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Fuel Injection Nomenclature—Spark Ignition Engines

1. **Scope**—This SAE Recommended Practice was developed to provide a common understanding and usage of the technical terms useful in fuel injection systems for spark ignition engines. Additional nomenclature related to specific components is covered in the individual component sections.
2. **References**—There are no referenced publications specified herein.
3. **Definitions**
 - 3.1 **Accumulator**—A device to maintain fuel system pressure after the fuel pump is turned off. The device dampens pressure fluctuations, which cause hydraulic and/or acoustic noise during normal system operation. See Damper 3.12.
 - 3.2 **Air-Assisted Fuel Injection (AAFI)**—A fuel injection system where pressurized auxiliary air is mixed with the metered fuel to aid in vaporization and/or transport of the fuel. See also 3.57 Vacuum Air-Assisted Fuel Injection.
 - 3.3 **Barometric Absolute Pressure (BAP)**—Absolute atmospheric air pressure.
 - 3.4 **Bi-Fuel Vehicle**—Any vehicle designed to operate on gasoline and some other alternate fuel. Switching from one fuel to the other requires some manual or automatic intervention. There is a separate fuel storage tank for each fuel used.
 - 3.5 **Bottom Feed Fuel Injector**—A fuel injector where fuel is delivered at the side or bottom allowing some of the recirculating fuel to pass through the device.
 - 3.6 **Camshaft/Crankshaft Position Sensor (CPS)**—Devices which supply an electrical output that indicate the given shaft reference angle.
 - 3.7 **Central Fuel Injection (CFI)**—An electronically controlled fuel injection system in which one or more fuel injectors are located in the throttle body. The injectors may be positioned upstream or downstream of the throttle plates.
 - 3.8 **Central Port and Sequential Central Port Injection (CPI/SCPI)**—A multi-point injection system where the actuation device is mounted remotely from the spray generation and metering device.

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- 3.9 Cold Start Injectors (CSI)**—An auxiliary fuel injector which supplies additional fuel during cold cranking. Fuel injection is continuous or duty cycle controlled and the fuel rate is based on the orifice size and fuel pressure.
- 3.10 Compressed Natural Gas (CNG)**—Natural Gas in a gaseous phase comprised of approximately 90% methane compressed for storage up to 4000 psi.
- 3.11 Continuous Injection System (CIS)**—A fuel injection system in which fuel flows continuously from the injector or injectors independent of cylinder events. Fuel flow rate can be controlled by a variable orifice or fuel pressure.
- 3.12 Damper**—A device whose primary function is to attenuate pressure fluctuations in the fuel system and, thereby, reduce hydraulic and acoustic noise.
- 3.13 Direct Injection (DI)**—An injection system that delivers fuel directly into the combustion chamber. There are other customer/supplier specific acronyms in use that refer to this same injection strategy.
- 3.14 Dual Spray Injector**—A fuel injector that develops two distinct sprays.
- 3.15 Electronic Control Unit/Module (ECU/ECM)**—An electronic module one function of which is to calculate a command signal for the injector driver circuit based on inputs from engine operating sensors. There are several acronyms which describe the fuel injection computer, these being the most common.
- 3.16 Electronic Fuel Injection (EFI)**—A general term referring to any fuel injection system in which fuel metering is controlled electronically. Quantity of fuel delivered is scheduled by an electronic control unit. Its output signal is based on information received from several sensors that monitor the operating conditions of the engine.
- 3.17 Electronic Returnless Fuel System**—A fuel system that maintains a controlled fuel pressure at the fuel rail (injectors) by adjusting the fuel pump speed (without using a pressure regulator and return fuel flow). See 3.43 Mechanical Returnless Fuel System.
- 3.18 Engine Coolant Temperature Sensor (ECTS)**—A sensor that provides an electrical output proportional to the engine coolant temperature.
- 3.19 Exhaust Gas Oxygen Sensor (EGOS)**—A sensor located in the exhaust system that provides a switching electrical output which indicates oxygen content, and consequently, whether the air/fuel ratio is rich or lean in relation to the stoichiometric ratio. See also 3.32 Heated Exhaust Gas Oxygen Sensor, and 3.56 Universal Exhaust Gas Oxygen Sensor.
- 3.20 Flexible Fuel Vehicle (FFV)**—Any vehicle designed to operate on both gasoline and gasoline/ethanol or gasoline/methanol fuel blends. These blends can include up to 85% ethanol or methanol. All of the different fuels used are stored and distributed through the same fuel tank and piping system.
- 3.21 Fuel Charging Assembly (FCA)**—A fuel delivery system for an engine which consists of fuel rail, fuel injectors, pressure regulator, dampers, and access port.
- 3.22 Fuel Injection (FI)**—A general term referring to any type of fuel injection system. Fuel delivery may be mechanically or electronically controlled.
- 3.23 Fuel Injector (INJ)**—An electromagnetic or mechanical device used to meter and/or deliver pressurized fuel, directly at the point of injection.
- 3.24 Fuel-Injector Driver**—An electronic circuit that converts the fuel control signal from the ECU into the proper voltage and current signal required. The two commonly used drivers in the industry are a peak-hold driver used with low resistance injectors and an “on-off” (saturated) driver used with high resistance injectors.

- 3.25 Fuel Meter Body**—A device which houses fuel injectors in a remote application like CFI, CPI/SCPI and TBI.
- 3.26 Fuel Pressure Regulator**—A device to maintain a controlled fuel pressure at the fuel injector or a controlled differential pressure across the injector.
- 3.27 Fuel Pump**—A mechanical or electromechanical device that provides a specified fuel flow at the required system pressure.
- 3.28 Fuel Pump Controller**—An electronic device that controls the fuel pump output based on input from the fuel pressure sensor. See 3.17 Electronic Returnless Fuel System.
- 3.29 Fuel Rail**—A fuel manifold that distributes fuel to the individual fuel injectors. This manifold may contain pressure regulation and/or damping capability. It is used with multi-point injection systems.
- 3.30 Fuel Rail Temperature Sensor (FRTS)**—A sensor that provides an electrical output proportional to the fuel temperature in the fuel rail.
- 3.31 Group Fuel Injection**—A multi-point delivery technique in which fuel is delivered in a predetermined sequence by groups of two or more injectors.
- 3.32 Heated Exhaust Gas Oxygen Sensor (HEGOS)**—A sensor located in the exhaust system that provides an electrical output which indicates oxygen content. This type of sensor is heated to allow its usage for engine closed loop control sooner. See also 3.19 Exhaust Gas Oxygen Sensor, and 3.57 Universal Exhaust Gas Oxygen Sensor.
- 3.33 Idle Speed Control (ISC)**—A general term used to indicate any device or system which provides programmed control of engine idle speed. Speed control is usually accomplished by adjusting the amount of air bypassing the throttle plate or by adjusting the position of the throttle plate.
- 3.34 Injection Pressure and Temperature Sensor (IPTS)**—A sensor that provides both the fuel injection rail pressure and temperature to the engine control unit.
- 3.35 Injection Pressure Sensor (IPS)**—A sensor that provides an electrical output proportional to the absolute or differential pressure of fuel in the fuel rail.
- 3.36 Intake Air Temperature Sensor**—A sensor that provides an electrical output proportional to the intake air temperature. It is typically mounted within or ahead of any airflow measuring device.
- 3.37 Intake-Manifold Absolute Pressure Sensor**—A sensor which provides an electrical output proportional to the absolute pressure within the intake manifold downstream of the throttle plate.
- 3.38 Intake-Manifold Charge Temperature Sensor**—A sensor located in the intake manifold that provides an electrical output proportional to the temperature of the air or air/fuel mixture.
- 3.39 Integrated Air/Fuel Module**—A module that consists of the intake manifold, fuel rail, fuel injectors, sensors, an electrical harness, etc.
- 3.40 Liquefied Natural Gas (LNG)**—Natural gas in a liquid phase which is refrigerated for low pressure storage.
- 3.41 Liquefied Petroleum Gas (LPG)**—A commercial fuel comprised of approximately 95% propane. It is mostly liquid when stored at ambient pressure and temperature.
- 3.42 Mass Airflow Sensor (MAFS)**—A sensor that provides an electrical output proportional to the mass flow rate of the intake air to the engine.

- 3.43 Mechanical Returnless Fuel System**—A fuel system that maintains a constant fuel pump outlet pressure by using a series pass regulator and/or a bypass regulator. See 3.17 Electronic Returnless Fuel System.
- 3.44 Multi-Point Injection (MPI)**—A fuel delivery system in which each cylinder is fueled by at least one injector. The injector is normally located in the intake manifold or port close to the intake valve.
- 3.45 Natural Gas Vehicle**—Any vehicle designed to run on only natural gas (whether gaseous or liquid phase).
- 3.46 Poppet Nozzle**—A device that is activated by pressure that provides a pressure regulation function and spray generation function in the CPI/SCPI fuel system.
- 3.47 Port Fuel Injection (PFI)**—See Multi-Point Injection.
- 3.48 Sequential Fuel Injection (SFI)**—A multi-point fuel delivery technique in which each injector is individually energized and timed relative to its cylinder event. Fuel is delivered to each cylinder once per two crankshaft revolutions in four-cycle engines and once per crankshaft revolution in two-cycle engines.
- 3.49 Simultaneous Double Fire (SDF)**—A multi-point fuel delivery technique in which all injectors in a four-cycle engine are energized simultaneously usually once per crankshaft revolution.
- 3.50 Single Point Injection (SPI)**—A fuel delivery system in which the total fuel requirement of the engine is delivered at one specific location in the intake system. More than one injector may be used.
- 3.51 Speed Density (SD)**—A system in which the mass air flow rate is calculated based on cylinder displacement and the measured intake manifold absolute pressure, engine speed, intake manifold air temperature, and volumetric efficiency.
- 3.52 Throttle Body (TB)**—A device used to vary the supply of intake air to the engine by means of one or more adjustable orifices and/or throttle plates.
- 3.53 Throttle Body Injection (TBI)**—See 3.7 Central Fuel Injection.
- 3.54 Throttle Position Sensor (TPS)**—A device that provides an electrical output as a function of throttle plate position.
- 3.55 Top Feed Fuel Injector**—A fuel injector where fuel is delivered to the top of the device such that recirculating fuel does not pass through the device.
- 3.56 Universal Exhaust Gas Oxygen Sensor (UEGO)**—A sensor located in the exhaust system that provides an electrical output which is linearly proportional to A/F ratio. These can be heated or non-heated types. See also 3.19 Exhaust Gas Oxygen Sensor, and 3.32 Heated Exhaust Gas Oxygen Sensor.
- 3.57 Vacuum Air-Assisted Fuel Injection**—A fuel injection system where auxiliary air which is drawn across the fuel injector nozzle by the pressure differential caused by the intake manifold vacuum is mixed with the metered fuel to aid in vaporization or transport, or both, of the fuel. See also 3.2 Air-Assisted Fuel Injection.

4. Notes

- 4.1 Marginal Indicia**—The change bar (I) located in the left margin is for the convenience of the user in locating areas where revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.