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PROPOSAL FOR NEW DRAFT GLOBAL TECHNICAL REGULATION (gtr)

UNIFORM PROVISIONS CONCERNING THE TECHNICAL REQUIREMENTS FOR ON-  
BOARD DIAGNOSTIC SYSTEMS (OBD) FOR ROAD VEHICLES

Transmitted by the Chairman of the World-Wide Harmonized Heavy-Duty OBD group  
(WWH-OBD)

Note: The text reproduced below was prepared by the GRPE informal group on WWH-OBD.  
This document is the draft global technical regulation (gtr) to establish technical requirements for  
on-board diagnostic systems (OBD) for road vehicles

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Note: This document is distributed to the Experts on Pollution and Energy only.

## MODULE A:

### JUSTIFICATION AND TECHNICAL RATIONALE

#### 1. INTRODUCTION

This global technical regulation (gtr) establishes technical requirements for on-board diagnostic systems (OBD) for road vehicles. Currently, the gtr is directed only at OBD requirements for heavy-duty engines/vehicles necessary to maintain emissions-related performance (i.e., emissions-OBD). Nonetheless, as discussed in more detail below, the gtr has been structured in a manner that facilitates a wider application of OBD to other vehicle systems in the future.

In brief, the gtr sets forth OBD performance requirements to which engine manufacturers must demonstrate compliance to certification authorities. The gtr also sets forth a basic set of demonstration requirements for manufacturers so that compliance can be demonstrated in a consistent manner. Also included are requirements to standardise the communication of on-board information to off-board devices to assist in maintenance of the increasingly complex modern diesel engines, and to facilitate the future use of OBD as a roadworthiness indicator for heavy-duty vehicles.

Of particular importance with respect to the use of OBD as a roadworthiness indicator is the introduction, with this gtr, of a failure severity indication via the dashboard malfunction warning signal (malfunction indicator). The failure severity indication is achieved in two ways. Firstly, the gtr requires the use of a separate and dedicated malfunction indicator to indicate a malfunction in the engine and emissions control system that results in an increase in emissions. Other failures that previously may have been communicated via a shared indicator must now use a separate and discreet indicator. Secondly, the gtr requires that the effect of malfunctions be assessed as part of the design function and that their effect be designated to a specific level within a 3-tier classification. Upon malfunction detection, the malfunction indicator is required to communicate in a unique way depending on which of the three tiers to which the detected malfunction has been designated. While the requirements for the malfunction indicator provide for each of these failure levels to be discernible, only the upper two failure levels are automatically indicated to the driver. This has been termed a "discriminatory display" strategy as it discriminates between three possible severities of malfunctions when indicating them via the malfunction indicator. This new requirement is intended to allow vehicle operators, maintenance staff, inspectors and enforcement authorities to make an informed decision with regard the roadworthiness of the vehicle. Nevertheless, not all Contracting Parties may wish to apply this approach. Therefore, the gtr provides for a malfunction indicator that would use a non-discriminatory display strategy (i.e., one that would communicate all malfunctions regardless of their severity in the same manner via the malfunction indicator) for regions that may find it more suitable than this new discriminatory display model.

The gtr recognizes that it is not always possible to know precisely the impact of a failure or deterioration of a system or its component parts on the actual emissions from the vehicle. Therefore, the gtr minimizes the burden on the manufacturer in this regard by allowing the classification of malfunctions to be achieved, as far as is reasonable, by engineering analyses. Inevitably, certification authorities will require validation of the engineering analyses and, therefore, the gtr provides for testing using deteriorated components to assess the OBD system performance. The gtr does not require testing to determine whether malfunctions should be placed in a lower level in the

classification than that proposed by the manufacturer at the time of certification or type approval. However, the expectation is that manufacturers will apply best practice to achieve correct classification of malfunctions and evidence of this effort will be assessed, in part, from the engineering analyses provided as part of the certification process. Where experience or testing in the market indicates a significant malfunction misclassification, the gtr provides for its re-classification (paragraph A.5., below, refers to the recommended administrative procedures for global technical regulations in such cases of reclassification).

Recent years have seen a rapid increase in the number of vehicle functions that depend upon the use of electrical/electronic control. This trend is expected to continue. Further, the emissions control systems on highway vehicles are not the only systems for which OBD capability is important. Vehicle systems provided to manage or deliver safety control are also equipped with diagnostic capability. Recognising this fact, and the negative implications that non-standardised diagnostics can have on maintenance and inspection procedures, this gtr has been structured such that further OBD functionality — e.g. OBD for safety related systems — could be added in the future as and when appropriate. This flexible structure is represented in two ways within this gtr. Firstly, a generic paragraph (Module B) is provided that sets out key definitions and functions to be applied to all OBD systems considered by this gtr. In developing Module B, the current regulatory requirements for failure identification and warning in both the field of emissions control and safety system management have been considered. Secondly, the gtr refers to particular work of the International Organization for Standardization (ISO) with respect to their work on a new standard "Road Vehicles – On board diagnostics (WWH-OBD) implementation", that considers the application of OBD beyond emissions control systems. By taking this approach, the intention is that future regulatory activity concerning OBD systems for all fields of road vehicle technology will deliver compatible requirements that provide a common feel for the user, be they the vehicle operator, the maintenance technician, the inspector, or the enforcement authority.

Given the flexible structure of the gtr, any future OBD working group developing requirements to add a new OBD functionality would simply need to add a new paragraph - termed modules - to the gtr that would address the specific OBD requirements of interest. Such a working group would also be required to review Module B of the gtr and, perhaps, revise it appropriately to ensure that there are no conflicting requirements or definitions. Further, Module C "Emission-Related Heavy-Duty Diesel OBD" should not require revision by any such future working group. Also of note is the use of parallel paragraph numbering between Modules B and C where possible. Future working groups are encouraged to follow this precedent.

It is important to note that many of the elements that have been developed for emissions-related OBD systems can be applicable to other types of OBD functionalities. For example, while the provisions for indicating the severity of malfunctions via the malfunction indicator have been developed as being specific to the emissions control system, the approach is fully consistent with failure warning provided for some safety systems today and would be easily developed as appropriate when additional OBD requirements might be considered.

OBD is likely to become increasingly important in future roadworthiness/inspection and maintenance procedures and the gtr reflects this expectation. It provides for standardized OBD data to be accessible from a common OBD access port. Telematic functions are being offered increasingly to improve the efficiency of working vehicles and, whilst this functionality is not included in the current version of the gtr, it nonetheless anticipates such a possible future need. The

work of ISO is such that, should there be a future political or commercial need for this technology, the impact on the design of the OBD systems, and on manufacturing industry, will be minimized.

## 2. PROCEDURAL BACKGROUND

During the one-hundred-and-twenty-sixth session of WP.29 of March 2002, the Executive Committee (AC.3) of the 1998 Global Agreement (1998 Agreement) adopted a programme of work, which includes the development of a global technical regulation (gtr) concerning onboard diagnostic systems for heavy-duty vehicles and engines.

An informal working group – the WWH-OBD working group – was actually established in September 2001, further to a proposal from the GRPE Chair in May 2001, to incorporate heavy-duty OBD into the GRPE agenda. Japan volunteered to lead the group.

The working group was instructed that the OBD system should detect failures from the engine itself, as well as from the exhaust after-treatment systems fitted downstream of the engine, and from the package of information exchanged between the engine electronic control unit(s) and the rest of vehicle and/or powertrain.

The working group was also instructed to base the OBD requirements on the technologies expected to be industrially available at the time the gtr would be enforced, and to take into account both the expected state of electronics in the years 2005-2008 and the expected newest engine and after-treatment technologies.

In November 2003, AC.3 further directed the working group to structure the gtr in such a manner as to enable its future extension to other functions of the vehicle. In so doing, AC.3 did not revise the scope of the task given to the working group (i.e., the scope remained emissions-related heavy-duty OBD). Hence the structure of the gtr as described above.

## 3. EXISTING REGULATIONS, DIRECTIVES, AND INTERNATIONAL VOLUNTARY STANDARDS

### 3.1. Those pertaining to emissions-related OBD

In the United States of America:

40 CFR 86.005-17 and 40 CFR 86.1806-05 contain OBD requirements for vehicles and engines fitted in vehicles less than 14,000 pounds gross vehicle weight. <sup>1/</sup> These regulations with respect to heavy-duty engines and vehicles were implemented in the 2004 and 2005 model years. As of this writing, the U.S. Environmental Protection Agency is developing proposed OBD requirements to be implemented in the 2010 model year for engines fitted in vehicles over 14,000 pounds gross vehicle weight.

Also, 13 CCR 1968.2, 13 CCR 1971 and 13 CCR 1971.1 contain OBD requirements for California vehicles up to 14,000 pounds gross vehicle weight and engines fitted in vehicles over 14,000 pounds gross vehicle weight, respectively.

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<sup>1/</sup> See 58 FR 9468 and 65 FR 59896.

In Europe:

Directive 98/69/EC 2/ (amending Directive 70/220/EEC 3/) introduced, for the first time, emission-related OBD requirements applicable to petrol and diesel passenger cars and light-commercial vehicles (nominally up to 3.5 t gross vehicle mass). Table A.1 below gives the application dates of OBD to the vehicles covered by Directive 70/220/EEC.

Directive 1999/102/EC 4/ introduced, amongst other things, revised provisions for misfire monitoring, adoption of the CAN protocol and provisions for deficiencies. These requirements applied from the same dates as given in Directive 98/69/EC.

Directive 2001/1/EC 5/ introduced OBD requirements for vehicles running permanently or part-time on liquid petroleum gas (LPG) or natural gas (NG) fuel. Table A.1. gives the application dates of OBD to vehicles equipped with spark-ignition engines running permanently or part-time on liquefied petroleum gas (LPG) or natural gas (NG).

Directive 2002/80/EC 6/ introduced requirements for the type-approval of OBD-compatible replacement catalytic converters and improved information to third Parties involved in the manufacturer of spare parts and diagnostic tools. These requirements will apply from 1 January 2006 onwards.

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2/ See Official Journal of the European Communities, L350, 28.12.1998, p.1.

3/ See Official Journal of the European Communities, L76, 6.4.1970, p1.

4/ See Official Journal of the European Communities, L334, 28.12.1999, p.43.

5/ See Official Journal of the European Communities, L35, 6.2.2001, p.34.

6/ See Official Journal of the European Communities, L291, 28.10.2002, p.20.

Table A.1.: Application dates of European OBD Directives

Vehicle category	Date from which all new vehicles shall be equipped with an OBD system complying with the requirements of Directive 70/220/EEC (as amended)
Spark-ignition (petrol) engines:	
Category M1 (i.e. passenger cars) ≤ 2,500 kg:	1 January 2001
Category N1 class 1 (i.e. goods vehicles ≤ 1,305 kg):	
Category M1 > 2,500 kg:	1 January 2002
Category N1 classes II and III (i.e. goods vehicles > 1,305 kg and ≤ 3,500 kg):	
Spark-ignition engines running permanently or part-time on LPG or NG:	
Category M1 ≤ 2,500 kg and Category N1 class I	1 January 2006
Category M1 > 2,500 kg and Category N1 classes II and III:	1 January 2007
Compression-ignition (diesel) engines:	
Category M1 ≤ 2,500 kg and those designed to carry ≤ 6 occupants:	1 January 2004
Category M1 designed to carry > 6 occupants:	1 January 2006
Category N1 class 1:	
Category M1 > 2,500 kg:	1 January 2007
Category N1 classes II and III:	

Directive 1999/96/EC 7/ (amending Directive 88/77/EEC 8/) laid down the Euro 3, Euro 4 and Euro 5 pollutant emission limits. Article 4 of that Directive required the European Commission to bring forward a proposal to introduce OBD for heavy-duty vehicles and engines in parallel with the Euro 4 stage of emission limits. In response to this request, Directive 2005/55/EC 9/ lays down the fundamental elements relating to OBD for heavy-duty vehicles and engines, i.e. the formal structure of the requirements and the OBD threshold limits. This is complemented by Directive 2005/yy/EC 10/ which provides the technical requirements for implementing the fundamental requirements of Directive 2005/55/EC.

In Japan:

Safety Regulations for Road Vehicles, Article 31 (Emission Control Device), Attachment 48 Technical Standard for On-Board Diagnostic (OBD) System for Exhaust Emission Control Devices

7/ See Official Journal of the European Communities, L44, 16.2.2000, p.1.

8/ See Official Journal of the European Communities, L36, 9.2.1988, p.33.

9/ See Official Journal of the European Communities, L275, 20.10.2005, p.1.

10/ See Official Journal of the European Communities, [...].

for Motor Vehicles.

Amendments of the Technical Standard relating to the Safety Regulations for Road Vehicles (see Table A.2.):

- mandatory installation of an OBD system that monitors malfunctions caused by open circuits for gasoline- or liquefied petroleum gas-fuelled ordinary-sized motor vehicles, small-sized motor vehicles and mini-sized motor vehicles (1998).
- mandatory installation of an OBD system that monitors malfunctions caused by open circuits for diesel-fuelled ordinary-sized motor vehicles and small-sized motor vehicles (2000).

Table A.2.: Application date of Japanese OBD Technical Standard

Category	Date of application
Spark-ignition (gasoline- or liquefied petroleum gas ) engines:	
GVW $\leq$ 3,500 kg:	1 October 2000
3,500 kg < GVW:	
Compression-ignition (diesel- fueled ) engines:	
GVW $\leq$ 3,500 kg:	1 October 2003
3,500 kg < GVW:	

#### 4. TECHNICAL RATIONALE, ECONOMIC IMPACTS, AND ANTICIPATED BENEFITS FOR THE EMISSIONS-RELATED OBD MODULE

##### 4.1. Technical rationale

On-board diagnostic (OBD) systems are of interest to regulators for many reasons. The advent of electronic controls in the 1990s made the diagnosis of improperly operating engine systems and emissions control systems very difficult. Furthermore, the addition of exhaust gas recirculation (EGR) systems and exhaust after-treatment devices are expected to provide 50 to 99 per cent control of pollutant emissions. Without some form of onboard system capable of monitoring the performance of these devices for proper functioning, a driver could be completely unaware of a situation that might cause emissions to far exceed the applicable regulatory requirements.

Because computer and electronic systems are difficult to diagnose and repair when not functioning properly, most manufacturers of vehicles, trucks, and engines have incorporated on-board diagnostic (OBD) systems into their products. These OBD systems are capable of identifying improper functioning and help to pinpoint where the malfunction is occurring. This serves to inform both the driver of the vehicle that repair is needed, and the repairer of the vehicle what needs to be repaired. In the heavy truck industry, these OBD systems have been geared traditionally toward detecting problems that cause drivability and/or fuel economy related effects. Understandably, the primary objective of these systems has been to protect against performance problems that might result in customer dissatisfaction. The emissions-related OBD requirements in this gtr would build on the efforts already undertaken by industry to ensure that key emission related components will be monitored and that the diagnosis and repair of those components will be as efficient and cost

effective as possible. The requirements of this gtr will ensure that malfunctions that are purely emissions-related (i.e., those types of malfunctions that could result in high emissions without a corresponding adverse drivability or fuel economy impact) will be detected and communicated to the driver and the repair technician. The result being that the air quality benefits expected from the regulatory programs of the Contracting Parties will be fully realized.

An OBD system meeting the emissions-OBD requirements of this gtr would be expected to monitor the engine's electronic sensors and actuators and to monitor the exhaust after treatment devices for their proper operation. Upon detecting any problems, the driver would be notified of the need to seek repair and pertinent information would be stored in the engine computer for retrieval by the repair professional. As a result, emissions-related problems are identified, their presence is communicated to the driver, repair is sought out, and proper repair is completed.

Further, the malfunction classification of the gtr will provide roadworthiness inspectors with the ability to determine not only the presence of malfunctions but also the severity of their emissions impact. This will allow for certain regions, depending on their air quality needs, to impose repair requirements and/or fees for only those malfunctions meeting the appropriate severity. This is important since many malfunctions that will be detected by an OBD system meeting the requirements of this gtr will result in only minor emissions increases and may not cause emissions to exceed the regulated emissions limits.

#### 4.2. Economic impacts

The requirements set forth in the emissions-related paragraph of the Regulation are believed to be technologically feasible in the timeframe expected for their implementation. The WWH-OBD working group consists of both regulators and industry representatives. General Agreement has been reached on the content of the gtr which should equate to general agreement on the feasibility of its requirements. Nonetheless, authorities are encouraged to carefully consider the costs, technological feasibility, and possible safety concerns that may be unique to their region when considering adoption of this gtr.

Designing and developing OBD systems that meet the emissions-OBD requirements of this gtr will cost industry considerable money. The cost of maintaining and repairing malfunctions identified by the OBD system will impact on industry, operators of heavy-duty vehicles and the general public. As noted in paragraph 3. above, many Contracting Parties have or are developing OBD requirements analogous to those in this gtr. Having one set of OBD requirements that would apply to all regions represented by the Contracting Parties would save industry considerable money relative to the situation they face currently with separate requirements in each region.

#### 4.3. Anticipated benefits

The specific air quality benefits expected to arise in Contracting Parties that implement the emissions-OBD paragraph of this gtr will be unique to each region. However, in general, the expectation is that properly operating emissions control systems will result in cleaner air regardless of the region being considered. Any effort to ensure that emissions control systems will operate properly during their real world lifetime is of value.

Specific cost effectiveness values for this gtr have not been calculated. The decision by the

Executive Committee of the 1998 Agreement to move forward with this gtr without specific emissions threshold levels (i.e., the emissions level at which a malfunction is indicated) is the key reason why this analysis has not been completed. This agreement has been made knowing that specific cost effectiveness values are not immediately available. However, it is fully expected that this information will be developed, generally in response to the adoption of this gtr in the national or regional requirements of the Contracting Parties and also in support of developing harmonized limit values for the next step in this gtr's development. For example, each Contracting Party adopting this gtr into its national or regional regulations will be expected to determine the appropriate emissions threshold levels associated with these OBD requirements. Experience will be gained by industry as to any costs and savings associated with these world harmonized requirements. This cost and savings data and emissions performance data can then be analysed as part of the next step in this Regulation development to determine the cost effectiveness values of world harmonized OBD when matched with new harmonized limit values. While costs per tonne of pollutant reduced have not been calculated, the belief of the technical group is that there are clear benefits associated with this gtr.

## 5. ADMINISTRATIVE CONSIDERATIONS

There are some technical issues associated with this gtr that require provisions to be set out in the procedures for the general operation of global technical regulations.

Paragraph 4. of Module C of this gtr establishes the requirements for the case where a manufacturer may request to the certification authority that a malfunction(s) be reclassified from their original approved classifications, for example due to the discovery of an error in software coding or calibration.

For example, if an engine manufacturer determines through in-service testing, servicing information or other appropriate means that a malfunction or malfunctions should be re-classified, the manufacturer should make a specific request to the Contracting Party who granted the initial approval according to the rules or regulations applying this gtr in that Contracting Party. The manufacturer would provide details of the malfunction(s) in question, a technical justification for the re-classification(s), a list of the affected vehicle/engine families or types and the actions it will undertake to correct the classification(s). According to such information and if in agreement with such information, the Contracting Party would then simply extend the approval for the vehicle/engine families or types in question. It is recommended that, according to the general procedures for the operation of global technical regulations, the Contracting Party would inform other Contracting Parties to this gtr of the issue and any consequential actions it plans or has completed.

As an additional example, a certification authority in a Contracting Party may determine through in-service testing or any other regulatory measure applicable in the region in which that authority is responsible that, in the case of a vehicle/engine type or family which has been approved according to this gtr, a malfunction or malfunctions should be re-classified from their initial approved classification. In such a case, the Contracting Party would, where applicable, inform the manufacturer of the vehicle/engine type or family in question and undertake any applicable measures defined according to the rules or regulations applying this Regulation in that Contracting Party. If the Contracting Party undertakes any actions with the manufacturer in question, it is recommended that the Contracting Party would inform other Contracting Parties to this global technical regulation

of the issue and any consequential actions it plans or has completed. On that basis, other Contracting Parties might decide to require a manufacturer of the same vehicle/engine type or family to undertake a similar re-classification for those same vehicles/engines within that Contracting Party.

While these examples speak specifically to malfunction re-classification, similar examples could be given for other forms of post-approval fixes meant to correct elements of the OBD system that are not working as designed or as intended, whether they be identified by the certification authority or the manufacturer. For example, an OBD monitor that never operates - whether due to poor design, a software glitch, or some other unforeseen circumstances - in one Contracting Party would, presumably, not operate in other Contracting Parties. It is recommended that Contracting Parties inform other Contracting Parties to this effect of such issues and any consequential actions it plans or has completed so that other Contracting Parties have the opportunity to consider the issue.

MODULE B:

GENERIC OBD PROVISIONS

1. PURPOSE

This gtr prescribes the requirements for on-board diagnostic systems to detect, and, if applicable, record and/or communicate failures of specific vehicle and engine systems that affect the environmental or safety 11/ performance of these systems, as described in the specific modules of this gtr.

In addition, this gtr specifies the elements concerning the OBD system to facilitate the diagnosis and maintenance of specific vehicle and engine systems and the possible enforcement of road-worthiness measures.

2. SCOPE

The current gtr addresses emission related failures from compression ignited engine systems used in on-road heavy-duty vehicles.

The scope and application of the modules of this gtr are summarized in table 1.

<u>OBD</u> Scope \ Vehicles/ Engines	On-road Heavy-Duty Diesel	(Reserved for later purposes)
Generic requirements	Modules A and B	
Exhaust emissions	Module C	
(Reserved for later purposes)		

Table 1.: OBD Scope and application

The requirements specified in specific modules are limited to the specific system to which that module refers. In this gtr, any reference to "specific module" shall refer to the specific module.

3. DEFINITIONS

3.1. "Alert system" means a system on-board the vehicle which informs the driver of the vehicle or any other interested party that the OBD system has detected a malfunction.

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11/ The current gtr only establishes requirements for emission-related OBD systems. Requirements addressing safety-related OBD systems may be added at a later date in accordance with future decisions of WP.29.

- 3.2. "Component monitoring" means the monitoring of input components for electrical circuit failures and rationality failures and monitoring of output components for electrical circuit failures and functionality failures.
- 3.2.1. "Electrical circuit failure" means a malfunction (e.g. open circuit or short circuit) that leads to the measured signal (i.e. voltages, currents, frequencies, etc.) being outside the range where the transfer function of the sensor is designed to operate.
- 3.2.2. "Functionality failure" means a malfunction where an output component does not respond to a computer command in the expected way.
- 3.2.3. "Rationality failure" means a malfunction where the signal from an individual sensor or component is at variance with that expected when assessed against signals available from other sensors or components within the control system. Rationality failures include malfunctions that lead to the measured signal (i.e. voltages, currents, frequencies, etc.) being inside the range where the transfer function of the sensor is designed to operate.
- 3.3. "Heavy-duty vehicle" means a power driven vehicle of Category 1-2 or 2, as defined in Special Resolution No.1 (S.R.1), which has a design speed exceeding 25 km/h and a maximum mass exceeding 3,500 kg.
- 3.4. Involved authorities:
- 3.4.1. "Certification authority" means the authority that grants the compliance certification of an OBD system considered by this gtr. Per extension it means also the technical service that has been accredited to evaluate the technical compliance of the OBD system.
- 3.4.2. "Contracting Party" means the party signatory to the UNECE 1998 Agreement.
- 3.5. "Malfunction" means a failure or deterioration of a vehicle or engine system or component, including the OBD system, as defined in the specific modules of this gtr.
- 3.6. "Malfunction indicator (MI)" is an indicator which clearly informs the driver of the vehicle in the event of a malfunction. The MI is part of the alert system.
- 3.7. "On-board diagnostic system (OBD)" means a system on-board a vehicle or engine which has the capability of detecting malfunctions, and, if applicable, of indicating their occurrence by means of a malfunction indicator, of identifying the likely area of the malfunctions by means of information stored in computer memory, and/or communicating that information off-board.
- 3.8. "Qualified deteriorated component or system (QDC)" means a component or system that has been intentionally deteriorated (e.g. accelerated aging) and/or manipulated in a controlled manner and which has been accepted by the authorities according to the provisions set in the applicable specific module as a qualified component for the

purpose of demonstrating compliance of the OBD system with this gtr. 12/

#### 4. GENERAL REQUIREMENTS

##### 4.1. Monitoring requirements

The monitoring requirements are prescribed in the specific modules of this gtr.

##### 4.2. Requirements for malfunction classification

A malfunction may be required to be classified according to its possible effects, in accordance with the requirements of a specific module.

Specific measures may be required depending on the class of this malfunction. Some measures may be part of a specific module (e.g. the MI activation scheme). 13/

Malfunction classification is determined by the manufacturer and the conformity of the classification shall be assessed at the time of certification of the OBD system.

##### 4.3. Alert system

The alert system for specific functions is prescribed in each of the specific modules of this gtr (see table 1. OBD scope and application).

The failure of the malfunction indicator(s) or of a component of the alert system shall not cause the OBD system to stop functioning.

##### 4.3.1. Malfunction indicator (MI)

Where required in a specific module, vehicles shall be equipped with a malfunction indicator(s).

Schemes for activating/deactivating the MI are prescribed in the specific modules.

The malfunction indicator shall be perceptible by the driver and its satisfactory condition shall be easily verifiable from the driver's seat, according to the provisions of the specific modules.

##### 4.4. Diagnostic information

When diagnostic information is required, it shall, at a minimum, fulfil the requirements of the following sub-paragraphs. Specific modules may prescribe additional

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12/ Specific modules may not require the use of such components or systems in their demonstration process.

13/ National or regional authorities may prescribe the requirements for use of the vehicle with respect to the method of malfunction indication for roadworthiness or other purposes. Paragraph 0 of Module C to this regulation is an example of such a prescription.

requirements.

Diagnostic information defined in a specific module shall be made available in response to an off-board request according to paragraph 4.4.1.

#### 4.4.1. Access to diagnostic information

Diagnostic information shall be provided only in accordance with the standards mentioned in Annex 1 of this module.

Annex 1 contains the complete list of standards that are applicable within the gtr.

Access to the module-specific diagnostic information shall not be dependent on any access code or other device obtainable only from the manufacturer or its suppliers. Interpretation of the diagnostic information shall not require any unique decoding information, unless that information is publicly available.

A single OBD access method (e.g. a single access point/node) for communication shall be supported to retrieve all diagnostic information.

This method shall permit access to the full diagnostic information required by each of the specific modules. This method shall also permit access to specific smaller information packages as defined in the specific modules of this gtr (e.g. road worthiness information packages in case of emission related OBD)

##### 4.4.1.1. Wired communication

This paragraph applies to the case a data communication based on a wired connection is required by any of the specific module. A standard data link connector shall then be incorporated in the vehicle.

There shall be only one wired communication data link for OBD off-board communication, defined according to the specification of the standards in Annex 1.

The communication speed on the wired data link of the OBD system shall be either 250 kbps or 500 kbps.

It is the manufacturer's responsibility to select the baud-rate and to design the OBD system according to the requirements specified in the standards mentioned in Annex 1, and referred to in the specific modules. The OBD system shall be tolerant against the automatic detection between these two baud-rates exercised by the external test equipment.

The connection interface between the vehicle and the diagnostic tester shall be standardised and shall meet all of the requirements of ISO 15031-3 Type A (12 VDC power supply), Type B (24 VDC power supply) or SAE J1939-13 (12 or 24 VDC power supply).

The connector shall be located in the driver's side foot-well region of the vehicle interior in the area bound by the driver's side of the vehicle and the driver's side edge of the centre console (or the vehicle centreline if the vehicle does not have a centre console) and at a location no higher than the bottom of the steering wheel when in the lowest adjustable position. The connector may not be located on or in the centre console (i.e., neither on the horizontal faces near the floor-mounted gear selector, parking brake lever, or cup holders nor on the vertical faces near the stereo/radio, climate system, or navigation system controls). The location of the connector shall be capable of being easily identified and accessed (e.g., to connect an off-board tool). For vehicles equipped with a driver's side door, the connector shall be capable of being easily identified and accessed by someone standing (or "crouched") outside the driver's side of the vehicle with the driver's side door open.

Upon request of the manufacturer regional authorities may approve an alternative location.

In all cases, the installation position shall be readily accessible by a person standing outside the vehicle and protected from accidental damage during normal conditions of use.

If the connector is covered or located in a specific equipment box, the cover or the compartment door must be removable by hand without the use of any tools and be clearly labelled "OBD" to identify the location of the connector.

The manufacturer may equip vehicles with additional diagnostic connectors and data-links for manufacturer-specific purposes other than the required OBD functions. If the additional connector conforms to one of the standard diagnostic connectors allowed in Annex 1, only the connector required by this gtr shall be clearly labelled "OBD" to distinguish it from other similar connectors.

#### 4.4.1.2. Additional access to on-board diagnostic information

In addition to providing OBD information through the standard diagnostic connector, the manufacturer may use an on-board diagnostic display, such as a dashboard mounted video display device, for providing access to OBD information.

#### 4.4.1.3. Erasing diagnostic information

The OBD system shall clear recorded diagnostic information in accordance with the provisions of the specific modules, when this request is provided via the external repair test equipment according to the standards of Annex 1 to this module.

#### 4.5. Durability of the OBD system

The OBD system shall be designed and constructed so as to enable it to identify types of malfunctions over the complete life of the vehicle or engine system.

Any additional provisions addressing the durability of OBD systems are contained in the

specific modules.

An OBD system shall not be programmed or otherwise designed to partially or totally deactivate based on age and/or mileage of the vehicle during the actual life of the vehicle, nor shall the system contain any algorithm or strategy designed to reduce the effectiveness of the OBD system over time.

5. PERFORMANCE REQUIREMENTS

Detailed provisions concerning performance requirements of an OBD system are contained in the specific modules.

Temporary disablement strategies of the OBD system are defined in the specific modules and shall apply only to the specific module.

6. DEMONSTRATION REQUIREMENTS

Detailed provisions concerning the demonstration of an OBD system's conformity with the requirements of the applicable modules of this gtr are contained in the specific modules.

7. TEST PROCEDURES

The detailed provisions concerning the applicable test procedure(s) for demonstrating compliance of an OBD system are contained in the specific modules.

8. DOCUMENTATION REQUIREMENTS

If required by the regional authority, and subject to supplementary specific provisions given in the specific modules, the following documentation requirements will, at a minimum, apply:

The manufacturer shall provide a documentation package to the authority that includes a full description of the OBD system.

This package may, depending on the requirements of each specific module, be separated into two parts:

- a primary documentation package, which shall be retained by the authority.
- a secondary documentation package containing the pieces of information that will remain strictly confidential. Retention of this documentation package by the certification authority will be dependent upon the requirements of the regional authorities applying this gtr.

The complete documentation package shall fully describe the functional characteristics of the OBD system as required in detail in the specific modules.

For the certification of an OBD system in respect of a vehicle sub-system, as provided for in one of the modules of this gtr, an additional documentation package shall be provided by the sub-system manufacturer containing the specific instructions and requirements for installation of the sub-system (e.g. engine system) in a vehicle.

9. ANNEXES

Annex 1: Reference standard documents

Annex 1

REFERENCE STANDARD DOCUMENTS

The following International Organization of Standards (ISO) documents are incorporated by reference into this regulation:

- (i) ISO standard xxx dated dd.mm.yy Road vehicles - On board diagnostics (WWH-OBD) implementation – Part 1 - General Information and use case definitions
- (ii) ISO standard xxx dated dd.mm.yy Road vehicles - On board diagnostics (WWH-OBD) implementation - Part 2 - Common emissions-related data dictionary
- (iii) ISO standard xxx dated dd.mm.yy Road vehicles - On board diagnostics (WWH-OBD) implementation - Part 3 - Common message dictionary
- (iv) ISO standard xxx dated dd.mm.yy Road vehicles - On board diagnostics (WWH-OBD) implementation - Part 4 - Wired connection
- (v) ISO standard xxx dated dd.mm.yy Road vehicles - On board diagnostics (WWH-OBD) implementation - Part 6 - Conformance test
- (vi) ISO standard 15031-3 dated dd.mm.yy

The following Society of Automotive Engineers (SAE) (ISO) documents are incorporated by reference into this Regulation:

- (vii) SAE J2403 "Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature," October 1998 (SAE J2403).
- (viii) SAE J1939-13 dated dd.mm.yy

## MODULE C

### EMISSION-RELATED OBD FOR HEAVY-DUTY DIESEL ENGINE SYSTEMS

#### 1. PURPOSE

This module complements the generic provisions specified in Module B by prescribing additional specific requirements for OBD systems to detect record and communicate emission-related malfunctions from an on-road heavy-duty diesel fuelled engine system that would affect the environmental performance of those systems.

This module specifies the elements concerning the OBD system to facilitate the diagnosis and maintenance of the emission-related engine system and the possible enforcement of road-worthiness measures.

#### 2. SCOPE

This module applies to heavy-duty diesel fuelled compression ignition engine systems and heavy-duty vehicles powered by diesel fuelled compression ignition engine systems that are certified to regulated emission limits requiring the measurement of their exhaust emissions on an engine test-bed.

For the purpose of this module, heavy-duty engine system means an engine system that is fitted into a heavy-duty vehicle.

The provisions of this module are limited to the responsibilities of the engine manufacturer.

With respect to the installation of an engine system that is certified to this module, the responsibilities of the engine manufacturer are limited to the provision of a comprehensive information package for installing the engine system in to a vehicle.

#### 3. DEFINITIONS

##### 3.1. Definitions of Module B further qualified

The generic definitions in paragraph 3. of Module B of this gtr shall apply for the purpose of this module. Nevertheless further qualification is given below to be consistent with the scope of the present specific module.

3.1.1. "Component monitoring" in the context of this module refers to components that are electrically connected to the controller(s) of the engine system.

3.1.2. "Malfunction" in the context of this module refers to a failure or deterioration of an engine system, including the OBD system, that may lead either to an increase in any of the regulated pollutants emitted by the engine system or to a reduction in the effectiveness of the OBD system.

3.1.3. "OBD" in the context of this module refers to an on-board diagnostic system dedicated

to malfunctions affecting the emission performance of the engine system.

3.2. Specific definitions

- 3.2.1. "Calibration verification number" means the number that is used by verification algorithms to validate that the calibration / software used by the engine system is the one that is supposed to be installed.
- 3.2.2. "Deficiency" means an OBD monitoring strategy or other OBD feature that does not meet all the detailed requirements of this gtr.
- 3.2.3. "Diagnostic trouble code (DTC)" means a numeric or alphanumeric identifier which identifies or labels a malfunction.
- 3.2.3.1. "Confirmed and active DTC" means a DTC that is stored when the OBD system has concluded that a malfunction exists.
- 3.2.3.2. "Pending DTC" means a DTC that is stored by the OBD system because a monitor has detected a situation where a malfunction may be present during the current or last completed operating sequence.
- 3.2.3.3. "Potential DTC" means a DTC that is stored by the OBD system because a monitor has detected a situation where a malfunction may be present but requires further evaluation to be confirmed. A potential DTC is a pending DTC which is not a confirmed and active DTC.
- 3.2.3.4. "Previously active DTC" means a formerly confirmed and active DTC that remains stored after the OBD system has concluded that the malfunction that caused the DTC is no longer present.
- 3.2.4. "Emission OBD family" means a manufacturer's grouping of engine systems having common methods of monitoring / diagnosing emission-related malfunctions.
- 3.2.5. "Engine system" means the system being certified. It includes:
- (a) the engine's electronic management controller(s)
  - (b) the exhaust after-treatment system(s)
  - (c) any emission-related component of the engine or the exhaust system which supplies input to, or receives output from, the engine's electronic management controller(s); and
  - (d) the communication interface (hardware and messages) between the engine's electronic management controller(s) and any other powertrain or vehicle control unit if the exchanged information has an influence on the control of emissions.
- 3.2.6. "Malfunction emission control strategy (MECS)" means a strategy within the engine system that is activated as a result of an emission-related malfunction and that does not rely on any input from the malfunctioning component or system for emission control

purposes. 14/

- 3.2.7. Malfunction indicator (definitions associated with):
- 3.2.7.1. "Continuous-MI" means the malfunction indicator showing a steady indication at all times while the key is in the on (run) position with the engine running (ignition on – engine on).
- 3.2.7.2. "MI status" means the command status of the MI, being either continuous-MI, Short-MI, on-demand-MI, or off.
- 3.2.7.3. "On-demand-MI" means the malfunction indicator showing a steady indication in response to a manual demand from the driving position when the key is in the on (run) position with the engine off (ignition on – engine off).
- 3.2.7.4. "Short-MI" means the malfunction indicator showing a steady indication from the time the key is moved to on (run) position and the engine is started (ignition on – engine on) and extinguishing after 15 seconds or the key is moved to off, whichever occurs first.
- 3.2.8. Monitoring (definitions associated with)
- 3.2.8.1. "Emission threshold monitoring" consists of:
- (a) Direct emissions measurement via a tailpipe emissions sensor(s) and a model to correlate the direct emissions to test-cycle specific emissions; and/or
  - (b) Indication of an emissions increase via correlation of computer input/output information to test-cycle specific emissions.
- 3.2.8.2. "Performance monitoring" consists of functionality checks and monitoring parameters that are not correlated to emission thresholds. Such monitoring is typically done on components or systems to verify that they are operating within the proper range (e.g. differential pressure in case of a DPF).
- 3.2.8.3. "Total functional failure monitoring" means monitoring a malfunction which is leading to a complete loss of the desired function of a system.
- 3.2.9. "OBD-parent engine system" means an engine system that has been selected from an emission-OBD family for which most of its OBD elements of design are representative of that family.
- 3.2.10. "OBD test-cycle" means the cycle over which an engine system is operated on an engine test-bed to evaluate the response of an OBD system to the presence of a qualified deteriorated component.
- 3.2.11. "Operating sequence" means a sequence consisting of an engine start-up, an operating period, an engine shut-off, and the time until the next start-up, where a specific OBD

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14/ The conditions associated with such strategies need to be defined by the GRPE Working Group on Off-Cycle Emissions (OCE).

monitor runs to completion and a malfunction would be detected if present.

- 3.2.12. "Readiness" means a status indicating whether a monitor or a group of monitors have run since the last erasing by request of an external OBD scan-tool.
- 3.2.13. "Scan-tool" means an external test equipment used for standardised off-board communication with the OBD system in accordance with the requirements of this gtr.
- 3.2.14. "Software calibration identification" means a series of alphanumeric characters that identifies the emission-related calibration / software version(s) installed in the engine system.
- 3.2.15. "Warm-up cycle" means sufficient engine operation such that the coolant temperature has risen by at least 22 K (22 °C / 40 °F) from engine starting and reaches a minimum temperature of 333 K (60 °C / 140 °F).
- 3.3. Definition to be adopted from other gtrs

The present gtr does not redefine and adopts the following terms that are already defined in other emission-related gtrs or international standards. This list includes the definition of the following terms:

- after treatment system
- diesel particulate filter
- DeNOx system
- AECS
- engine control system

3.4. Abbreviations

CV Crankcase Ventilation  
DOC Diesel Oxidation Catalyst  
DPF Diesel Particulate Filter or Particulate Trap including catalyzed DPFs and Continuously Regenerating Traps (CRT)  
DTC Diagnostic trouble code  
EGR Exhaust Gas Recirculation  
HC Hydrocarbon  
LNT Lean NOx Trap (or NOx adsorber)  
MECS Malfunction Emission Control Strategy  
NOx Oxides of Nitrogen  
OTL OBD Threshold Limit  
PM Particulate Matter  
SCR Selective Catalytic Reduction  
TFF Total Functional Failure monitoring  
VGT Variable Geometry Turbocharger  
VVT Variable Valve Timing

4. GENERAL REQUIREMENTS

In the context of this specific module, the OBD system shall have the capability of detecting malfunctions, of indicating their occurrence by means of a malfunction indicator, of identifying the likely area of the malfunctions by means of information stored in computer memory, and communicating that information off-board.

4.1. Requirements for certification

4.1.1. Engine entities subject to certification

4.1.1.1. Certification of an individual OBD system

The manufacturer of an engine system may apply for the certification of its OBD system by demonstrating that OBD system complies with all the provisions of modules B and C of the present gtr.

4.1.1.2. Certification of an emission-OBD family

The manufacturer may apply for the certification of an emission-OBD family by demonstrating that the OBD-parent engine system of the family complies with all the provisions of modules B and C of the present gtr.

4.1.1.3. Certification of an OBD system as member of a certified emission-OBD family

The manufacturer of an engine system may apply for the certification of its OBD system by demonstrating that OBD system meets the criteria for belonging to an emission-OBD family that has already been certified.

4.1.2. Requirements to extend / modify an existing certificate

4.1.2.1. Extension to include a new engine system into an emission-OBD family

At the request of the manufacturer and upon approval of the certification authority, a new engine system may be included as a member of a certified emission-OBD family if all of the engine systems within the emission-OBD family would still have common methods of monitoring / diagnosing emission-related malfunctions.

If all OBD elements of design of the OBD-parent engine system are representative of the new engine system, then the OBD-parent engine system shall remain unchanged and the manufacturer shall modify the documentation package according to paragraph 8 of this module.

If the new engine system contains elements of design that are not represented by the OBD-parent engine system but itself would represent the whole family, then the new engine system shall become the new OBD-parent engine system. In this case the new OBD elements of design shall be demonstrated to comply with the provisions of Modules B and C of this gtr, and the documentation package shall be modified according to paragraph 8. of this module.

4.1.2.2. Extension to address a design change that affects the OBD system

At the request of the manufacturer and upon approval of the certification authority, an extension of an existing certificate may be granted in the case of a design change of the OBD system.

The manufacturer shall demonstrate that the design changes comply with the provisions of Modules B and C of this gtr, and the documentation package shall be modified according to paragraph 8. of this module.

If the existing certificate applies to an emission-OBD family, the manufacturer shall justify to the certification authority that the methods of monitoring/diagnosing emission-related malfunctions are still common within the family and that the OBD-parent engine system remains representative of the family.

4.1.2.3. Certificate modification to address a malfunction reclassification

Following a request by the authority that granted the certification, or at its own initiative, the manufacturer shall apply for a modification of an existing certificate in order to reclassify one or several malfunctions.

In that case the compliance of the new classification shall be demonstrated according to the provisions of modules B and C of this gtr and the documentation package shall be modified according to paragraph 8 of this module.

4.2. Monitoring requirements

All emission-related components and systems included in an engine system shall be monitored by the OBD system in accordance with the requirements of this paragraph.

The OBD system shall also monitor its own components.

4.2.1. Selection of the monitoring technique

There shall be four available types of monitoring techniques, depending on the type of technology and/or the type of malfunction. The available monitoring technique shall be: emission threshold monitoring, performance monitoring, component monitoring, or total functional failure monitoring.

Annex 3 identifies the major existing systems on heavy-duty diesel engines based on the state of art at the time of publication of this gtr.

Each identified system shall be subject to monitoring to detect emission-related malfunctions. This does not preclude other systems from being monitored.

The appendices of Annex 3 list the sub-systems or components required to be monitored by the OBD system and describes the types of monitoring generally expected for each of these components or systems. The appendices also identify enhanced monitoring

requirements that may be introduced, some or all, into a regional regulation, where determined to be technically feasible by a Contracting Party at the time of introduction of that regulation.

The manufacturer shall determine, subject to the certification authority's approval, the most appropriate type of monitoring (i.e. emission threshold monitoring, performance monitoring, total functional failure monitoring, or component monitoring) to apply to the specific system or component.

The chosen type of monitoring shall be shown by the manufacturer, to be robust, timely and efficient (i.e. through either technical considerations, test results, previous agreements, etc.).

#### 4.2.1.1. Correlation to actual emissions

In the case of emission threshold monitoring, a correlation to test-cycle specific emissions shall be required. This correlation would typically be demonstrated on a test engine in a laboratory setting.

In all other monitoring cases, no correlation to actual emissions is necessary (although test data may be requested by the certification authority to verify the classification of the malfunction effects as described in this module).

Examples:

An electrical malfunction may not require a correlation because this is a yes/no failure. A DPF malfunction monitored via delta pressure may not require a correlation because it anticipates a malfunction.

If the manufacturer demonstrates, according to the demonstration requirements of this module, that emissions would not exceed the OBD threshold limits upon total failure or removal of a component or system, a performance monitoring of this component or system shall be accepted.

When a tailpipe emission sensor is used for monitoring the emissions of a specific pollutant all other monitors may be exempted from further correlation to the actual emissions of that pollutant.

Nevertheless, such exemption shall not preclude the need to include these monitors, using other monitoring techniques, as part of the OBD system as the monitors are still needed for the purpose of malfunction isolation.

A malfunction shall always be classified according to paragraph 4.5. based on its impact on emissions, regardless of the type of monitoring used to detect the malfunction.

#### 4.2.2. Component monitoring (input/output components/systems)

In the case of input components that belong to the engine system, the OBD system shall at a minimum detect electrical circuit failures and, where feasible, rationality failures.

The rationality failure diagnostics shall then verify that a sensor output is neither inappropriately high nor inappropriately low (i.e. there shall be "two-sided" diagnostics).

To the extent feasible, and with the agreement of the certification authority, the OBD system shall detect separately, rationality failures (e.g. inappropriately high and inappropriately low), and electrical circuit failures (e.g. out-of-range high and out-of-range low). Additionally, unique DTCs for each distinct malfunction (e.g. out-of-range low, out-of-range high and rationality failure) shall be stored.

In the case of output components that belong to the engine system, the OBD system shall at a minimum detect electrical circuit failures, and, where feasible, if the proper functional response to computer commands does not occur.

To the extent feasible, and with the agreement of the certification authority, the OBD system shall detect separately functionality failures, electrical circuit failures (e.g. out-of-range high and out-of-range low) and store unique DTCs for each distinct malfunction (e.g. out-of-range low, out-of-range high, functionality failure).

The OBD system shall also perform rationality monitoring on the information coming from or provided to components that do not belong to the engine system when this information compromises the emission control system and/or the engine system for proper performance.

#### 4.2.2.1. Exception to component monitoring

Monitoring of electrical circuit failures, and to the extent feasible, functionality, and rationality failures of the engine system shall not be required if all the following conditions are met:

- the failure results in an emission increase of any pollutant of less than 50 per cent of the regulated emission limit, and
- the failure does not cause any emission to exceed the regulated emission limit 15/, and
- the failure does not affect a component or system enabling the proper performance of the OBD system.

Determination of the emissions impact shall be performed on a stabilized engine system in an engine dynamometer test cell, according to the demonstration procedures of this module.

#### 4.2.3. Monitoring frequency

Monitors shall run continuously, at any time where the monitoring conditions are fulfilled, or once per operating sequence (e.g. for monitors that lead to an increase of

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15/ The measured value shall be considered taking into account the relevant precision tolerance of the test-cell system and the increased variability in the test results due to the malfunction.

emission when it runs).

When a monitor does not run continuously, the manufacturer shall clearly inform the certification authority and describe the conditions under which the monitor runs.

The monitors shall run during the applicable OBD test-cycle as specified in paragraph 7.2.2.

A monitor shall be regarded as running continuously, if it runs at a rate not less than once per second. If a computer input or output component is sampled less frequently than one sample per second for engine control purpose, a monitor shall also be regarded as running continuously, if the signal of the component is evaluated each time sampling occurs.

For components or systems monitored continuously, it is not required to activate an output component/system for the sole purpose of monitoring that output component/system.

#### 4.3. Requirements for recording OBD information

When a malfunction has been detected but is not yet confirmed, the possible malfunction shall be considered as a "Potential DTC" and accordingly a "Pending DTC" status shall be recorded. A "Potential DTC" shall not lead to an activation of the alert system according to paragraph 4.6.

Within the first operating sequence, a malfunction may be directly considered "confirmed and active" without having been considered a "potential DTC". It shall be given the "Pending DTC" and a "confirmed and active DTC" status.

The monitoring system shall conclude whether a malfunction is present before the end of the next operating sequence following its first detection. At this time, a "confirmed and active" DTC shall be stored and the alert system be activated according to paragraph 4.6.

In some specific cases monitors may need more than two operating sequences to accurately detect and confirm a malfunction (e.g., monitors using statistical models or with respect to fluid consumption on the vehicle). The certification authority may permit the use of more than two operating sequences for monitoring provided the manufacturer justifies the need for the longer period (e.g., by technical rationale, experimental results, in house experience, etc).

When a confirmed malfunction is no longer detected by the system, and until this malfunction is erased from the computer memory according to paragraph 4.4., the malfunction shall be given the "previously active" status and shall not lead to an activation of the alert system (see paragraph 4.6.).

#### 4.4. Requirements for erasing OBD information

When a DTC is in the previously active status for at least 40 warm-up cycles or 200 engine operating hours, whichever occurs first, this DTC and when applicable its associated freeze frame may be erased from the computer memory.

#### 4.5. Requirements for malfunction classification

Malfunction classification specifies the class to which a malfunction is assigned when such a malfunction is detected, according to the requirements of paragraph 4.2. of this module.

A malfunction shall be assigned to one class for the actual life of the vehicle unless the authority that granted the certificate or the manufacturer determines that reclassification of that malfunction is necessary.

If a malfunction would result in a different classification for different regulated pollutant emissions or for its impact on other monitoring capability, the malfunction shall be assigned to the class that takes precedence in the discriminatory display strategy.

If an MECS is activated as a result of the detection of a malfunction, this malfunction shall be classified based on either the emission impact of the activated MECS or its impact on other monitoring capability. The malfunction shall then assigned to the class that takes precedence in the discriminatory display strategy.

##### 4.5.1. Class A malfunction

A malfunction shall be identified as Class A when the relevant OBD threshold limits (OTLs) are assumed to be exceeded.

It is accepted that the emissions may not be above the OTLs when this class of malfunction occurs.

##### 4.5.2. Class B1 malfunction

A malfunction shall be identified as Class B1 where circumstances exist that have the potential to lead to emissions being above the OTLs but for which the exact influence on emission cannot be estimated and thus the actual emissions according to circumstances may be above or below the OTLs.

Examples of Class B1 malfunctions may include malfunctions detected by monitors that infer emission levels based on readings of sensors or restricted monitoring capability.

Class B1 malfunctions shall include malfunctions that restrict the ability of the OBD system to carry out monitoring of Class A or B1 malfunctions.

##### 4.5.3. Class B2 malfunction

A malfunction shall be identified as Class B2 when circumstances exist that are assumed to influence emissions but not to a level that exceeds the OTL.

Malfunctions that restrict the ability of the OBD system to carry out monitoring of Class B2 malfunctions shall be classified into Class B1 or B2.

4.5.4. Class C malfunction

A malfunction shall be identified as Class C when circumstances exist that, if monitored, are assumed to influence emissions but to a level that would not exceed the regulated emission limits.

Malfunctions that restrict the ability of the OBD system to carry out monitoring of Class C malfunctions shall be classified into Class B1 or B2.

4.6. Alert system

4.6.1. MI specification

The malfunction indicator shall be a visual signal that is perceptible under all lighting conditions. The malfunction indicator shall comprise a yellow warning signal identified by the (F01/F22) symbol in accordance with ISO Standard 2575:2004.

Failure or deterioration of components of the engine system that do not lead directly to an increase in emissions as indicated under paragraph 4.2. of this module may be indicated by a separate warning signal or message. (e.g., a plugged particulate filter may be indicated a specific symbol, such as F01 or F21, in accordance with ISO Standard 2575:2004).

4.6.2. MI illumination schemes

Depending on the malfunction(s) detected by the OBD system, the MI shall be illuminated according to one of the activation modes described in the following table

	Activation mode 1	Activation mode 2	Activation mode 3
Conditions of activation	Class A malfunction or B1 counter > 200 h	Class B malfunction and B1 counters < 200 h	Class C malfunction
Key on engine on	Discriminatory display or non-discriminatory display strategy	Discriminatory display or non-discriminatory display strategy	Discriminatory display or non-discriminatory display strategy
Key on engine off	Harmonized display strategy	Harmonized display strategy	Harmonized display strategy

A Contracting Party implementing this gtr may require a discriminatory or a non-discriminatory display strategy. These strategies are defined in paragraphs 4.6.3.1. and 4.6.3.2.

The discriminatory display strategy requires the MI to be activated according to the

class in which a malfunction has been classified. The non-discriminatory display strategy requires only a single type of MI activation.

The alert system shall provide both strategies and the MI's default display strategy shall be the discriminatory display strategy. This default strategy shall be locked by software coding that shall not be routinely available via the scan tool.

In order to gain access to the market of a Contracting Party implementing this gtr, the manufacturer may be required to enable the non-discriminatory display strategy. In this instance, the market selection of the discriminatory or the non-discriminatory display strategy shall be possible from the scan tool.

At key on, engine off, a single MI activation strategy is required. This strategy is described in paragraph 4.6.4.

Figures C4 and C5 illustrate the prescribed activation strategies at key on, engine on or off.

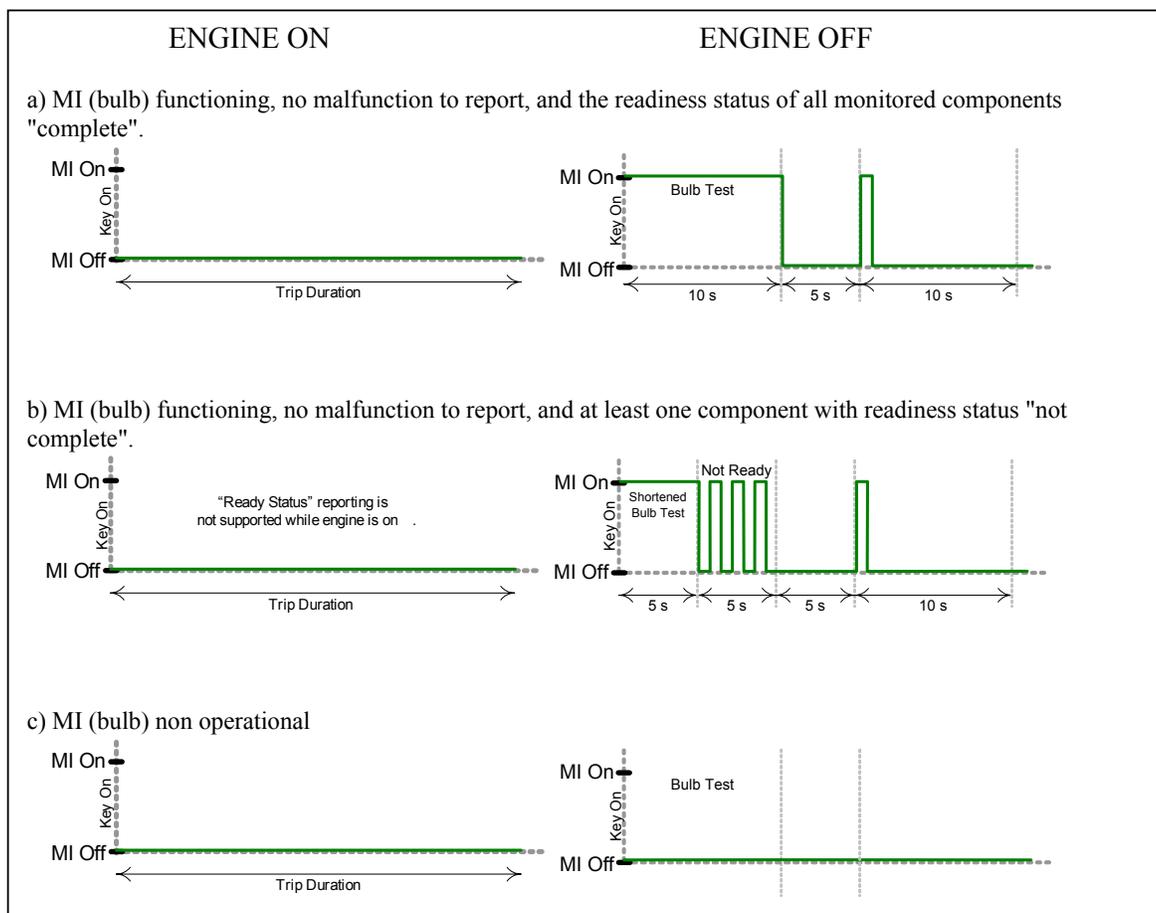


Figure C4

Bulb test and readiness indication

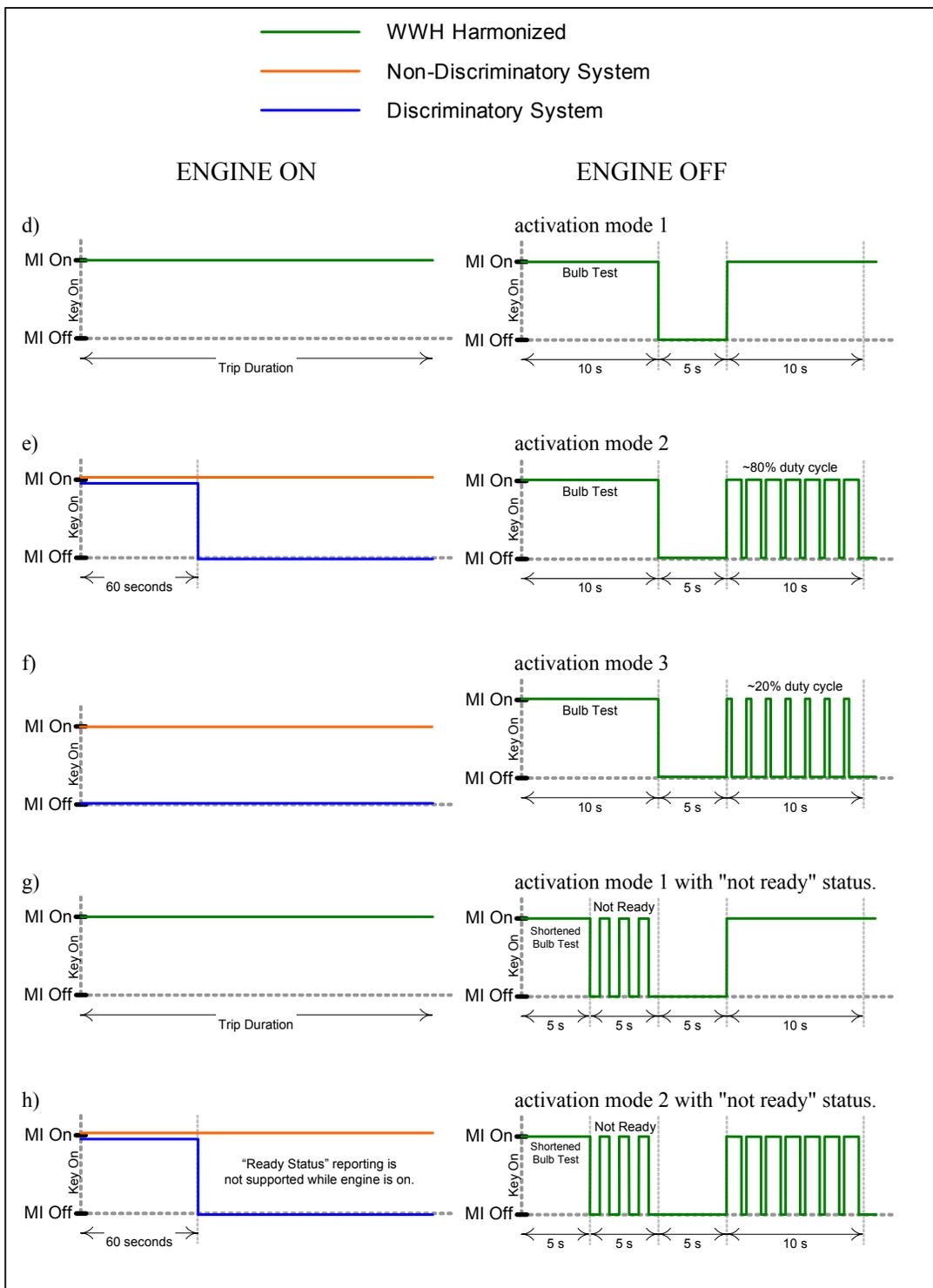


Figure C5:  
Malfunction display strategy

4.6.3. MI activation at "engine on"

When the key is placed in the on position and the engine is started (engine on), the MI shall be commanded off unless the provisions of paragraph 4.6.3.1. and/or paragraph 4.6.3.2. have been met.

4.6.3.1. Discriminatory Display strategy

For the purpose of activating the MI, continuous-MI shall take precedence to short-MI and on-demand-MI. For the purpose of activating the MI, short-MI shall take precedence to on-demand-MI.

4.6.3.1.1. Class A Malfunctions

The OBD system shall command a continuous-MI upon storage of a confirmed DTC associated with a Class A malfunction.

4.6.3.1.2. Class B Malfunctions

The OBD system shall command a "short-MI" at the next key-on event following storage of a confirmed and active DTC associated with a Class B malfunction.

Whenever a B1 counter reaches 200 hours, the OBD system shall command a continuous-MI.

4.6.3.1.3. Class C malfunctions

The manufacturer may make available information on Class C malfunctions through the use of an on-demand-MI which shall be available until the engine is started.

4.6.3.1.4. MI de-activation scheme

The "continuous-MI" shall switch to a "short-MI" if a single monitoring event occurs and the malfunction that originally activated the continuous-MI is not detected during the current operating sequence and a continuous-MI is not activated due to another malfunction.

The "short-MI" shall be deactivated if the malfunction is not detected during 3 subsequent sequential operating sequences and the MI is not activated due to another Class A or B malfunction.

4.6.3.2. Non-discriminatory display strategy

The OBD system shall command a continuous-MI upon storage of a confirmed and active DTC associated with a Class A, B or C malfunction.

4.6.3.2.1. MI de-activation scheme

The "continuous-MI" shall be deactivated if the malfunction is not detected during 3 subsequent sequential operating sequences and the MI is not activated due to any other malfunction.

4.6.4. MI activation at key-on/engine-off

The MI activation at key-on/engine-off shall consist of two sequences separated by a 5 seconds MI off:

- the first sequence is designed to provide an indication of the MI functionality and the readiness status of the monitored components;
- the second sequence is designed to provide an indication of the presence of a malfunction.

4.6.4.1. MI functionality/readiness status

The MI shall show a steady indication for 5 seconds to indicate that the MI is functional.

The MI shall then remain at the on position for 5 seconds to indicate that the readiness status for all monitored components is complete.

The MI shall blink once per second for 5 seconds to indicate that the MI is functional and that the readiness status for one or more of the monitored components is not complete.

After these initial 10 seconds, the MI shall remain off for 5 seconds.

4.6.4.2. Presence of a malfunction

Following the 5 second period:

- the MI shall indicate the presence of a malfunction according to one of the following modes. Activation mode 1 shall take precedence over activation modes 2 and 3, and activation mode 2 shall take precedence over activation mode 3; or
- the MI shall blink once for a period of 1 second, and remain off in absence of a malfunction.

4.6.4.2.1. Activation mode 1

The MI shall show a steady indication for 10 seconds if the OBD system would command a continuous-MI according to the discriminatory display strategy described in paragraph 4.6.3.1.

4.6.4.2.2. Activation mode 2

The MI shall show a periodically steady indication for 10 seconds if the OBD system would command a 60-second MI according to the discriminatory display strategy described in paragraph 4.6.3.1. The total illumination time shall be 8 seconds, and the

frequency of the flashes shall be 1 Hz.

#### 4.6.4.2.3. Activation mode 3

The MI shall show a periodically steady indication for 10 seconds if the OBD system would command an on-demand-MI according to the discriminatory display strategy described in paragraph 4.6.3.1. The total illumination time shall be 2 seconds, and the frequency of the flashes shall be 1 Hz.

#### 4.6.5. Limp-home strategies

The OBD system shall activate the MI according to the specifications of paragraph 0 and store a confirmed and active DTC to inform the vehicle operator whenever the engine enters a default or "limp home" mode of operation that can affect emissions or the performance of the OBD system or in the event of a malfunction of the on-board computer(s) itself that can affect the performance of the OBD system.

If the default or "limp home" mode of operation is recoverable (i.e., operation automatically returns to normal at the beginning of the following ignition cycle), the OBD system may wait and activate the MI according to the specifications of paragraph 0 and store the confirmed and active DTC only if the default or "limp home" mode of operation is again entered before the end of the next ignition cycle in lieu of illuminating the MI within 10 seconds on the first driving cycle where the default or "limp home" mode of operation is entered.

#### 4.6.6. Counters associated with malfunctions

##### 4.6.6.1. MI Counters

##### 4.6.6.1.1. Continuous-MI Counter

The OBD system shall contain a Continuous-MI Counter to record the number of hours during which the engine has been operated while a Continuous-MI is activated.

The Continuous-MI counter shall count up to the maximum value provided in a 2 byte counter with 1 hour resolution and hold that value unless the conditions allowing the counter to be reset to zero are met.

The Continuous-MI counter shall operate as follows:

- if starting from zero, the continuous-MI counter shall begin counting as soon as a continuous-MI is activated
- the continuous-MI counter shall halt and hold its present value when the continuous-MI is no longer activated.
- the continuous-MI counter shall continue counting from the point at which it had been held if a malfunction that results in a continuous-MI is detected within 3 operating sequences.
- the continuous-MI counter shall start again counting from zero when a malfunction that results in a continuous-MI is detected after 3 operating sequences since the

- counter was last held.
- the continuous-MI counter shall be reset to zero when:
  - no malfunction that results in a continuous-MI is detected during 40 warm-up cycles or 100 engine operating hours since the counter was last held whichever occurs first; or
  - the OBD scan tool commands the OBD System to clear diagnostic information.

Figure C1 illustrates the principle of the continuous-MI counter and Annex 2 contains examples that illustrate the logic.

Figure C1: illustration of the MI counters activation principles

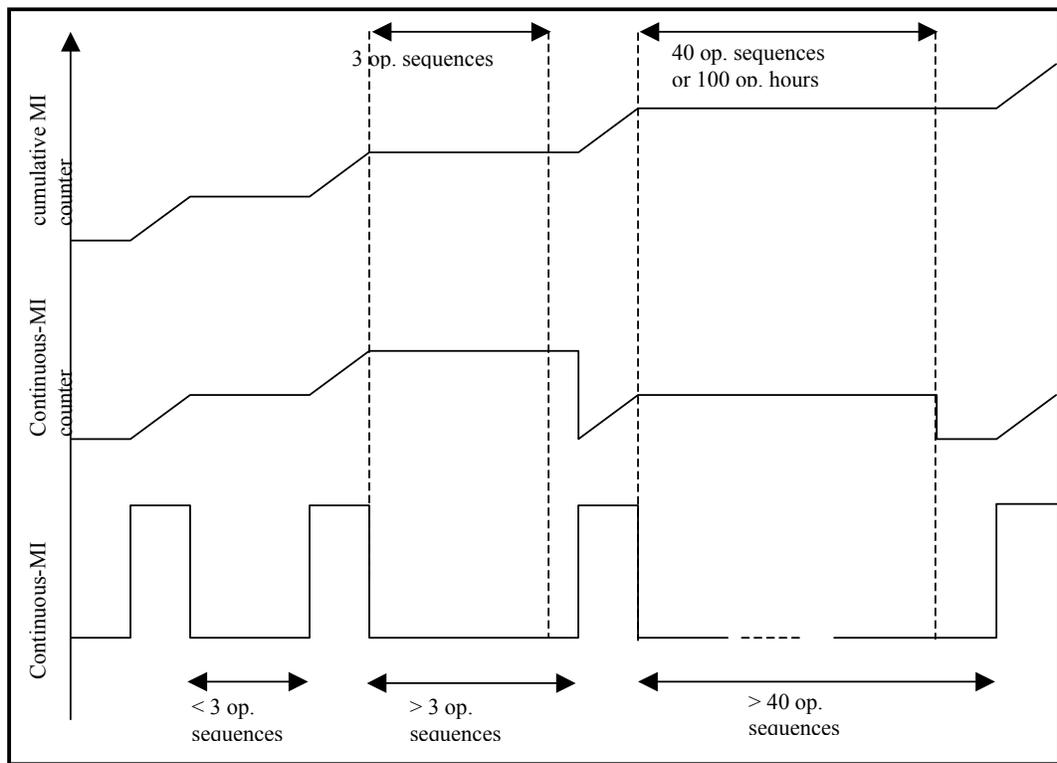
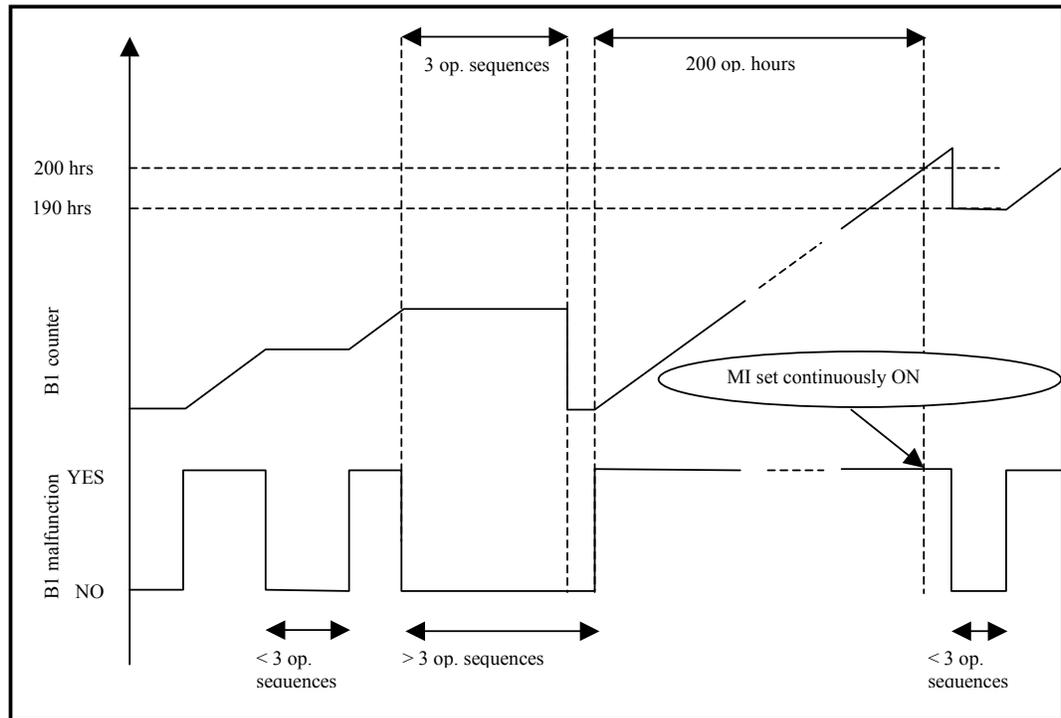


Figure C2: Illustration of the B1 counter activation principles



#### 4.6.6.1.2. Cumulative continuous-MI counter

The OBD system shall contain a cumulative continuous-MI counter to record the cumulative number of hours during which the engine has been operated over its life while a continuous-MI is activated.

The cumulative continuous-MI counter shall count up to the maximum value provided in a 2-byte counter with 1 hour resolution and hold that value.

The cumulative continuous-MI counter shall not be reset to zero by the engine system, a scan tool or a disconnection of a battery.

The cumulative continuous-MI counter shall operate as follows:

- the cumulative continuous-MI counter shall begin counting when the continuous-MI is activated.
- the cumulative continuous-MI counter shall halt and hold its present value when the continuous-MI is no longer activated.
- the cumulative continuous-MI counter shall continue counting from the point it had been held when a continuous-MI is activated.

Figure C1 illustrates the principle of the cumulative continuous-MI counter and Annex 2 contains examples that illustrate the logic.

#### 4.6.6.2. Counters associated with Class B1 malfunctions

##### 4.6.6.2.1. Single B1-counter

The OBD system shall contain a B1 counter to record the number of hours during which the engine has operated while a Class B1 malfunction is present.

The B1 counter shall operate as follows:

- the B1 counter shall begin counting when a Class B1 malfunction is detected.
- the B1 counter shall halt and hold its present value if no Class B1 malfunction is present.
- the B1 counter shall continue counting from the point it had been held if a subsequent Class B1 malfunction is detected within 3 operating sequences.

In the case where the B1 counter has exceeded 200 engine running hours, the OBD system shall set the counter to 190 or 199 engine running hours when the OBD system has determined that a Class B1 malfunction is no longer present. The B1 counter shall begin counting from 190 or 199 engine running hours if a subsequent Class B1 malfunction is present within 3 operating sequences.

The B1 counter shall be reset to zero when three consecutive operating sequences have occurred during which no Class B1 malfunctions have been detected.

Note: The B1 counter does not indicate the number of engine running hours with a single Class B1 malfunction present.

The number of hours counted by the B1 counter may cumulate the number of hours of 2 or more different Class B1 malfunctions, none of them having reached the time the counter indicates.

The B1 counter is only intended to determine when the continuous-MI shall be activated.

Figure C2 illustrates the principle of the B1 counter and Annex 2 contains examples that illustrate the logic.

#### 4.6.6.2.2. Multiple B1-counters

A manufacturer may use more than one B1 counter.

When a Class B1 malfunction occurs:

- if a B1 counter is at zero, this counter shall begin counting;
- if no B1 counter is at zero, the B1 counters with the lowest value shall be linked to this malfunction. This counter shall accumulate the time during which the engine operates with any of the Class B1 malfunctions it is linked with.

(Complete operating principle of each of the B1 counters to be developed.)

### 4.7. Diagnostic information

#### 4.7.1. Recorded information

The information recorded by the OBD system shall be available upon off-board request in the following packages manner:

- information about the engine state;
- information about emission-related malfunctions;
- information for diagnosis and repair.

##### 4.7.1.1. Information about the engine state

This information will provide an enforcement agency 16/ with the malfunction indicator status and associated data (e.g. continuous-MI counter, readiness status).

The OBD system shall provide all information (according to the ISO xxx Part 2) for the external roadside check test equipment to assimilate the data and provide an enforcement agent with the following information:

- the gtr (and revision) number
- discriminatory/non-discriminatory display strategy

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16/ A typical use of this information package may be to establish basic emission road-worthiness of the engine system.

- the VIN (vehicle identification number)
- presence of a continuous-MI.
- the readiness status of the OBD system
- the number of engine operating hours during which a continuous-MI was last activated (continuous-MI counter)

This information shall be read only access (i.e. no clearing).

#### 4.7.1.2. Information about active emission-related malfunctions

This information will provide any inspection station 17/ with a subset of engine related OBD data including the malfunction indicator status and associated data (MI counters), a list of active/confirmed malfunctions of classes A and B and associated data (e.g. B1-counter).

The OBD system shall provide all information (according to the ISO xxx Part 2) for the external inspection test equipment to assimilate the data and provide an inspector with the following information:

- the gtr (and revision) number
- discriminatory/ non-discriminatory display strategy
- the VIN (vehicle identification number)
- the Malfunction Indicator status
- the Readiness status of the OBD system
- the number of engine operating hours during which a continuous-MI was last activated (continuous-MI counter)
- the cumulated operating hours with a continuous-MI (cumulative continuous-MI counter).
- the confirmed and active DTCs for Class A malfunctions
- the confirmed and active DTCs for Classes B (B1 and B2) malfunctions
- the confirmed and active DTCs Class B1 malfunctions

This information shall be read only access (i.e. no clearing).

#### 4.7.1.3. Information for repair

This information will provide repair technicians with a all OBD data specified in this module (e.g. freeze frame information).

The OBD system shall provide all information (according to the ISO xxx Part 2) for the external repair test equipment to assimilate the data and provide a repair technician with the following information:

- the gtr (and revision) number
- the VIN (vehicle identification number)
- the malfunction indicator status
- the readiness status of the OBD system

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17/ A typical use of this information package may be to establish detailed understanding of the emission road-worthiness of the engine system.

- the number of engine operating hours since the malfunction indicator has been activated (MI counter)
- the confirmed and active DTCs for Class A malfunctions
- the confirmed and active DTCs for Classes B (B1 and B2) malfunctions
- the confirmed and active DTCs for Class B1 malfunctions and the number of engine operating hours from the B1-counters
- the confirmed and active DTCs for Class C malfunctions
- the pending DTCs and their associated class
- the previously active DTCs and their associated class
- real-time information on OEM selected and supported sensor signals, internal parameters and output signals (see Annex 5)
- the freeze frame data requested by this module
- the software calibration identification(s)
- the calibration verification number(s).

The OBD system shall clear all the recorded malfunctions of the engine system and related data (operating time information, freeze frame, etc...) in accordance with the provisions of this module, when this request is provided via the external repair test equipment according to the ISO xxx Part 2.

#### 4.7.1.4. Freeze frame information

(Text to be developed.)

#### 4.7.2. Access to OBD information

Access to OBD information shall be provided in accordance to the specifications of ISO standard XXX/xxx parts 1 to 6.

In the case of emission-related OBD of heavy-duty diesel engines, access to OBD information shall always be possible by the means indicated in ISO standard xxx Part 4 – wired connection.

OBD data shall be provided by the OBD system upon request using an off-board test equipment that complies with the requirements of ISO standard – part 6 – compliance test (communication with external tester).

In case of emission-related OBD of heavy-duty diesel engines, access to OBD information shall always be possible by means of a wired communication system.

#### 4.8. Durability of the OBD system

The OBD system shall be designed and constructed so as to enable it to identify types of malfunctions over the complete life of the vehicle/engine. In achieving this objective, the certification authority will recognise that engines which have been used in excess of their regulatory useful life may show some deterioration in OBD system performance and sensitivity such that the OBD thresholds may be exceeded before the OBD system signals a malfunction to the driver of the vehicle.

This paragraph does not extend the engine manufacturer's compliance liability for an engine beyond its regulated useful life (i.e. the time or distance period during which emission standards or emission limits continue to apply).

#### 4.9. Electronic security

Any vehicle with an emission control unit must include features to deter modification, except as authorized by the manufacturer. The manufacturer shall authorize modifications if these modifications are necessary for the diagnosis, servicing, inspection, retrofitting or repair of the vehicle.

Any reprogrammable computer codes or operating parameters shall be resistant to tampering and afford a level of protection at least as good as the provisions in ISO 15031-7 (SAE J2186) or J1939-73 provided that the security exchange is conducted using the protocols and diagnostic connector as prescribed in module B of this gtr. Any removable calibration memory chips shall be potted, encased in a sealed container or protected by electronic algorithms and shall not be changeable without the use of specialised tools and procedures.

Computer-coded engine operating parameters shall not be changeable without the use of specialised tools and procedures (e.g. soldered or potted computer components or sealed (or soldered) computer enclosures).

Manufacturers shall take adequate steps to protect the maximum fuel delivery setting from tampering while a vehicle is in-service.

Manufacturers may apply to the certification authority for an exemption from one of these requirements for those vehicles that are unlikely to require protection. The criteria that the certification authority will evaluate in considering an exemption will include, but are not limited to, the current availability of performance chips, the high-performance capability of the vehicle and the projected sales volume of the vehicle.

Manufacturers using programmable computer code systems (e.g. electrical erasable programmable read-only memory, EEPROM) shall deter unauthorized reprogramming. Manufacturers shall include enhanced tamper-protection strategies and write protect features requiring electronic access to an off-site computer maintained by the manufacturer. Alternative methods giving an equivalent level of tamper protection may be approved by the certification authority.

### 5. PERFORMANCE REQUIREMENTS

#### 5.1. Thresholds

Specific thresholds may be defined for specific sub-systems or components. Consequences on the classification need to be checked. An overall threshold may be needed.

Harmonized OBD performance requirements will evolve with the harmonization of the test-cycles (for emissions and OBD), the emission limits and the process for calculating the OTLs.

The following table summarizes the major steps towards fully harmonized OBD performance requirements:

	Step 1	Step 2	Step 3
Test-cycles (emissions and OBD)	Non-harmonized or harmonized	Harmonized	Harmonized
Emission limits	Non harmonized	Non harmonized	Harmonized
OTLs calculation process	Non harmonized	Harmonized	Harmonized
OTLs	Regionally defined	Regionally calculated with the harmonized calculation process	Harmonized

The current gtr addresses only the first step of this process.

#### Step 1:

In the first step, OTLs are not world-harmonized and the process for defining the OTLs is not world-harmonized;

The OTLs shall be defined as follows:

- if the UNECE Regulation No. 49 is used for certifying the engine in regards to its exhaust emissions, then the UN-ECE Regulation No. 49 OBD test-cycle and the UNECE Regulation No. 49 OTLs shall be applicable accordingly.
- if the US/Californian regulation is used for certifying the engine in regards to its exhaust emissions, then the US/Californian OBD test-cycle and the US/Californian OTLs shall be applicable accordingly.
- if the Japanese regulation is used for certifying the engine in regards to its exhaust emissions, then the Japanese OBD test-cycle and the Japanese OTLs shall be applicable accordingly.
- if the procedures of the "WHDC" gtr is used for certifying the engine in regards to its exhaust emissions, then the world harmonized test cycle as defined in this module applies and the relevant regional OTLs shall be applicable accordingly

#### Step 2

In the second step, the test-cycles (for emissions and OBD) and the process for defining the OTLs are world harmonized 18/, but the emission limits are not world-harmonized;

The OTLs shall be defined as follows:

- if the UNECE Regulation No. 49 is used for certifying the engine in regards to its

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18/ The process to define OTLs will be described when decided, in an annex to this module.

- exhaust emissions, then the OTLs shall be calculated on the basis of the UNECE Regulation No. 49 emission limits through the process described in an annex to this module.
- if the US/Californian regulation is used for certifying the engine in regards to its exhaust emissions, then the OTLs shall be calculated on the basis of the US/Californian emission limits through the process described in an annex to this module.
  - if the Japanese regulation is used for certifying the engine in regards to its exhaust emissions, then the OTLs shall be calculated on the basis of the Japanese emission limits through the process described in an annex to this module.
  - if the procedures of the "WHDC" gtr is used for certifying the engine in regards to its exhaust emissions, then the world harmonized test cycle as defined in this module applies and the OTLs shall be calculated on the basis of the relevant regional emission limits through the process described in an annex to this module.

### Step 3

In this ultimate case, the test-cycles (for emissions and OBD), the emission limits and the process to define the OTLs are harmonized.

The OTLs shall be defined as follows:

(empty table)

#### Notes:

- In all the three cases,
- some malfunctions may only be monitored against specific pollutant OTLS;
  - different monitors may require different OTLs for the same pollutant.

#### 5.2. Temporary disablement of the OBD system

An OBD system may be temporarily disabled under the conditions specified in the following sub-paragraphs.

Manufacturers shall obtain approval for temporary disablement strategies by the certification authority at the time of certification or type approval.

At the time of certification or type-approval, the manufacturer shall provide the certification authority with the detailed description of each of the OBD system's temporary disablement strategies and the data and/or engineering evaluation demonstrating that monitoring during the applicable conditions would be unreliable or impractical.

In all cases, monitoring shall resume once the conditions justifying temporary disablement are no longer present.

##### 5.2.1. Engine/vehicle operational safety

The affected OBD monitoring systems may be temporarily disabled when operational

safety strategies are activated.

The OBD monitoring system is not required to evaluate components during malfunction if such evaluation would result in a risk to the safe use of the vehicle.

5.2.2. Ambient temperature and altitude conditions 19/

OBD system monitors may be disabled at ambient engine start temperatures below 266 K (-7 degrees Celsius or 20 degrees Fahrenheit) or above 308 K (35 degrees Celsius or 95 degrees Fahrenheit), or at elevations above 2,500 meters (8,202 feet) above sea level.

A manufacturer may further request that an OBD system monitor be disabled at other ambient engine start temperatures upon determining that the manufacturer has demonstrated with data and/or an engineering evaluation that misdiagnosis would occur at the ambient temperatures because of its effect on the component itself (e.g., component freezing).

Note: Ambient conditions may be estimated by indirect methods. For example ambient temperature conditions may be determined based on intake air temperature.

5.2.3. Low fuel level

Monitoring systems that can be affected by low fuel level or running out of fuel (e.g., diagnosis of a malfunction of the fuelling system) may be disabled during such conditions. Low fuel level is defined to be when the fuel level is 20 per cent or less of the nominal capacity of the fuel tank.

5.2.4. Vehicle battery or system voltage levels

Manufacturers may disable monitoring systems that can be affected by vehicle battery or system voltage levels.

5.2.4.1. Low voltage

For monitoring systems affected by low vehicle battery or system voltages, manufacturers may disable monitoring systems when the battery or system voltage is below 90 per cent of the nominal voltage (or 11.0 Volts for a 12 Volt battery, 22.0 Volts for a 24 volt battery). Manufacturers may request approval to utilize a voltage threshold higher than this value to disable system monitoring.

The manufacturer shall demonstrate that monitoring at the voltages would be unreliable and that either operation of a vehicle below the disablement criteria for extended periods of time is unlikely or the OBD system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

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19/ WWH-OCE conditions to be considered in the next revision of this gtr.

#### 5.2.4.2. High voltage

For monitoring systems affected by high vehicle battery or system voltages, manufacturers may request approval to disable monitoring systems when the battery or system voltage exceeds a manufacturer-defined voltage.

The manufacturer shall demonstrate that monitoring above the manufacturer-defined voltage would be unreliable and that either the electrical charging system/alternator warning light is illuminated (or voltage gauge is in the "red zone") or the OBD system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

#### 5.2.5. Active PTO (power take-off units)

A manufacturer may temporarily disable affected monitoring systems in vehicles when the PTO unit is temporarily active.

A manufacturer may similarly disable affected monitoring systems in vehicles designed to operate with permanent PTO active when the vehicle is not being driven.

A manufacturer may similarly disable affected monitoring systems in vehicles not designed to operate with a permanent PTO active when the vehicle detects the activation of such a PTO.

#### 5.2.6. Forced regeneration

The affected OBD monitoring systems may be temporarily disabled during the forced regeneration of an emission control system downstream of the engine (e.g. a particulate filter).

#### 5.2.7. AECS

OBD system monitors may be temporarily disabled during the operation of an AECS, including default and limp-home modes, under conditions not already covered in paragraph 5.2. if the monitoring capability of a monitor is affected by the operation of an AECS.

### 6. DEMONSTRATION REQUIREMENTS

The basic elements for demonstrating the compliance of an OBD system with the requirements of this gtr are as follows:

- procedure for selecting the OBD-parent engine system. The OBD-parent engine system shall be selected in agreement with the certification authority. It shall be subject to the complete demonstration process decided by the Contracting Party.
- procedure for demonstrating the classification of a malfunction. The manufacturer shall submit to the certification authority the classification of each malfunction for that OBD-parent engine system and the necessary supporting data in order to justify each classification. The manufacturer shall conduct the classification demonstration

test as requested by the Contracting Parties.

- procedure for qualifying a deteriorated component. When required by the certification authority, the manufacturer shall provide deteriorated components for OBD testing purposes. These components shall be qualified on the basis of supporting data provided by the manufacturer. The certification authority may require emission testing to complete the qualification.
- procedure for demonstrating malfunction detection. The engine system shall be equipped with the appropriate qualified deteriorated component and tested on an engine test-bed to demonstrate the proper detection of the malfunction by the OBD system.

#### 6.1. Emission-OBD family

The manufacturer is responsible for determining the composition of an emission-OBD family. Grouping engine systems within an emission-OBD family shall be based on good engineering judgement and be subject to approval by the certification authority.

Engines that do not belong to the same engine family may still belong to the same emission-OBD family.

##### 6.1.1. Parameters defining an emission-OBD family

The emission-OBD family may be defined by basic design parameters that shall be common to engine systems within the family.

In order that engine systems may be considered to belong to the same OBD-engine family, the following list of basic parameters shall be similar:

- the emission control systems,
- the methods of OBD monitoring,
- the methods of malfunction detection.

These similarities shall be demonstrated by the manufacturer by means of relevant engineering demonstration or other appropriate procedures and subject to the approval of the certification authority.

It is understood there may be minor differences in the methods of monitoring/ diagnosing the engine emission control system due to engine system configuration variation:

- methods may be considered as similar if they differ only to match specificities of the considered components (e.g. size, exhaust flow, etc.);
- other methods may be considered as similar if based on good engineering judgement and approved by the certification authority.

##### 6.1.2. OBD-parent engine system

Compliance of an emission-OBD family with the requirements of this gtr may be achieved by demonstrating the compliance of the OBD-parent engine system of this family.

The selection of the OBD-parent engine system is made by the manufacturer and subject to the approval of the certification authority.

Prior to testing the certification authority may decide to request the manufacturer to select an additional engine for demonstration.

The manufacturer may also propose to the certification authority to test additional engines to cover the complete emission-OBD family.

## 6.2. Procedures for demonstrating the malfunction classification

The manufacturer shall provide the documentation justifying the proper classification of each malfunction to the certification authority. This documentation shall include a failure analysis (for example elements of a "failure mode and effect analysis") and may also include:

- simulation results;
- test results;
- reference to previously approved classification.

In the following paragraphs the requirements for demonstrating the correct classification are listed, including requirements for testing. The maximum and/or minimum number of tests to be required by the certification authority will be defined by each Contracting Party.

### 6.2.1. Demonstration of classification into A

The classification by the manufacturer of a malfunction into Class A shall not be subject to a demonstration test.

If the certification authority disagrees with a manufacturer's classification of a malfunction as Class A, the certification authority may require the classification of the malfunction into Class B1, B2 or C, as appropriate.

In that case the certification document shall record that the malfunction classification has been assigned according to the request of the certification authority.

### 6.2.2. Demonstration of classification into B1 (distinguishing between A and B1)

In order to justify the classification of a malfunction into Class B1 the documentation shall clearly demonstrate that, in some circumstances, the malfunction results in emissions that are lower than the OTLs.

Some examples of such circumstances that will influence if and when OTLs may be exceeded are the age of the engine system or whether the test is conducted with a new or aged component.

In the case that the certification authority requires an emission test for demonstrating

the classification of a malfunction into Class B1 the manufacturer shall demonstrate that the emissions due to that particular malfunction are, in selected circumstances, below the OTLs:

- the manufacturer selects the circumstances of the test in agreement with the certification authority
- the manufacturer shall not be required to demonstrate that in other circumstances the emissions due to the malfunction are actually above the OTLs.

If the manufacturer fails to demonstrate the classification as Class B1, the malfunction is classified as Class A.

6.2.3. Demonstration of classification into B1 (distinguishing between B2 and B1)

If the certification authority disagrees with a manufacturer's classification of a malfunction as Class B1 because it considers that the OTLs are not exceeded, the certification authority may require the reclassification of that malfunction into Class B2 or C. In that case the certification documents shall record that the malfunction classification has been assigned according to the request of the certification authority.

6.2.4. Demonstration of classification into B2 (distinguishing between B2 and B1)

In order to justify the classification of a malfunction into Class B2 the manufacturer shall demonstrate that emissions are lower than the OTLs.

In case the certification authority disagrees with the classification of a malfunction as Class B2 because it considers that the OTLs are exceeded, the manufacturer may be required to demonstrate by testing that the emissions due to the malfunction are below the OTLs.

If the test fails, then the certification authority shall require the reclassification of that malfunction into A or B1 and the manufacturer shall subsequently demonstrate the appropriate classification and the documentation shall be updated.

6.2.5. Demonstration of classification into B2 (distinguishing between B2 and C)

If the certification authority disagrees with a manufacturer's classification of a malfunction as Class B2 because it considers the regulated emission limits are not exceeded, the certification authority may require the reclassification of that malfunction into Class C. In that case the certification documents shall record that the malfunction classification has been assigned according to the request of the certification authority.

6.2.6. Demonstration of classification into C

In order to justify the classification of a malfunction into Class C the manufacturer shall demonstrate that emissions are lower than the regulated emission limits.

In case the certification authority disagrees with the classification of a malfunction as Class C the manufacturer may be required to demonstrate by testing that the emissions

due to the malfunction are below the regulated emission limits.

If the test fails, then the certification authority shall request the reclassification of that malfunction and the manufacturer shall subsequently demonstrate the appropriate reclassification and the documentation shall be updated.

### 6.3. Procedures for demonstrating the OBD performance

The manufacturer shall submit to the certification authority a complete documentation package justifying the compliance of the OBD system as regards its monitoring capability, which may include:

- algorithms and decision charts
- tests and/or simulation results
- reference to previously approved monitoring systems, etc.

#### 6.3.1. Procedures for demonstrating the OBD performance by testing

In addition to the supporting data referred to in paragraph 6.3., the regulation of the Contracting Party may require the manufacturer to demonstrate the proper monitoring of specific emission control systems or components by testing them on an engine tested according to the test procedures specified in paragraph 7.2. of this module.

In that case, the manufacturer shall make available the qualified deteriorated components or the electrical device which would be used to simulate a malfunction.

The proper detection of the malfunction by the OBD system and its proper response to that detection (cf. MI indication, DTC storage, etc) shall be demonstrated according to paragraph 7.2.

#### 6.3.2. Procedures for qualifying a deteriorated component (or system)

This paragraph applies to the cases where the malfunction selected for an OBD demonstration test is monitored against tailpipe emissions 20/ (emission threshold monitoring - see paragraph 4.2.), and the legislation of the Contracting Party requires the manufacturer to demonstrate, by an emission test, the qualification of that deteriorated component.

In very specific cases the qualification of deteriorated components or systems by testing may not be possible (for example, if a limp home strategy is activated, if the engine cannot run any test, etc.). In such cases, the deteriorated component shall be qualified without testing. This exception shall be documented by the manufacturer and is subject to the agreement of the certification authority.

##### 6.3.2.1. Procedure for qualifying a deteriorated component used to demonstrate the detection of classes A and B1 malfunctions

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20/ This paragraph will be extended to other monitors than mission threshold monitors in a later stage.

In the case the malfunction selected by the certification authority results in tailpipe emissions that may exceed an OBD threshold limit, the manufacturer shall demonstrate by an emission test according to paragraph 7. that the deteriorated component or device does not result in the relevant emission exceeding its OTL by more than 20 per cent.

6.3.2.2. Qualification of deteriorated components used to demonstrate the detection of Class B2 malfunctions

In the case of Class B2 malfunctions, and upon request of the certification authority, the manufacturer shall demonstrate by an emission test according to paragraph 7. that the deteriorated component or device does not lead the relevant emission to exceed its applicable OTL.

6.3.2.3. Qualification of deteriorated components used to demonstrate the detection of Class C malfunctions

In the case of Class C malfunctions, and upon request of the certification authority, the manufacturer shall demonstrate by an emission test according to paragraph 7. that the deteriorated component or device does not lead the relevant emission to exceed its applicable regulated emission limit.

6.3.3. Test protocol

The manufacturer, together with the certification authority, shall report on the test(s) that has (have) been performed according to the provisions of this module.

The content of the provided information package shall be identical to the one proposed in Annex 4. Depending on each regional or national regulation, it may be decided to use another template than the one proposed in Annex 4.

6.4. Certification of an OBD system containing deficiencies

(To be developed)

6.4.1. Deficiency period

(To be developed)

7. TEST PROCEDURES

7.1. Testing process

The demonstration by testing of the proper malfunction classification and the demonstration by testing of the proper monitoring performance of an OBD system are issues that shall be considered separately. For example, a Class A malfunction will not require a classification test while it may be subject to an OBD performance test.

Where appropriate, the same test may be used to demonstrate the correct classification of a malfunction, the qualification of a deteriorated component provided by the manufacturer and the correct monitoring by the OBD system.

#### 7.1.1. Testing process for demonstrating the malfunction classification

When, according to paragraph 6.2., the certification authority requests the manufacturer to justify by testing the classification of a specific malfunction, the compliance demonstration will consist of a series of emission tests.

According to paragraph 6.2.2., when testing is required by the certification authority to justify the classification of a malfunction into Class B1 rather than in Class A, the manufacturer shall demonstrate that the emissions due to that particular malfunction are, in selected circumstances, below the OTLs:

- the manufacturer selects these circumstances of test in agreement with the certification authority
- the manufacturer shall not be required to demonstrate that in other circumstances the emissions due to the malfunction are actually above the OTLs.

The emission test may be repeated upon request of the manufacturer up to three times.

If any of these tests leads to emissions below the considered OTL, then the malfunction classification into Class B1 shall be approved.

When testing is required by the certification authority to justify the classification of a malfunction into Class B2 rather than in Class B1 or into Class C rather than in Class B2, the emission test shall not be repeated. If the emissions measured in the test are above the OTL or the emission limit, respectively, then the malfunction shall require a reclassification.

Note: According to paragraph 6.2.1., this paragraph does not apply to malfunctions classified into Class A.

#### 7.1.2. Testing process for demonstrating the OBD performance

When the certification authority requests according to paragraph 6.3. to test the OBD system performance, the compliance demonstration shall consist of the following phases (see chart 2):

- a malfunction is selected by the certification authority and a corresponding deteriorated component or system shall be made available by the manufacturer;
- when appropriate and if requested, the manufacturer shall demonstrate by an emission test that the deteriorated component is qualified for a monitoring demonstration;
- the manufacturer shall demonstrate that the OBD system responds in a manner that complies with the provisions of this gtr (i.e. MI indication, DTC storage, etc) at the latest by the end of a series of OBD test-cycles.

##### 7.1.2.1. Qualification of the deteriorated component

When the certification authority requests the manufacturer to qualify a deteriorated component by testing according to paragraph 6.3.2., this demonstration shall be made by performing an emissions test.

If it is determined that the installation of a deteriorated component or device on an engine system means that a comparison with the OBD threshold limits is not possible (e.g. because the statistical conditions for validating the applicable emission test cycle are not met), the malfunction of that component or device may be considered as qualified upon the agreement of the certification authority based on technical rationale provided by the manufacturer.

In the case that the installation of a deteriorated component or device on an engine means that the full load curve (as determined with a correctly operating engine) cannot be attained during the test, the deteriorated component or device may be considered as qualified upon the agreement of the certification authority based on technical rationale provided by the manufacturer.

#### 7.1.2.2. Malfunction detection

Each monitor selected by the certification authority to be tested on an engine test-bed, shall respond to the introduction of a qualified deteriorated component in a manner that meets the requirements of this gtr within two consecutive OBD test-cycles according to paragraph 7.2.2. of this module.

When it has been specified in the monitoring description and agreed by the certification authority that a specific monitor needs more than two operating sequences to complete its monitoring, the number of OBD test-cycles may be increased according to the manufacturer's request.

Each individual OBD test-cycle in the demonstration test shall be separated by an engine shut-off. The time until the next start-up shall take into consideration any monitoring that may occur after engine shut-off and any necessary condition that must exist for monitoring to occur at the next start up.

The test may be considered complete as soon as the OBD system has responded in a manner that meets the requirements of this gtr.

#### 7.2. Applicable tests

The emission test is the test-cycle used when for the measurement of the regulated emissions.

The OBD test-cycle is the test-cycle used when evaluating the performance of the OBD monitor. In many case these test-cycles are the same.

##### 7.2.1. Emission test cycle

The World-wide harmonized test-cycle considered in this module for measuring emissions is the transient portion (WHTC test-cycle) of the World-wide harmonized heavy-duty certification procedure (WHDC).

(To be considered: hot start and/or cold start).

When the engine-system has been certified to exhaust emissions limits measured over a test-cycle other than the WHDC, the emission test-cycle required within paragraph 6. and referred to in paragraph 7. will be the European Union, Japanese, or United States test-cycle(s) applicable for emission measurement for OBD purposes.

#### 7.2.2. OBD test cycle

The World-wide harmonized OBD test-cycle considered in this module is the transient portion (WHTC test-cycle) of the World-wide harmonized heavy-duty certification procedure (WHDC).

(To be considered: hot start and/or cold start).

When the engine-system has been certified to exhaust emissions limits measured over a test-cycle other than the WHDC, the OBD test-cycle may consist of the regionally accepted corresponding OBD test-cycles.

Manufacturers may request approval from the certification authority to use an alternative OBD test-cycle to the applicable test-cycles mentioned in this paragraph. The request shall contain elements (technical considerations, simulation, test results, etc.) demonstrating:

- the requested test-cycle results in a monitor that will run in real world driving, and;
- the applicable world-wide harmonized or regionally accepted OBD test-cycle is shown to be less appropriate for the considered monitoring (e.g. fluid consumption monitoring).

#### 7.2.3. Test operating conditions

The conditions (i.e. temperature, altitude, fuel quality etc) for conducting the tests referred to in paragraphs 7.2.1. and 7.2.2. shall be those required for operating the World-wide harmonized heavy-duty certification procedure (WHDC) in the "WHDC" gtr.

When the engine-system has been certified to exhaust emissions limits measured over a test-cycle other than the WHDC, the conditions for conducting the tests referred to in paragraphs 7.2.1. and 7.2.2. are the conditions required for operating the applicable regionally accepted emission test-cycle.

In the case of an emission test aimed at justifying the classification of a specific malfunction into Class B1, the test operating conditions may deviate from the ones in the paragraphs above according to paragraph 6.2.2.

7.3. Test protocols

The manufacturer, together with the certification authority shall report on the test(s) that has (have) been performed according to the provisions of this module.

The content of the provided information package shall be identical to the one proposed in Annex 4. Nevertheless Contracting Parties may decide to use another template than the one proposed in Annex 4.

8. DOCUMENTATION REQUIREMENTS

8.1. Documentation for purpose of certification

The manufacturer shall provide a documentation package that includes a full description of the OBD system. The documentation package shall be made available in two parts:

- (a) a primary documentation package, which may be brief, provided that it exhibits evidence concerning the relationships between monitors, sensors/actuators, and operating conditions (i.e. describes all enable conditions for monitors to run and disable conditions that cause monitors not to run). The documentation shall describe the functional operation of the OBD and outline each monitoring strategy and the decision process, including the malfunction ranking within the hierarchical classification. This material shall be retained by the certification authority. This information may be made available to interested parties upon request.
- (b) a secondary documentation package containing any data, including details of qualified deteriorated components or systems and associated test results, which are used as evidence to support the decision process referred to above, and a listing of all input and output signals that are available to the engine system and monitored by the OBD system.

This additional material shall remain strictly confidential and, at the discretion of the certification authority, may be retained by the manufacturer but shall be made open for inspection by the certification authority at the time of certification or at any time during the validity of an approval.

8.1.1. Documentation associated with each monitored component or system

The documentation package shall include the following information for each monitored component or system:

- (a) the malfunctions and associated DTC(s);
- (b) the monitoring method used for malfunction detection;
- (c) the parameters used for malfunction detection and when applicable the fault criteria limits and/or OBD thresholds;
- (d) the criteria for storing a DTC.

8.1.2. Documentation associated with each DTC

For each DTC the information shall include but shall not be limited to:

- the monitoring method or procedure for malfunction;
- primary monitored parameters;
- fault criteria limits used to evaluate output signal of primary parameter;
- other monitored secondary parameters and conditions necessary for malfunction detection;
- the monitoring "time length" (operation time/procedure necessary to complete the monitoring) and "frequency" of checks (e.g. continuous, once per trip, etc.);
- the criteria for storing DTC;
- the criteria for illuminating malfunction indicator light (i.e. pending, confirmed issue);
- the criteria used for determining out of range values and input component rationality checks.

These elements shall be common within an emission-OBD family, although different calibration may be allowed.

8.1.3. Documentation associated with the malfunction classification

The malfunction classification of each DTC shall be documented. This classification may be different for different engine types (e.g. different engine ratings) within the same emission-OBD family.

This information shall include the technical justification required in paragraph 4.2. of this module for classification into Class A, Class B1 or Class B2.

8.1.4. Documentation associated with the emission-OBD family

A description of the emission-OBD family shall be provided. This description shall include a list and a description of the engine types within the family, the description of the OBD-parent engine system, and all elements that characterise the family according to paragraph 6.1.1. of this module.

In the case where the emission-OBD family includes engines belonging to different engine families, a summary description of these engine families shall be provided.

In addition, the manufacturer shall provide a list of all electronic input and output an identification of the communication protocol utilized by each emission-OBD family.

8.2. Documentation for installing in a vehicle an OBD equipped engine system

The engine manufacturer shall include in the installation documents of its engine system the appropriate requirements that will ensure the vehicle, when used on the road or elsewhere as appropriate, will comply with the requirements of this gtr. This documentation shall include but is not limited to:

- the detailed technical requirements, including the provisions ensuring the compatibility with the OBD system of the engine system;
- the verification procedure to be completed.

The existence and the adequacy of such installation requirements may be checked during the certification process of the engine system.

Note: In cases the installation of the engine system is certified by a regional certification authority, or the engine system is installed on the vehicle by the engine manufacturer, this documentation is not required.

Annex 1

DIRECT CERTIFICATION OF A VEHICLE EQUIPPED WITH AN OBD SYSTEM

This paragraph considers the case where the vehicle manufacturer directly applies for a certification of the complete vehicle emission-OBD system instead of applying for both a certification of the engine-system and a certification of its installation.

The vehicle manufacturer is then responsible for the complete emission-OBD system, including the OBD elements mounted on-board the vehicle that are not part of the engine-system and for the proper installation of engine system with respect to its OBD system (cf. interface compatibility).

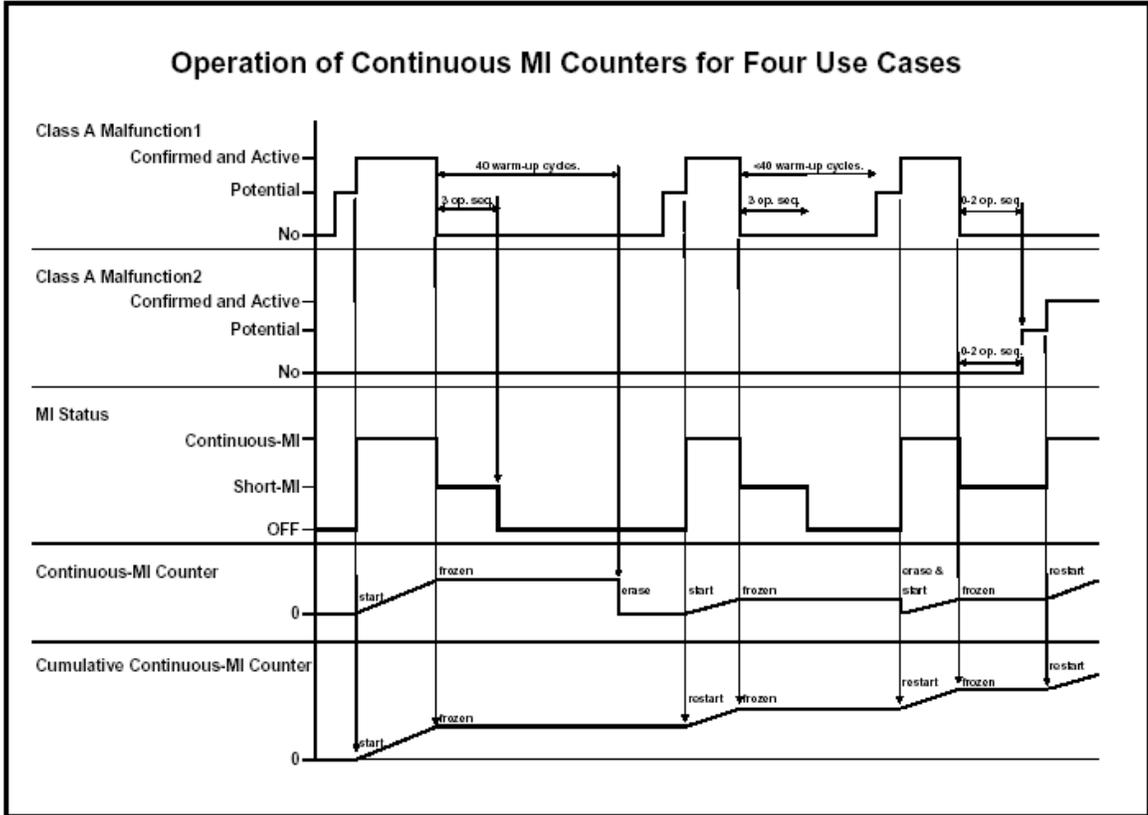
In this case, and in addition to the general requirements of this module, a demonstration of the correct installation may be required. This demonstration shall be done on the basis of the appropriate element of design, results of verification tests, etc. and address the conformity of the following elements to the requirements of this gtr:

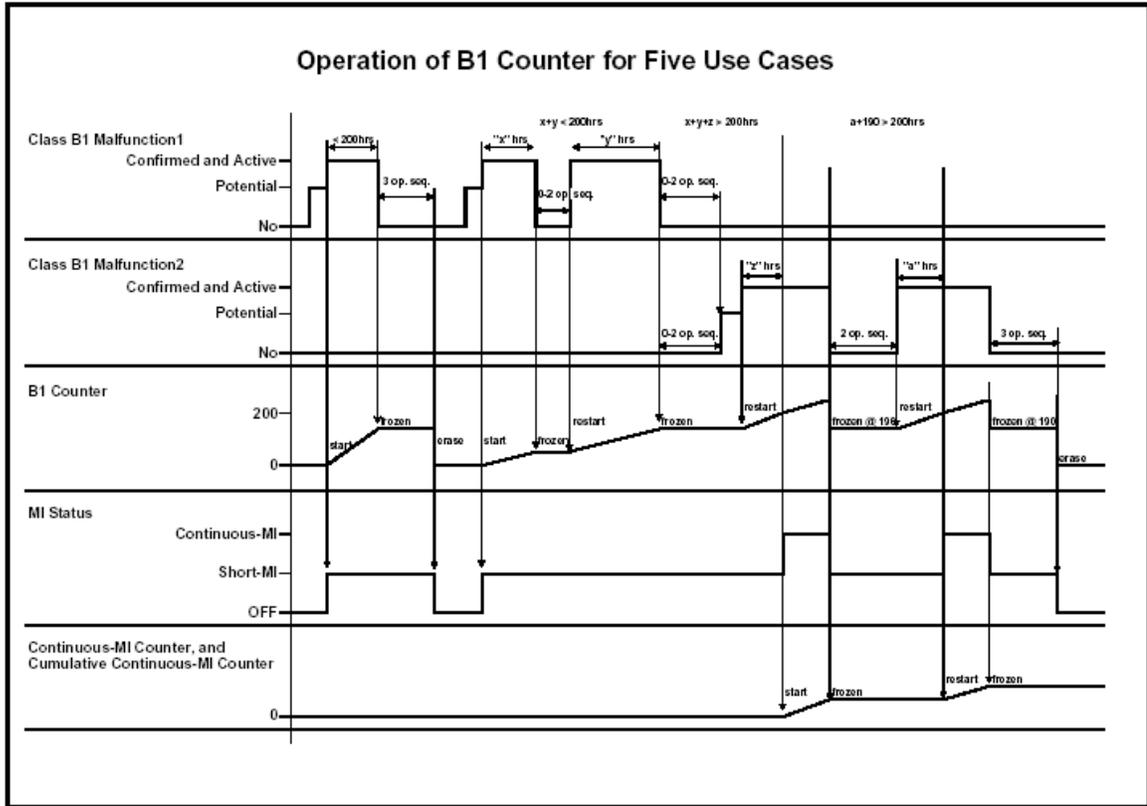
- the installation on-board the vehicle as regards its compatibility with the OBD system of the engine-system;
- the MI and, where appropriate, the additional warning modes;
- the wired communication interface.

In some specific cases the certification authority may also require an additional experimental verification. In this case one simple failure mode, such as an electric disconnection should be selected by the certification authority. Correct MI illumination, information storage and on-board off-board OBD communication will be checked.

Annex 2

OPERATION OF MI AND B1 COUNTERS (EXAMPLES)





Note: In this example, it is assumed that there is a single B1 counter.

Annex 3

EMISSIONS CONTROL SYSTEM ELEMENTS AND ASSOCIATED OBD MONITORS

The OBD monitors listed in this annex are intended to cover all of the emission control system elements that are being considered currently by engine manufacturers for compliance with emissions limits in the year 2010 and later timeframe. The expectation is that no engine would be equipped with all of these emissions control system elements but would, instead, be equipped with some subset of elements found here. As such, the monitors noted here have implied with them the phrase "if equipped" and/or "if applicable".

The intention behind this list of OBD monitors is not that all of these emissions control system elements necessarily be monitored, even where applicable. Instead, the list is meant to inform both the engine manufacturer and the certification authority of the types of monitors that should be considered by and would, presumably, be present in a robustly designed OBD system. The gtr allows that an engine can be approved or certified by the certification authority without certain OBD monitors provided a specific set of criteria can be demonstrated by the manufacturer. These criteria could include emissions effects relative to emissions limits which, as of now, are stipulated by regional regulation. These criteria could also include the case where one monitor is capable of detecting multiple malfunctions.

For these reasons, the expectation is that the OBD monitors will be, for now, handled largely through regional regulations and regional implementation policies. When the time comes where regional emissions limits are equivalent and measured over a world harmonized test cycle, the expectation would be that OBD monitoring requirements and threshold levels could be harmonized.

Annex 3 - Appendix 1

ELECTRIC / ELECTRONIC COMPONENTS MONITORING

Electric / electronic components used to control or monitor the emission control systems described in this annex shall be subject to Component Monitoring according to the provisions of paragraph 4.1. of this module. This includes, but is not limited to, pressure sensors, temperature sensors, exhaust gas sensors, in-exhaust fuel or reductant injector(s), in-exhaust burners or heating elements, glow plugs, intake air heaters.

Wherever a feedback control loop exists, the OBD system shall monitor the system's ability to maintain feedback control as designed (e.g., to enter feedback control within a manufacturer specified time interval, system fails to maintain feedback control, feedback control has used up all the adjustment allowed by the manufacturer) – component monitoring.

Annex 3 - Appendix 2

DIESEL PARTICULATE FILTER (DPF), OR PARTICULATE MATTER TRAP

The OBD system shall monitor the following elements of the DPF system on engines so-equipped for proper operation:

- DPF substrate: the presence of the DPF substrate – total functional failure monitoring
- DPF performance: particulate accumulation during the filtering process and particulate removal during the forced regeneration process – performance monitoring (for example, evaluation of measurable DPF properties such as backpressure or differential pressure, which may not detect all failure modes that reduce trapping efficiency).

The following enhanced monitoring requirements may also be introduced into regional regulation, where determined to be technically feasible by a Contracting Party at the time of introduction of that regulation:

- DPF filtering performance: the filtering capability of the DPF. This requirement would apply to PM emissions only – emission threshold monitoring.
- DPF forced regeneration excessive frequency: the frequency of forced regeneration events (i.e., those regeneration events that are initiated via a driver selectable switch or activator and/or those initiated by computer software). This requirement would apply to HC and possibly CO emissions – performance monitoring.
- DPF incomplete forced regeneration: forced regeneration events for completeness – performance monitoring.
- DPF HC and CO conversion efficiency: the ability of the DPF to convert HC and CO as required for compliance with emissions limits – emission threshold monitoring.
- DPF active/intrusive reductant injection system: the system's ability to regulate reductant delivery properly, whether delivered via an in-exhaust injection or an in-cylinder injection – component monitoring.

Annex 3 - Appendix 3

SELECTIVE CATALYTIC REDUCTION (SCR) AND LEAN NOX CATALYST  
MONITORING

The OBD system shall monitor the following elements of the SCR system on engines so-equipped for proper operation:

- active/intrusive reductant injection system: the system's ability to regulate reductant delivery properly, whether delivered via an in-exhaust injection or an in-cylinder injection – performance monitoring.
- active/intrusive reductant: the quantity in the tank, the proper consumption and the quality of the reductant if a reductant other than fuel is used (e.g., urea) – performance monitoring.

The following enhanced monitoring requirements may also be introduced into regional regulation, where determined to be technically feasible by a Contracting Party at the time of introduction of that regulation:

- SCR catalyst conversion efficiency: the catalyst's ability to convert NO<sub>x</sub> - emission threshold monitoring.

Annex 3 - Appendix 4

LEAN-NOX TRAP (LNT, OR NOX ADSORBER)

The OBD system shall monitor the following elements of the LNT system on engines so-equipped for proper operation:

- LNT capability: the LNT system's ability to adsorb/store and convert NO<sub>x</sub> – performance monitoring.
- LNT active/intrusive reductant injection system: the system's ability to regulate reductant delivery properly, whether delivered via an in-exhaust injection or an in-cylinder injection – performance monitoring.

The following enhanced monitoring requirements may also be introduced into regional regulation, where determined to be technically feasible by a Contracting Party at the time of introduction of that regulation:

- LNT capability: the LNT system's ability to adsorb/store and convert NO<sub>x</sub> – emission threshold monitoring.

Annex 3 - Appendix 5

DIESEL OXIDATION CATALYST (DOC) MONITORING

The OBD system shall monitor the following elements of the DOC on engines so-equipped for proper operation:

- HC and CO conversion efficiency: the DOC's ability to convert HC and CO upstream of other after-treatment devices– total functional failure monitoring.
- HC and CO conversion efficiency: the DOC's ability to convert HC and CO downstream of other after-treatment devices – total functional failure monitoring.

The following enhanced monitoring requirements may also be introduced into regional regulation, where determined to be technically feasible by a Contracting Party at the time of introduction of that regulation:

- HC and CO conversion efficiency: the DOC's ability to convert HC and CO upstream of other after-treatment devices – emission threshold monitoring.
- Other aftertreatment assistance functions – catalysts upstream of other aftertreatment devices: the DOC's ability to generate an exotherm when used for that purpose (e.g., to assist in particulate filter regeneration); the DOC's ability to generate a necessary feedgas composition when used for that purpose (e.g., to increase NO<sub>2</sub> concentration upstream of a urea selective catalytic reduction system (SCR)) – performance monitoring.
- Other aftertreatment assistance functions – DOCs downstream of other aftertreatment devices: the DOC's ability to convert HC and CO - total functional failure monitoring.

Annex 3 - Appendix 6

EXHAUST GAS RECIRCULATION (EGR) SYSTEM MONITORING

The OBD system shall monitor the following elements of the EGR system on engines so-equipped for proper operation:

- EGR low/high flow: the EGR system's ability to maintain the commanded EGR flow rate, detecting both "flow rate too low" and "flow rate too high" conditions – emission threshold monitoring.
- EGR slow response: the EGR system's ability to achieve the commanded flow rate within a manufacturer specified time interval following the command – performance monitoring.
- EGR cooler undercooling performance: the EGR cooler system's ability to achieve the manufacturer's specified cooling performance – performance monitoring

The following enhanced monitoring requirements may also be introduced into regional regulation, where determined to be technically feasible by a Contracting Party at the time of introduction of that regulation:

- EGR slow response: the EGR system's ability to achieve the commanded flow rate within a manufacturer specified time interval following the command – emission threshold monitoring.
- EGR cooler performance: the EGR cooler system's ability to achieve the manufacturer's specified cooling performance – emission threshold monitoring.

Appendix 7

FUEL SYSTEM MONITORING  
(To be developed)

Appendix 8

AIR HANDLING AND TURBOCHARGER/BOOST PRESSURE CONTROL SYSTEM  
(To be developed)

Appendix 9

VARIABLE VALVE TIMING (VVT) SYSTEM  
(To be developed)

Appendix 10

MISFIRE MONITORING  
(To be developed)

Appendix 11

CRANKCASE VENTILATION SYSTEM MONITORING  
(To be developed)

Appendix 12

ENGINE COOLING SYSTEM MONITORING  
(To be developed)

Appendix 13

EXHAUST GAS SENSOR MONITORING  
(To be developed)

Appendix 14

IDLE SPEED CONTROL SYSTEM MONITORING  
(To be developed)

Appendix 15

OTHER EMISSIONS CONTROL SYSTEM MONITORING  
(To be developed)

Annex 4

TEST PROTOCOL

(Annex to be reviewed)

Annex 4 - Appendix 1

INFORMATION CONCERNING THE OBD SYSTEM

WWH-OBD TEST PROTOCOL

Examination in accordance with gtr concerning the approval of vehicles with regard to the emission-related OBD requirements of module 1 by the engine according to engine fuel requirements  
Draft gtr including amendment until Supplement 1

Emission-OBD family	OBD description
Vehicle type: Truck XYZ [n.a.]	Issue: 22-05-2005 Version: Basis
OBD Engine system: Example ABC	

Vehicle type: Bus UVW [n.a.]	Issue: ....-....-2006 Version: Update 01
OBD Engine system: Example ABC, DEF, GHI	

Annex 4 - Appendix 2

INFORMATION CONCERNING THE CONFORMITY OF THE OBD SYSTEM

1. Documentation package

<p>The elements provided by the manufacturer in the documentation package of the emission-OBD family, is complete and complies with the requirements of paragraph 8. of module C of the referenced gtr, on the following issues:</p> <ul style="list-style-type: none"> <li>- documentation associated with each monitored component or system</li> <li>- documentation associated with each DTC</li> <li>- documentation associated with the malfunction classification</li> <li>- documentation associated with the emission-OBD engine family</li> </ul>	<p>YES / NO</p> <p>YES / NO</p> <p>YES / NO</p>
<p>The documentation for installing in a vehicle an OBD equipped engine system has been provided by the manufacturer in the documentation package of the emission-OBD family, is complete and complies with the requirements of paragraph 8. of module C of the referenced gtr</p>	<p>YES / NO</p>
<p>If not, the installation of the engine system equipped with the OBD system has been certified</p>	<p>YES / NO</p>

2. Content of the documentation

<p>The monitors, the malfunction classification, the indication, the activation and the extinguishing of the malfunction indicator and to the storage and erasing of DTCs comply with the requirements of paragraph 4. of module C of the reference gtr</p>	<p>YES / NO</p>
<p>MI illumination scheme:  According to paragraph 4.5.3. of the reference gtr, the MI-illumination scheme is</p>	<p>Discriminatory /  Non-discriminatory</p>
<p>Disablement of the OBD system:  The strategies described in the documentation package for a momentary disconnection or disablement of the OBD system comply with the requirements of paragraph 5.2. of the reference gtr</p>	<p>YES / NO</p>
<p>Electronic system security  The measures described by the manufacturer for electronic system security comply with the requirements of paragraph 4.8. of the reference gtr</p>	<p>YES / NO</p>

Annex 4 - Appendix 3

INFORMATION CONCERNING DEFICIENCIES

Number of deficiencies of OBD system submitted by the manufacturer	. . . . (ex: 4 deficiencies)
They comply with the requirements of paragraph 6.4. of the reference gtr	YES / NO
Deficiency Nr.1: Object of the deficiency  Period of deficiency  (Description of deficiencies 2 to n-1)  Deficiency Nr.n: Object of the deficiency  Period of deficiency	. . . . (ex: measuring of the Urea concentration (SCR) within defined tolerances  . . . . (ex: two years after the date of certification)  . . . . (ex: Measuring of NH3 concentration behind SCR system)  . . . . (ex: three years after the date of certification)

Annex 4 - Appendix 4

DEMONSTRATION TESTS OF THE OBD SYSTEM

1. Test result of the OBD system

Results of the tests The OBD system described in the above complying documentation package has been tested with success according to Paragraph 6 of the referenced gtr for demonstrating the compliance of a selection of monitors and of malfunction classifications	YES / NO
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Details to the conducted demonstration tests are given in the attachment.

1.1. Tested OBD system

Engine Engine type: Engine number:  Engine ECU Type and marking:  SCR control unit Type and marking:	 ..... .....  ..... .....
Diagnostic tool Manufacturer: Type:  Software / Version:  Test information Test conditions: Place and Date:	 ..... .....  .....  ..... .....

2. Demonstration tests of installation of the OBD system

In addition to the demonstration of the OBD system, the installation of the OBD system has been tested on a vehicle, according to the provisions of Annex 1 of the referenced gtr	YES / NO
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2.1. Test result of the installation OBD system

<p>The elements provided by the manufacturer in the documentation package of the emission-OBD family, is complete and complies with the requirements of paragraph 8 of module C of the referenced gtr, on the following issues:</p> <ul style="list-style-type: none"> <li>- documentation associated with each monitored component or system documentation associated with each DTC</li> <li>- documentation associated with the malfunction classification</li> <li>- documentation associated with the emission-OBD engine family</li> </ul>	<p>YES / NO YES / NO YES / NO</p>
<p>Results of the test The installation of the OBD system has been tested with success according to Annex 1 to the referenced gtr</p>	<p>YES / NO</p>

Details to the conducted demonstration tests are given in the attachment.

2.2. Tested installation

<p>Tested vehicle Vehicle type: Vehicle Identification No. (VIN):</p>	<p>.... ....</p>
<p>Diagnostic tool Manufacturer: Type: Software / Version:</p>	<p>... .... ....</p>
<p>Test information Test conditions: Place and Date:</p>	<p>.... ....</p>

Annex 4 - Appendix 5

FINAL CERTIFICATE

The documentation package and the herewith described OBD system comply with the requirements of the referenced gtr.

Test laboratory accredited by the accreditation body of .....  
under ..... - registration-No. ABC – 12345 - 2005.

A duplication and a publication in extracts of the test report is not allowed without the written permission of the testing laboratory.

The test report encompasses pages 1 to 5.

Place, Date: .....  
Order-No.: .....

Dipl.-Engineer .....

Responsible technical service  
Emissions, engine performance, fuel consumption

Enclosures:  
Attachment (4 pages)

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