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From:	Secretary-General of the European Commission, signed by Mr Jordi AYET PUIGARNAU, Director
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To:	Mr Jeppe TRANHOLM-MIKKELSEN, Secretary-General of the Council of the European Union
No. Cion doc.:	C(2017) 8469 final ANNEXES 1 to 2
Subject:	ANNEXES to the Commission Delegated Regulation (EU) .../... amending Delegated Regulation (EU) No 44/2014, as regards vehicle construction and general requirements, and Delegated Regulation (EU) No 134/2014, as regards environmental and propulsion unit performance requirements for the approval of two- or three-wheel vehicles and quadricycles

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Delegations will find attached document C(2017) 8469 final ANNEXES 1 to 2.

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Brussels, 15.12.2017  
C(2017) 8469 final

ANNEXES 1 to 2

## **ANNEXES**

**to the**

**Commission Delegated Regulation (EU) .../...**

**amending Delegated Regulation (EU) No 44/2014, as regards vehicle construction and general requirements, and Delegated Regulation (EU) No 134/2014, as regards environmental and propulsion unit performance requirements for the approval of two- or three-wheel vehicles and quadricycles**

## **ANNEX I**

### **Amendments to Delegated Regulation (EU) No 44/2014**

Annexes IV and XII to Delegated Regulation (EU) No 44/2014 are amended as follows:

1. In Annex IV, points 4.1.1.3.1.1.1.1.1., 4.1.1.3.1.1.1.1.2. and 4.1.1.3.1.1.1.1.3. are replaced by the following:

"4.1.1.3.1.1.1.1.1. If the durability method set out in Article 23(3)(a) of Regulation (EU) No 168/2013 is applicable, the deterioration factors shall be calculated from the type I emission test results up to and including full distance referred to in Annex VII(A) to Regulation (EU) No 168/2013 and in accordance with the linear calculation method referred to in point 4.1.1.3.1.1.1.1.2. resulting in slope and offset values per emission constituent. The CoP pollutant emission results shall be calculated with the formula:

Equation 4-1:

$$Y_{full} = a (X_{Full} - X_{CoP}) + Y_{CoP}$$

where:

a = slope value ((mg/km)/km) determined in accordance with test type V set out in Annex V(A) to Regulation (EU) No 168/2013;

X<sub>Full</sub> = durability mileage (km) as set out in Annex VII to Regulation (EU) No 168/2013;

X<sub>CoP</sub> = Mileage of the CoP vehicle at moment of Type I CoP test;

Y<sub>full</sub> = CoP emission result per pollutant emission constituent in mg/km. The average CoP results shall be lower than the pollutant emission limits set out in Annex VI(A) to Regulation (EU) No 168/2013;

Y<sub>CoP</sub> = pollutant emission (THC, CO, NO<sub>x</sub>, NMHC and PM if applicable) test result (mg/km) per emission constituent of test type I with CoP vehicle.

4.1.1.3.1.1.1.1.2 If the durability method set out in Article 23(3)(b) of Regulation (EU) No 168/2013 is applicable, the deterioration trend shall consist of the slope value a, as is reflected in point 4.1.1.3.1.1.1.1.1, per emission constituent calculated to comply with test type V in accordance with Annex V(A) to Regulation (EU) No 168/2013. Equation 4-1 shall be used to calculate the CoP emission results per pollutant emission constituent (Y<sub>full</sub>).

4.1.1.3.1.1.1.1.3. If the durability method set out in Article 23(3)(c) of Regulation (EU) No 168/2013 is applicable, the fixed deterioration factors set out in Annex VII(B) to Regulation (EU) No 168/2013 shall be multiplied by the type test I result of the CoP vehicle (Y<sub>cop</sub>) to calculate the average CoP emission results per pollutant emission constituent (Y<sub>full</sub>).".

2. Annex XII is amended as follows:

- (a) the following point 3.2.3. is inserted:

"3.2.3. Identification of deterioration or malfunctions may also be done outside a driving cycle (e.g. after engine shutdown).";

- (b) point 3.3.2.2. is replaced by the following:

"3.3.2.2. Engine misfire

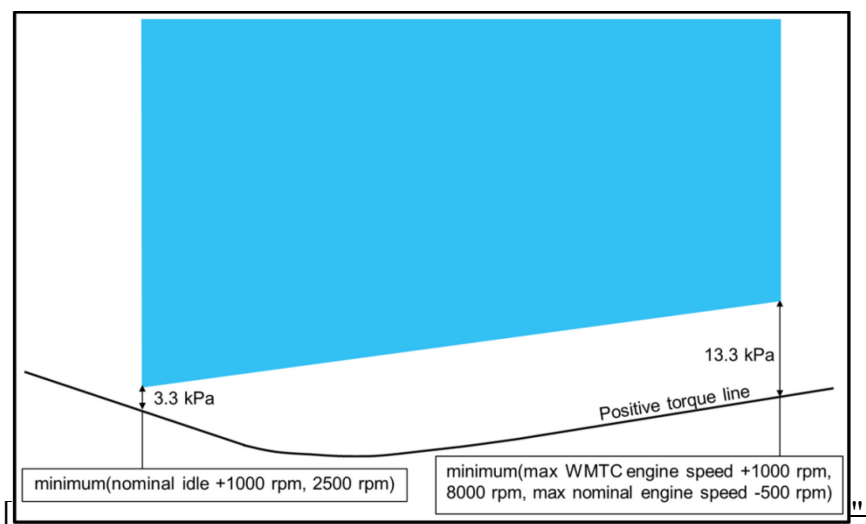
The presence of engine misfire in the engine operating region bounded by the following lines:

- (a) low speed limit: A minimum speed of  $2500 \text{ min}^{-1}$  or normal idle speed  $+1000 \text{ min}^{-1}$ , whichever is the lower
- (b) high speed limit: A maximum speed of  $8000 \text{ min}^{-1}$  or  $1000 \text{ min}^{-1}$  greater than the highest speed occurring during a type I test cycle or maximum design engine speed minus  $500 \text{ min}^{-1}$ , whichever is lower
- (c) a line joining the following engine operating points:
  - (i) a point on the low speed limit defined in (a) with the engine intake vacuum at  $3.3 \text{ kPa}$  lower than that at the positive torque line;
  - (ii) a point on the high speed limit defined in (b) with the engine intake vacuum at  $13.3 \text{ kPa}$  lower than that at the positive torque.

The engine operation region for misfire detection is reflected in figure 10-1.

Figure 10-1

Operating region for misfire detection



- (c) the following point 3.10. is inserted:

"3.10. Additional provisions for vehicles employing engine shut - off strategies.

3.10.1. Driving cycle

3.10.1.1. Autonomous engine restarts commanded by the engine control system following an engine stall may be considered a new driving cycle or a continuation of the existing driving cycle.";

- (d) Appendix 1 is amended as follows:

- (1) point 3.2. is replaced by the following:

"3.2. If available, the following signals in addition to the required freeze-frame information shall be made available on demand through the serial port on the standardised diagnostic connector, if the information is available to the on-

board computer or can be determined using information available to the on-board computer: diagnostic trouble codes, engine coolant temperature, fuel control system status (closed-loop, open-loop, other), fuel trim, ignition timing advance, intake air temperature, manifold air pressure, air flow rate, engine speed, throttle position sensor output value, secondary air status (upstream, downstream or atmosphere), calculated load value, vehicle speed and fuel pressure.

The signals shall be provided in standard units based on the specifications in point 3.7. Actual signals shall be clearly identified separately from default value or limp-home signals.";

- (2) points 3.11., 3.12. and 3.13 are replaced by the following:

"3.11. When a fault is registered, the manufacturer shall identify the fault using an appropriate fault code consistent with those in ISO 15031-6:2010 'Road vehicles — Communication between vehicle and external test equipment for emissions-related diagnostics — Part 6: Diagnostic trouble code definitions' relating to 'emission-related system diagnostic trouble codes'. If this is not possible, the manufacturer may use the diagnostic trouble codes of ISO DIS 15031-6:2010. Alternatively, fault codes may be compiled and reported in accordance with ISO14229:2006. The fault codes shall be fully accessible by standardised diagnostic equipment complying with point 3.9.

The vehicle manufacturer shall provide to a national standardisation body the details of any emission-related diagnostic data, e.g. PID's, OBD monitor Id's, Test Id's not specified in ISO 15031-5:2011 or ISO14229:2006, but relating to this Regulation.

3.12. The connection interface between the vehicle and the diagnostic tester shall be standardised and meet all the requirements of ISO 19689:2016 'Motorcycles and mopeds — Communication between vehicle and external equipment for diagnostics — Diagnostic connector and related electrical circuits, specification and use' or ISO 15031-3:2004 'Road vehicles — Communication between vehicle and external test equipment for emissions-related diagnostics — Part 3: Diagnostic connector and related electric circuits: specification and use'. The preferred installation position is under the seating position. Any other position of the diagnostic connector shall be subject to the approval authority's agreement and be readily accessible by service personnel but protected from tampering by non-qualified personnel. The position of the connection interface shall be clearly indicated in the user manual.

3.13. Until an OBD stage II system for L-category vehicle has been implemented on the vehicle, an alternative connection interface may be installed at the request of the vehicle manufacturer. Where such an alternative connection interface is installed, the vehicle manufacturer shall make available to test equipment manufacturers the details of the vehicle connector pin configuration free of charge. The vehicle manufacturer shall provide an adapter enabling connection to a generic scan tool. Such an adapter shall be of suitable quality for professional workshop use. It shall be provided upon request to all independent operators in a non-discriminating manner. Manufacturers may charge a reasonable and proportionate price for this adapter, taking into account the additional costs caused for the customer by this choice of the manufacturer. The connection interface and the adapter may not include any

specific design elements which would require validation or certification before use, or which would restrict the exchange of vehicle data when using a generic scan tool.";

- (3) point 4.1.4. is replaced by the following:

"4.1.4. From 1 January 2024, if, in accordance with the requirements of this Annex, the vehicle is equipped with a specific monitor M, IUPRM shall be greater than or equal to 0,1 for all monitors M.";

- (4) the following point 4.1.4.1. is inserted:

"4.1.4.1. Until 31 December 2023, the manufacturer shall demonstrate to the approval authority the functionality of IUPR determination, for new types of vehicles as of 1 January 2020 and for existing types of vehicles as of 1 January 2021.";

- (5) point 4.5. and 4.5.1. is replaced by the following:

"4.5. General Denominator

4.5.1. The general denominator is a counter measuring the number of times a vehicle has been operated. It shall be incremented within 10 seconds, if the following criteria are satisfied on a single driving cycle:

(a) Cumulative time since engine start is greater than or equal to 600 seconds at an elevation of less than 2 440 m above sea level or an ambient pressure of more than 75,7 kPa and an ambient temperature of 266,2 K (– 7 °C) or more;

(b) Cumulative vehicle operation at or above 25 km/h occurs for 300 seconds or more at an elevation of less than 2 440 m above sea level or an ambient pressure of more than 75,7 kPa and an ambient temperature of 266,2 K (– 7 °C) or more;

(c) Continuous vehicle operation at idle (i.e. accelerator pedal released by driver and vehicle speed of 1,6 km/h or less) for 30 seconds or more at an elevation of less than 2 440 m above sea level or an ambient pressure of more than 75,7 kPa and an ambient temperature of 266,2 K (– 7 °C) or more.

The general denominator may also be incremented outside the boundary conditions for altitude or ambient pressure and ambient temperature. ”;

- (6) the following point 4.6.2.1. is inserted:

"4.6.2.1. Numerators and denominators for specific monitors of components or systems that are monitoring continuously for short circuit or open circuit failures are exempted from reporting.

For the purposes of this point, "continuously" means monitoring is always enabled and sampling of the signal used for monitoring occurs at a rate no less than two samples per second and the presence or the absence of the failure relevant to that monitor has to be concluded within 15 seconds. If for control purposes, a computer input component is sampled less frequently, the signal of the component may instead be evaluated each time sampling occurs. It is not required to activate an output component/system for the sole purpose of monitoring that output component/system.";

- (7) point 4.7.4. is replaced by the following:

“4.7.4. The OBD system shall disable further incrementing of the general denominator within 10 seconds if a malfunction has been detected of any component used to determine whether the criteria in point 4.5 are satisfied (i.e. vehicle speed, ambient temperature, elevation, idle operation or time of operation) and the corresponding pending fault code has been stored. The general denominator may not be disabled from incrementing for any other condition. Incrementing of 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).”;

(e) Appendix 2 is amended as follows:

(i) in point 1, the footnote is deleted;

(ii) point 2.1. is replaced by the following;

"2.1.

Table Ap2-1

**Overview of devices (if fitted) to be monitored in OBD stage I and /or II**

No	Device circuits		Circuit continuity			Circuit rationality			Basic monitoring requirement	Comment No
			Level, refer to 2.3	Circuit High	Circuit Low	Open Circuit	Out of Range	Performance/Plausibility	Signal stuck	
1	Control module (ECU/PCU) internal error	3							I&II	<a href="#">(1)</a>
Sensor (input to control units)										
1	Accelerator (pedal/handle) position sensor	1	I&II	I&II	I&II	I&II	I&II	I&II		<a href="#">(2)</a>
2	Barometric pressure sensor	1	I&II	I&II	I&II		II			
3	Camshaft position	3							I&II	

	sensor									
4	Crankshaft position sensor	3							I&II	
5	Engine coolant temperature sensor	1	I&II	I&II	I&II	II	II	II		<sup>(4)</sup>
6	Exhaust control valve angle sensor	1	I&II	I&II	I&II	II	II	II		<sup>(4)</sup>
7	Exhaust gas recirculation sensor	1	II	II	II	II	II	II		<sup>(4)</sup>
8	Fuel rail pressure sensor	1	I&II	I&II	I&II	II	II	II		<sup>(4)</sup>
9	Fuel rail temperature sensor	1	I&II	I&II	I&II	II	II	II		<sup>(4)</sup>
10	Gear shift position sensor (potentiometer type)	1	I&II	I&II	I&II	II	II	II		<sup>(4)(5)</sup>
11	Gear shift position sensor (switch type)	3					II		I&II	<sup>(5)</sup>
12	Intake air temperature sensor	1	I&II	I&II	I&II	II	II	II		<sup>(4)</sup>
13	Knock sensor (Non-resonance type)	3							I&II	
14	Knock sensor (Resonance type)	3					I&II			
15	Manifold absolute pressure sensor	1	I&II	I&II	I&II	II	II	II		<sup>(4)</sup>
16	Mass air flow sensor	1	I&II	I&II	I&II	II	II	II		<sup>(4)</sup>
17	Engine oil temperature sensor	1	I&II	I&II	I&II	II	II	II		<sup>(4)</sup>
18	O <sub>2</sub> sensor (binary/linear) signals	1	I&II	I&II	I&II	II	II	II		<sup>(4)</sup>



19	Fuel (high) pressure sensor	1	I&II	I&II	I&II	II	II	II		<a href="#">(4)</a>
20	Fuel storage temperature sensor	1	I&II	I&II	I&II	II	II	II		<a href="#">(4)</a>
21	Throttle position sensor	1	I&II	I&II	I&II	I&II	I&II	I&II		<a href="#">(2)</a>
22	Vehicle speed sensor	3					II		I&II	<a href="#">(5)</a>
23	Wheel speed sensor	3					II		I&II	<a href="#">(5)</a>

#### Actuators (output control units)

1	Evaporative emission system purge control valve	2	II	I&II	II				I&II	<a href="#">(6)</a>
2	Exhaust control valve actuator (motor driven)	3					II		I&II	
3	Exhaust gas recirculation control	3					II			
4	Fuel injector	2		I&II					I&II	<a href="#">(6)</a>
5	Idle air control system	1	I&II	I&II	I&II		II		I&II	<a href="#">(6)</a>
6	Ignition coil primary control circuits	2		I&II					I&II	<a href="#">(6)</a>
7	O <sub>2</sub> sensor heater	1	I&II	I&II	I&II		II		I&II	<a href="#">(6)</a>
8	Secondary air injection system	2	II	I&II	II				I&II	<a href="#">(6)</a>
9	Throttle by wire actuator	3		I&II					I&II	<a href="#">(6)</a>

#### Comments :

(<sup>1</sup>) Only in case of an activated default mode leading to a significantly reduced propulsion torque or if a throttle by wire system is fitted.

(<sup>2</sup>) If redundant APS or redundant TPS are fitted, signal cross check(s) shall meet all circuit rationality requirements. If there is only one APS or TPS fitted, APS or TPS circuit rationality monitoring is not mandatory.

- (<sup>3</sup>) Deleted.
- (<sup>4</sup>) OBD stage II: two out of three of the circuit rationality malfunctions marked with ‘II’ shall be monitored in addition to circuit continuity monitoring.
- (<sup>5</sup>) only if used as input to ECU/PCU with relevance to environmental or functional safety performance.
- (<sup>6</sup>) Derogation allowed if manufacturer requests, level 3 instead, actuator signal present only without indication of symptom.";

(iii) point 2.4 is replaced by the following

"2.4. Two out of three symptoms in circuit continuity as well as in circuit rationality monitoring diagnostic may be combined, e.g.

- circuit high or open and low circuit;
- high and low or open circuit;
- signal out of range or circuit performance and signal stuck;
- circuit high and out of range high or circuit low and out of range low.";

(f) the following Appendices 3, 4 and 5 are added:

### "Appendix 3

#### In-use performance ratio

1. Introduction
  - 1.1. This Appendix sets out the in-use performance ratio of a specific monitor M of the OBD systems (IUPR M) requirements for L3e, L5e-A, and L7e-A vehicles type approved in accordance with this Regulation.
2. Audit of IUPR M
  - 2.1. At the request of the approval authority, the manufacturer shall report to the type-approval authority on warranty claims, warranty repair works and OBD faults recorded at servicing, according to a format agreed at type-approval. The information shall detail the frequency and substance of faults for emissions-related components and systems. The reports shall be filed at least once in the vehicle's production cycle, for each vehicle model for the duration of 5 years of age or the distance as laid down in Annex VII(A) to Regulation (EU) No 168/2013, whichever is sooner.
  - 2.2. Parameters defining IUPR family
 

For defining the IUPR family the OBD family parameters listed in Appendix 5 shall be used.
  - 2.3. Information requirements
 

An audit of IUPR M will be conducted by the approval authority on the basis of information supplied by the manufacturer. Such information shall include in particular, the following:

    - 2.3.1. The name and address of the manufacturer;

- 2.3.2. The name, address, telephone and fax numbers and e-mail address of his authorised representative within the areas covered by the manufacturer's information;
- 2.3.3. The model name(s) of the vehicles included in the manufacturer's information;
- 2.3.4. Where appropriate, the list of vehicle types covered within the manufacturer's information, i.e. for OBD and IUPR M, the OBD family in accordance with Appendix 5;
- 2.3.5. The vehicle identification number (VIN) codes applicable to these vehicle types within the family (VIN prefix);
- 2.3.6. The numbers of the type-approvals applicable to these vehicle types within the IUPR family, including, where applicable, the numbers of all extensions and field fixes/recalls (re-works);
- 2.3.7. Details of extensions, field fixes/recalls to those type-approvals for the vehicles covered within the manufacturer's information (if requested by the approval authority);
- 2.3.8. The period of time over which the manufacturer's information was collected;
- 2.3.9. The vehicle build period covered within the manufacturer's information (e.g. vehicles manufactured during the 2017 calendar year);
- 2.3.10. The manufacturer's IUPR M checking procedure, including:
- (a) vehicle location method;
  - (b) vehicle selection and rejection criteria;
  - (c) test types and procedures used for the programme;
  - (d) the manufacturer's acceptance/rejection criteria for the family group;
  - (e) geographical area(s) within which the manufacturer has collected information;
  - (f) sample size and sampling plan used.
- 2.3.11. The results from the manufacturer's IUPR M procedure, including:
- (a) identification of the vehicles included in the programme (whether tested or not). The identification shall include the following:
    - model name;
    - vehicle identification number (VIN);
    - region of use (where known
    - date of manufacture.
  - (b) the reason(s) for rejecting a vehicle from the sample:
  - (c) test data, including the following:
    - date of test/download;
    - location of test/download;

- all data, as required in accordance with point 4.1.6. of Appendix 1, downloaded from the vehicle;
- for each monitor to be reported the in-use-performance ratio.

2.3.12. For IUPR M sampling, the following:

- (a) the average of in-use-performance ratios IUPR M of all selected vehicles for each monitor in accordance with point 4.1.4. of Appendix 1.
- (b) The percentage of selected vehicles, which have an IUPR M greater or equal to the minimum value applicable to the monitor in accordance with point 4.1.4. of Appendix 1.

3. Selection of vehicles for IUPR M

3.1. The manufacturer's sampling shall be drawn from at least two Member States with substantially different vehicle operating conditions (unless only made available on the market in one Member State). Factors such as differences in fuels, ambient conditions, average road speeds, and urban/highway driving split shall be taken into consideration in the selection of the Member States.

For IUPR M testing, only vehicles fulfilling the criteria of point 2.3 of Appendix 4 shall be included in the test sample.

3.2. In selecting the Member States for sampling vehicles, the manufacturer may select vehicles from a Member State that is considered to be particularly representative. In this case, the manufacturer shall demonstrate to the approval authority which granted the type approval that the selection is representative (e.g. by the market having the largest annual sales of a vehicle family within the Union). When a family requires more than one sample lot to be tested as defined in point 3.3, the vehicles in the second and third sample lots shall reflect different vehicle operating conditions from those selected for the first sample.

3.3. Sample size

3.3.1. The number of sample lots shall depend on the annual sales volume of an OBD family in the Union, as defined in the following table:

EU Registrations — per calendar year (for tailpipe emission tests), — of vehicles of an OBD family with IUPR in the sampling period	Number of sample lots
up to 100 000	1
100 001 to 200 000	2
above 200 000	3

3.3.2. For IUPR, the number of sample lots to be taken is described in the table in point 3.3.1. and is based on the number of vehicles of an IUPR family that are approved with IUPR

For the first sampling period of an IUPR family, all of the vehicle types in the family that are approved with IUPR shall be considered to be subject to sampling. For subsequent sampling periods, only vehicle types

which have not been previously tested or are covered by emissions approvals that have been extended since the previous sampling period shall be considered to be subject to sampling.

For families consisting of fewer than 5 000 EU registrations that are subject to sampling within the sampling period the minimum number of vehicles in a sample lot is six. For all other families, the minimum number of vehicles in a sample lot to be sampled is fifteen.

Each sample lot shall adequately represent the sales pattern, i.e. at least high volume vehicle types ( $\geq 20\%$  of the family total) shall be represented.

Vehicles of small series productions with less than 1000 vehicles per OBD family are exempted from minimum IUPR requirements as well as the requirement to demonstrate these to the type approval authority.

4. On the basis of the audit referred to in Section 2 the approval authority shall adopt one of the following decisions and actions:
  - (a) decide that the IUPR family is satisfactory and not take any further action;
  - (b) decide that the data provided by the manufacturer is insufficient to reach a decision and request additional information or test data from the manufacturer;
  - (c) decide that based on data from the approval authority or Member State surveillance testing programmes, that information provided by the manufacturer is insufficient to reach a decision and request additional information or test data from the manufacturer;
  - (d) decide that the outcome of the audit for the IUPR family is unsatisfactory and proceed to have such vehicle type or IUPR family tested in accordance with Appendix 1.

If according to the IUPR M audit the test criteria of point 3.2. of Appendix 4 are met for the vehicles in a sample lot, the type-approval authority must take the further action described in point (d) of this point.

- 4.1. The approval authority, in cooperation with the manufacturer, shall select a sample of vehicles with sufficient mileage whose use under normal conditions can be reasonably assured. The manufacturer shall be consulted on the choice of the vehicles in the sample and allowed to attend the confirmatory checks of the vehicles.

#### Appendix 4

##### Selecting criteria for vehicles with respect to in use performance ratios

1. Introduction
  - 1.1. This Appendix sets out the criteria referred to in Section 4 of appendix 1 to this annex regarding the selection of vehicles for testing and the procedures for IUPR M.
2. Selection criteria

The criteria for acceptance of a selected vehicle are defined for IUPR M in Sections 2.1. to 2.5.

- 2.1. The vehicle shall belong to a vehicle type that is type-approved under this Regulation and covered by a certificate of conformity in accordance with Implementing Regulation (EU) No 901/2014<sup>1</sup>. For checking of IUPR M, the vehicle shall be approved to the OBD standard stage II or later. It shall be registered and have been used in the Union.
- 2.2. The vehicle shall have been in service for at least 3 000 km or 6 months, whichever the later, and for no more than the durability mileages given for the relevant vehicles category mentioned in Annex VII(A) to Regulation (EU) No 168/2013 or 5 years, whichever the sooner.
- 2.3. For checking IUPR M, the test sample shall include only vehicles that:
- (a) have collected sufficient vehicle operation data for the monitor to be tested.
- For monitors required to meet the in-use monitor performance ratio and to track and report ratio data pursuant to point 4.6.1. of Appendix 1, sufficient vehicle operation data shall mean the denominator meets the criteria set forth below. The denominator, as defined in points 4.3 and 4.5 of Appendix 1, for the monitor to be tested must have a value equal to or greater than one of the following values:
- (i) 15 for evaporative system monitors, secondary air system monitors, and monitors utilising a denominator incremented in accordance with point 4.3.2. of Appendix 1 (e.g. cold start monitors, air conditioning system monitors, etc.); or
  - (ii) 5 for particulate filter monitors and oxidation catalyst monitors utilising a denominator incremented in accordance with point 4.3.2. of Appendix 1; or
  - (iii) 30 for catalyst, oxygen sensor, EGR, VVT, and all other component monitors.
- (b) have not been tampered with or equipped with add-on or modified parts that would cause the OBD system not to comply with the requirements of Annex XII.
- 2.3. If any service has taken place, it shall be to the manufacturer's recommended service intervals.
- 2.4. The vehicle shall exhibit no indications of abuse (e.g. racing, overloading, mis-fuelling, or other misuse), or other factors (e. g. tampering) that could affect emission performance. The fault code and mileage information stored in the computer shall be taken into account. A vehicle shall not be selected for testing if the information stored in the computer shows that the vehicle has operated after a fault code was stored and a relatively prompt repair was not carried out.
- 2.5. There shall have been no unauthorised major repair to the engine or major repair of the vehicle.

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<sup>1</sup> Commission Implementing Regulation (EU) No 901/2014 of 18 July 2014 implementing Regulation (EU) No 168/2013 of the European Parliament and of the Council with regard to the administrative requirements for the approval and market surveillance of two- or three-wheel vehicles and quadricycles (OJ L 249, 22.8.2014, p. 1).

3. Plan of remedial measures
  - 3.1. The type approval authority shall request the manufacturer to submit a plan of remedial measures to remedy the non-compliance when:
  - 3.2. For IUPRM of a particular monitor M the following statistical conditions are met in a test sample, the size of which is determined in accordance with point 3.3.1. of Appendix 3.

For vehicles certified to a ratio of 0.1 in accordance with point 4.1.4. of Appendix 1, the data collected from the vehicles indicate for at least one monitor M in the test sample either that the test sample average in-use-performance ratio is less than 0.1 or that 66 per cent or more of the vehicles in the test sample have an in-use monitor performance ratio of less than 0.1.
  - 3.3. The plan of remedial measures shall be filed with the type approval authority not later than 60 working days from the date of the notification referred to in point 3.1. The type approval authority shall within 30 working days declare its approval or disapproval of the plan of remedial measures. However, where the manufacturer can demonstrate, to the satisfaction of the competent type approval authority, that further time is required to investigate the non-compliance in order to submit a plan of remedial measures, an extension is granted.
  - 3.4. The remedial measures shall apply to all vehicles likely to be affected by the same defect. The need to amend the type approval documents shall be assessed.
  - 3.5. The manufacturer shall provide a copy of all communications related to the plan of remedial measures, and shall also maintain a record of the recall campaign, and supply regular status reports to the type approval authority.
  - 3.6. The plan of remedial measures shall include the requirements specified in points 3.6.1. to 3.6.11. The manufacturer shall assign a unique identifying name or number to the plan of remedial measures.
    - 3.6.1. A description of each vehicle type included in the plan of remedial measures.
    - 3.6.2. A description of the specific modifications, alterations, repairs, corrections, adjustments, or other changes to be made to bring the vehicles into conformity including a brief summary of the data and technical studies which support the manufacturer's decision as to the particular measures to be taken to correct the non-conformity.
    - 3.6.3. A description of the method by which the manufacturer informs the vehicle owners.
    - 3.6.4. A description of the proper maintenance or use, if any, which the manufacturer stipulates as a condition of eligibility for repair under the plan of remedial measures, and an explanation of the manufacturer's reasons for imposing any such condition. No maintenance or use conditions may be imposed unless it is demonstrably related to the non-conformity and the remedial measures.

- 3.6.5. A description of the procedure to be followed by vehicle owners to obtain correction of the non-conformity. This shall include a date after which the remedial measures may be taken, the estimated time for the workshop to perform the repairs and where they can be done. The repair shall be done expediently, within a reasonable time after delivery of the vehicle.
- 3.6.6. A copy of the information transmitted to the vehicle owner.
- 3.6.7. A brief description of the system which the manufacturer uses to assure an adequate supply of component or systems for fulfilling the remedial action. It shall be indicated when there will be an adequate supply of components or systems to initiate the campaign.
- 3.6.8. A copy of all instructions to be sent to those persons who are to perform the repair.
- 3.6.9. A description of the impact of the proposed remedial measures on the emissions, fuel consumption, driveability, and safety of each vehicle type, covered by the plan of remedial measures with data, technical studies, etc. which support these conclusions.
- 3.6.10. Any other information, reports or data the type approval authority may reasonably determine is necessary to evaluate the plan of remedial measures.
- 3.6.11. Where the plan of remedial measures includes a recall, a description of the method for recording the repair shall be submitted to the type approval authority. If a label is used, an example of it shall be submitted.
- 3.7. The manufacturer may be required to conduct reasonably designed and necessary tests on components and vehicles incorporating a proposed change, repair, or modification to demonstrate the effectiveness of the change, repair, or modification.
- 3.8. The manufacturer is responsible for keeping a record of every vehicle recalled and repaired and the workshop which performed the repair. The type approval authority shall have access to the record on request for a period of 5 years from the implementation of the plan of remedial measures.
- 3.9. The repair and/or modification or addition of new equipment shall be recorded in a certificate supplied by the manufacturer to the vehicle owner.

## Appendix 5

### On-board diagnostics family

- 1. Introduction
  - 1.1. This Appendix sets out the criteria to define a OBD family as referred to in Appendices 3 and 4
- 2. Selection criteria
 

Vehicle types for which at least the parameters described below are identical are considered to belong to the same engine/emission control/OBD system combination.



- 2.2 Engine:
- combustion process (i.e. positive-ignition/compression-ignition, two stroke/four stroke/rotary),
  - method of engine fuelling (i.e. single or multi-point fuel injection),
  - fuel type (i.e. petrol, diesel, flex fuel petrol/ethanol, flex fuel diesel/biodiesel, NG/biomethane, LPG, bi fuel petrol/NG/biomethane, bi fuel petrol/LPG),
- 2.3 Emission control system:
- type of catalytic converter (i. e. oxidation, three-way, heated catalyst, SCR, other),
  - type of particulate trap,
  - secondary air injection (i.e. with or without),
  - exhaust gas recirculation (i.e. with or without),
- 2.4 OBD parts and functioning:
- the methods of OBD functional monitoring, malfunction detection and malfunction indication to the vehicle driver.

## ANNEX II

### Amendments to Delegated Regulation (EU) No 134/2014

Annexes II to VI, VIII and X to Delegated Regulation (EU) No 134/2014 are amended as follows:

1. Annex II is amended as follows:

(a) points 4.5.5.2.1.1. and 4.5.5.2.1.2. are replaced by the following:

"4.5.5.2.1.1. Step 1 — Calculation of shift speeds

Upshift speeds ( $v_{1 \rightarrow 2}$  and  $v_{i \rightarrow i+1}$ ) in km/h during acceleration phases shall be calculated using the following formula:

Equation 2-3:

$$v_{i \rightarrow i+1} = \left[ (0.5753 \times e^{(-1.9 \times \frac{P_n}{M_{ref}})}) \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_i}, i = 2 \text{ to } ng - 1$$

Equation 2-4:

$$v_{1 \rightarrow 2} = \left[ (0.5753 \times e^{(-1.9 \times \frac{P_n}{M_{ref}})}) - 0.1 \right] \times (s - n_{idle}) + n_{idle} \times \frac{1}{ndv_1}$$

where:

‘i’ is the gear number ( $\geq 2$ )

‘ng’ is the total number of forward gears

‘ $P_n$ ’ is the rated power in kW

$m_{ref}$ ’ is the reference mass in kg

$n_{idle}$ ’ is the idling speed in min<sup>-1</sup>

‘s’ is the rated engine speed in min<sup>-1</sup>

‘ $ndv_i$ ’ is the ratio between engine speed in min<sup>-1</sup> and vehicle speed in km/h in gear ‘i’.

4.5.5.2.1.2. Downshift speeds ( $v_{i \rightarrow i-1}$ ) in km/h during cruise or deceleration phases in gears 4 (4th gear) to ng shall be calculated using the following formula

Equation 2-5:

$$v_{i \rightarrow i-1} = \left[ (0.5753 \times e^{(-1.9 \times \frac{P_n}{M_{ref}})}) \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_{i-2}}, i = 4 \text{ to } ng$$

where:

i is the gear number ( $\geq 4$ )

ng is the total number of forward gears

$P_n$  is the rated power in kW

$M_{ref}$  is the reference mass in kg

$n_{idle}$  is the idling speed in min<sup>-1</sup>

$s$  is the rated engine speed in min<sup>-1</sup>

$ndv_{i-2}$  is the ratio between engine speed in min<sup>-1</sup> and vehicle speed in km/h in gear  $i-2$

The downshift speed from gear 3 to gear 2 ( $v_{3 \rightarrow 2}$ ) shall be calculated using the following equation:

Equation 2-6:

$$v_{2 \rightarrow 3} = \left[ (0.5753 \times e^{(-1.9 \times \frac{P_n}{M_{ref}})} - 0.1) \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_1}$$

where:

$P_n$  is the rated power in kW

$M_{ref}$  is the reference mass in kg

$n_{idle}$  is the idling speed in min<sup>-1</sup>

$s$  is the rated engine speed in min<sup>-1</sup>

$ndv_1$  is the ratio between engine speed in min<sup>-1</sup> and vehicle speed in km/h in gear 1

The downshift speed from gear 2 to gear 1 ( $v_{2 \rightarrow 1}$ ) shall be calculated using the following equation:

Equation 2-7:

$$v_{2 \rightarrow 1} = \left[ 0.03 \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_2}$$

where:

$ndv_2$  is the ratio between engine speed in min<sup>-1</sup> and vehicle speed in km/h in gear 2

Since the cruise phases are defined by the phase indicator, slight speed increases could occur and it may be appropriate to apply an upshift. The upshift speeds ( $v_{1 \rightarrow 2}$ ,  $v_{2 \rightarrow 3}$  and  $v_{i \rightarrow i+1}$ ) in km/h during cruise phases shall be calculated using the following equations:

Equation 2-7a:

$$v_{1 \rightarrow 2} = \left[ 0.03 \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_2}$$

Equation 2-8:

$$v_{2 \rightarrow 3} = \left[ (0.5753 \times e^{(-1.9 \times \frac{P_n}{M_{ref}})} - 0.1) \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_1}$$

Equation 2-9:

$$v_{i \rightarrow i+1} = \left[ (0.5753 \times e^{(-1.9 \times \frac{P_n}{M_{ref}})}) \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_{i-1}}, i = 3 \text{ to } ng$$

";

- (b) in point 4.5.6.1.2.2., in the last paragraph, the words "As an alternative,  $m_{r1}$  may be estimated as  $f$  percent of  $m$ ." are replaced by the words "As an alternative,  $m_{r1}$  may be estimated as 4 percent of  $m$ .";
- (c) in point 6.1.1.6.2.2., in Table 1-10, in the rows corresponding to vehicle categories L3a, L4e, L5e-A and L7e-A with a maximum speed lower than 130 km/h, the text in the fifth column (weighing factors) is replaced by the following:  
 $w_1 = 0,30$   
 $w_2 = 0,70$ ;
- (d) in Appendix 6, in section 3 ("World Harmonised Motorcycle Test Cycle (WMTC), stage 2"), in point 4.1.1, in Table Ap6-19, in the entry corresponding to 148 s, in the column for roller speed in km/h, the words "75,4" are replaced by the words "85,4".

2. Annex III is amended as follows:

- (a) point 4.2.2. is replaced by the following :  
 "4.2.2. For each adjustment component with a continuous variation, a sufficient number of characteristic positions shall be determined. The test shall be carried out with the engine at 'normal idling speed' and at 'high idle speed'. The definition of the possible position of the adjustment components to a just 'Normal idling speed' is defined under point 4.2.5. High idle engine speed is defined by the manufacturer but it must be higher than  $2\,000\text{ min}^{-1}$ . The high idle speed is reached and kept stable by manually operating the throttle pedal or throttle handle.";
- (b) point 4.2.5.1. is replaced by the following:  
 "4.2.5.1. the larger of the following two values:
  - (a) the lowest idling speed which the engine can reach;
  - (b) the speed recommended by the manufacturer, minus 100 revolutions per minute;"

3. Annex IV is amended as follows:

- (a) point 2.2.1. is replaced by the following:  
 "2.2.1. for new vehicle types and new engine types with regard to environmental performance equipped with a new design of the crankcase gas ventilation system, in which case a parent vehicle, with a crankcase gas ventilation concept representative of that approved, may be selected if the manufacturer so chooses to demonstrate to the satisfaction of the technical service and approval authority that the type III test has been passed;"
- (b) point 4.1. is replaced by the following:

"4.1. Test method 1.

The type III test shall be conducted in accordance with the following test procedure:";

- (c) point 4.1.4.3. is replaced by the following:

"4.1.4.3. The vehicle shall be deemed satisfactory if, in every condition of measurement defined in point 4.1.2., the average pressure measured in the crankcase does not exceed the average atmospheric pressure prevailing at the time of measurement.";

- (d) the following point 4.1.8. is inserted:

"4.1.8. If, in one or more of the conditions of measurement in point 4.1.2., the average pressure value measured in the crankcase within the time period in point 4.1.7. exceeds the atmospheric pressure, the additional test as defined in point 4.2.3. shall be performed to the satisfaction of the approval authority.";

- (e) points 4.2. and 4.2.1. are replaced by the following:

"4.2. Test method 2

4.2.1. The type III test shall be conducted in accordance with the following test procedure.";

- (f) point 4.2.1.2. is replaced by the following:

"4.2.1.2. A flexible bag impervious to crankcase gases and having a capacity of approximately 3 times the engine swept volume shall be connected to the dipstick hole. The bag shall be empty before each measurement.";

- (g) point 4.2.1.4. is replaced by the following:

"4.2.1.4. The vehicle shall be deemed satisfactory if, after every condition of measurement defined in points 4.1.2. and 4.2.1.3., no visible inflation of the bag occurs.";

- (h) the following point 4.2.2.4. is inserted:

"4.2.2.4. If one or more of the conditions of the test defined in point 4.2.1.2. are not met, the additional test set out in point 4.2.3. shall be performed to the satisfaction of the approval authority.";

- (i) point 4.2.3. is replaced by the following:

"4.2.3. Alternative additional type III test method (No 3)".

4. Annex V is amended as follows:

- (a) point 2.5. is replaced by the following:

"2.5. L-vehicle (sub-)categories L1e, L2e, L5e-B, L6e-B, L7e-B and L7e-C - shall be tested either in accordance with the permeation test procedure set out in Appendix 2 or the SHED test procedure set out in Appendix 3, at the choice of the manufacturer.";

- (b) point 2.6. is deleted;

- (c) in Appendix 2, point 1.1. is replaced by the following:

"1.1. As of the date of first application laid down in Annex IV to Regulation (EU) No 168/2013, fuel system permeation shall be tested in accordance with

the test procedure laid down in point 2. This base requirement shall apply to all L-category vehicles equipped with a fuel tank to store liquid, high volatile fuel, as applicable for a vehicle equipped with a positive ignition combustion engine, in accordance with Part B of Annex V to Regulation (EU) No 168/2013.

In order to satisfy the evaporative emission test requirements set out in Regulation (EU) No 168/2013, L-vehicle (sub-)categories L3e, L4e, L5e-A, L6e-A and L7e-A shall only be tested in accordance with the SHED test procedure laid down in Appendix 3 to this Annex."

5. Annex VI is amended as follows:

(a) point 3.3.1 is replaced by the following

"3.3.1. The emission results of the vehicle that has accumulated more than the distance prescribed in Article 23(3)(c) of Regulation (EU) No 168/2013 after it was first started at the end of the production line, the applied deterioration factors set out in Part B of Annex VII to Regulation (EU) No 168/2013, and the product of the multiplication of both and the emission limit set out in Annex VI to Regulation (EU) No 168/2013 shall be added to the test report.";

(b) point 3.4.2 is replaced by the following:

"3.4.2. The USA EPA Approved Mileage Accumulation cycle

At the choice of the manufacturer, the approved mileage accumulation (AMA) durability cycle may be conducted as alternative type V mileage accumulation cycle. The AMA durability cycle shall be conducted in accordance with the technical details laid down in Appendix 2.";

(c) the following point 3.4.3. is inserted:

"3.4.3. The AMA durability cycle is phased out for vehicles of class III referred to in table AP2-1 in Appendix 2 but may be used in a transitional period up to 31 December 2024.";

(d) the following points 3.6., 3.6.1., 3.6.2. and 3.7. are added:

"3.6. Bench ageing durability test.

3.6.1. As an alternative to points 3.1. or 3.2., the manufacturer may request to use the bench ageing procedure laid down in Appendix 3. The bench ageing durability test, as laid down in Appendix 3, shall determine the emissions of an aged vehicle by means of ageing the vehicle catalyst with the standard bench cycle (SBC) to produce the same amount of deterioration experienced by the catalyst due to thermal deactivation over the assigned test distance test laid down in Part A of Annex VII to Regulation (EU) No 168/2013.

3.6.2. The emission results of the vehicle that has accumulated more than 100 km after it was first started at the end of the production line and the deterioration factors as determined using the procedure as set out in Appendix 3 shall not exceed the emission limits in the applicable type I emission laboratory test cycle, as set out in Part A of Annex VI to Regulation (EU) No 168/2013. The emission results of the vehicle that has accumulated more than 100 km after it was first started at the end of the production line, the deterioration factors as determined using the procedure as set out in Appendix 3 to this Annex, the total emissions (calculated with the multiplication or

additive equations), and the emission limit set out in Annex VI to Regulation (EU) No 168/2013 shall be added to the test report.

3.7. At the request of the manufacturer, an additive exhaust emission deterioration factor (D.E.F.) may be calculated and used for the procedure set out in points 3.1. and 3.2. The deterioration factor shall be calculated for each pollutant as follows:

$$D. E. F. = M_{i2} - M_{i1}$$

Where:

$M_{i1}$  = mass emission of the pollutant i in g/km after the type 1 test of a vehicle in accordance with the procedure set out in points 3.1. and 3.2.

$M_{i2}$  = mass emission of the pollutant i in g/km after the type test 1 of an aged vehicle in accordance with the procedure set out in points 3.1. and 3.2.";

- (e) in Appendix 1, point 2.6.1. is replaced by the following:

"2.6.1. For the purpose of accumulating distance in the SRC-LeCV, the L-vehicle categories shall be grouped in accordance with Table Ap1-1.

Table Ap1-1.

L-vehicle category groups for SRC-LeCV

SRC Cycle classification	WTMC classification
1	Class 1
2	Class 2-1
2	Class 2-2
3	Class 3-1
4	Class 3-2";

- (f) Appendix 2 is amended as follows:

- (i) point 1.1. is replaced by the following

"1.1. The approved mileage accumulation (AMA) durability cycle by the Environmental Protection Agency (EPA) of the United States of America (USA) is a mileage accumulation cycle used to age test vehicles and their pollution-control devices in a way that is repeatable but significantly less representative for the EU fleet and traffic situation than the SRC-LeCV. The AMA durability cycle is phased out for vehicles of class III referred to in table Ap2-1 in this Appendix, however at the request of the manufacturer the cycles may be used in a transitional period up to 31 December 2024. The L- category

test vehicles may run the test cycle on the road, on a test track or on a kilometre accumulation chassis dynamometer.";

(ii) point 2.1. is replaced by the following:

"2.1. For the purpose of accumulating mileage in the AMA durability cycle, the L- category vehicles shall be grouped as follows:

Table Ap2-1

Grouping of L-category vehicles for the purpose of the AMA durability test

L-category vehicle class	Engine capacity (cm <sup>3</sup> )	V <sub>max</sub> (Km/h)
I	< 150	Not applicable
II	≥ 150	<130
III	≥ 150	≥130";

(g) the following Appendices 3 and 4 are added

### "Appendix 3

#### Bench ageing durability test

1. Bench ageing durability test
  - 1.1 The vehicle tested according the procedure laid down in this appendix has driven more than 100 accumulated kilometres after it was first started at the end of the production line.
  - 1.2. The fuel used during the test shall be the one of the specified fuels in Appendix 2 of Annex II.
2. Procedure for Vehicles with Positive Ignition Engines
  - 2.1. The following bench ageing procedure shall be applicable for positive-ignition vehicles including hybrid vehicles which use a catalyst as the principle after-treatment emission control device.  
  
The bench ageing procedure requires the installation of the catalyst-plus-oxygen sensor system on a catalyst ageing bench.  
  
Ageing on the bench shall be conducted by following the standard bench cycle (SBC) for the period of time calculated from the bench ageing time (BAT) equation. The BAT equation requires, as input, catalyst time-at-temperature data measured during the Standard Road Cycle (SRC-LeCV) described in Appendix 1. As an alternative, if applicable, the catalyst time-at-temperature data measured during the AMA durability cycle, as described in Appendix 2, may be used.
  - 2.2. Standard bench cycle (SBC). Standard catalyst bench ageing shall be conducted following the SBC. The SBC shall be run for the period of time calculated from the BAT equation. The SBC is described in Appendix 4 .
  - 2.3. Catalyst time-at-temperature data. Catalyst temperature shall be measured during at least two full cycles of the SRC-LeCV cycle as described in Appendix 1, or if applicable at least two full cycles of AMA as described in Appendix 2.



Catalyst temperature shall be measured at the highest temperature location in the hottest catalyst on the test vehicle. Alternatively, the temperature may be measured at another location providing that it is adjusted to represent the temperature measured at the hottest location using good engineering judgement.

Catalyst temperature shall be measured at a minimum rate of one hertz (one measurement per second).

The measured catalyst temperature results shall be tabulated into a histogram with temperature groups of no larger than 25 °C.

- 2.4. Bench-ageing time. Bench ageing time shall be calculated using the bench ageing time (BAT) equation as follows:

$$te \text{ for a temperature bin} = th \cdot e^{((R/Tr)-(R/Tv))}$$

Total  $te$  = Sum of  $te$  over all the temperature groups

$$\text{bench ageing time} = A \cdot (\text{Total } te)$$

Where:

A	= 1,1 This value adjusts the catalyst ageing time to account for deterioration from sources other than thermal ageing of the catalyst.
R	= Catalyst thermal reactivity = 18.500
th	= The time (in hours) measured within the prescribed temperature bin of the vehicle's catalyst temperature histogram adjusted to a full useful life basis e.g., if the histogram represented 400 km, and useful life is, in accordance with Annex VII to Regulation (EU) No 168/2013, for example for Le3 20.000 km; all histogram time entries would be multiplied by 50 (20.000/400).
Total $te$	= The equivalent time (in hours) to age the catalyst at the temperature of $Tr$ on the catalyst ageing bench using the catalyst ageing cycle to produce the same amount of deterioration experienced by the catalyst due to thermal deactivation over the use for live distance specific for the vehicle class in Annex VII to Regulation (EU) No 168/2013, for example for Le3 20.000 km
$te$ for a temperature bin	= The equivalent time (in hours) to age the catalyst at the temperature of $Tr$ on the catalyst ageing bench using the catalyst ageing cycle to produce the same amount of deterioration experienced by the catalyst due to thermal deactivation at the temperature bin of $Tv$ over the use for live distance specific for the vehicle class in Annex VII to Regulation (EU) No 168/2013, for example for Le3 20.000 km
$Tr$	= The effective reference temperature (in °K) of the catalyst on the catalyst bench run on the bench ageing cycle. The effective temperature is the constant temperature that would result in the same amount of ageing as the various temperatures experienced during the bench ageing cycle.
$Tv$	= The mid-point temperature (in °K) of the temperature bin of the vehicle on-road catalyst temperature histogram.

2.5. Effective reference temperature on the standard bench cycle (SBC). The effective reference temperature of the SBC shall be determined for the actual catalyst system design and actual ageing bench which will be used using the following procedures:

- (a) Measure time-at-temperature data in the catalyst system on the catalyst ageing bench following the SBC. Catalyst temperature shall be measured at the highest temperature location of the hottest catalyst in the system. Alternatively, the temperature may be measured at another location providing that it is adjusted to represent the temperature measured at the hottest location.

Catalyst temperature shall be measured at a minimum rate of one hertz (one measurement per second) during at least 20 minutes of bench ageing. The measured catalyst temperature results shall be tabulated into a histogram with temperature groups of no larger than 10 °C.

- (b) The BAT equation shall be used to calculate the effective reference temperature by iterative changes to the reference temperature (Tr) until the calculated ageing time equals or exceeds the actual time represented in the catalyst temperature histogram. The resulting temperature is the effective reference temperature on the SBC for that catalyst system and ageing bench.

2.6. Catalyst ageing bench. The catalyst ageing bench shall follow the SBC and deliver the appropriate exhaust flow and emission level in line with the exhaust flow of engine for which the catalyst is designed, exhaust constituents, and exhaust temperature at the face of the catalyst.

All bench ageing equipment and procedures shall record appropriate information (such as measured A/F ratios and time-at-temperature in the catalyst) to assure that sufficient ageing has actually occurred.

2.7. Required testing. For calculating deterioration factors at least two Type 1 tests before bench ageing of the emission control hardware and at least two Type 1 tests after the bench-aged emission hardware is reinstalled have to be performed on the test vehicle.

Calculation of the deterioration factors has to be done in accordance with the calculation method as specified below.

A multiplicative exhaust emission deterioration factor shall be calculated for each pollutant as follows:

$$D.E.F. = \frac{Mi2}{Mi1}$$

Where:

Mi 1 = mass emission of the pollutant i in g/km after the type 1 test of a vehicle specified in point 1.1. of this Appendix.

Mi 2 = mass emission of the pollutant i in g/km after the type test 1 of an aged vehicle according the procedure described in this Annex.

These interpolated values shall be carried out to a minimum of four places to the right of the decimal point before dividing one by the other to determine the deterioration factor. The result shall be rounded to three places to the right of the decimal point.

If a deterioration factor is less than one, it is deemed to be equal to one.

At the request of a manufacturer, an additive exhaust emission deterioration can be used, the factor shall be calculated for each pollutant as follows:

$$D. E. F. = M_{i2} - M_{i1}$$

#### Appendix 4

##### Standard bench cycle (SBC)

##### 1. Introduction

The standard ageing durability procedure consists of ageing a catalyst/oxygen sensor system on an ageing bench which follows the standard bench cycle (SBC) described in this Appendix. The SBC requires use of an ageing bench with an engine as the source of feed gas for the catalyst. The SBC is a 60-second cycle which is repeated as necessary on the ageing bench to conduct ageing for the required period of time. The SBC is defined based on the catalyst temperature, engine air/fuel (A/F) ratio, and the amount of secondary air injection which is added in front of the first catalyst.

##### 2. Catalyst temperature control

2.1. Catalyst temperature shall be measured in the catalyst bed at the location where the highest temperature occurs in the hottest catalyst. Alternatively, the feed gas temperature may be measured and converted to catalyst bed temperature using a linear transform calculated from correlation data collected on the catalyst design and ageing bench to be used in the ageing process.

2.2. Control the catalyst temperature at stoichiometric operation (1 to 40 seconds on the cycle) to a minimum of 800 °C (±10 °C) by selecting the appropriate engine speed, load, and spark timing for the engine. Control the maximum catalyst temperature that occurs during the cycle to 890 °C (±10 °C) by selecting the appropriate A/F ratio of the engine during the 'rich' phase described in the table below.

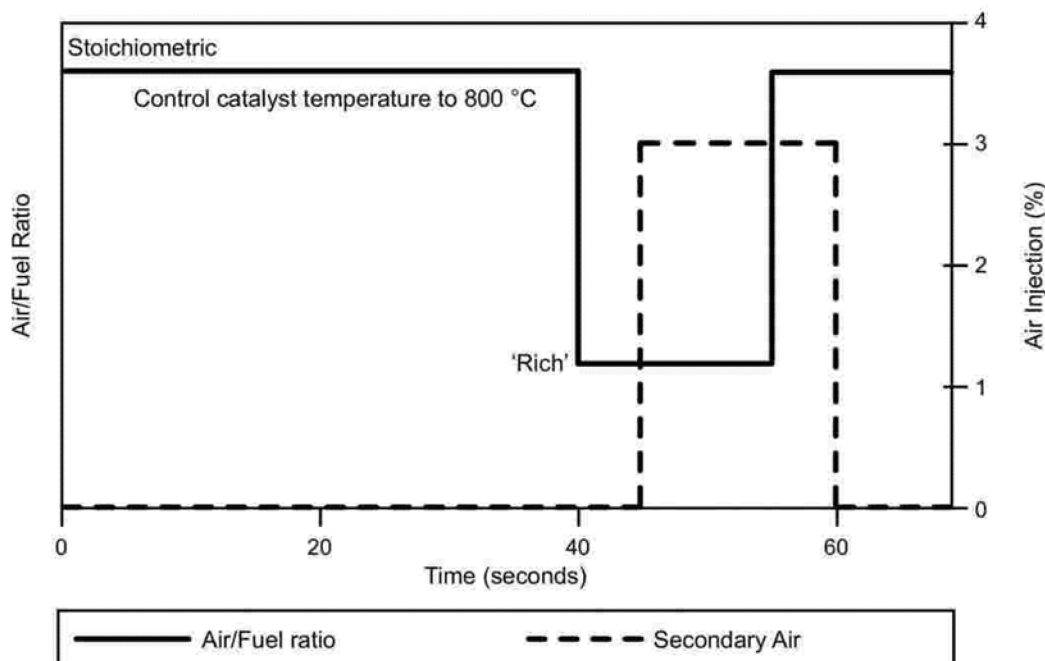
2.3. If a low control temperature other than 800 °C is utilized, the high control temperature shall be 90 °C higher than the low control temperature.

Standard bench cycle (SBC)

Time (seconds)	Engine Air/Fuel Ratio	Secondary Air Injection
1-40	Stoichiometric with load, spark timing and engine speed controlled to achieve a minimum catalyst temperature of 800 °C	None
41-45	'Rich' (A/F ratio selected to achieve a maximum catalyst temperature over the entire cycle of 890 °C or 90 °C higher than lower control	None

	temperature)	
46-55	'Rich' (A/F ratio selected to achieve a maximum catalyst temperature over the entire cycle of 890 °C or 90 °C higher than lower control temperature)	3 % ( $\pm 0,1$ %)
56-60	Stoichiometric with same load, spark timing and engine speed as used in the 1-40 sec period of the cycle	3 % ( $\pm 0,1$ %)

**Standard Bench Cycle**



### 3. Ageing bench equipment and procedures

#### 3.1. Ageing bench configuration. The ageing bench shall provide the appropriate exhaust flow rate, temperature, air-fuel ratio, exhaust constituents and secondary air injection at the inlet face of the catalyst.

The standard ageing bench consists of an engine, engine controller, and engine dynamometer. Other configurations may be acceptable (e.g. whole vehicle on a dynamometer, or a burner that provides the correct exhaust conditions), as long as the catalyst inlet conditions and control features specified in this Appendix are met.

A single ageing bench may have the exhaust flow split into several streams providing that each exhaust stream meets the requirements of this appendix. If the bench has more than one exhaust stream, multiple catalyst systems may be aged simultaneously.

#### 3.2. Exhaust system installation. The entire catalyst(s)-plus-oxygen sensor(s) system, together with all exhaust piping which connects these components, will be installed on the bench. For engines with multiple exhaust streams, each bank of the exhaust system will be installed separately on the bench in parallel.

For exhaust systems that contain multiple in-line catalysts, the entire catalyst system including all catalysts, all oxygen sensors and the associated exhaust piping will be installed as a unit for ageing.

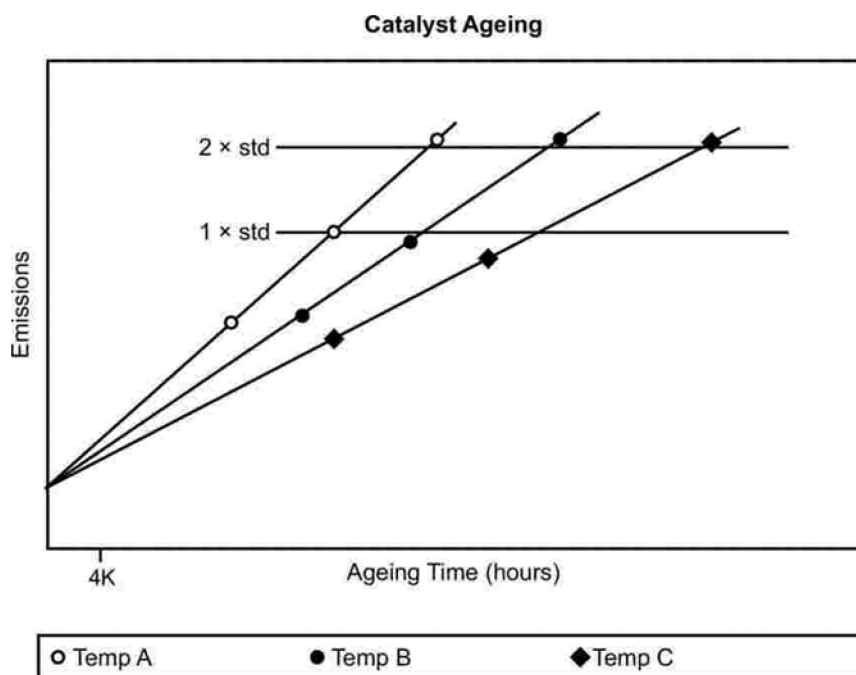
Alternatively, each individual catalyst may be separately aged for the appropriate period of time.

- 3.3. Temperature measurement. Catalyst temperature shall be measured using a thermocouple placed in the catalyst bed at the location where the highest temperature occurs in the hottest catalyst. Alternatively, the feed gas temperature just before the catalyst inlet face may be measured and converted to catalyst bed temperature using a linear transform calculated from correlation data collected on the catalyst design and ageing bench to be used in the ageing process. The catalyst temperature shall be stored digitally at the speed of 1 hertz (one measurement per second).
- 3.4. Air/Fuel measurement. Provisions shall be made for the measurement of the air/fuel (A/F) ratio (such as a wide-range oxygen sensor) as close as possible to the catalyst inlet and outlet flanges. The information from these sensors shall be stored digitally at the speed of 1 hertz (one measurement per second).
- 3.5. Exhaust flow balance. Provisions shall be made to assure that the proper amount of exhaust (measured in grams/second at stoichiometry, with a tolerance of  $\pm 5$  grams/second) flows through each catalyst system that is being aged on the bench.
- The proper flow rate is determined based upon the exhaust flow that would occur in the original vehicle's engine at the steady state engine speed and load selected for the bench ageing in point 3.6..
- 3.6. Setup. The engine speed, load, and spark timing are selected to achieve a catalyst bed temperature of  $800\text{ }^{\circ}\text{C}$  ( $\pm 10\text{ }^{\circ}\text{C}$ ) at steady-state stoichiometric operation.
- The air injection system is set to provide the necessary air flow to produce 3,0 % oxygen ( $\pm 0,1\text{ }%$ ) in the steady-state stoichiometric exhaust stream just in front of the first catalyst. A typical reading at the upstream A/F measurement point (required in point 5) is lambda 1,16 (which is approximately 3 % oxygen).
- With the air injection on, set the 'Rich' A/F ratio to produce a catalyst bed temperature of  $890\text{ }^{\circ}\text{C}$  ( $\pm 10\text{ }^{\circ}\text{C}$ ). A typical A/F value for this step is lambda 0,94 (approximately 2 % CO).
- 3.7. Ageing cycle. The standard bench ageing procedures use the standard bench cycle (SBC). The SBC is repeated until the amount of ageing calculated from the bench ageing time (BAT) equation is achieved.
- 3.8. Quality assurance. The temperatures and A/F ratio in points 3.3. and 3.4. shall be reviewed periodically (at least every 50 hours) during ageing. Necessary adjustments shall be made to assure that the SBC is being appropriately followed throughout the ageing process.

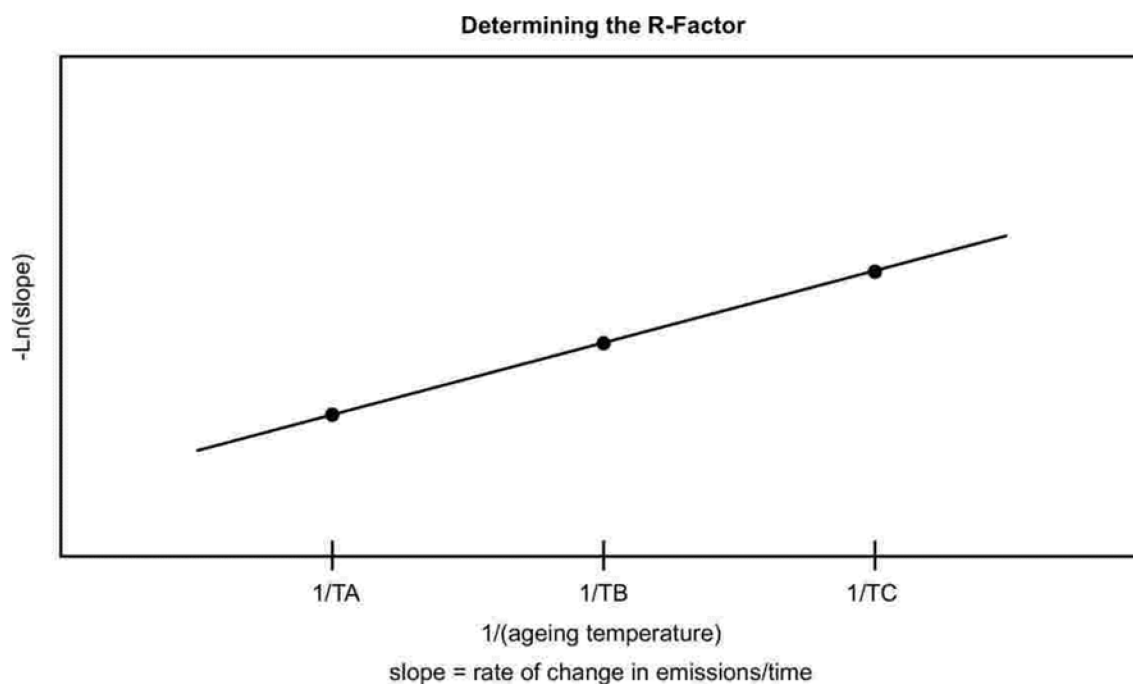
After the ageing has been completed, the catalyst time-at-temperature collected during the ageing process shall be tabulated into a histogram with temperature groups of no larger than  $10\text{ }^{\circ}\text{C}$ . The BAT equation and the calculated effective reference temperature for the ageing cycle in accordance with point 2.4. of Appendix 3 to Annex VI will be used to determine if the appropriate amount of thermal ageing of the catalyst has

in fact occurred. Bench ageing will be extended if the thermal effect of the calculated ageing time is not at least 95 % of the target thermal ageing.

- 3.9. Startup and shutdown. Care should be taken to assure that the maximum catalyst temperature for rapid deterioration (e.g., 1 050 °C) does not occur during startup or shutdown. Special low temperature startup and shutdown procedures may be used to alleviate this concern.
4. Experimentally determining the R-factor for bench ageing durability procedures
  - 4.1. The R-factor is the catalyst thermal reactivity coefficient used in the bench ageing time (BAT) equation. Manufacturers may determine the value of R experimentally using the following procedures.
  - 4.2. Using the applicable bench cycle and ageing bench hardware, age several catalysts (minimum of 3 of the same catalyst design) at different control temperatures between the normal operating temperature and the damage limit temperature. Measure emissions (or catalyst inefficiency (1-catalyst efficiency)) for each exhaust constituent. Assure that the final testing yields data between one- and two-times the emission standard.
  - 4.3. Estimate the value of R and calculate the effective reference temperature ( $T_r$ ) for the bench ageing cycle for each control temperature in accordance with point 2.4 of Appendix 3 to Annex VI.
  - 4.4. Plot emissions (or catalyst inefficiency) versus ageing time for each catalyst. Calculate the least-squared best-fit line through the data. For the data set to be useful for this purpose the data should have an approximately common intercept [between 0 and 6 400 km. See the following graph for an example.]
  - 4.5. Calculate the slope of the best-fit line for each ageing temperature.
  - 4.6. Plot the natural log (ln) of the slope of each best-fit line (determined in point 4.5) along the vertical axis, versus the inverse of ageing temperature ( $1/(\text{ageing temperature, deg K})$ ) along the horizontal axis, Calculate the least squared best-fit lines through the data. The slope of the line is the R-factor. See the following graph for an example



- 4.7. Compare the R-factor to the initial value that was used in accordance with point 4.3. If the calculated R-factor differs from the initial value by more than 5 %, choose a new R-factor that is between the initial and calculated values, and then repeat steps of point 4., to derive a new R-factor. Repeat this process until the calculated R-factor is within 5 % of the initially assumed R-factor.
- 4.8. Compare the R-factor determined separately for each exhaust constituent. Use the lowest R-factor (worst case) for the BAT equation.



6. Annex VIII is amended as follows:
- (a) point 1.2. is replaced by the following:

"1.2. The manufacturer shall make available the defective components or electrical devices to be used to simulate failures. When measured over the appropriate test type I cycle, such defective components or devices shall not cause the vehicle emissions to exceed by more than 20 percent the OBD thresholds set out in Annex VI(B) to Regulation (EU) No 168/2013. For electrical failures (short/open circuit), the emissions may exceed the limits of set out in Annex VI(B) to Regulation (EU) No 168/2013 by more than twenty per cent.

When the vehicle is tested with the defective component or device fitted, the OBD system shall be approved if the MI is activated. The OBD system shall also be approved if the MI is activated below the OBD threshold limits.";

- (b) point 3.1.2. is replaced by the following:

"3.1.2. In case of applying the durability test procedure set out in Article 23(3)(a) or 23(3)(b) of Regulation (EU) No 168/2013, or set out in point 3.6. of Annex VI to this Regulation, the test vehicles shall be equipped with the aged emission components used for durability tests as well as for the purposes of this Annex and the OBD environmental tests shall be finally verified and reported at the conclusion of the Type V durability testing. At the request of the manufacturer, a suitable aged and representative vehicle may be used for these OBD demonstrations test";

- (c) the following point 8.1.1. is inserted:

"8.1.1. The Type I test need not be performed for the demonstration of electrical failures (short/open circuit). The manufacturer may demonstrate these failure modes using driving conditions in which the component is used and the monitoring conditions are encountered. Those conditions shall be documented in the type approval documentation.";

- (d) the following point 8.2.3. is inserted:

"8.2.3. The use of additional preconditioning cycles or alternative preconditioning methods shall be documented in the type approval documentation.";

- (e) point 8.4.1.1. is replaced by the following:

"8.4.1.1. After vehicle preconditioning in accordance with point 8.2., the test vehicle is driven over the appropriate type I test.

The malfunction indicator shall activate before the end of this test under any of the conditions given in points 8.4.1.2. to 8.4.1.6. The MI may also be activated during preconditioning. The approval authority may substitute those conditions with others in accordance with point 8.4.1.6. However, the total number of failures simulated shall not exceed four for the purpose of type-approval.

For bi-fuelled gas vehicles, both fuel types shall be used within the maximum of four simulated failures at the discretion of the approval authority.".

7. Annex X is amended as follows:

- (f) in Appendix 1, point 8.1. is replaced by the following:

"8.1. The maximum vehicle speed, as determined by the technical service to the satisfaction of the approval authority, may differ from the value in point 7



by  $\pm 10\%$  for vehicles with a  $V_{\max} \leq$  than 30 km/h, and by  $\pm 5\%$  for vehicles with a  $V_{\max} > 30$  km/h.";

(g) Appendix 4 is amended as follows

(i) the title is replaced by the following

"Requirements concerning the method for measuring the maximum continuous rated power, switch-off distance and maximum assistance factor of an L1e category vehicle designed to pedal referred to in Article 3(94)(b) and pedal cycles as referred to in Article 2(2)(h) of Regulation (EU) No 168/2013";

(ii) the following point 1.3. is inserted

"1.3. Pedal cycles with pedal assistance as referred to in Article 2(2)(h) of Regulation (EU) No 168/2013.";

(iii) point 3.2. is replaced by the following

"3.2. Test procedure to measure the maximum continuous rated power

The maximum continuous rated power shall be measured in accordance with Appendix 3 or, alternatively, in accordance with the test procedure set out in section 4.2.7 of EN 15194:2009."