Submitted by the experts from EC

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Proposal for draft amendments to ECE/TRANS/WP.29/2010/53

(Regulation No. 83)

As a conclusion of the GRPE expert meeting on Euro-5 requirements (held in Geneva on 12 January 2010), this document was prepared by the experts from the European Commission to update and clarify the amendments to Regulation No. 83 with regard to the Euro 5 emissions level. It has been prepared as a revised version of document ECE/TRANS/WP.29/2010/53. The amendments to that document are marked a grey highlighted characters.

Paragraph 2.1.1., amend to read:

"2.1.1. the equivalent inertia determined in relation to the reference mass as prescribed in **Annex 4a, Table 3** and"

Paragraph 2.2., amend to read:

"2.2. "Reference mass" means the "unladen mass" of the vehicle increased by a uniform figure of 100 kg for test according to Annexes **4a** and 8;"

Insert a new Paragraph 2.2.2. after Paragraph 2.2.1.:

"2.2.2. "Running order mass" means the mass described in Paragraph 2.6. of Annex 1 to this Regulation and for vehicles designed and constructed for the carriage of more than 9 persons (in addition to the driver), the mass of a crew member (75 kg), if there is a crew seat amongst the nine or more seats."

Paragraph 2.5., amend to read:

"2.5. "Particulate pollutants" means components of the exhaust gas which are removed from the diluted exhaust gas at a maximum temperature of 325 K (52 °C) by means of the filters described in **Annex 4a; Appendix 4.**"

Insert a new Paragraph 2.5.1. after Paragraph 2.5.:

2.5.1. "Particle numbers" mean the total number of particles of greater than 23nm diameter present in the diluted exhaust gas after it has been conditioned to remove volatile material, as described in Annex 4A Appendix 5.

Paragraph 2.6., amend to read:

2.6. "Exhaust emissions" means:
- for positive-ignition (P.I.) engines, emissions of gaseous and particulate pollutants;

- for compression-ignition (C.I.) engines, emissions of gaseous pollutants, particulate pollutants and particle numbers;

Paragraph 3.1.1., subparagraph (a), amend to read:

"… from the start of a Type I test as described in **Annex 4a** to this Regulation …"

Paragraph 4.4.3., amend to read:

"4.4.3. The approval mark shall contain an additional character after the **type approval number,** the purpose of which is to distinguish **vehicle category and class** for which the approval has been granted. **This letter should be chosen according to the Table 1 in Annex 3 to this Regulation.**"

Paragraph 5.2.3. Table A, amend as follows (the complete table is reproduced with the amendments):

~~For bi-fuel vehicles with P.I. engines fuelled with Petrol (E5) or hydrogen, the test requirements "… (petrol only)" shall be replaced by "…~~**~~(petrol only)~~**~~(2)~~~~"~~,

~~and for flex-fuel vehicles with C.I. engines including hybrids, the test requirements "Yes" shall be replaced by "~~**~~Yes (B5 only)~~**~~(2)~~~~"~~,

~~For flex-fuel vehicles with P.I. engines fuelled with Petrol (E5) or ethanol, the test requirements for the Type VI test "Yes (both fuels)" shall be replaced by "~~**~~Yes (both fuels)~~**~~(3)~~~~"~~,

~~and notes (2) and (3) shall be added below the table:~~

~~**"(2) This provision is temporary, further requirements for biodiesel and hydrogen shall be proposed later on."**~~
~~**(3) For this test, fuel applicable to low ambient temperatures should be used. In the absence of a winter grade reference fuel specification, the applicable winter grade fuel for this test should be agreed between the approval authority and the manufacturer according to the existing market specifications."**~~

"Table A. REQUIREMENTS
Application of test requirements for type approval and extensions

	Vehicles with positive ignition engines including hybrids								Vehicles with C.I. engines including hybrids	
	Mono fuel				Bi fuel[1]			Flex fuel[1]	Flex fuel	Mono fuel
Reference fuel	Petrol (E5)	LPG	NG/ Biomethane	Hydrogen	Petrol (E5) LPG	Petrol (E5) NG/ Biomethane	Petrol (E5) Hydrogen	Petrol (E5) Ethanol (E85)	Diesel (B5) Biodiesel	Diesel (B5)
Gaseous pollutants (Type I test)	Yes	Yes	Yes		Yes (both fuels)	Yes (both fuels)	Yes (petrol only) [2]	Yes (both fuels)	Yes (B5 only) [2]	Yes
Particulates (Type I test)	Yes (direct injection)	-	-		Yes (direct injection) (petrol only)	Yes (direct injection) (petrol only)	Yes (direct injection) (petrol only) [2]	Yes (direct injection) (both fuels)	Yes (B5 only) [2]	Yes
Idle emissions (Type II test)	Yes	Yes	Yes		Yes (both fuels)	Yes (both fuels)	Yes (petrol only) [2]	Yes (both fuels)	-	-
Crankcase emissions (Type III test)	Yes	Yes	Yes		Yes (petrol only)	Yes (petrol only)	Yes (petrol only) [2]	Yes (petrol)	-	-
Evaporative emissions (Type IV test)	Yes	-	-		Yes (petrol only)	Yes (petrol only)	Yes (petrol only) [2]	Yes (petrol)	-	-
Durability (Type V test)	Yes	Yes	Yes		Yes (petrol only)	Yes (petrol only)	Yes (petrol only) [2]	Yes (petrol)	Yes (B5 only) [2]	Yes
Low temperature emissions (Type VI test)	Yes	-	-		Yes (petrol only)	Yes (petrol only)	Yes (petrol only) [2]	Yes (both fuels) [3]	-	-
In-service conformity	Yes	Yes	Yes		Yes (both fuels)	Yes (both fuels)	Yes (petrol only) [2]	Yes (both fuels)	Yes (B5 only) [2]	Yes
On-board diagnostics	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes

(1) When a bi fuel vehicle is combined with a flex fuel vehicle, both test requirements are applicable.

(2) This provision is temporary, further requirements for biodiesel and hydrogen shall be proposed later on.

(3) For this test, fuel applicable to low ambient temperatures should be used. In the absence of a winter grade reference fuel specification, the applicable winter grade fuel for this test should be agreed between the approval authority and the manufacturer according to the existing market specifications. Development of a reference fuel for this application is underway."

Paragraph 5.3.1.3., amend to read:

"5.3.1.3. The test is carried out using the **procedure of Type I test as described in Annex 4a. The method used to collect and analyse the gases is prescribed in Appendix 2 and 3 of Annex 4a, and the method to sample and analyse the particulates shall be as prescribed in Appendix 4 and 5 of Annex 4a.**"

Paragraph 5.3.1.4., Table I (emission limits), amend to read (the table is reproduced with the amendments):

Amend the header of the column "Mass of particulate matter(1) (PM)" to read "Mass of particulate matter (PM)", and

in the the column "Mass of particulate matter (PM)", delete limit value 5.0 in both subcolumns (for PI and DI engines), and retain only 4.5, and

delete notes (1) and (2), and renumber note (3) as (1).

Table 1:

Emissions limits

Limit values																
		Reference mass (RM) (kg)	Mass of carbon monoxide (CO)		Mass of total hydrocarbons (THC)		Mass of non-methane hydrocarbons (NMHC)		Mass of oxides of nitrogen (NO_x)		Combined mass of hydrocarbons and oxides of nitrogen (THC + NO_x)		Mass of particulate matter (PM)		Number of particles (P)	
			L_1 (mg/km)		L_2 (mg/km)		L_3 (mg/km)		L_4 (mg/km)		$L_2 + L_3$ (mg/km)		L_5 (mg/km)		L_6 (number/km)	
Category	Class		PI	CI	PI	CI	PI	CI	PI	CI	PI	CI	PI (1)	CI	PI	CI
M	-	All	1,000	500	100	-	68	-	60	180	-	230	4.5	4.5	-	6.0×10^{11}
N_1	I	RM ≤ 1,305	1,000	500	100	-	68	-	60	180	-	230	4.5	4.5	-	6.0×10^{11}
	II	1,305 < RM ≤ 1,760	1,810	630	130	-	90	-	75	235	-	295	4.5	4.5	-	6.0×10^{11}
	III	1,760 < RM	2,270	740	160	-	108	-	82	280	-	350	4.5	4.5	-	6.0×10^{11}
N_2	-	All	2,270	740	160	-	108	-	82	280	-	350	4.5	4.5	-	6.0×10^{11}
Key: PI = Positive Ignition, CI = Compression Ignition (1) Positive ignition particulate mass standard shall apply only to vehicles with direct injection engines.																

Paragraph 5.3.5.1., the first part of the paragraph, amend to read:

"5.3.5.1. This test shall not be applied to compression ignition vehicles

However, for compression ignition vehicles when applying for type approval, manufacturers shall present to the approval authority information showing that the NO_X after treatment device reaches a sufficiently high temperature for efficient operation within 400 seconds after a cold start at –7 °C as described in Type VI test.

In addition…"

Paragraph 5.3.5.1.2., amend to read:

"5.3.5.1.2. The test consists of the four elementary urban driving cycles of Part One of the Type I test. The Part One test is described in **paragraph 6.1.1. of Annex 4a, and illustrated in figure 1 of the same Annex.** The low ambient temperature …"

Paragraph 9.3.1, amend to read (the text of document ECE/TRANS/WP.29/2009/57 remains):

"9.3.1. The information gathered by the manufacturer shall be sufficiently comprehensive to ensure that in-service performance can be assessed for normal conditions of use as defined in paragraph 9.2. The manufacturer's sampling shall be drawn from at least two **Contracting Parties with substantially different vehicle operating conditions** ~~geographic regions when substantially different vehicle operating conditions exist within the Contracting Party~~. 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 Contracting Parties."

Paragraph 9.3.2., amend to read:

"9.3.2. In selecting the **Contracting Parties** ~~geographic regions~~ for sampling vehicles, the manufacturer may select vehicles from a ~~region~~ **Contracting Party** 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 ~~region~~ **market** having the largest annual sales of a vehicle family within the ~~Contracting Party~~ **applicable Contracting Party**). When an in-service family requires more than one sample lot to be tested as defined in paragraph 9.3.5., the vehicles in the second and third sample lots shall reflect different vehicle operating conditions from those selected for the first sample. ~~if such differencies exist within the Contracting Party.~~"

Paragraph 12, amend to read (paragraphs 12.1.2. (New type approvals), 12.1.3. (New vehicles) and 12.1.4. (On board diagnostic (OBD) system) and their sub-paragraphs shall be deleted):

"12. TRANSITIONAL PROVISIONS

12.1. General provisions

12.1.1. As from the official date of entry into force of the 06 series of amendments, no Contracting Party applying this Regulation shall refuse to grant approval under this Regulation as amended by the 06 series of amendments.

12.2. Special provisions

12.2.1. Contracting Parties applying this Regulation may continue to grant approvals to those vehicles which comply with previous levels of this Regulation, provided that the vehicles are intended for export to countries to apply the relating requirements in their national legislations."

Appendix 3,

Paragraph 4.1., amend to read:

"4.1. When a check on vehicles is deemed necessary, emission tests in accordance with **Annex 4a** to this Regulation are performed on pre-conditioned vehicles selected in accordance with the requirements of paragraphs 2. and 3. of this Appendix. Pre-conditioning cycles additional to those specified in **paragraph 6.3. of Annex 4a** to this Regulation will only be allowed if they are representative of normal driving."

Annex 1,

Item 1.1.1., renumber as item 1.3.3.

Item 2.1., renumber as item 2.6.

Item 2.2., renumber as item 2.8.

Item 3.2.9., delete the first of the two items 3.2.9.1.

Item 3.2.9.4, renumber as item 3.2.10.

Item 3.2.12.2.5.1., amend to read:

"3.2.12.2.5.1. ~~Complete~~ **D**etailed description of the devices and their state of tune:"

Item 3.2.12.2.6.4., amend to read:

"3.2.12.2.6.4. Regeneration system/method. Description and/or drawing: ....."

Item 3.5 and its sub-items, shall be deleted.

Item 6.6.1., amend to read:

6.6.1. Tyre / wheel combination(s)

(a) for all tyre options indicate size designation, load-capacity index, speed category symbol. ~~rolling resistance to ISO 28580 (where applicable)~~

(b) for tyres of category Z intended to be fitted on vehicles whose maximum speed exceeds 300 km/h equivalent information shall be provided; for wheels indicate rim size(s) and off-set(s)

Annex 2,

Addendum to Type approval Communication

Item 2.1, amend to read:

"2.1. Tailpipe emissions test results: .....
Emissions classification: 06 series of amendments ~~/ 07 series of amendments~~ 2/

Type approval…"

Item 2.5. and its sub-paragraphs, shall be deleted.

Annex 3, amend to read:

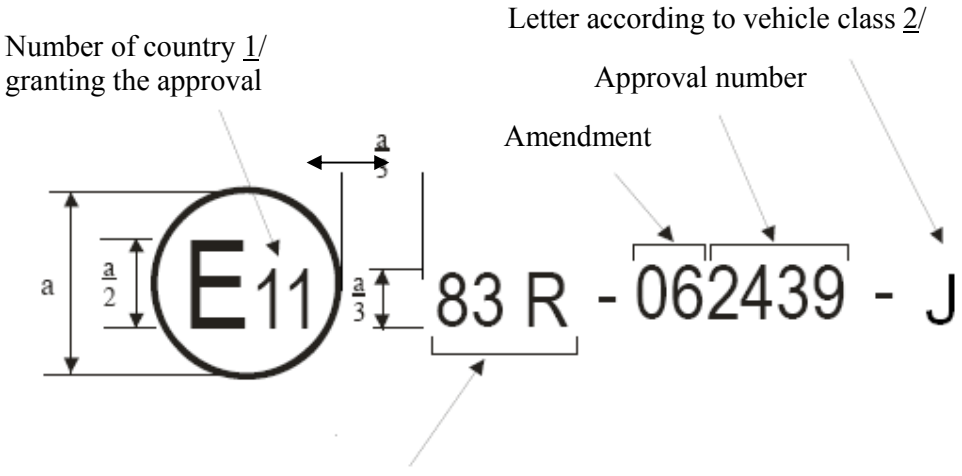
"Annex 3

ARRANGEMENTS OF THE APPROVAL MARK

In the approval mark issued and affixed to a vehicle in conformity with paragraph 4. of this Regulation, the type approval number shall be accompanied by an alphabetical character assigned according to Table 1 of this Annex, reflecting the vehicle category and class that the approval is limited to.

This annex outlines the appearance of this mark, and gives an example how it shall be composed.

The following schematic graph presents the general lay-out, proportions and contents of the marking. The meaning of numbers and alphabetical character are identified, and sources to determine the corresponding alternatives for each approval case are also referred.

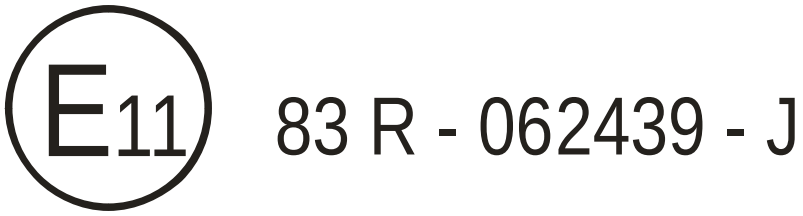


a = 8 mm (minimum)

Number of Regulation (Reg No. 83)

1/ Number of country according to footnote in paragraph 4.4.1. of this Regulation
2/ According to Table 1 of this Annex

The following graph is a practical example of how the marking should be composed.



The preceding approval mark affixed to a vehicle in conformity with paragraph 4. of this Regulation shows that the vehicle type concerned has been approved in the United Kingdom (E_{11}), pursuant to Regulation No. 83 under approval number 2439. This mark indicates that the approval was given in accordance with the requirements of this Regulation with the 06 series of amendments incorporated. Furthermore, the accompanying letter (J) denotes that the vehicle belongs to vehicle category M or $N_{1,I}$.

Table 1

Letters with reference to fuel, engine and vehicle category

Character	Vehicle category and class	Engine type
J	**M, N_1 class I.**	**PI CI**
K	**M_1 to fulfill specific social needs (excluding M_{1G})**	**CI**
L	**N_1 class II**	**PI CI**
M	**N_1 class III, N_2**	**PI CI**

"

Annex 4 and all its appendices, shall be deleted

Annex 4a,

Paragraph 1, amend to read:

"1. APPLICABILITY

This Annex effectively replaces former Annex 4.

Paragraph 6.6.4, amend to read:

6.6.4. Correction for dilution air concentration

The concentration of pollutant in the diluted exhaust gas shall be corrected by the amount of the pollutant in the dilution air as follows:

$$C_i = C_e - C_d \cdot \left(1 - \frac{1}{DF}\right) \quad (4)$$

where:

C_i = concentration of the pollutant i in the diluted exhaust gas, expressed in ppm and corrected by the amount of i contained in the dilution air,

C_e = measured concentration of pollutant i in the diluted exhaust gas, expressed in ppm,

C_d = concentration of pollutant i in the air used for dilution, expressed in ppm,

DF = dilution factor.

The dilution factor is calculated as follows:

$$DF = \frac{13.4}{C_{CO2} + (C_{HC} + C_{CO}) \cdot 10^{-4}} \quad \textbf{for petrol (E5)} \quad (5a)$$

$$DF = \frac{13.5}{C_{CO2} + (C_{HC} + C_{CO}) \cdot 10^{-4}}$$ **and diesel (B5)**(5a)

$$DF = \frac{11.9}{C_{CO2} + (C_{HC} + C_{CO}) \cdot 10^{-4}}$$ for LPG(5b)

$$DF = \frac{9.5}{C_{CO2} + (C_{HC} + C_{CO}) \cdot 10^{-4}}$$ for **NG/biomethane**(5c)

$$DF = \frac{12.5}{C_{CO2} + (C_{HC} + C_{CO}) \cdot 10^{-4}}$$ **for Ethanol (E85)(5d)**

In these equations:

C_{CO2} = concentration of CO_2 in the diluted exhaust gas contained in the sampling bag, expressed in per cent volume,

C_{HC} = concentration of HC in the diluted exhaust gas contained in the sampling bag, expressed in ppm carbon equivalent,

C_{CO} = concentration of CO in the diluted exhaust gas contained in the sampling bag, expressed in ppm.

Non-methane hydrocarbon concentration is calculated as follows:

CNMHC = CTHC — (Rf CH4 × CCH4) where:

CNMHC = corrected concentration of NMHC in the diluted exhaust gas, expressed in ppm carbon equivalent,

CTHC = concentration of THC in the diluted exhaust gas, expressed in ppm carbon equivalent and corrected by the amount of THC contained in the dilution air,

CCH4 = concentration of CH4 in the diluted exhaust gas, expressed in ppm carbon equivalent and corrected by the amount of CH4 contained in the dilution air,

Rf CH4 = is the FID response factor to methane as defined in paragraph 2.3 of Annex 4-Appendix 6.

Annex 4a, Appendix 3, Paragraph 1.3.2 – 1.3.10., amend to read:

1.3.2. **Total** hydrocarbons (**T**HC) analysis - spark-ignition engines:
The analyser shall be of the flame ionisation (FID) type calibrated with propane gas expressed equivalent to carbon atoms (C_1).

1.3.3. **Total** hydrocarbons (**T**HC) analysis - compression-ignition engines:
The analyser shall be of the flame ionisation type with detector, valves, pipework, etc., heated to 463 K (190 °C) ± 10 K (HFID). It shall be calibrated with propane gas expressed equivalent to carbon atoms (C_1).

1.3.4. Nitrogen oxide (NO_x) analysis:
The analyser shall be either of the chemi-luminescent (CLA) or of the non-dispersive ultra-violet resonance absorption (NDUVR) type, both with an NO_x-NO converter.

1.3.5. Methane (CH_4) analysis:
The analyser shall be either a gas chromatograph combined with a flame ionisation (FID), or a flame ionisation (FID) with a non-methane cutter type, calibrated with methane gas expressed equivalent to carbon atoms (C_1).

1.3.~~5~~**6.** The analysers shall have a measuring range compatible with the accuracy required to measure the concentrations of the exhaust gas sample pollutants.

1.3.~~6~~**7.** Measurement error shall not exceed ±2 per cent (intrinsic error of analyser) disregarding the true value for the calibration gases.

1.3.~~7~~**8.** For concentrations of less than 100 ppm, the measurement error shall not exceed ±2 ppm.

1.3.~~8~~**9.** The ambient air sample shall be measured on the same analyser with an appropriate range.

1.3.~~9~~**10.** No gas drying device shall be used before the analysers unless shown to have no effect on the pollutant content of the gas stream.

Annex 4a, Appendix 7,

Paragraph 4.1.2., amend to read:

"4.1.2. **The widest tyre shall be chosen. If there are more than three tyre sizes, the widest minus one shall be chosen.**"

Annex 7,

Paragraph 4.1., amend to read:

"4.1. Chassis dynamometer

The chassis dynamometer shall meet the requirements of **Appendix 1 of Annex 4a**."

Paragraph 5.2.1., amend to read:

"… Type I test as specified in **Annex 4a** …"

Paragraph 5.4.1., amend to read:

"… Type I test as described in **Annex 4a** (cold start urban and extra urban test) …"

Annex 7 - Appendix 1,

Paragraph 3.2., amend to read:

"3.2. Calibration of the HC analyser

The analyser should be calibrated using propane in air and purified synthetic air. See paragraph 3.2. of Appendix 3 of **Annex 4a**

Establish a calibration curve as described in paragraphs 4.1. to 4.5. of this appendix."

Annex 8,

Paragraph 2.1.1., amend to read:

"… requirements for the Type I test as specified in Annex 4a, … "

Paragraph 2.2.1., amend to read:

"2.2.1. The requirements of **Appendix 1 of Annex 4a** apply. The dynamometer shall be adjusted to simulate the operation of a vehicle on the road at 266 K (-7 °C). Such adjustment may be based on a determination of the road load force profile at 266 K (-7°C). Alternatively the driving resistance determined according to **Appendix 7 of Annex 4a** may be adjusted for a 10 per cent decrease of the coast-down time. The technical service may approve the use of other methods of determining the driving resistance."

Paragraph 2.2.2., amend to read:

"2.2.2. For calibration of the dynamometer the provisions of **Appendix 1 of Annex 4a** apply."

Paragraph 2.3.1., amend to read:

"2.3.1. The **provisions of Appendix 2 and Appendix 3 of Annex 4a** apply."

Paragraph 2.4.1., amend to read:

"2.4.1. The provisions of **Appendix 3 of Annex 4a** apply, but only for carbon monoxide, carbon dioxide, and **total** hydrocarbon testing."

Paragraph 2.4.2., amend to read:

"2.4.2. For calibrations of the analytical equipment the provisions of **Annex 4a** apply"

Paragraph 2.5.1., amend to read:

"2.5.1. The provisions of **paragraph 3 of Appendix 3 of Annex 4a** apply, where they are relevant."

Paragraph 2.6.1., amend to read:

"2.6.1. For equipment used for the measurement of volume, temperature, pressure and humidity the provisions in **paragraph 4.6 of Annex 4a** apply"

Paragraph 3.2., amend to read:

"3.2. The Part One urban driving cycle according to **Figure 1 in Annex 4a** …"

Paragraph 3.2.1., amend to read:

"… operation of the first cycle shall be in accordance with **Table 1 and Figure 1 in Annex 4a** …"

Paragraph 3.3.1., amend to read:

"3.3.1. For the test vehicle the provisions of **paragraph 3.2 of Annex 4a** apply. For setting the equivalent inertia mass on the dynamometer the provisions of **paragraph 6.2.1 of Annex 4a** apply."

Paragraph 4.2.3., amend to read:

"4.2.3. The preconditioning consists of ~~the~~ **one complete** driving cycle, Parts One and Two, **according to Tables 1 and 2 and Figure 1 of Annex 4a**. At the request of the manufacturer, vehicles with a positive-ignition engine may be preconditioned with one Part One and two Part Two driving cycles."

Paragraph 4.2.5., amend to read:

"4.2.5. The drive-wheel tyre pressure shall be set in accordance with the provisions of **paragraph 6.2.3. of Annex 4a**."

Paragraph 4.2.7., amend to read:

"… Part One cycle as described in **Table 1 and Figure 1 of Annex 4a.** …"

Paragraph 5.1.1., amend to read:

"… Part One cycle (**Annex 4a, Table 1 and Figure 1**)…"

Paragraph 5.2.1.4., amend to read:

"5.2.1.4. The vehicle speed as measured from the dynamometer roll(s) shall be used (**paragraph 1.2.6. of Appendix 1 of Annex 4a.**)"

Paragraph 5.3.1., amend to read:

"5.3.1. The provisions of **paragraph 6.4., excluding 6.4.1.2., of Annex 4a** apply …"

Paragraph 5.3.2., amend to read:

"…the provisions of **paragraph 6.5., excluding paragraph 6.5.2., of Annex 4a** apply. In…"

Paragraph 5.3.3., amend to read:

"… the provisions of **paragraph 6.6. of Annex 4a** apply."

Annex 9,

Paragraph 6.3.1.2., amend to read:

"… those described in **Appendix 7 of Annex 4a**."

Paragraph 6.3.1.4., amend to read:

"… those described in **Annex 4a** …"

Paragraph 7., amend to read:

7. MEASURING EMISSIONS OF POLLUTANTS

At the start of the test (0 km), and every 10,000 km (± 400 km) or more frequently, at regular intervals until having covered **160,000** km, exhaust emissions are measured in accordance with the Type I test as defined in paragraph 5.3.1. of this Regulation. The limit values to be complied with are those laid down in paragraph 5.3.1.4. of this Regulation.

In the case of vehicles equipped with periodically regenerating systems as defined in paragraph 2.20. of this Regulation, it shall be checked that the vehicle is not approaching a regeneration period. If this is the case, the vehicle shall be driven until the end of the regeneration. If regeneration occurs during the emissions measurement, a new test (including preconditioning) shall be performed, and the first result not taken into account.

All exhaust emissions results shall be plotted as a function of the running distance on the system rounded to the nearest kilometre and the best fit straight line fitted by the method of least squares shall be drawn through all these data points. This calculation shall not take into account the test results at 0 km.

The data will be acceptable for use in the calculation of the deterioration factor only if the interpolated 6,400 km and **160,000** km points on this line are within the above mentioned limits.

The data are still acceptable when a best fit straight line crosses an applicable limit with a negative slope (the 6,400 km interpolated point is higher than the **160,000** km interpolated point) but the **160,000** km actual data point is below the limit.

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

$$D.E.F. = \frac{Mi_2}{Mi_1}$$

where:

Mi_1 = mass emission of the pollutant i in g/km interpolated to 6,400 km,
Mi_2 = mass emission of the pollutant i in g/km interpolated to **160,000** km.

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 factor shall be calculated for each pollutant as follows:

$D . E . F . = Mi_2 – Mi_1$

Insert Appendix 1- 3 into Annex 9

Appendix 1

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

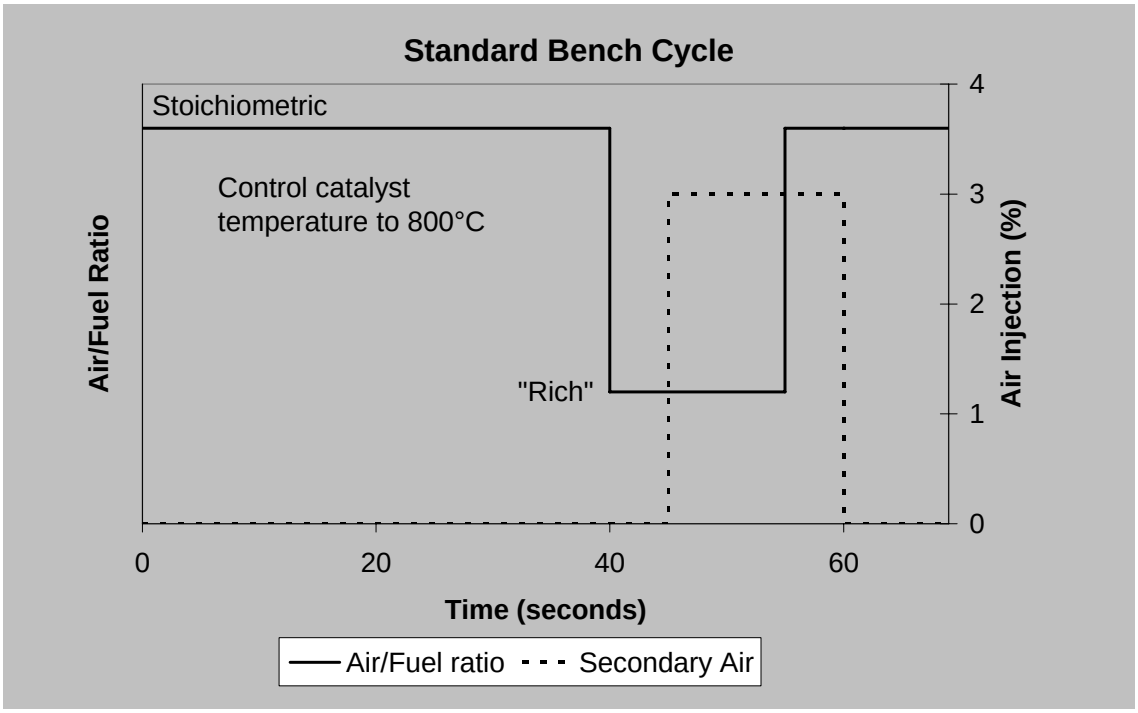
2.1. Catalyst temperature shall be measured in the catalyst bed at the location where the highest temperature occurs in the hottest catalyst. Alternatively, the feed gas temperature may be measured and converted to catalyst bed temperature using a linear transform calculated from correlation data collected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

2.2. Control the catalyst temperature at stoichiometric operation (01 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 temperature)	None
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% (± 1%)
56-60	Stoichiometric with load, spark timing and engine speed controlled to achieve a minimum catalyst temperature of 800°C	3% (± 1%)



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 (such as some V6 and V8 engines), 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 ±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 Paragraph 3.6. of this Appendix.

3.6. Setup. The engine speed, load, and spark timing are selected to achieve a catalyst bed temperature of 800 °C (± 10 °C) at steady-state stoichiometric operation.

The air injection system is set to provide the necessary air flow to produce 3.0% oxygen (± 0.1%) 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 paragraph 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 °C (±10 °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 equation (BAT) is achieved.

3.8. Quality Assurance. The temperatures and A/F ratio in paragraphs 3.3. and 3.4. of this appendix 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 °C. The BAT equation and the calculated effective reference temperature for the ageing cycle according to Paragraph 2.3.1.4. of Annex 9 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., 1050 °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.

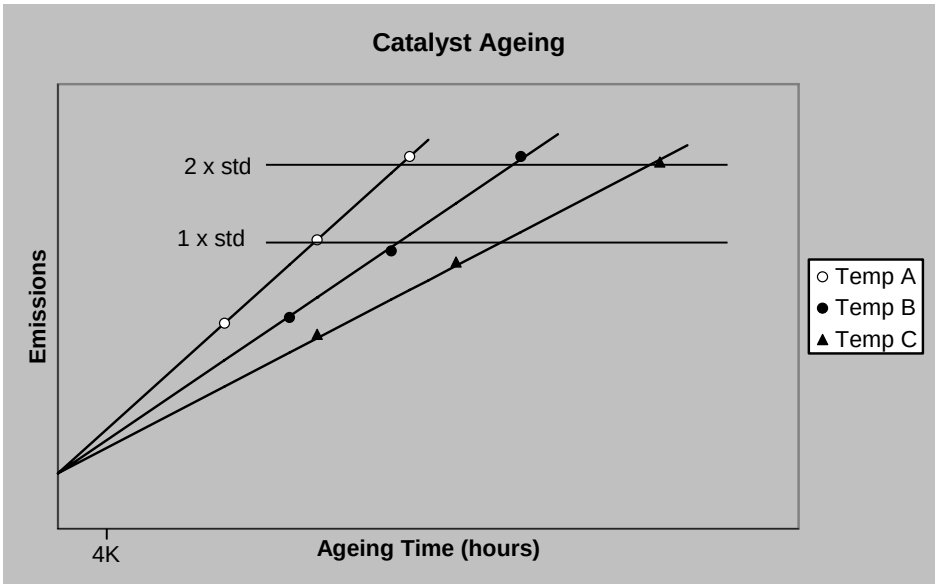
4.1.1. Using the applicable bench cycle and ageing bench hardware, age several catalysts (minimum of 3 of the same catalyst design) at different control temperatures between the normal operating temperature and the damage limit temperature. Measure emissions (or catalyst inefficiency (1-catalyst efficiency)) for each exhaust constituent. Assure that the final testing yields data between one- and two-times the emission standard.

4.1.2. Estimate the value of R and calculate the effective reference temperature (Tr) for the bench ageing cycle for each control temperature according to Paragraph 2.3.1.4. of Annex 9.

4.1.3. 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 6400 km. See the following graph for an example.

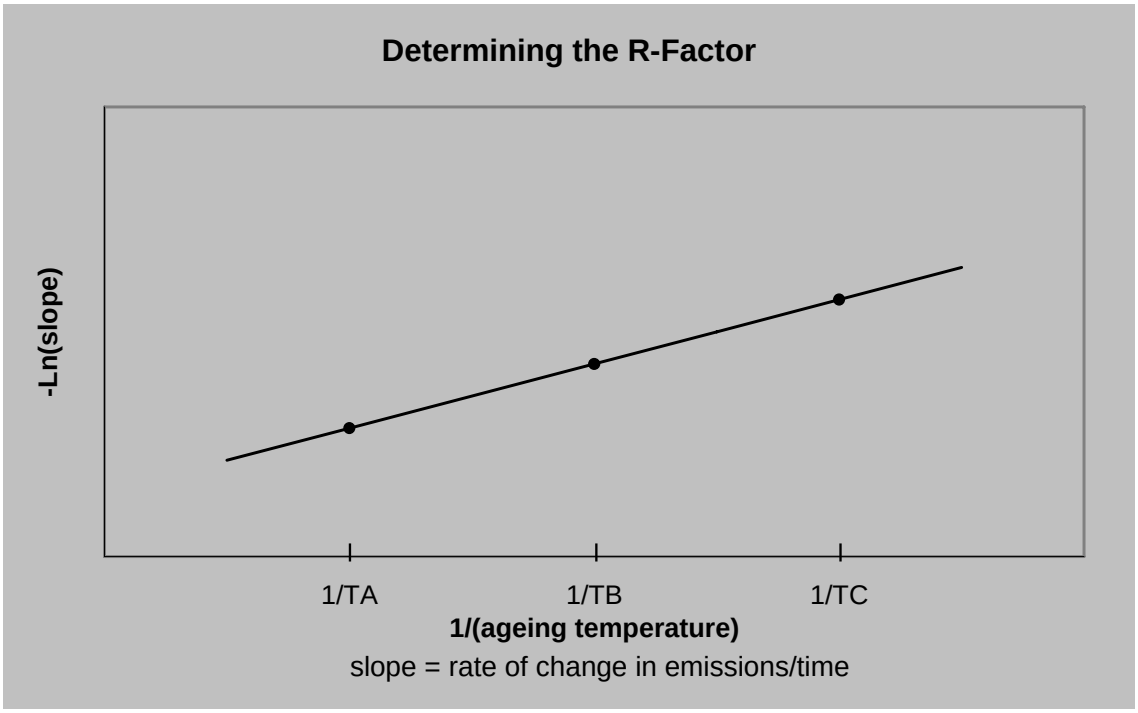
4.1.4. Calculate the slope of the best-fit line for each ageing temperature.

4.1.5. Plot the natural log (ln) of the slope of each best-fit line (determined in step 4.1.4.) along the vertical axis, versus the inverse of ageing temperature (1/(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.



4.1.6. Compare the R-factor to the initial value that was used in Step 4.1.2. 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 2–6 to derive a new R-factor. Repeat this process until the calculated R-factor is within 5% of the initially assumed R-factor.

4.1.7. Compare the R-factor determined separately for each exhaust constituent. Use the lowest R-factor (worst case) for the BAT equation.



Appendix 2

Standard Diesel Bench Cycle (SDBC)

1. Introduction

For particulate filters, the number of regenerations is critical to the ageing process. For systems that require desulphurisation cycles (e.g. NOx storage catalysts), this process is also significant.

The standard diesel bench ageing durability procedure consists of ageing an aftertreatment system on an ageing bench which follows the standard bench cycle (SDBC) described in this Appendix. The SDBC requires use of an ageing bench with an engine as the source of feed gas for the system.

During the SDBC, the regeneration/desulphurisation strategies of the system shall remain in normal operating condition.

2. The Standard Diesel Bench Cycle reproduces the engine speed and load conditions that are encountered in the SRC cycle as appropriate to the period for which durability is to be determined. In order to accelerate the process of ageing, the engine settings on the test bench may be modified to reduce the system loading times. For example the fuel injection timing or EGR strategy may be modified.

3. Ageing Bench Equipment and Procedures

3.1. 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 aftertreatment system 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 aftertreatment systems may be aged simultaneously.

3.2. Exhaust System Installation. The entire aftertreatment system, together with all exhaust piping which connects these components, will be installed on the bench. For engines with multiple exhaust streams (such as some V6 and V8 engines), each bank of the exhaust system will be installed separately on the bench.

The entire aftertreatment system will be installed as a unit for ageing. Alternatively, each individual component may be separately aged for the appropriate period of time.

Appendix 3

Standard Road Cycle (SRC)

Introduction

The standard road cycle (SRC) is a kilometre accumulation cycle. The vehicle may be run on a test track or on a kilometre accumulation dynamometer.

The cycle consists of 7 laps of a 6 km course. The length of the lap may be changed to accommodate the length of the mileage accumulation test track.

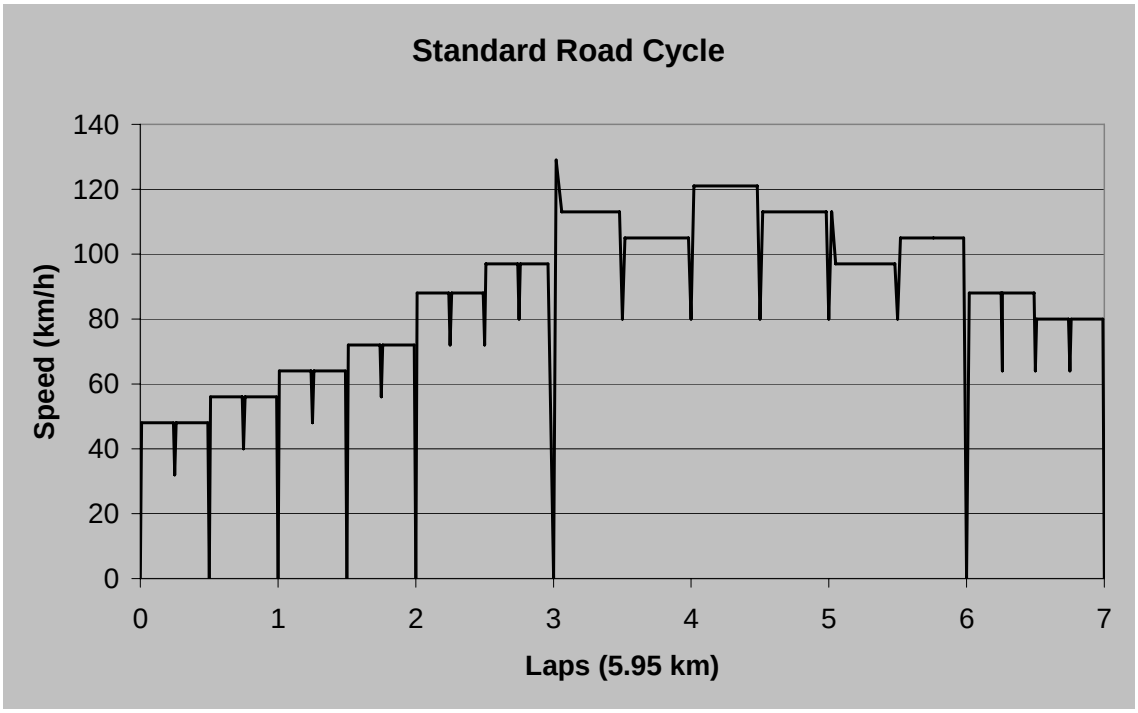
Standard Road cycle

	Description	Typical acceleration rate m/s²
	(start engine) idle 10 seconds	0
	Moderate acceleration to 48 km/h	1.79
	Cruise at 48 km/h for ¼ lap	0
	Moderate deceleration to 32 km/h	-2.23
	Moderate acceleration to 48 km/h	1.79
	Cruise at 48 km/h for ¼ lap	0
	Moderate deceleration to stop	-2.23
	Idle 5 seconds	0
	Moderate acceleration to 56 km/h	1.79
	Cruise at 56 km/h for ¼ lap	0
	Moderate deceleration to 40 km/h	-2.23
	Moderate acceleration to 56 km/h	1.79
	Cruise at 56 km/h for ¼ lap	0
	Moderate deceleration to stop	-2.23
2	idle 10 seconds	0
2	Moderate acceleration to 64 km/h	1.34
2	Cruise at 64 km/h for ¼ lap	0
2	Moderate deceleration to 48 km/h	-2.23
2	Moderate acceleration to 64 km/h	1.34
2	Cruise at 64 km/h for ¼ lap	0
2	Moderate deceleration to stop	-2.23
2	Idle 5 seconds	0
2	Moderate acceleration to 72 km/h	1.34
2	Cruise at 72 km/h for ¼ lap	0
2	Moderate deceleration to 56 km/h	-2.23
2	Moderate acceleration to 72 km/h	1.34
2	Cruise at 72 km/h for ¼ lap	0
2	Moderate deceleration to stop	-2.23

Lap	Description	Typical acceleration rate m/s²
3	idle 10 seconds	0
3	Hard acceleration to 88 km/h	1.79
3	Cruise at 88 km/h for ¼ lap	0
3	Moderate deceleration to 72 km/h	-2.23
3	Moderate acceleration to 88 km/h	0.89
3	Cruise at 88 km/h for ¼ lap	0
3	Moderate deceleration to 72 km/h	-2.23
3	Moderate acceleration to 97 km/h	0.89
3	Cruise at 97 km/h for ¼ lap	0
3	Moderate deceleration to 80 km/h	-2.23
3	Moderate acceleration to 97 km/h	0.89
3	Cruise at 97 km/h for ¼ lap	0
3	Moderate deceleration to stop	-1.79
4	idle 10 seconds	0
4	Hard acceleration to 129 km/h	1.34
4	Coastdown to 113 km/h	-0.45
4	Cruise at 113 km/h for ½ lap	0
4	Moderate deceleration to 80 km/h	-1.34
4	Moderate acceleration to 105 km/h	0.89
4	Cruise at 105 km/h for ½ lap	0
4	Moderate deceleration to 80 km/h	-1.34
5	Moderate acceleration to 121 km/h	0.45
5	Cruise at 121 km/h for ½ lap	0
5	Moderate deceleration to 80 km/h	-1.34
5	Light acceleration to 113 km/h	0.45
5	Cruise at 113 km/h for ½ lap	0
5	Moderate deceleration to 80 km/h	-1.34
6	Moderate acceleration to 113 km/h	0.89
6	Coastdown to 97 km/h	-0.45
6	Cruise at 97 km/h for ½ lap	0
6	Moderate deceleration to 80 km/h	-1.79
6	Moderate acceleration to 104 km/h	0.45
6	Cruise at 104 km/h for ½ lap	0
6	Moderate deceleration to stop	-1.79
7	idle 45 seconds	0
7	Hard acceleration to 88 km/h	1.79
7	Cruise at 88 km/h for ¼ lap	0
7	Moderate deceleration to 64 km/h	-2.23
7	Moderate acceleration to 88 km/h	0.89
7	Cruise at 88 km/h for ¼ lap	0

7	**Moderate deceleration to 64 km/h**	**-2.23**
7	**Moderate acceleration to 80 km/h**	**0.89**
7	**Cruise at 80 km/h for ¼ lap**	**0**
7	**Moderate deceleration to 64 km/h**	**-2.23**
7	**Moderate acceleration to 80 km/h**	**0.89**
7	**Cruise at 80 km/h for ¼ lap**	**0**
7	**Moderate deceleration to stop**	**-2.23**

The standard road cycle is represented graphically in the following figure:



Annex 11,

Paragraph 2.9., amend to read:

"2.9. "Type I test" means the driving cycle (Parts One and Two) used for emission approvals, as detailed in **Tables 1 and 2 of Annex 4a**."

Annex 11 - Appendix 1,

Paragraph 3.1., amend to read:

"3.1. The test vehicle shall meet the requirements of **paragraph 3.2. of Annex 4a**."

Paragraph 4.1., amend to read:

"… Type I test as described in **paragraph 3.2. of Annex 4a**."

Paragraph 5.1., amend to read:

"… the requirements of **Appendix 1 of Annex 4a**."

Paragraph 6.1., amend to read:

"… the requirements **of Annex 4a**."

Annex 12,

Paragraph 3.1.1.1., amend to read:

"… pre-conditioning cycle referred to in **paragraph 6.3. of Annex 4a** may be extended."

Annex 13,

Paragraph 3.1., amend to read:

"… calculations shall be carried out according to **Annex 4a, paragraphs 6.4. to 6.6.** Determination of …"

Paragraph 3.2.1., amend to read:

"… preparation cycles in **paragraph 6.3. of Annex 4a** …"

Paragraph 3.2.2., amend to read:

"… Type I test described in **Annex 4a** …"

Paragraph 3.2.6., amend to read:

"… shall be calculated according to **Annex 4a, paragraph 6.6.**, …"

Annex 14,

Paragraph 1.2., amend to read:

"… shall be tested according to **Annex 4a**, 5, …"

Paragraph 3.1.2.2.1., amend to read:

"… Part Two cycle described in **Table 2 (and Figure 3) of Annex 4a** …"

Paragraph 3.1.2.5.3., amend to read:

"3.1.2.5.3. The vehicle shall be driven according to **provisions in Annex 4a**, or in case of special gear shifting strategy, according to the manufacturer's instructions, as incorporated in the drivers' handbook of production vehicles and indicated by a technical gear shift instrument (for drivers' information). For these vehicles the gear shifting points prescribed **in Annex 4a**) are not applied. For the pattern of the operating curve the description according to **paragraph 6.1.3. of Annex 4a** shall apply.

Paragraph 3.1.2.5.4., amend to read:

"3.1.2.5.4. The exhaust gases shall be analyzed according to provisions in **Annex 4a.**"

Paragraph 3.1.3.4.3., amend to read:

"3.1.3.4.3. The vehicle shall be driven according to **Annex 4a**, or in case of special gear shifting strategy, according to the manufacturer's instructions, as incorporated in the drivers' handbook of production vehicles and indicated by a technical gear shift instrument (for drivers' information). For these vehicles the gear shifting points prescribed in **Annex 4a** are not applied. For the pattern of the operating curve the description according to **paragraph 6.1.3.2. of Annex 4a** shall apply."

Paragraph 3.1.3.4.4., amend to read:

"3.1.3.4.4. The exhaust gases shall be analysed according to provisions in **Annex 4a**."

Paragraph 3.2.2.3.1., amend to read:

"3.2.2.3.1. For compression-ignition engined vehicles the Part Two cycle described in **Table 2 (and Figure 3) of Annex 4a** shall be used. Three consecutive cycles shall be driven according to paragraph 3.2.2.6.3. below."

Paragraph 3.2.2.6.3., amend to read:

3.2.2.6.3. The vehicle shall be driven according to **Annex 4a**, or in case of special gear shifting strategy, according to the manufacturer's instructions, as incorporated in the drivers' handbook of production vehicles and indicated by a technical gear shift instrument (for drivers' information). For these vehicles the gear shifting points prescribed in **Annex 4a** are not applied. For the pattern of the operating curve the description according to **paragraph 6.1.3. of Annex 4a** shall apply.

Paragraph 3.2.2.6.4., amend to read:

3.2.2.6.4. The exhaust gases shall be analysed according to **Annex 4a**.

Paragraph 3.2.3.1.1., amend to read:

"… Part Two cycle described in **Table 2 and Figure 2 of Annex 4a**…"

Paragraph 3.2.3.4.3., amend to read:

"3.2.3.4.3. The vehicle shall be driven according to **Annex 4a,** or in case of special gear shifting strategy, according to the manufacturer's instructions, as incorporated in the drivers' handbook of production vehicles and indicated by a technical gear shift instrument (for drivers' information). For these vehicles the gear shifting points prescribed in **Annex 4a** are not applied. For the pattern of the operating curve the description according to **paragraph 6.1.3. of Annex 4a** shall apply."

Paragraph 3.2.3.4.4., amend to read:

"3.2.3.4.4. The exhaust gases shall be analysed according to provisions in **Annex 4a**."

Paragraph 3.3.1., amend to read:

"3.3.1. These vehicles shall be tested according to **Annex 4a**."

Paragraph 3.3.3., amend to read:

"3.3.3. The vehicle shall be driven according to **Annex 4a,** or in case of special gear shifting strategy according to the manufacturer's instructions, as incorporated in the drivers' handbook of production vehicles and indicated by a technical gear shift instrument (for drivers information). For these vehicles the gear shifting points prescribed in **Annex 4a** are not applied. For the pattern of the operating curve the description according to **paragraph 6.1.3. of Annex 4a** shall apply.

Paragraph 3.4.1., amend to read:

"… tested in hybrid mode according to **Annex 4a**. If several hybrid …"

Paragraph 3.4.3., amend to read:

"3.4.3. The vehicle shall be driven according to **Annex 4a**, or in case of special gear shifting strategy according to the manufacturer's instructions, as incorporated in the drivers' handbook of production vehicles and indicated by a technical gear shift instrument (for drivers information). For these vehicles the gear shifting points prescribed in **Annex 4a**, are not applied. For the pattern of the operating curve the description according to **paragraph 6.1.3.2. of Annex 4a** shall apply."

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