

Comparative Study Of On Board Diagnostics Systems- EOBD, OBD-I, OBD-II, IOBD-I and IOBD-II

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ABSTRACT -Vehicle transportation has become integral part of our life and hence increasing number of vehicles on road day-by day .Due to increase in vehicle population, the greenhouse gas emission is also increasing.

First time California studied the vehicle out emissions and decided to form standards to reduce in-use vehicle emissions. The quick and easy method was also developed and implemented as OBD (On Board diagnostics) system.

This system identify the sensors/actuators, system or sub-systems of Power train system which are likely to increase emissions when malfunction during operation/use.

This paper is a study of different On Board Diagnostics Systems adopted by different countries i.e. US, Europe and India. This paper is to understand different OBD strategies followed in these countries.

Key Words: IOBD-I, IOBD-II , EOBD, OBD-I, OBD-II

1. INTRODUCTION

In early 1980's large no. of vehicles started using computers ,called ECU which was used to control the engine fuel ,air and emission control systems, to achieve the emission targets. These parts are different than every-days used mechanical / electrical engine

This was different electronic/electrical sensors and actuators were used. This was new era started and mechanics were not convergent with repairing of these vehicles, then this Inspection and Maintenance was started implementing.

The aim was to provide a system at dashboard to know that during vehicle operation of any by-chance any failure of components/systems which can cause increase in vehicle out emissions must be detected by suitable lamp. This lamp is called MIL (Malfunction Indicator Lamp).

2.0 OBD SYSTEMS

2.1 OBD-I

OBD-I is based on some experience about road vehicles emission out of standard norms, CARB proposed and then implemented first OBD requirement in April 1985. The main objective was to improve in-use emission compliance by monitoring the computerized emission control system

during on road and give indication to driver that it should recheck/repair.

First generation OBD-I Requirements applied to light duty vehicles beginning with 1988 Model year.

The requirements was

-Emission related inputs to ECU were required to be monitored for open and short.

The component required to monitor were

- ECU
- Fuel Metering system
- Ignition
- Exhaust Recirculation system if equipped.

The OBD-I Regulation represented a substantial step forward in supporting the technician to indentify repairing systems/parts.

2.2 OBD-II

In year 1988, CARB prepared and implemented OBD-II

The purpose was to monitor the performance of sensors and actuators affecting the engine emission norms and finally 1994 onward applied to all vehicles.

OBD-II has to monitor following parts

- Catalyst system
- Engine Misfire
- Evaporative emission control system
- Secondary Injection system
- Fuel system
- Oxygen Sensor
- Exhaust Gas Recirculation system
- Positive crankcase ventilation system
- Engine cooling system
- Cold start emission reduction strategy
- Air conditioning system,
- Variable Valve timing system,
- Diesel Particulate Trap

2.3 IOBD-I

In India first GSR 84(E) dated 9 th 2009 , was published for both positive and compression Ignition Engines from BSIV 1st April 2010

Only Discontinuity Test : MIL must be activated if discontinuity of emission related components occurs

Emission related parts were Oxygen sensor, Secondary air system if provided, coolant temperature sensor, fuel tank leakage & evaporation and fuel system.

Catalyst, misfire, EGR if provided was not included in IOBD-I Circuit continuity of all emission related parts/systems and distance travelled since MIL ON was included.

2.4 IOBD-II

IOBD-II was further made stringent and MIL must be activated if emission related components causes emission to exceed OBD threshold.

3.0 MIL

Malfunction Indicator Lamp Diagnostic Malfunction Lamp will be turn ON according to the described below.

OBD-II- since MIL function is detected, the engine management system can turn the MIL ON and record the failure up to two consecutive trips with the Malfunction present.

Once the MIL is ON, that diagnostic test shall pass for 3 consecutive trips without the same fault according to turn the MIL OFF.

EOBD-Since a malfunction is detected ,the engine management system can turn the MIL ON and record the failure up to ten consecutive trips with the Malfunction present.

Once the MIL is ON that diagnostics test shall pass for three consecutive trips without the same fault occurring to turn the MIL OFF. After 40 keys cycles of pass reports the Malfunction will be eliminated from history.

3.1 IOBD-II

Malfunction Indicator (MIL) means a visible or audible indication that clearly informs that the Driver of the vehicle in the event of Malfunction of any emission related components connected to the OBD system or OBD system.

IOBD-II –India is following same as OBD-II codes

As per 6.3 of ISO DIS 15031-6 (Communication between vehicle and external test equipments for emission related diagnostics)

–Part-6 Diagnostic Trouble code definition’ related to ‘emission related system –diagnostic trouble codes’ if not possible ,manufacturer may use according to section-5.3 & 5.6 of ISO DIS 15031-6

3.2 EOBD

There is specific malfunction codes that represents the components and an extension code that represents the symptom for example

P0105X2- Manifold Absolute pressure circuit low Input

P0105X1- Manifold Absolute pressure circuit High Input

Malfunction Codes

Malfunction codes are the categorized in following manner as per fig-1

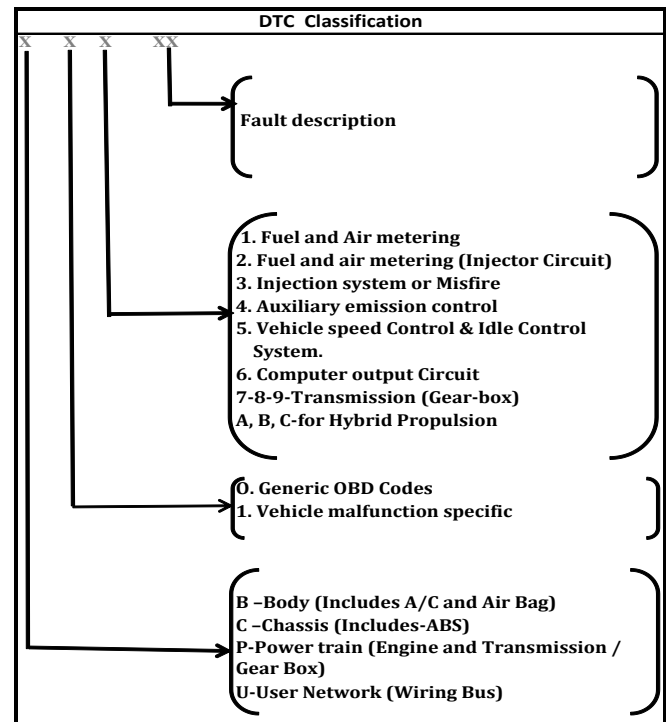


Fig-1 : DTC Categorizations

When the engine Management system detects emission related component malfunction its trouble codes should be logged.

OBD-II There is specific malfunction code that represents the components and symptom for example.

P0107-Manifold Absolute pressure circuit low Input
P0108-Manifold Absolute pressure circuit High Input

4.0 SENSORS/ACTUATORS/SUB-SYSTEM PERFORMANCE MONITORING

4.1 Catalytic Converter Degradation Diagnostic

The purpose of catalytic converter degradation is to determine the grade of the catalytic converter deterioration. The dual O2 sensor method (pre and post catalytic converter) is used to relate the oxygen storage capacity of the converter. The method analysis the HC conversion efficiency.

OBD-II The MIL will be turn ON if the emission exceed 1.75 times the applicable HC standard .The catalytic converter should maintain its characteristics at least 160 000 km.

EOBD-The MIL will turn ON if the emission exceeds the absolute tailpipe HC emission standards. The catalytic converter should maintain its characteristics at least 100000 km.

IOBD-I-Not applicable

IOBD-II-Reduction in the efficiency of the catalytic converter with respect to the emissions

of HC only. Manufactures may monitor the front catalyst alone or in combination with the next catalyst(s) downstream. Each monitored catalyst or catalyst Combination shall be considered malfunctioning when the emissions exceed the HC threshold given in the applicable Gazette Notification under CMVR.

Replacement of a catalyst with a deteriorated or defective catalyst or electronic simulation of a deteriorated or defective catalyst that results in emissions exceeding the HC limit given in the applicable Gazette Notification under CMVR.

4.2 O2 Sensor Response Degradation Diagnostics

The Purpose of the Oxygen sensor response is to monitor the front O2 sensor function. It is an indication of switching quality of the sensor.

OBD-II –the MIL will turn ON if that signal has deteriorated to a point where the emissions thresholds are reached 1.5 times the tailpipe standards.

EOBD-The MIL will turn ON if that signal has deteriorated to a point where the emission thresholds exceed the absolute tailpipe standards

IOBD-I NOT applicable

IOBD-II –The MIL should turn ON and Emission threshold must not exceed.

4.3. Misfire Diagnostics

The purpose of the O2 sensor is to continuously monitor for misfiring cylinders during the operation of engine. This misfire can occur due injector or ignition coil problem.

OBDII –The MIL will turn ON if the rate of misfire exceeds to a point where the emissions thresholds are reached 1.5 times the tailpipe standard. The diagnostic can be disabled below 15 percent of fuel tank level.

EOBDII- The MIL will turn ON if the rate of misfire exceeds the absolute tailpipe standards. The misfire detection is below of 4500 rpm engine speed and below of 2500 m altitude. The diagnostic can be disabled below 20 percent of fuel tank level.

IOBD-I- Not applicable

IOBD-II- It is part of OBD system and it must not exceeds threshold emission limits.

4.4 Exhaust Gas Recirculation (EGR) System Degradation Diagnostics-

The purpose of the exhaust gas recirculation system degradation diagnostics is to allow a precise control of the

amount of exhaust gas directed from the exhaust manifold to the intake manifold.

OBDII –The diagnostic is always performed and it is independent of pollutants caused in case of malfunction.

EOBDII-The diagnostic is required if a malfunction results in a pollutants higher than the absolute of tailpipe standard.

IOBD-I- Not applicable

IOBD-II- It is applicable and it must meet emission threshold limit.

4.5 Positive Crankcase Ventilation

The purpose of the positive crankcase ventilation system monitoring is to monitor and ensure the integrity of the connections between the crankcase and the PCV hose or valve.

OBD-II –The detection of subsystem disconnection.

EOBD-It is NOT Applicable but consider in Type III robust design.

IOBD-I NOT applicable

IOBD-II –The MIL should turn ON and Emission threshold must not exceed.

5.0 OBD THRESHOLD

It is the higher limit than Type approval test results and it is applicable for testing OBD declared sensors or actuators which affects vehicle out emissions.

OBD-II –It is Emission std X Factor

EOBD- It is Emission std X Factor

IOBD-I NOT applicable

IOBD-II – It is independent from emission.

6.0 OBD PROTOCOL

It is the systems /procedures / test conditions are based on reference standards

OBD-II –from MY08 or ISO 15765-4(CAN)

EOBD-ISO 9141-2; SAEJ1850;ISO14230-4 ; or ISO 15765-4

IOBD-I NOT applicable

IOBD-II - ISO 9141-2; SAEJ1850;ISO14230-4 ; or ISO 15765-4

7.0 GENERAL INFORMATION

7.1 Altitude-

OBDII can be disabled at altitude above 2438 m.

EOBD can be disabled at altitude above 2500 m

IOBDII- can be disabled at above 2500 m

7.2 Diagnostics-

If any other emission controls component or system which would result in tailpipe emission exceeding the EOBD limits in case of malfunction, make its diagnostics. The OBDII specific the emissions control components or system which should make diagnostics.

IOBD-II It make possible to identify parts or sub-system components not working as per required calibration.

7.3 Distance Travelled-

The EOBD requires the distance traveled since a malfunction code was stored. This information should be stored at Non volatile Memory and available for the scan tool. The OBD-II does not consider this function.

IOBDII-It should be stored in ECU with complete information as freeze frame data.

8.0 CONCLUSION

The following conclusions may be drawn from the present exercise:

1. In India IOBD- started in 2010 and IOBD-II in 2013 for all class of vehicles.

For Positive Ignition engines , Catalyst ,Misfire, Oxygen sensor ,Secondary Air system, EGR if provided, fuel system, Fuel tank and evaporative (evaporative emission is not applicable for Natural Gas Vehicles) Emission control are included.

2. System/components(comprehensive components),circuit continuity for all emission related power train components, Coolant temperature and distance travelled since MIL are included in IOBD-II .

3. India Implemented OBD standard at par with International standard to reduce in-use vehicle emissions.

4. Recently India has decided to skip BSV emission norms and proposed BSVI emission norms from 2025 to 2020.

Indian government has directed to implement BSVI from 2020 for all class of vehicles. Two , Three and Four wheeler vehicles.

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ACKNOWLEDEMENT

The author express sincere thanks to Dr.S.S.Kore -HOD of Mechanical Engineering department of M/s Sinhgad Institute of engineering , Kondhwa , Pune ,India for supporting the above research work. The author would like to thank Dr.S.S.Thipse, Industry Guide for their time to time support and updation of Technology development in OBD area. Author is also would like to thank Mr.Sandeep Rairikar ,Mr.Kavthekar ,Mr.Ashwin D-Souza and Mr. Sonawane from M/s ARAI for their guidance and Mr. Prashant Pawar from M/s Advantek Fuel system for their technical support ..

APPENDIX

IOBD-I-Indian On Board Diagnostics stage-I

IOBD-II- Indian On Board Diagnostics stage-II

EOB-II-European On Board Diagnostics Stage II

OBD-I-US On Board Diagnostics stage I

OBD-II-US On Board Diagnostics stage-II

CARB-California Air Resource Board

EGR-Exhaust Gas Recirculation

O2-Oxygen sensor