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World Forum for Harmonization of Vehicle Regulations

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Geneva, 10-13 November 2009
Item 4.2.17 of the provisional agenda

1958 AGREEMENT

Consideration of draft amendments to existing Regulations

Proposal for Supplement 3 to the 05 series of amendments to Regulation No. 49 (Emissions of C.I. and P.I. (LPG and CNG) engines)

Submitted by the Working Party on Pollution and Energy */

The text reproduced below was adopted by the Working Party on Pollution and Energy (GRPE) at its fifty-eighth session. It is based on ECE/TRANS/WP.29/GRPE/2009/14, as amended by Annex III to the report. It is submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) and to the Executive Committee (AC.3) for consideration (ECE/TRANS/WP.29/GRPE/58, para. 12).

*/ In accordance with the programme of work of the Inland Transport Committee for 2006-2010 (ECE/TRANS/166/Add.1, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance performance of vehicles. The present document is submitted in conformity with that mandate.

The table of contents, amend to read:

"CONTENTS

……

ANNEXES

……

Annex 9B - Technical requirements for on-board diagnostic systems (OBD)

Appendix 1 - Approval ……
……
Appendix 7 - Documentation regarding OBD related information

Annex 9C - Technical requirements for on-board diagnostic systems (OBD)
Appendix 1 - Groups of monitors"

Annex 9B

The title, amend to read:

"TECHNICAL REQUIREMENTS FOR ON-BOARD DIAGNOSTIC SYSTEMS (OBD)"

Paragraph 1., amend to read:

"1. APPLICABILITY

This annex is applicable to diesel or gaseous-fuelled (NG or LPG) engines intended to be mounted in road vehicles, but is not applicable to dual-fuel or bi-fuelled engines.

Note: Annex 9B is applicable instead of Annex 9A upon decision of the Contracting Parties, provided that Annex 4B is also applied. Nevertheless, in the case a Contracting Party decides to apply this annex, some requirements of Annex 9A may still remain applicable at the explicit request of that Contracting Party, provided that these requirements are not in contradiction to the specifications of this annex."

Paragraph 3.35., amend to read:

"3.35. "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) 2/."

Paragraph 3.36., amend to read:

"3.36. 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 NO_x Trap (or NO_x absorber)
LPG	Liquefied Petroleum Gas
MECS	Malfunction Emission Control Strategy
NG	Natural Gas
NO_x	Oxides of Nitrogen
OTL	OBD Threshold Limit
PM	Particulate Matter
SCR	Selective Catalytic Reduction
SW	Screen Wipers
TFF	Total Functional Failure monitoring
VGT	Variable Geometry Turbocharger
VVT	Variable Valve Timing"

Paragraph 4., amend to read (deleting the word "In"):

"4. GENERAL REQUIREMENTS

In the context of this annex, the OBD system shall have the capability of detecting malfunctions, of indicating their occurrence by means of a malfunction ……
……"

Paragraph 4.3., amend to read:

"4.3. Requirements for recording OBD information

When a malfunction ……

When a confirmed and active malfunction is no longer detected by the system during a complete operating sequence, it shall be given the previously active status by the start of the next operating sequence and keep that status until the OBD information associated with this malfunction is erased by a scan tool or erased from the computer memory according to paragraph 4.4."

Paragraph 4.7.1.2., item (l), correct "active DTCs Class B1" to read "active DTCs for Class B1".

Paragraph 5.2.3., amend to read:

"5.2.3. Low fuel level

Manufacturers may request approval to disable monitoring systems that are affected by low fuel level / pressure or running out of fuel (e.g. diagnosis of a malfunction of the fuelling system or misfiring) as follows:

	DIESEL	GAS	
		NG	LPG
(a) The low fuel level considered for such a disablement shall not exceed 100 litres or 20 per cent of the nominal capacity of the fuel tank, whichever is lower.	X		X
(b) The low fuel pressure in the tank considered for such a disablement shall not exceed 20 per cent of the nominal fuel pressure in the tank		X	"

Add a new paragraph 5.2.8., to read:

"5.2.8. Re-fuelling

After a refuelling, the manufacturer of a gaseous-fuelled vehicle may temporarily disable the OBD system when the system has to adapt to the recognition by the ECU of a change in the fuel quality and composition.

The OBD system shall be re-enabled as soon as the new fuel is recognized and the engine parameters are readjusted. This disablement shall be limited to a maximum of 10 minutes."

Paragraph 6., amend to read (adding a new subparagraph (d)):

"6. DEMONSTRATION REQUIREMENTS

……

(d) procedure for selecting the reference fuel in case of a gas engine"

Paragraph 6.1.1., subparagraph (a), correct "mission" to read "emission".

Paragraph 6.3., amend to read:

"6.3. Procedures for demonstrating the OBD performance

The manufacturer shall ……

In the following paragraphs the requirements for demonstrating the OBD performance are listed, including requirements for testing. The number of tests shall be four times the number of engine families considered within the emission OBD family, but shall not be less than 8.

The monitors selected shall reflect the different types of monitors mentioned in paragraph 4.2. (i.e. emission threshold monitoring, performance monitoring, total functional failure monitoring, or component monitoring) in a well balanced manner. The monitors selected shall also reflect the different items listed in Appendix 3 of this annex in a well balanced manner."

Paragraph 6.3.2., amend to read (correcting also footnote 10/):

"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 10/ (emission threshold monitoring - see paragraph 4.2.) and it is required that the manufacturer demonstrates, by an emission test, the qualification of that deteriorated component.

10/ This paragraph will be extended to other monitors than emission threshold monitors at a later stage."

Insert a new paragraph 6.5., to read:

"6.5. Procedure for selecting the reference fuel in case of a gas engine

Demonstration of the OBD performance and malfunction classification shall be performed by using one of the reference fuels mentioned in Annex 5 on which the engine is designed to operate.

The selection of this reference fuel is done by the type approval authority, who shall provide sufficient time for the test laboratory to supply the selected reference fuel"

Paragraph 7.2., amend to read:

"7.2. Applicable tests

In the context of this annex:

(a) the emission test-cycle is the test-cycle used for the measurement of the regulated emissions when qualifying a deteriorated component or system,

(b) the OBD test-cycle is the test-cycle used to demonstrate the capacity of the OBD monitors to detect malfunctions."

Paragraph 7.2.2., amend to read (deleting the word "Word-wide harmonized"):

"7.2.2. OBD test cycle

The OBD test-cycle considered in this annex is the hot part of the WHTC cycle as described in Annex 4B.

On request of the manufacturer and after approval of the type approval authority, an alternative OBD test-cycle can be used (e.g. the cold part of the WHTC cycle) for a specific monitor. The request shall contain documentation (technical considerations, simulation, test results, etc.) showing that:

(a) the requested test-cycle appropriate to demonstrate monitoring occurs under real world driving conditions, and,

(b) the hot part of the WHTC cycle appears as less appropriate for the considered monitoring (e.g. fluid consumption monitoring)."

Paragraph 8.1.3., correct to read:

"8.1.3. Documentation associated with the emission-OBD family

……

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

Annex 9B, Appendix 2, correct the first paragraph to read:

"This appendix aims at illustrating the requirements set in paragraphs 4.3. and 4.6.5. of this annex."

Annex 9B, Appendix 3, amend to read (inserting also a new item 15):

"MONITORING REQUIREMENTS

The items of this appendix list the systems or components required to be monitored by the OBD system, according to paragraph 4.2. Unless specified otherwise, the requirements apply to both diesel and gas engines.

Appendix 3 - Item 1

ELECTRIC / ELECTRONIC COMPONENTS MONITORING

Electric/electronic components used to control or monitor the emission control systems described in this appendix shall be subject to Component Monitoring according to the provisions of paragraph 4.2. of this annex. This includes, but is not limited to, pressure sensors, temperature sensors, exhaust gas sensors and oxygen sensors when present, knock sensors, in-exhaust fuel or reagent 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.

Note: These provisions apply to all electric-electronic components, even if they belong to any of the monitors described in the other items of this appendix.

Appendix 3 - Item 2

DPF SYSTEM

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

(a) DPF substrate: the presence of the DPF substrate - total functional failure monitoring

(b) DPF performance: clogging of the DPF - total functional failure

(c) DPF performance: filtering and regeneration processes (e.g. particulate accumulation during the filtering process and particulate removal during a 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).

Appendix 3 - Item 3

SELECTIVE CATALYTIC REDUCTION (SCR) MONITORING

For the purpose of this Item, SCR means selective catalytic reduction or other lean NO_x catalyst device. The OBD system shall monitor the following elements of the SCR system on engines so-equipped for proper operation:

(a) Active/intrusive reagent injection system: the system's ability to regulate reagent delivery properly, whether delivered via an in-exhaust injection or an in-cylinder injection - performance monitoring.

(b) Active/intrusive reagent: the on-board availability of the reagent, the proper consumption of the reagent if a reagent other than fuel is used (e.g. urea) - performance monitoring.

(c) Active/intrusive reagent: to the extent feasible the quality of the reagent if a reagent other than fuel is used (e.g. urea) - performance monitoring.

(d) SCR catalyst conversion efficiency: the catalyst's SCR ability to convert NOx emission threshold monitoring.

Appendix 3 - Item 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:

(a) LNT capability: the LNT system's ability to adsorb/store and convert NO_x - performance monitoring.

(b) LNT active/intrusive reagent injection system: the system's ability to regulate reagent delivery properly, whether delivered via an in-exhaust injection or an in-cylinder injection - performance monitoring.

Appendix 3 - Item 5

OXIDATION CATALYSTS (incl. DIESEL OXIDATION CATALYST - DOC) MONITORING

This item applies to oxidation catalysts that are separate from other after-treatment systems. Those that are included in the canning of an after-treatment system are covered within the appropriate item of this appendix.

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

(a) HC conversion efficiency: the oxidation catalysts ability to convert HC upstream of other after-treatment devices - total functional failure monitoring.

(b) HC conversion efficiency: the oxidation catalysts ability to convert HC downstream of other after-treatment devices - total functional failure monitoring.

Appendix 3 - Item 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:

	DIESEL	GAS
(a1) 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.	X	
(a2) 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 - performance monitoring. (monitoring requirement to be further discussed)		X
(b) Slow response of the EGR actuator: the EGR system's ability to achieve the commanded flow rate within a manufacturer specified time interval following the command - performance monitoring.	X	X
(c) EGR cooler under cooling performance: the EGR cooler system's ability to achieve the manufacturer's specified cooling performance - performance monitoring.	X	X

Appendix 3 - Item 7

FUEL SYSTEM MONITORING

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

	DIESEL	GAS
(a) Fuel system pressure control: fuel system ability to achieve the commanded fuel pressure in closed loop control - performance monitoring.	X	
(b) Fuel system pressure control: fuel system ability to achieve the commanded fuel pressure in closed loop control in the case where the system is so constructed that the pressure can be controlled independently of other parameters - performance monitoring.	X	
(c) Fuel injection timing: fuel system ability to achieve the commanded fuel timing for at least one of the injection events when the engine is equipped with the appropriate sensors - performance monitoring.	X	
(d) Fuel injection system: ability to maintain the desired air-fuel ratio (incl. but not limited to self adaptation features) – performance monitoring.		X

Appendix 3 - Item 8

AIR HANDLING AND TURBOCHARGER/BOOST PRESSURE CONTROL SYSTEM

The OBD system shall monitor the following elements of the Air Handling and Turbocharger/Boost Pressure Control System on engines so-equipped for proper operation:

	DIESEL	GAS
(a1) Turbo under/over boost: turbo boost system's ability to maintain the commanded boost pressure, detecting both "boost pressure too low" and "boost pressure too high" conditions – emission threshold monitoring.	X	
(a2) Turbo under/over boost: turbo boost system's ability to maintain the commanded boost pressure, detecting both "boost pressure too low" and "boost pressure too high" conditions – performance monitoring (monitoring requirement to be further discussed).		X
(b) Variable geometry turbo (VGT) slow response: VGT system's ability to achieve the commanded geometry within a manufacturer specified time-performance monitoring.	X	X
(c) Charge air cooling: Charge air cooling system efficiency - total functional failure.	X	X

Appendix 3 - Item 9

VARIABLE VALVE TIMING (VVT) SYSTEM

The OBD system shall monitor the following elements of the Variable Valve Timing (VVT) System on engines so-equipped for proper operation:

(a) VVT target error: VVT system's ability to achieve the commanded valve timing - performance monitoring.

(b) VVT slow response: VVT system's ability to achieve the commanded valve timing within a manufacturer specified time interval following the command- performance monitoring.

Appendix 3 - Item 10

MISFIRE MONITORING

	DIESEL	GAS
(a) No prescriptions.	X	
(b) Misfire that may cause catalyst damage (e.g. by monitoring a certain percentage of misfiring in a certain period of time) – performance monitoring (monitoring requirement to be further discussed together with items 6 and 8).		X

Appendix 3 - Item 11

CRANKCASE VENTILATION SYSTEM MONITORING

No prescriptions.

Appendix 3 - Item 12

ENGINE COOLING SYSTEM MONITORING

The OBD system shall monitor the following elements of the Engine cooling system for proper operation:

(a) Engine coolant temperature (thermostat): Stuck open thermostat. Manufacturers need not monitor the thermostat if its failure will not disable any other OBD monitors - total functional failure.

Manufacturers need not monitor the engine coolant temperature or the engine coolant temperature sensor if the engine coolant temperature or the engine coolant temperature sensor is

not used to enable closed-loop/feedback control of any emissions control systems and/or will not disable any other monitor.

Manufacturers may suspend or delay the monitor for the time to reach close loop to enable temperature if the engine is subjected to conditions that could lead to false diagnosis (e.g. vehicle operation at idle for more than 50 to 75 per cent of the warm-up time).

Appendix 3 - Item 13

EXHAUST GAS AND OXYGEN SENSORS MONITORING

The OBD system shall monitor:

	DIESEL	GAS
(a) the electrical elements of the exhaust gas sensors on engines so-equipped for proper operation according to item 1 to this appendix – component monitoring.	X	X
(b) both the Primary and Secondary (fuel control) oxygen sensors. These sensors are considered as exhaust gas sensors to be monitored for proper operation according to item 1 to this appendix – component monitoring.		X

Appendix 3 - Item 14

IDLE SPEED CONTROL SYSTEM MONITORING

The OBD system shall monitor the electrical elements of the idle speed control systems on engines so-equipped for proper operation according to item 1 to this appendix.

Appendix 3 – Item 15

THREE-WAY CATALYST

The OBD system shall monitor the three-way catalyst on engines so-equipped for proper operation:

	DIESEL	GAS
(a) Three-way Catalyst Conversion efficiency: the catalyst ability to convert NOx and CO – performance monitoring.		X

"

Annex 9B, Appendix 4, amend to read:

"TECHNICAL COMPLIANCE REPORT

This report ……

FINAL COMPLIANCE REPORT

The documentation package and the herewith described OBD system / emission OBD family comply with the requirements of the following regulation:

Regulation … / version …/ enforcement date …. / type of fuel …
……"

Annex 9B, Appendix 4, item 4, paragraph 1.1., the table, line "Test information", amend "Testing fuel" to read "Reference fuel".

Annex 9B, Appendix 5, table 3, amend to read:

"Table 3: OPTIONAL INFORMATION, IF USED BY THE EMISSION OR THE OBD SYSTEM TO ENABLE OR DISABLE ANY OBD INFORMATION

	Freeze frame	Data stream
Fuel level or tank fuel pressure (as appropriate)	x	x
Engine oil temperature	x	x
Vehicle speed	x	x
Status of the fuel quality adaptation (active / not active) in case of gas engines		x
Engine control computer system voltage (for the main control chip)	x	x

"

Annex 9B, Appendix 5, table 4, amend to read:

"Table 4: OPTIONAL INFORMATION, IF THE ENGINE IS SO EQUIPPED, SENSES OR CALCULATES THE INFORMATION:

	Freeze frame	Data stream
Absolute throttle position ……	x	x
……		
Oxygen sensor output		x
Secondary Oxygen sensor output (when fitted)		x
NO_x sensor output		x

"

Insert a new Annex 9C, to read:

"Annex 9C

TECHNICAL REQUIREMENTS FOR ASSESSING THE IN-USE PERFORMANCE OF ON-BOARD DIAGNOSTIC SYSTEMS (OBD)

1. APPLICABILITY

In its current version, this annex is only applicable to road-vehicles equipped with a Diesel engine

2. (Reserved)

3. DEFINITIONS

3.1. "In-Use performance ratio"
The in-use performance ratio (IUPR) of a specific monitor m of the OBD system is: $IUPR_m = Numerator_m / Denominator_m$

3.2. "Numerator"
The numerator of a specific monitor m ($Numerator_m$) is a counter indicating the number of times a vehicle has been operated such that all monitoring conditions necessary for that specific monitor to detect a malfunction have been encountered.

3.3. "Denominator"
The denominator of a specific monitor m ($Denominator_m$) is a counter indicating the number of vehicle driving events, taking into account conditions specific to that specific monitor.

3.4. "General Denominator"
The general denominator is a counter indicating the number of times a vehicle has been operated, taking into account general conditions.

3.5. "Ignition cycle counter"
The ignition cycle counter is a counter indicating the number of engine starts a vehicle has experienced.

3.6. "Engine start"
An engine start consists of ignition-On, cranking and start of combustion, and is completed when the engine speed reaches 150 min^{-1} below the normal, warmed-up idle speed.

3.7. "Driving cycle"
A driving cycle means a sequence consisting of an engine start, an operating period, an engine shut-off, and the time until the next engine start.

3.8. Abbreviations

IUPR In-Use Performance Ratio

$IUPR_m$ In-Use Performance Ratio of a specific monitor m

4. GENERAL REQUIREMENTS

The OBD system shall have the capability of tracking and recording in-use performance data (paragraph 6.) of the OBD monitors specified in this paragraph, of storing these data in computer memory and communicating them off-board upon request (paragraph 7.).

The in-use performance data of a monitor consists of the numerator and denominator enabling the calculation of the IUPR.

4.1. IUPR monitors

4.1.1. Groups of monitors

Manufacturers shall implement software algorithms in the OBD system to individually track and report in-use performance data of the groups of monitors mentioned in Appendix 1 of this annex.

Manufacturers are not required to implement software algorithms in the OBD system to individually track and report in-use performance data of monitors running continuously as defined in paragraph 4.2.3. of Annex 9B if these monitors are already part of one of the groups of monitors mentioned in Appendix 1 of this annex.

In-use performance data of monitors associated to different exhaust lines or engine banks within a group of monitors shall be tracked and recorded separately as specified in paragraph 6 and reported as specified in paragraph 7.

4.1.2. Multiple monitors

For each group of monitors which are required to be reported by paragraph 4.1.1., the OBD system shall separately track in-use performance data, as specified in paragraph 6., for each of the specific monitors belonging to that group.

4.2. Limitation of the use of in-use performance data

In-use performance data of a single vehicle are used for the statistical evaluation of the in-use performance of the OBD system of a larger group of vehicles.

Contrary to other OBD data, in-use performance data cannot be used to draw conclusions concerning the road-worthiness of an individual vehicle.

5. REQUIREMENTS FOR CALCULATING IN-USE PERFORMANCE RATIOS

5.1. Calculation of the in-use performance ratio

For each monitor m considered in the present annex, the in-use performance ratio is calculated with the following formula:

$IUPR_m = Numerator_m / Denominator_m$

where the $Numerator_m$ and $Denominator_m$ are incremented according to the specifications of this paragraph.

5.1.1. Requirements for the ratio when calculated and stored by system

Each $IUPR_m$ ratio shall have a minimum value of zero and a maximum value of 7.99527 with a resolution of 0.000122. 1/

A ratio for a specific component shall be considered to be zero whenever the corresponding numerator is equal to zero and the corresponding denominator is not zero.

A ratio for a specific component shall be considered to be the maximum value of 7.99527 if the corresponding denominator is zero or if the actual value of the numerator divided by the denominator exceeds the maximum value of 7.99527.

5.2. Requirements for incrementing the numerator

The numerator shall not be incremented more than once per driving cycle.

The numerator for a specific monitor shall be incremented within 10 seconds if and only if the following criteria are satisfied on a single driving cycle:

(a) Every monitoring condition necessary for the monitor of the specific component to detect a malfunction and store a potential DTC has been satisfied, including enable criteria, presence or absence of related DTCs, sufficient length of monitoring time, and diagnostic executive priority assignments (e.g., diagnostic "A" shall execute prior to diagnostic "B").
Note: For the purpose of incrementing the numerator of a specific monitor, it may not be sufficient to satisfy all the monitoring conditions necessary for that monitor to determine the absence of a malfunction.

(b) For monitors that require multiple stages or events in a single driving cycle to detect a malfunction, every monitoring condition necessary for all events to

1/ This value corresponds to a maximum hexadecimal value of 0xFFFF with a resolution of 0x1.

have been completed shall be satisfied.

(c) For monitors which are used for failure identification and that run only after a potential DTC has been stored, the numerator and denominator shall be the same as those of the monitor detecting the original malfunction.

(d) For monitors that require an intrusive operation to further investigate the presence of a malfunction, the manufacturer may submit to the type approval authority an alternative way to increment the numerator. This alternative should be equivalent to that which would, had a malfunction been present, have permitted to increment the numerator.

For monitors that run or complete during engine-off operation, the numerator shall be incremented within 10 seconds after the monitor has completed during engine-off operation or during the first 10 seconds of engine start on the subsequent driving cycle.

5.3. Requirements for incrementing the denominator

5.3.1. General incrementing rules

The denominator shall be incremented once per driving cycle, if during this driving cycle

(a) the general denominator is incremented as specified in paragraph 5.4., and

(b) the denominator is not disabled according to paragraph 5.6., and

(c) when applicable, the specific additional incrementing rules specified in paragraph 5.3.2. are met.

5.3.2. Additional monitor specific incrementing rules

5.3.2.1. Specific denominator for evaporative system (reserved)

5.3.2.2. Specific denominator for secondary air systems (reserved)

5.3.2.3. Specific denominator for components / systems that operate at engine start-up only

In addition to the requirements of paragraph 5.3.1. (a) and (b), the denominator(s) for monitors of components or systems that operate only at engine start-up shall be incremented if the component or strategy is commanded "on" for a time greater than or equal to 10 seconds.

For purposes of determining this commanded "on" time, the OBD system may not include time during intrusive operation of any of the components or strategies later in the same driving cycle solely for the purposes of monitoring.

5.3.2.4. Specific denominator for components or systems that are not continuously commanded to function

In addition to the requirements of paragraph 5.3.1. (a) and (b), the denominator(s) for monitors of components or systems that are not continuously commanded to function (e.g. Variable Valve Timing systems - VVT- or EGR valves), shall be incremented if that component or system is commanded to function (e.g., commanded "on", "open", "closed", "locked") on two or more occasions during the driving cycle, or for a cumulative time greater than or equal to 10 seconds, whichever occurs first.

5.3.2.5. Specific denominator for DPF

In addition to the requirements of paragraph 5.3.1. (a) and (b), in at least one driving cycle the denominator(s) for DPF shall be incremented if at least 800 cumulative kilometres of vehicle operation or alternatively at least 750 minutes of engine run time have been experienced since the last time the denominator was incremented.

5.3.2.6. Specific denominator for oxidation catalysts

In addition to the requirements of paragraph 5.3.1 (a) and (b), in at least one driving cycle the denominator(s) for monitors of oxidation catalyst used for the purpose of DPF active regeneration shall be incremented if a regeneration event is commanded for a time greater than or equal to 10 seconds.

5.3.2.7. Specific denominator for hybrids (reserved)

5.4. Requirements for incrementing the general denominator

The general denominator shall be incremented within 10 seconds, if and only if, all the following criteria are satisfied on a single driving cycle:

(a) Cumulative time since start of driving cycle is greater than or equal to 600 seconds while remaining:
  (i) at an elevation of less than 2,500 meters above sea level, and
  (ii) at an ambient temperature of greater than or equal to 266 K (-7 degrees Celsius), and
  (iii) at an ambient temperature of lower than or equal to 308 K (35 degrees Celsius).

(b) Cumulative engine operation at or above 1150 min^{-1} for greater than or equal to 300 seconds while under the conditions specified in the above subparagraph (a); as alternatives left to the manufacturer an engine operation at or above 15 per cent calculated load or a vehicle operation at or above 40 km/h may be used in lieu of the 1150 min^{-1} criterion.

(c) Continuous vehicle operation at idle (e.g., accelerator pedal released by driver

and either vehicle speed less than or equal to 1.6 km/h or engine speed less than or equal to 200 min^{-1} above normal warmed-up idle) for greater than or equal to 30 seconds while under the conditions specified in the above subparagraph (a).

5.5. Requirements for incrementing the ignition cycle counter

The ignition cycle counter shall be incremented once and only once per engine start.

5.6. Incrementing disablement of the numerators, of the denominators and of the general denominator

5.6.1. Within 10 seconds of a malfunction being detected (i.e. a potential or a confirmed and active DTC is stored), which disables a monitor, the OBD system shall disable further incrementing of the corresponding numerator and denominator for each monitor that is disabled.

When the malfunction is no longer detected (e.g. the potential DTC is erased through self-clearing or through a scan-tool command), incrementing of all corresponding numerators and denominators shall resume within 10 seconds.

5.6.2. Within 10 seconds of the start of operation of a Power Take-Off unit (PTO) that disables a monitor as permitted in paragraph 5.2.5. of Annex 9B, the OBD system shall disable further incrementing of the corresponding numerator and denominator for each monitor that is disabled.

When the PTO operation ends, incrementing of all corresponding numerators and denominators shall resume within 10 seconds.

5.6.3. In the case of a malfunction (i.e. a potential or confirmed and active DTC has been stored) preventing determination of whether the criteria for the $Denominator_m$ of a monitor m mentioned in paragraph 5.3. are satisfied 2/, the OBD system shall disable further incrementing the $Numerator_m$ and $Denominator_m$ within 10 seconds.

Incrementing the $Numerator_m$ and $Denominator_m$ shall resume within 10 seconds when the malfunction is no longer present (e.g., pending code erased through self-clearing or by a scan tool command).

5.6.4. In the case of a malfunction (i.e. a potential or confirmed and active DTC has been stored) preventing determination of whether the criteria for the General denominator mentioned in paragraph 5.4. are satisfied 3/, the OBD system shall disable further

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2/ e.g. vehicle speed / engine speed / calculated load, ambient temperature, elevation, idle operation, or time of operation.

3/ The manufacturer is allowed to use an additional on-board diagnostic display, such as a dashboard mounted video display device, for providing access to in-use performance data. Such an additional device is not subject to the requirements of this annex.

incrementing the general denominator within 10 seconds.

Incrementing the general denominator shall resume within 10 seconds when the malfunction is no longer present (e.g., pending code erased through self-clearing or by a scan tool command).

The general denominator may not be disabled from incrementing for any other condition.

6. REQUIREMENTS FOR TRACKING AND RECORDING IN-USE PERFORMANCE DATA

For each group of monitors listed in Appendix 1 to this annex, the OBD system shall separately track numerators and denominators for each of the specific monitors listed in Appendix 3 of Annex 9B and belonging to that group.

It shall report only the corresponding numerator and denominator for the specific monitor that has the lowest numerical ratio.

If two or more specific monitors have identical ratios, the corresponding numerator and denominator for the specific monitor that has the highest denominator shall be reported for the specific group of monitors.

In order to determine without bias the lowest ratio of a group, only the monitors specifically mentioned in that group shall be taken into consideration (e.g. a NOx sensor when used to perform one of the monitors listed in Annex 9B, Appendix 3, item 3 "SCR" will be taken into consideration into the "exhaust gas sensor" group of monitors and not in the "SCR" group of monitors)

The OBD system shall also track and report the general denominator and the ignition cycle counter.

Note: according to paragraph 4.1.1., manufacturers are not required to implement software algorithms in the OBD system to individually track and report numerators and denominators of monitors running continuously.

7. REQUIREMENTS FOR STORING AND COMMUNICATING IN-USE PERFORMANCE DATA

Communication of the in-use performance data is a new use-case and is not included in the three existing use-cases which are dedicated to the presence of possible malfunctions

7.1. Information about in-use performance data

The information about in-use performance data recorded by the OBD system shall be available upon off-board request according to paragraph 7.2.

This information will provide type approval authorities with in use performance data.

The OBD system shall provide all information (according to the applicable standard set in Appendix 6) for the external IUPR test equipment to assimilate the data and provide an inspector with the following information:

(a) the VIN (vehicle identification number),

(b) the numerator and denominator for each group of monitors recorded by the system according to paragraph 6.,

(c) the general denominator,

(d) the value of the ignition cycle counter,

(e) the total engine running hours.

This information shall be available through "read-only" access (i.e. no clearing).

7.2. Access to in-use performance data

Access to in-use performance data shall be provided only in accordance with the standards mentioned in Appendix 6 of Annex 9B and the following sub-paragraphs. 4/

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

The access method (i.e. the access point/node) to in-use performance data shall be the same as the one used to retrieve all OBD information. This method shall permit access to the complete in-use performance data required by this annex.

7.3. Reinitialising in-use performance data

7.3.1. Reset to zero

Each number shall be reset to zero only when a non-volatile random access memory (NVRAM) reset occurs (e.g., reprogramming event). Numbers may not be reset to zero under any other circumstances including when a scan tool command to clear

4/ The manufacturer is allowed to use an additional on-board diagnostic display, such as a dashboard mounted video display device, for providing access to in-use performance data. Such an additional device is not subject to the requirements of this annex.

fault codes is received.

7.3.2. Reset in case of memory overflow

If either the numerator or denominator for a specific monitor reaches 65,535 ±2, both numbers shall be divided by two before either is incremented again to avoid overflow problems.

If the ignition cycle counter reaches the maximum value of 65,535 ±2, the ignition cycle counter may rollover and increment to zero on the next ignition cycle to avoid overflow problems.

If the general denominator reaches the maximum value of 65,535 ±2, the general denominator may rollover and increment to zero on the next driving cycle that meets the general denominator definition to avoid overflow problems.

Annex 9C - Appendix 1

GROUPS OF MONITORS

The groups of monitors considered in this annex are the following:

A. Oxidation catalysts
The monitors specific to that group are those listed in item 5 of Appendix 3 to Annex 9B.

B. Selective Catalytical Reduction systems (SCR)
The monitors specific to that group are those listed in item 3 of Appendix 3 to Annex 9B.

C. Exhaust gas and oxygen sensors
The monitors specific to that group are those listed in item 13 of Appendix 3 to Annex 9B.

D. EGR systems and VVT
The monitors specific to that group are those listed in items 6 and 9 and of Appendix 3 to Annex 9B.

E. DPF systems
The monitors specific to that group are those listed in item 2 of Appendix 3 to Annex 9B.

F. Boost pressure control system
The monitors specific to that group are those listed in item 8 of Appendix 3 to Annex 9B.

G. NOx adsorber
The monitors specific to that group are those listed in item 4 of Appendix 3 to Annex 9B.

H. Three-way catalyst
The monitors specific to that group are those listed in item 15 of Appendix 3 to Annex 9B.

I. Evaporative systems (reserved)

J. Secondary Air system (reserved)

A specific monitor shall belong only to one of these groups"

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