area per unit of substrate volume.

## HEV

Hybrid-electric vehicle. Various types of electric vehicles that use another power source to propel the vehicle or generate power for an electric drive train, or a combination of the two types.

## Hydraulic/Electronic Unit Injector (HEUI)

A type of unit injector actuated by engine oil pressure rather than the camshaft. A very high oil pressure (up to 3,000 psi) is created by a separate oil pump. This high pressure is routed to every injector through a gallery. The engine's Electronic Control Module varies the pressure in response to engine speed and other parameters.

## Hydromechanical Injection

An injection system in which mechanical parts work through hydraulic pressure to meter and time the injection of fuel. No electronics are incorporated into hydromechanical injection systems.



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## Ignition Delay

The length of time or number of degrees of crankshaft rotation between the beginning of injection and ignition of the fuel

## In-Direct Injection (IDI)

In diesel engines with in-direct injection the fuel is injected to an auxiliary pre-chamber. Combustion starts in the pre-chamber and propagates to the cylinder.

## Inherently Low Emission Vehicle (ILEV)

Any vehicle that is certified to meet transitional low-emission vehicle standards established by the California Air Resources Board (CARB) and does not emit any evaporative emissions.

## Injection Period

The time, measured in degrees of crankshaft rotation, between the beginning and end of injection. On engines with hydromechanical injection systems, it is controlled by the opening and closing of ports in the injector body or by the action of a plunger forcing fuel out of a cup. On electronic injection systems, it is determined directly or indirectly by the action of a solenoid valve.

## In-Line Injection Pump

An injection pump with a separate cylinder and plunger for each engine cylinder. Each plunger is rotated by a rack to determine metering via ports in the body of the pump and helical cuts on the pump plungers. The plungers are driven off a camshaft, which usually incorporates a centrifugal or electronically controlled timing advance mechanism.

## Intumescent Mat

Ceramic fibre mat which irreversibly expands after exposed to high temperature. Usually contains vermiculite. Intumescent mats are used in the canning of catalytic converters and diesel filters to hold the ceramic substrate inside the steel canister.

## Lean NO<sub>x</sub> Catalyst (LNC)

Catalyst designed to reduce nitrogen oxides from diesel or spark ignited engine exhaust gases under net oxidizing conditions, i.e., in the presence of excessive amount of oxygen.

## Liquefied Natural Gas (LNG)

Natural gas that has been refrigerated to cryonic temperatures where the gas condenses into a liquid. Liquefied Natural Gas is natural gas that has been processed to remove either valuable components such as helium, or those impurities that could cause difficulty downstream such as water and heavy hydrocarbons. It is then condensed into a liquid at almost atmospheric pressure (Maximum Transport Pressure is set at around 25 kPa) by cooling it to approximately -163 degrees Celsius.

## Liquefied Petroleum Gas (LPG)

Liquefied Petroleum Gas (LPG) is a mixture of low-boiling hydrocarbons that exists in a liquid state at ambient temperatures when under moderate pressures (less than 1.5 MPa or 200 psi). LPG is a by-product from the processing of natural gas and from petroleum refining. Major components of LPG are propane (min. 85% content in the U.S.), butane and propylene.

## Low Emission Vehicle (LEV)

A vehicle that is certified to meet the LEV emission standards set by the California Air Resources Board (CARB).

## Methane –

A significant and plentiful fuel which is the principal component of natural gas. Burning one molecule of methane (CH<sub>4</sub>) in the presence of oxygen releases one molecule of CO<sub>2</sub> (carbon dioxide) and two molecules of H<sub>2</sub>O (water).

## Mother/Daughter Refuelling Stations –

Mother/daughter systems were developed for markets with inadequate natural gas pipeline infrastructures. The system is based on a central distribution point, the mother station, providing CNG to remote refuelling stations through a fleet of specially designed tanker trucks. The tanker trucks deliver CNG to the remote refuelling stations, the daughter stations, almost the way gasoline is currently delivered to gasoline stations



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## National Ambient Air Quality Standards (NAAQS)

Ambient standards for six pollutants including ozone, carbon monoxide, nitrogen dioxide, lead, particulate matter, and oxides of sulphur specifically regulated under the U.S. Clean Air Act of 1990. Urban areas are required to achieve attainment in regards to ambient concentrations of these criteria pollutants.

## Natural Gas (NG)

A mixture of hydrocarbon compounds and small quantities of various non hydrocarbon components existing in the gas phase or in solution with crude oil in natural underground reservoirs. The main component of natural gas is methane.

## NGV (Natural Gas Vehicle) –

A vehicle that uses compressed natural gas (CNG) or, less commonly, liquefied natural gas (LNG)) as a clean alternative to other automobile fuels.

## Nitrogen Oxides (NO<sub>x</sub>)

Several air-polluting gases composed of nitrogen and oxygen which play an important role in the formation of photochemical smog. Nitrogen oxides are collectively referred to as "NO<sub>x</sub>", where "x" represents a changing proportion of oxygen to nitrogen. Internal combustion engines are significant contributors to the worldwide nitrogen oxide emissions. For the purpose of emission regulations, NO<sub>x</sub> is composed of colourless nitric oxide (NO), and the reddish-brown, very toxic and reactive nitrogen dioxide (NO<sub>2</sub>). Other nitrogen oxides, such as nitrous oxide N<sub>2</sub>O (the anaesthetic "laughing gas"), are not regulated emissions.

## NMHC

Non-Methane Hydrocarbons.

## NMOG

Non-Methane Organic Gases.

## Nonattainment Area

A region that exceeds the U.S. National Ambient Air Quality Standards (NAAQS) for one or more criteria pollutants. Such regions, or areas, are required to seek modifications to their State Implementation Plans (SIPs), setting forth a reasonable timetable using means that are approved by the Environmental Protection Agency (EPA) to achieve attainment of NAAQS by a certain date. Under the Clean Air Act, if a non-attainment area fails to attain NAAQS, the EPA may superimpose a Federal Implementation Plan (FIP) with stricter requirements. Also, the EPA may impose fines, construction bans, or cut-offs in Federal grant revenues until the area achieves applicable NAAQS.

## Open Frontal Area (OFA)

In monolith catalyst substrates, the part of the total substrate cross-section area which is available for the flow of gas. The OFA is frequently expressed as a percentage of the total substrate cross-section and sometimes also called the substrate void fraction.

## Original Equipment Manufacturer (OEM)

Manufacturers of equipment (such as engines, vehicles, etc.) that provide the original product design and materials for its assembly and manufacture. OEMs are directly responsible for manufacturing and modifying the products, making them commercially available, and providing the warranty.

## Overhead Cam

A camshaft used for operating both valves and unit injectors, located on top of or within the cylinder head. Such camshafts are driven by a multi-gear gear train off the crankshaft. They simplify the design of the cylinder head and eliminate pushrods, allowing for much larger, open intake and exhaust ports and better breathing.

## Oxygenated Fuel

Any fuel substance containing oxygen, such as ethanol, methanol, or biodiesel. Oxygenated fuel tends to give a more complete combustion of its carbon into carbon dioxide (CO<sub>2</sub>), thereby reducing emissions of hydrocarbons and carbon monoxide. Oxygenated fuels may result in increased nitrogen oxides emissions.

## Ozone (O<sub>3</sub>)



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An oxygen molecule with three oxygen atoms. The stratosphere ozone layer, which is a concentration of ozone molecules located at 10 to 50 kilometres above sea level, is in a state of dynamic equilibrium. Oxygen molecules absorb ultraviolet (UV) light to form ozone which, in turn, decomposes back to oxygen. These processes absorb most of the ultraviolet light from the sun, shielding life from the harmful effects of UV radiation. Ozone is normally present at ground level in low concentrations. In cities where high level of air pollutants is present, the action of the sun's ultraviolet light can, through a complex series of reactions, produce harmful concentrations of the ground level ozone. The resulting air pollution is known as photochemical smog.

### **Particulate Matter (PM)**

Particles formed by incomplete combustion of fuel. Compression ignition (diesel) engines generate significantly higher PM emissions than spark ignited engines. The particles are composed of elemental carbon, heavy hydrocarbons (SOF), and hydrated sulphuric acid ("sulphate particulates").

### **Petroleum**

A generic term applied to oil and oil products in all forms. Examples include crude oil, lease condensate, unfinished oil, refined petroleum products, and natural gas plant liquids.

### **Polycyclic Organic Matter (POM)**

A class of air toxics defined in the US Clean Air Act as compounds with more than one benzene ring and a boiling point of 100°C and higher. Includes practically all of diesel PAH material.

### **Polynuclear Aromatic Hydrocarbons (PAH)**

Aromatic hydrocarbons with two or more (up to five or six) benzene rings joined in various, more or less clustered forms.

### **Pour Point**

A measure of the ability of a diesel fuel to operate under cold weather conditions. Defined as the temperature at which the amount of wax out of solution is sufficient to gel the fuel when tested under standard conditions (ASTM D97).

### **Precombustion Chamber**

A small, auxiliary combustion chamber connected by a narrow orifice with the main chamber. Fuel is injected into the pre-chamber and ignites there, causing hot gases to expand into the main chamber (cylinder).

### **Propane (C<sub>3</sub>H<sub>8</sub>)**

A normally gaseous straight-chain hydrocarbon. Propane is a colourless paraffin gas that boils at a temperature of -42°C. It is extracted from natural gas or refinery gas streams.

### **Pump-Line-Nozzle Fuel System**

A fuel system using a single injection pump driven off the gear train on the front of the engine that also drives the camshaft. The central injection pump feeds a separate injection nozzle located in the cylinder head above each cylinder. Lines which must be of exactly equal length link each pump plunger with the associated nozzle. Each nozzle incorporates a needle valve and the orifices which actually handle atomization.

### **Reformulated Gasoline (RFG)**

Gasoline whose composition has been changed, from that of gasoline sold in 1990, to (1) include oxygenates, (2) reduce the content of olefins, aromatics and volatile components, and (3) reduce the content of heavy hydrocarbons to meet performance specifications for ozone-forming tendency and for release of toxic substances (benzene, formaldehyde, acetaldehyde, 1, 3-butadiene, and polycyclic aromatic hydrocarbons) into the air from both evaporation and tailpipe emissions.

### **Renewable Energy**

Energy obtained from sources that are essentially inexhaustible, unlike fossil fuels. It includes conventional hydro-electric, wood, bio-feed stocks, waste, geothermal, wind, photovoltaic, and solar thermal energy.

### **Respirable Combustible Dust (RCD)**

A method of measuring ambient DPM exposures using a combustion process. Used in underground mines in Canada.

### **Rotary Injection Pump**



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A lower-cost injection pump used with pump-line-nozzle systems. The pump has a central plunger system (usually consisting of two opposing plungers) that provides fuel to every cylinder during the required injection period. A plate located near the top of the pump rotates, opening an appropriate orifice at the right time for distribution to each cylinder's injection nozzle through a separate line. It is usually used with automotive or agricultural engines that have lower performance and durability requirements than the heavy-duty truck diesels.

### **Selective Catalytic Reduction (SCR)**

Term frequently used as a synonym for catalytic reduction of NO<sub>x</sub> in diesel exhaust or flue gases by nitrogen containing compounds, such as ammonia or urea. Such systems are commercially available for stationary applications. Since "selective catalytic reduction" is a generic term also used in regards to other reactions, its use may lead to confusion in some situations.

### **Soluble Organic Fraction (SOF)**

The organic fraction of diesel particulates. SOF includes heavy hydrocarbons derived from the fuel and from the engine lubricating oil. The term "soluble" originates from the analytical method used to measure SOF which is based on extraction of particulate matter samples using organic solvents.

### **Super Ultra Low Emission Vehicle (SULEV)**

A vehicle that meets the SULEV emission standards set by the California Air Resources Board. The SULEV standards are more stringent than the ULEV standards.

### **Swirl Combustion**

A combustion chamber configuration which uses curved mixing ridges in the intake ports and/or a re-entrant piston bowl (a bowl whose top edges curve inward). Some swirl combustion chambers have a larger rim around the outside of the piston and a more compact combustion chamber or bowl. The swirl is used to reduce particulate emissions.

### **Total Particulate Matter (TPM)**

The total particulate matter emissions including all fractions of diesel particulates, i.e. the carbonaceous, organic (SOF), and sulphate particulates.

### **Transitional Low Emission Vehicle (TLEV)**

A vehicle that is certified to meet the TLEV emission standards established by the California Air Resources Board (CARB). The TLEV standards are less stringent than the LEV standards.

### **Threshold Limit Value (TLV)**

Time-weighted average concentration of an air pollutant at the workplace for a conventional 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed without adverse health effects.

### **Total Carbon (TC)**

The sum of the elemental carbon and organic carbon associated with diesel particulates. Typically amounts to 80-85% of the total DPM mass.

### **Turbo charging**

A process of compressing the engine intake air charge in order to allow more air and fuel into the cylinder and, thus, to increase the engine power output. The compressor, called the turbocharger, is driven by an exhaust gas propelled turbine.

### **Ultra-Low Emission Vehicle (ULEV)**

A vehicle that meets the ULEV emission standards set by the California Air Resources Board. The ULEV standards are more stringent than the LEV standards.

### **Unit Injector**

An injector which is camshaft-driven and incorporates a plunger. The plunger works in conjunction with a metering cup or appropriate orifices in the injector body to determine the beginning and end of injection. Plungers which meter in conjunction with injector body orifices have helical cuts and are rotated by a rack so the beginning and end of injection can occur closer together or farther apart, thus shortening or lengthening the injection period and changing metering. Plungers which meter with a metering cup (PT injectors) have a



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fill cycle of a fixed crankshaft duration. A special pump which supplies fuel through an orifice to the injector operates at a pressure which is precisely controlled depending on the changes in engine speed.

## VMT

Vehicle miles travelled.

## Volatile Organic Compounds (VOC)

Hydrocarbon-based emissions released through evaporation or combustion. The term VOC is usually used in regard to stationary emission sources.

## Volatile Organic Fraction (VOF)

The organic fraction of diesel particulate matter as determined by vacuum evaporation. It may or may not be equivalent to the SOF fraction. Depending on the exact analytical procedure, the VOF may include the organic material (SOF) as well as some of the sulphate particulates which, being composed primarily of hydrated sulphuric acid, are also volatile.

## Volumetric ratio (V/V) –

The efficiency of gas storage tanks is typically measured by volumetric ratio. It is the relation of the volume of the storage container that holds the pressurized gas, and the volume occupied by the same quantity of gas in a non-pressurized state.

## White Smoke

The smoke emitted during a cold start from a diesel engine, composed mainly of unburnt fuel and particulate matter.

## Zero Emission Vehicles (ZEV)

A vehicle that is certified to meet the most stringent emission standards established by the California Air Resources Board (CARB). These standards require zero regulated emissions of non-methane organic gases (NMOGs), carbon monoxide (CO) and nitrogen oxides (NO<sub>x</sub>). A ZEV is most likely powered by electricity, fuel cells or hydrogen.

## Appendix - LPG vs. Natural Gas

Confusion exists between the terms LPG (Liquefied Petrol Gas) and Natural Gas or CNG (Compressed Natural Gas) is common.

**Economy:** LPG is a product of petrol refinery – therefore more expensive than petrol and tied to petrol price. The price of Natural Gas is basically not connected to petrol price – therefore much cheaper.

**Composition:** Natural Gas is basically composed of methane (the simplest and shortest hydrocarbon) whereas LPG is a mixture of propane, butane and other chemicals.

**Physical characteristics:** Natural Gas does not liquefy under high pressure - it remains a gas, unless cooled to - 164°C. LPG on the other hand becomes liquid when it is compressed (therefore the name "Liquefied Petroleum Gas"). A large part of NG is hydrogen, making it lighter than air (this attribute makes CNG very safe: if there is a leak in the system, the gas will simply be released to the atmosphere). LPG is twice as heavy as air. Any leak will pool at a low point and constitute a danger.

**Extraction:** NG comes directly from a gas field. The only processing may be filtering. CNG can be used as a fuel right after the compression process. LPG, however, is an artificial product. It is a mixture of the above-mentioned gases and requires blending.