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BSI Standards Publication

Motorcycles — Measurement method for gaseous exhaust emissions and fuel consumption

Part 2: Test cycles and specific test conditions

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National foreword

This British Standard is the UK implementation of ISO 6460-2:2014. It supersedes BS ISO 6460-2:2007 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee AUE/14, Motor cycles and mopeds.

A list of organizations represented on this committee can be obtained on request to its secretary.

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ISBN 978 0 580 83770 8

ICS 13.040.50; 43.140

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 December 2014.

Amendments issued since publication

Date	Text affected

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INTERNATIONAL STANDARD

ISO 6460-2

Second edition
2014-12-01

Motorcycles — Measurement method for gaseous exhaust emissions and fuel consumption —

Part 2: Test cycles and specific test conditions

Motocycles — Méthode de mesure des émissions de gaz d'échappement et de la consommation de carburant —

Partie 2: Conditions d'essai spécifiques et cycles d'essai

Reference number
ISO 6460-2:2014(E)

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 22, *Motorcycles*.

This second edition cancels and replaces the first edition (ISO 6460-2:2007), which has been technically revised.

ISO 6460 consists of the following parts, under the general title *Motorcycles — Measurement method for gaseous exhaust emissions and fuel consumption*:

— *Part 1: General test requirements*

— *Part 2: Test cycles and specific test conditions*

— *Part 3: Fuel consumption measurement at a constant speed*

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Introduction

This part of ISO 6460 has been prepared to provide details of the typical test cycles for measurement of gaseous exhaust emissions and fuel consumption. The measurements can be carried out by referring to this part of ISO 6460 and to ISO 6460-1.

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Motorcycles — Measurement method for gaseous exhaust emissions and fuel consumption —

Part 2: Test cycles and specific test conditions

1 Scope

This part of ISO 6460 defines test cycles for measurement for the gaseous exhaust emissions from motorcycles, as well as for determining the fuel consumption of motorcycles as defined in ISO 3833, equipped with a spark ignition engine (four-stroke engine, two-stroke engine, or rotary piston engine) or a compression ignition engine. The test cycle 1 is equivalent to the test cycle specified in the European Union Commission Directive 2003/77/EC[6] and the test cycle 2 is equivalent to the test cycle specified in global technical regulations No.2 (WMTC), United Nations Economic Commission for Europe, ECE/TRANS/180/Add.2[9]. A selection of other test cycles adopted or to be adopted by several countries is described in Annex C for information purpose.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4106, *Motorcycles — Engine test code — Net power*

ISO 6460-1, *Motorcycles — Measurement method for gaseous exhaust emissions and fuel consumption — Part 1: General test requirements*

ISO 7117, *Motorcycles — Measurement method for determining maximum speed*

3 Test cycle 1

3.1 General

The test cycle 1 is equivalent to the test cycle specified in European Union Commission Directive 2003/77/EC[6].

a) For vehicle types with an engine capacity less than 150 cm^3, the test shall be conducted by carrying out six elementary urban cycles. The emission sampling shall begin before or at the initiation of the engine start-up procedure and end on conclusion of the final idling period of the last elementary urban cycle.

b) For vehicle types with an engine capacity greater than or equal to 150 cm^3, the test shall be conducted by carrying out six elementary urban cycles and one extra-urban cycle. The emission sampling shall begin before or at the initiation of the engine start-up procedure and end on conclusion of the final idling period of the extra-urban cycle.

During the test, the exhaust gases shall be diluted with air so that the flow volume of the mixture remains constant. Throughout the test, a continuous flow of samples of the mixture shall be passed into one or more bags so that concentrations (average test values) of carbon monoxide, unburnt hydrocarbons, oxides of nitrogen, and carbon dioxide can be determined.

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3.2 Type 1 test

3.2.1 Operating cycle on the chassis dynamometer

3.2.1.1 Description of cycle

The operating cycles on the chassis dynamometer are indicated in 3.2.4.

3.2.1.2 General conditions for carrying out the cycle

Preliminary test cycles shall be carried out if necessary to determine how best to actuate the accelerator and brake controls so as to achieve a cycle approximating to the theoretical cycle within the prescribed limits.

3.2.1.3 Use of the gearbox

3.2.1.3.1 Use of the gearbox is determined as described below.

a) At constant speed, the engine speed shall as far as possible remain between 50 % and 90 % of the maximum speed. If this speed can be achieved using more than one gear, the engine is tested using the highest gear.

b) With respect to the urban cycle, during acceleration the engine shall be tested using the gear which allows maximum acceleration. The next higher gear is engaged, at the latest, when the engine speed has reached 110 % of the speed at which the maximum net power output occurs. If a motorcycle reaches a speed of 20 km/h in first gear or 35 km/h in second gear, the next higher gear shall be engaged at these speeds.

   In these cases, no other change into higher gears is permitted. If, during the acceleration phase, the gears are changed at fixed motorcycle speeds, the constant speed phase which follows shall be performed with the gear which is engaged when the motorcycle begins the constant speed phase, irrespective of the engine speed.

c) During deceleration, the next lower gear shall be engaged before the engine reaches virtual idling speed or when the engine speed has fallen to 30 % of the speed of the maximum net power, whichever occurs first. First gear shall not be engaged during deceleration.

3.2.1.3.2 Motorcycles equipped with automatic gearboxes shall be tested with the highest gear engaged (drive). The accelerator shall be operated in such a way as to obtain as steady an acceleration as possible, so that the transmission engages the different gears in the normal order. The tolerances specified in 3.2.1.4 apply.

3.2.1.3.3 For carrying out the extra-urban cycle, the gearbox shall be used in accordance with the manufacturer's recommendation.

Acceleration shall continue throughout the period represented by the straight line connecting the end of each period of idling with the beginning of the next following period of constant speed. The tolerances given in 3.2.1.4 apply.

3.2.1.4 Tolerances

3.2.1.4.1 The theoretical speed shall be maintained to a tolerance of ±2 km/h during all phases. Speed tolerances greater than those prescribed are permitted during phase changes provided that the tolerances are never exceeded for more than 0,5 s on any one occasion, in all cases subject to the provisions of 3.2.2.5.2 and 3.2.2.6.3.

3.2.1.4.2 A tolerance of ±0,5 s above or below the theoretical times shall be allowed.

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3.2.1.4.3 The speed and time tolerances are combined as indicated in 3.2.4.

3.2.1.4.4 The distance travelled during the cycle shall be measured with a tolerance of ±2 %.

3.2.2 Procedure for chassis dynamometer tests

3.2.2.1 Special conditions for carrying out the cycle

3.2.2.1.1 The temperature in the premises where the chassis dynamometer bench is situated shall be between 293 K and 303 K throughout the test, and shall be as close as possible to the temperature of the premises where the motorcycle was conditioned.

3.2.2.1.2 The motorcycle shall as far as possible be horizontal during the test so as to avoid any abnormal distribution of the fuel.

3.2.2.1.3 During the test, the motorcycle speed shall be plotted against time in order to check that the cycles have been performed correctly.

3.2.2.1.4 The temperatures of the cooling water and the crankcase oil may be recorded.

3.2.2.2 Starting up the engine

3.2.2.2.1 Once the preliminary operations on the equipment for collecting, diluting, analysing, and measuring the gases have been carried out, the engine is started up by means of the devices provided for that purpose, such as the choke, the starter valve, etc., in accordance with the manufacturer's instructions.

3.2.2.2.2 The first cycle begins when the taking of samples and the measuring of the pump rotations commence.

3.2.2.3 Use of the manual choke

The choke shall be cut out as soon as possible and in principle before acceleration from 0 km/h to 50 km/h. If this requirement cannot be met, the moment of actual cut-out shall be indicated. The choke shall be adjusted in accordance with the manufacturer's instructions.

3.2.2.4 Idling

3.2.2.4.1 Manual-shift gearbox

During periods of idling, the clutch shall be engaged and the gears shall be in neutral.

To enable the accelerations to be performed in accordance with the normal cycle, the motorcycle shall be put in first gear, with the clutch disengaged, 5 s before start of the acceleration following the idling period in question.

The first idling period at the beginning of the cycle consists of 6 s of idling in neutral with the clutch engaged and 5 s in first gear with the clutch disengaged.

For the idling periods during each cycle, the corresponding times are 16 s in neutral and 5 s in first gear with the clutch disengaged.

The last idling period in the cycle consists of 7 s in neutral with the clutch engaged.

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3.2.2.4.2 Semi-automatic gearboxes

The manufacturer's instructions for driving in town, or in their absence instructions applicable to manual gearboxes, shall be followed.

3.2.2.4.3 Automatic gearboxes

The selector shall not be operated at any time during the test unless the manufacturer specifies otherwise. In the latter case, the procedure for manual gearboxes applies.

3.2.2.5 Accelerations

3.2.2.5.1 Accelerations shall be effected so as to ensure that the rate of acceleration is as constant as possible throughout the operation.

3.2.2.5.2 If the acceleration capacities of the motorcycle are not sufficient to perform the acceleration cycles within the prescribed tolerances, the motorcycle shall be driven with the throttle completely open until the speed prescribed for the cycle has been reached. The cycle may then continue normally.

3.2.2.6 Decelerations

3.2.2.6.1 All decelerations shall be effected by completely closing the throttle, the clutch remaining engaged. The clutch shall be disengaged at a speed of 10 km/h.

3.2.2.6.2 If the period of deceleration is longer than that prescribed for the corresponding phase, the motorcycle's brakes are used to keep to the cycle.

3.2.2.6.3 If the period of deceleration is shorter than that prescribed for the corresponding phase, the timing of the theoretical cycle is restored by a steady state or an idling period merging into the following steady state or idling operation. In this case, 3.2.1.4.3 is not applicable.

3.2.2.6.4 At the end of the deceleration period (stopping motorcycle on the rollers), the gear shall be put into neutral and the clutch engaged.

3.2.2.7 Constant speeds

3.2.2.7.1 "Pumping" or the closing of the throttle shall be avoided when passing from acceleration to the following constant speed.

3.2.2.7.2 Periods of constant speed shall be achieved by keeping the accelerator position fixed.

3.2.3 Analysis

The exhaust gases contained in the bag shall be analysed as soon as possible and in any event not later than 20 min after the end of the test cycle.

3.2.4 Breakdown of the operating cycles

The operating cycle of the urban driving cycle (UDC) on the chassis dynamometer is described in Table 1, and the operation cycle of the extra-urban driving cycle (EUDC) on the chassis dynamometer is described in Table 2. The operating cycle of UDC is described in Figure 1 and the operating cycle of UDC/EUDC is described in Figure 2.

In EUDC on the chassis dynamometer, for motorcycles with a permitted maximum speed of 110 km/h, the maximum speed for EUDC shall be restricted to 90 km/h and the operation cycle on the chassis

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dynamometer is described in Table 3. The operating cycle of UDC/EUDC for motorcycles with a permitted maximum speed of 110 km/h is described in Figure 2.

Table 1 — UDC operating cycle on the chassis dynamometer

Operation no.	Operation	Phase	Acceleration m/s²	Speed km/h	Duration of each		Cumulative time s	Distance covered m
					Operation s	Phase s		
1	Idling	1	0	0	11	11	11	0
2	Acceleration	2	1,04	0 to 15	4	4	15	8
3	Constant speed	3	0	15	8	8	23	34
4	Deceleration	4	−0,69	15 to 10	2	5	25	7
5	Deceleration, clutch disengaged		−0,92	10 to 0	3		28	4
6	Idling	5	0	0	21	21	49	0
7	Acceleration	6	0,74	0 to 32	12	12	61	54
8	Constant speed	7	0	32	24	24	85	214
9	Deceleration	8	−0,75	32 to 10	8	11	93	48
10	Deceleration, clutch disengaged		−0,92	10 to 0	3		96	4
11	Idling	9	0	0	21	21	117	0
12	Acceleration	10	0,53	0 to 50	26	26	143	183
13	Constant speed	11	0	50	12	12	155	167
14	Deceleration	12	−0,52	50 to 35	8	8	163	95
15	Constant speed	13	0	35	13	13	176	127
16	Deceleration	14	−0,68	35 to 10	9	12	185	64
17	Deceleration, clutch disengaged		−0,92	10 to 0	3		188	4
18	Idling	15	0	0	7	7	195	0
							Total distance covered	1 013

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Table 2 — EUDC operating cycle on the chassis dynamometer

Operation no.	Operation	Phase	Acceleration m/s²	Speed km/h	Duration of each		Cumulative time s	Gear to be used in the case of a manual gearbox
					Operation s	Phase s		
1	Idling	1			20	20	20	See 3.2.1.3.3; use of the gearbox over the extra-urban cycle in accordance with the manufacturer's recommendations.
2	Acceleration	2	0,47	0 to 70	41	41	61	
3	Constant speed	3		70	50	50	111	
4	Deceleration	4	−0,69	70 to 50	8	8	119	
5	Constant speed	5		50	69	69	188	
6	Acceleration	6	0,43	50 to 70	13	13	201	
7	Constant speed	7		70	50	50	251	
8	Acceleration	8	0,24	70 to 100	35	35	286	
9	Constant speed	9		100	30	30	316	
10	Acceleration	10	0,28	100 to 120	20	20	336	
11	Constant speed	11		120	10	10	346	
12	Deceleration	12	−0,69	120 to 80	16	34	362	
13	Deceleration		−1,04	80 to 50	8		370	
14	Deceleration, clutch disengaged		−1,39	50 to 0	10		380	
15	Idling	13			20	20	400	

NOTE This table is the result of reformatting Annex III, Appendix 1, Section 3 of Directive 91/441/EEC,[7] in accordance with 3.2.1.3.3.

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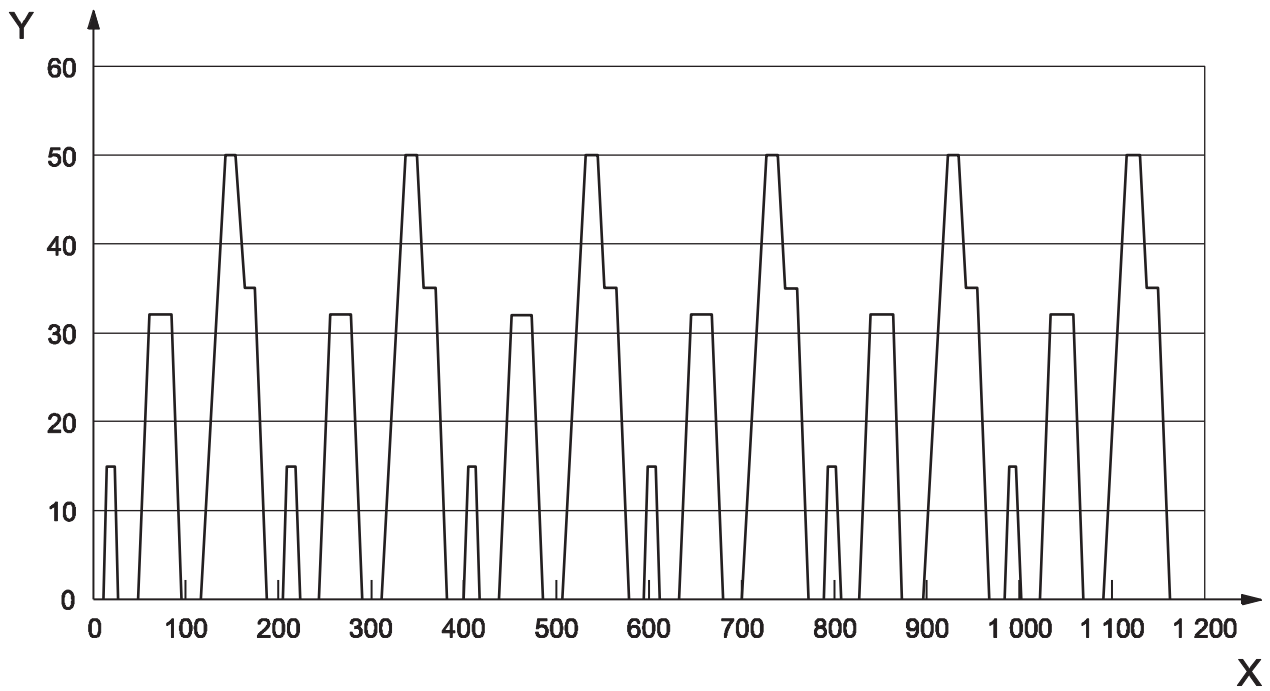
Table 3 — EUDC operating cycle on the chassis dynamometer for motorcycles with a maximum designed speed of 110 km/h

Operation no.	Operation	Phase	Acceleration m/s²	Speed km/h	Duration of each		Cumulative time s	Gear to be used in the case of a manual gearbox
					Operation s	Phase s		
1	Idling	1			20	20	20	See 3.2.1.3.3; use of the gearbox over the extra-urban cycle in accordance with the manufacturer's recommendations.
2	Acceleration	2	0,47	0 to 70	41	41	61	
3	Constant speed	3		70	50	50	111	
4	Deceleration	4	−0,69	70 to 50	8	8	119	
5	Constant speed	5		50	69	69	188	
6	Acceleration	6	0,43	50 to 70	13	13	201	
7	Constant speed	7		70	50	50	251	
8	Acceleration	8	0,24	70 to 90	23,1	23,1	274,1	
9	Constant speed	9		90	84	84	358,1	
10	Deceleration	10	−0,69	90 to 80	3,9	21,9	362	
11	Deceleration		−1,04	80 to 50	8		370	
12	Deceleration, clutch disengaged		−1,39	50 to 0	10		380	
13	Idling	11			20	20	400	



Key

X time, s

Y speed, km/h

Figure 1 — Operating cycle on chassis dynamometer (UDC)

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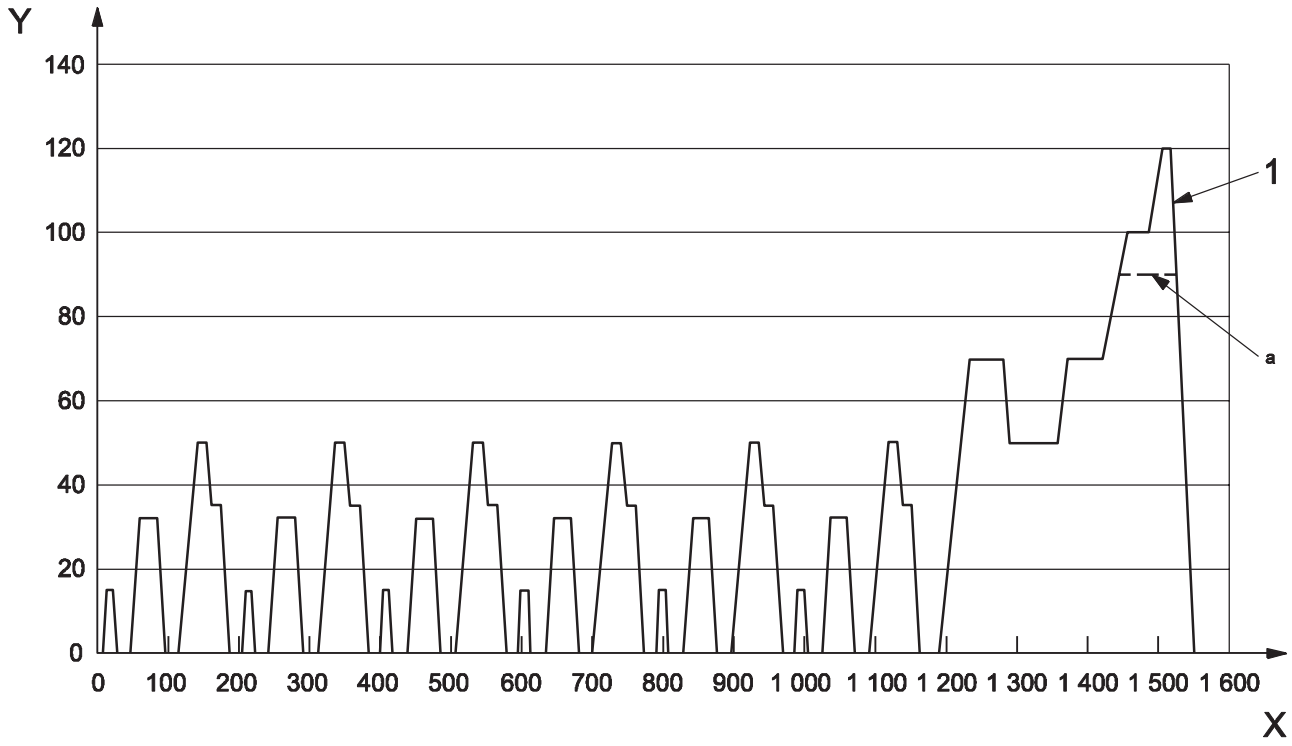

Key

1 UDC/EUDC

X time, s

Y speed, km/h

a For motorcycles with a maximum designed speed of 110 km/h or less.

Figure 2 — Operating cycle on chassis dynamometer (UDC/EUDC)

3.3 Type 2 test

3.3.1 Application

This requirement only applies to all test motorcycles powered by a positive-ignition engine.

3.3.2 Measurement conditions

The type 2 test shall be measured immediately after the type 1 test with the engine at normal idling speed and at high idle.

In the case of motorcycles with manual or semi-automatic gearboxes, the test is carried out with the gear lever in the “neutral” position and with the clutch engaged.

In the case of motorcycles with automatic transmissions, the test is carried out with the selector in position “zero” or “park”.

3.3.3 Sampling of gases

The exhaust outlet shall be fitted with a sufficiently leak-tight extension piece such that the exhaust-gas sampling probe can be inserted to at least 60 cm without increasing back pressure by more than 1,25 kPa and without affecting operation of the motorcycle. Nevertheless, the shape of the extension piece shall be such as to avoid appreciable dilution of exhaust gases by air at the point of the sampling probe. If the motorcycle is equipped with more than one exhaust outlet, either these outlets shall be

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connected up to a common pipe or carbon monoxide concentrations shall be tested at each outlet, with the results of the measurements being the arithmetical mean of these concentrations.

The concentrations for carbon monoxide, $c_{CO,e}$, and carbon dioxide, $c_{CO2,e}$, are determined by reading off the results shown by the instruments or recording devices and using the appropriate calibration tables.

The corrected concentration of carbon monoxide in two-stroke engines, $c_{CO,ec2}$, calculated in percent volume, is

$$c_{CO,ec2} = c_{CO,e} \frac{10}{c_{CO,e} + c_{CO2,e}} \tag{1}$$

The corrected concentration of carbon monoxide in four-stroke engines, $c_{CO,ec4}$, calculated in percent volume, is

$$c_{CO,ec4} = c_{CO,e} \frac{15}{c_{CO,e} + c_{CO2,e}} \tag{2}$$

It is not necessary to correct the concentration of $c_{CO,e}$ measured in accordance with Formula (1) or (2) if the sum of the concentrations measured, $c_{CO,e} + c_{CO2,e}$, is 10 or more for two-stroke engines, and 15 or more for four-stroke engines.

3.3.4 Normal and high idling speed tests

3.3.4.1 When tested in accordance with 3.3.1 and 3.3.2 at normal idling speed,

a) the carbon monoxide content by volume of the exhaust gases emitted is recorded, and

b) the engine speed during the test shall be recorded, including any tolerances.

3.3.4.2 When tested at “high idle” speed (i.e. >2 000 min^{-1}),

a) the carbon monoxide content by volume of the exhaust gases emitted is recorded, and

b) the engine speed during the test shall be recorded, including any tolerances.

The engine oil temperature at the time of the test shall be measured and recorded.

4 Test cycle 2

4.1 General

The test cycle 2 is equivalent to the test cycle specified in global technical regulations No.2 (WMTC), United Nations Economic Commission for Europe, ECE/TRANS/180/Add.2 [9]

4.2 Test room conditions

The test room with the chassis dynamometer and the gas sample collection device shall have a temperature of 298 K ±5 K. The room temperature shall be measured twice in the vicinity of motorcycle cooling blower (fan), both before and after the type 1 test.

4.3 Motorcycle classification

4.3.1 General

Figure 3 gives an overview of the motorcycle classification in terms of engine capacity and maximum motorcycle speed. The numerical values of the engine capacity and maximum motorcycle speed shall not be rounded up or down.

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4.3.2 Class 1

Motorcycles that fulfil either of the following specifications belong to class 1:

a) 50 cm^3 < engine capacity < 150 cm^3 and $v_{max} \leq 50$ km/h;

b) engine capacity < 150 cm^3 and 50 km/h < v_{max} < 100 km/h.

4.3.3 Class 2

Motorcycles that fulfil either of the following specifications belong to class 2:

a) subclass 2-1: engine capacity < 150 cm^3 and 100 km/h ≤ v_{max} < 115 km/h or engine capacity ≥ 150 cm^3 and v_{max} < 115 km/h;

b) subclass 2-2: 115 km/h ≤ v_{max} < 130 km/h.

4.3.4 Class 3

Motorcycles that fulfil either of the following specifications belong to class 3:

a) subclass 3-1: 130 km/h ≤ v_{max} < 140 km/h;

b) subclass 3-2: v_{max} ≥ 140 km/h.

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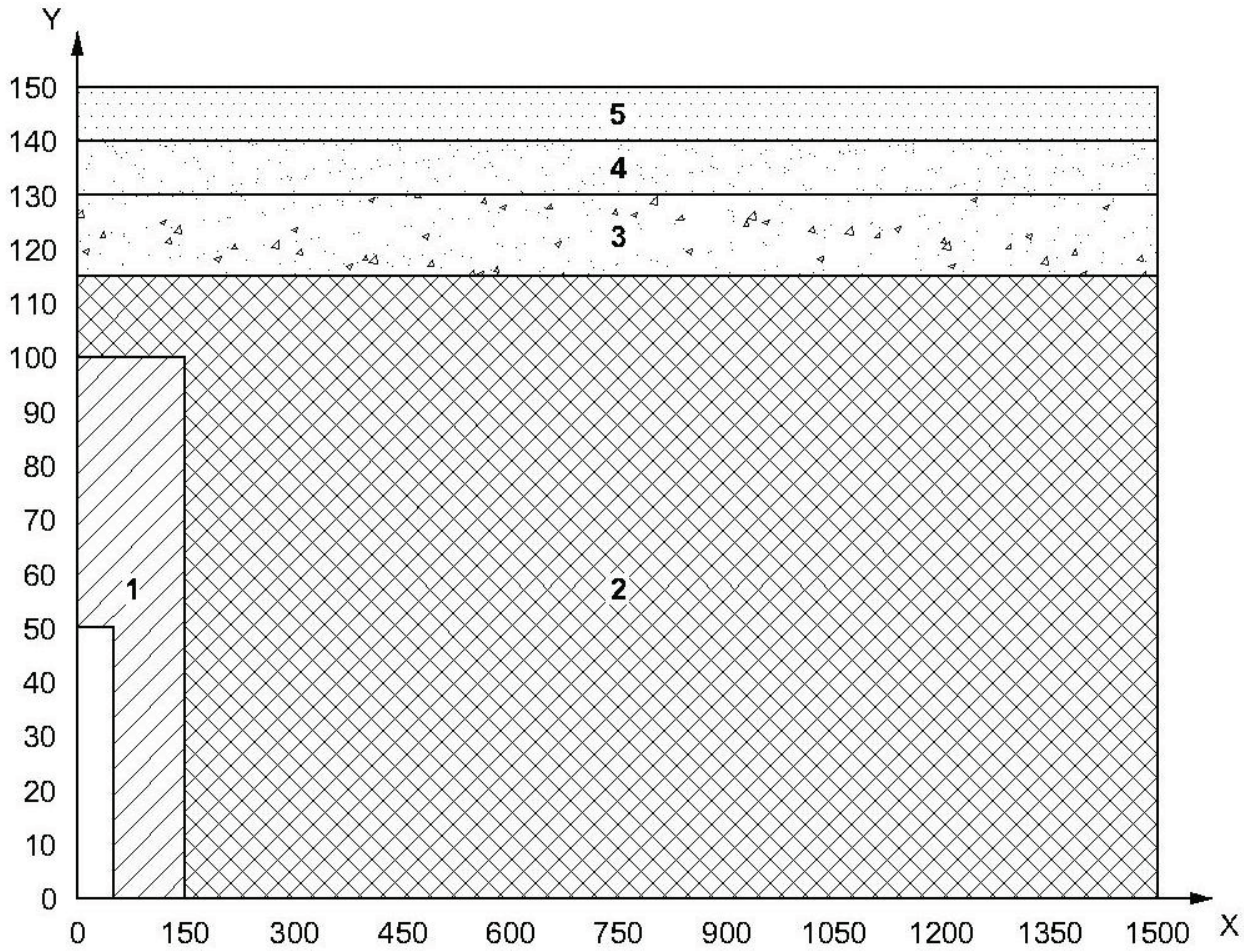

Key

1 class 1
2 class 2 subclass 2-1
3 class 2 subclass 2-2
4 class 3 subclass 3-1
5 class 3 subclass 3-2
X engine capacity, cm^3
Y maximum motorcycle speed, km/h

Figure 3 — Motorcycle classification

4.4 Type 1 tests

4.4.1 Driving schedules

4.4.1.1 Test cycles

Test cycles (motorcycle speed patterns) for the type 1 test consists of up to three parts that are shown in 4.8. Depending on the motorcycle class (see 4.3), the following test cycle parts shall be run.

a) class 1:

part 1, reduced speed in cold condition, followed by part 1 reduced speed in hot condition;

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b) class 2:

1) subclass 2-1: part 1, reduced speed in cold condition, followed by part 2, reduced speed in hot condition;

2) subclass 2-2: part 1 in cold condition, followed by part 2 in hot condition;

c) class 3

1) subclass 3-1: part 1 in cold condition, followed by part 2 in hot condition, followed by part 3 reduced speed in hot condition;

2) subclass 3-2: part 1 in cold condition, followed by part 2 in hot condition, followed by part 3 in hot condition.

4.4.1.2 Speed tolerances

The speed tolerance at any given time on the test cycle prescribed in 4.4.1.1 is defined by upper and lower limits. The upper limit is 3,2 km/h higher than the highest point on the trace within 1 s of the given time. The lower limit is 3,2 km/h lower than the lowest point on the trace within 1 s of the given time. Speed variations greater than the tolerances (such as can occur during gear changes) are acceptable provided they occur for less than 2 s on any occasion. Speeds lower than those prescribed are acceptable provided the motorcycle is operated at maximum available power during such occurrences. Figure 4 shows the range of acceptable speed tolerances for typical points.

Apart from these exceptions the deviations of the roller speed from the set speed of the cycles shall meet the requirements described above. If not, the test results shall not be used for the further analysis and the run shall be repeated.

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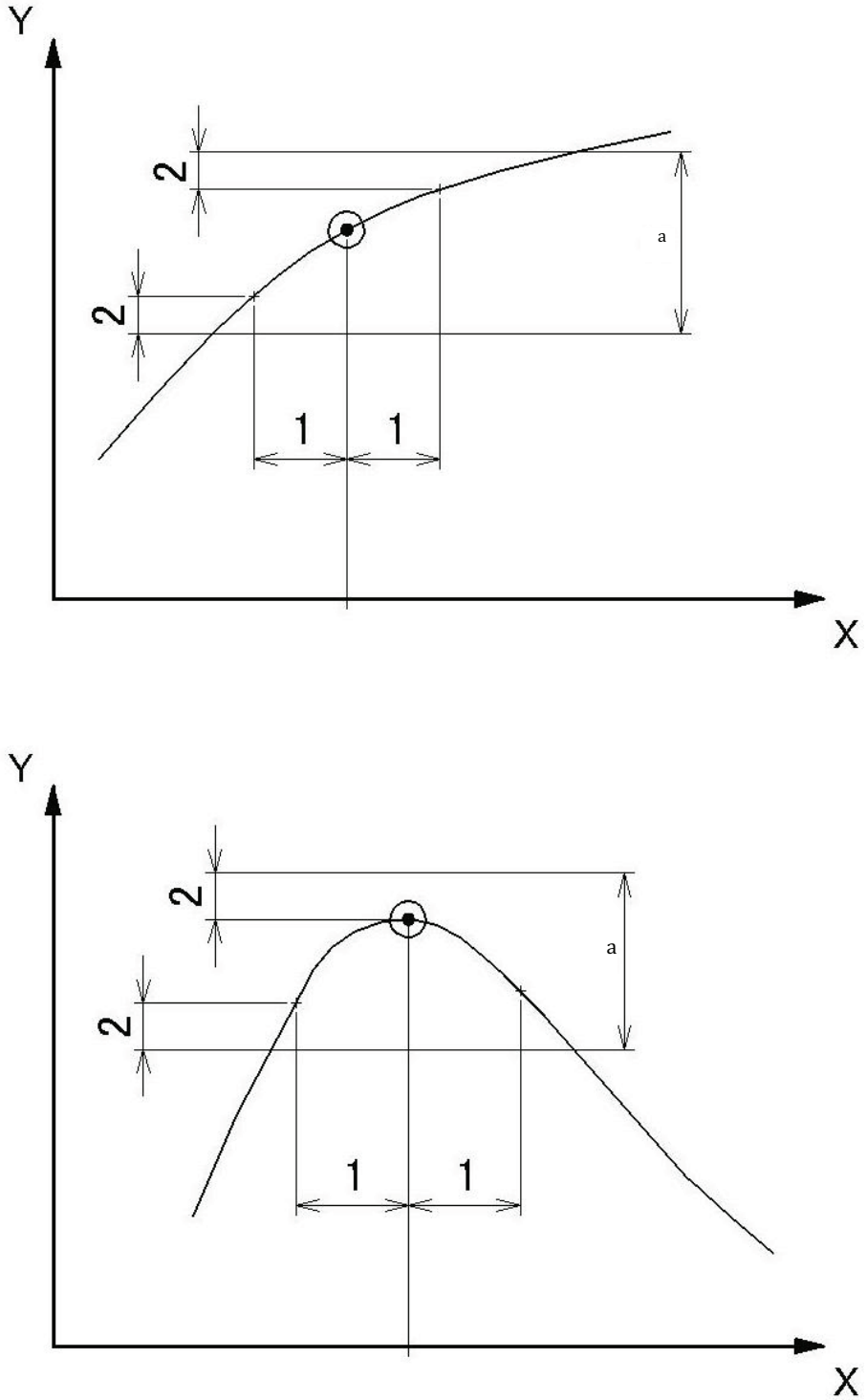

Key

1 1 s

2 3,2 km/h

X time

Y speed

a Allowable range.

Figure 4 — Drivers trace, allowable range

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4.4.2 Gearshift prescriptions

4.4.2.1 Test motorcycles with automatic transmission

Motorcycles equipped with transfer cases, multiple sprockets, etc., shall be tested in the manufacturer's recommended configuration for street or highway use.

All tests shall be conducted with automatic transmissions in "drive" (highest gear). Automatic clutch-torque converter transmissions may be shifted as manual transmissions at the option of the manufacturer.

Idle modes shall be run with automatic transmissions in "drive" and the wheels braked.

Automatic transmissions shall shift automatically through the normal sequence of gears.

The deceleration modes shall be run in gear using brakes or throttle as necessary to maintain the desired speed.

4.4.2.2 Test motorcycles with manual transmission

4.4.2.2.1 Mandatory requirements

4.4.2.2.1.1 Step 1 — Calculation of shift speeds

Upshift speeds ($v_{1\to 2}$ and $v_{i\to i+1}$) in km/h during acceleration phases shall be calculated in accordance with Formulae (3) and (4).

$$v_{1\to 2} = \left[\left(0{,}5753\times e^{\left(-1{,}9\times\frac{P_n}{m_k+75}\right)} - 0{,}1\right)\times\left(s - n_{idle}\right) + n_{idle}\right]\times\frac{1}{ndv_1} \tag{3}$$

$$v_{i\to i+1} = \left[\left(0{,}5753\times e^{\left(-1{,}9\times\frac{P_n}{m_k+75}\right)}\right)\times\left(s - n_{idle}\right) + n_{idle}\right]\times\frac{1}{ndv_i},\ i = 2 \text{ to } ng-1 \tag{4}$$

where

i is the gear number (≥2);

ng is the total number of forward gears;

P_n is the rated power, in kW;

m_k is the kerb mass, in kg;

n_{idle} is the idling speed, in min^{-1};

s is the rated engine speed, in min^{-1};

ndv_i is the ratio between engine speed, in min^{-1}, and motorcycle speed, in km/h, in gear i.

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Downshift speeds ($v_{i \to i-1}$) in km/h during cruise or deceleration phases in gear 4 (4th gear) to *ng* shall be calculated in accordance with Formula (5).

$$v_{i \to i-1} = \left[\left(0{,}5753 \times e^{\left(-1{,}9 \times \frac{P_n}{m_k + 75} \right)} \right) \times \left(s - n_{idle} \right) + n_{idle} \right] \times \frac{1}{ndv_{i-2}}, \; i = 4 \text{ to } ng \tag{5}$$

where

i is the gear number (≥4);

ng is the total number of forward gears;

P_n is the rated power, in kW;

m_k is the kerb mass, in kg;

n_{idle} is the idling speed, in min^{-1};

s is the rated engine speed, in min^{-1};

ndv_{i-2} is the ratio between engine speed, in min^{-1}, and motorcycle speed, in km/h, in gear i–2.

The downshift speed from gear 3 to gear 2 ($v_{3 \to 2}$) shall be calculated in accordance with Formula (6).

$$v_{3 \to 2} = \left[\left(0{,}5753 \times e^{\left(-1{,}9 \times \frac{P_n}{m_k + 75} \right)} - 0{,}1 \right) \times \left(s - n_{idle} \right) + n_{idle} \right] \times \frac{1}{ndv_1} \tag{6}$$

where

P_n is the rated power, in kW;

m_k is the kerb mass, in kg;

n_{idle} is the idling speed, in min^{-1};

s is the rated engine speed, in min^{-1};

ndv_1 is the ratio between engine speed, in min^{-1}, and motorcycle speed, in km/h, in gear 1.

The downshift speed from gear 2 to gear 1 ($v_{2 \to 1}$) shall be calculated in accordance with Formula (7).

$$v_{2 \to 1} = \left[0{,}03 \times \left(s - n_{idle} \right) + n_{idle} \right] \times \frac{1}{ndv_2} \tag{7}$$

where

ndv_2 is the ratio between engine speed, in min^{-1}, and motorcycle speed, in km/h, in gear 2.

Since the cruise phases are defined by the phase indicator, slight speed increases could occur and it can be meaningful to apply an upshift. The upshift speeds ($v_{1 \to 2}$, $v_{2 \to 3}$ and $v_{i \to i+1}$) in km/h during cruise phases can be calculated in accordance with Formulae (8) to (10).

$$v_{1 \to 2} = \left[0{,}03 \times \left(s - n_{idle} \right) + n_{idle} \right] \times \frac{1}{ndv_2} \tag{8}$$

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$$v_{2\to3} = \left[\left(0{,}5753\times e^{\left(-1{,}9\times\frac{P_n}{m_k+75}\right)} - 0{,}1\right)\times\left(s - n_{idle}\right) + n_{idle}\right]\times\frac{1}{ndv_1} \quad (9)$$

$$v_{i\to i+1} = \left[\left(0{,}5753\times e^{\left(-1{,}9\times\frac{P_n}{m_k+75}\right)}\right)\times\left(s - n_{idle}\right) + n_{idle}\right]\times\frac{1}{ndv_{i-1}},\ i = 3 \text{ to } ng-1 \quad (10)$$

The results of shift speeds shall be mathematically rounded to the first place of the decimal point.

4.4.2.2.1.2 Step 2 — Gear choice for each cycle sample

In order to avoid different interpretations about acceleration, deceleration, cruise, and stop phases, corresponding indicators are added to the motorcycle speed pattern as integral parts of the cycles (see Tables 5 to 28).

The appropriate gear for each sample shall then be calculated according to the motorcycle speed ranges resulting from the shift speed formulae [Formulae (3) to (10)] and these phase indicators for the cycle parts appropriate for the test motorcycle as follows:

— gear choice for stop phases

  For the last 5 s of a stop phase, the gear lever shall be set to gear 1 and the clutch shall be disengaged. For the previous part of a stop phase, the gear lever shall be set to neutral or the clutch shall be disengaged.

— gear choice for acceleration phases:

  — gear 1, if $v \le v_{1\to2}$;
  — gear 2, if $v_{1\to2} < v \le v_{2\to3}$;
  — gear 3, if $v_{2\to3} < v \le v_{3\to4}$;
  — gear 4, if $v_{3\to4} < v \le v_{4\to5}$;
  — gear 5, if $v_{4\to5} < v \le v_{5\to6}$;
  — gear 6, if $v > v_{5\to6}$;

— gear choice for deceleration or cruise phases:

  — gear 1, if $v < v_{2\to1}$;
  — gear 2, if $v < v_{3\to2}$;
  — gear 3, if $v_{3\to2} \le v < v_{4\to3}$;
  — gear 4, if $v_{4\to3} \le v < v_{5\to4}$;
  — gear 5, if $v_{5\to4} \le v < v_{6\to5}$;
  — gear 6, if $v \ge v_{4\to5}$.

The clutch shall be disengaged, if

a) the motorcycle speed drops below 10 km/h,

b) the engine speed drops below $n_{idle} + 0{,}03 \times (s - n_{idle})$, or

c) there is a risk of engine stalling during cold start phase.

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4.4.2.2.1.3 Step 3 — Corrections according to additional requirements

The gear choice has then to be modified according to the following requirements.

a) There shall be no gearshift at a transition from an acceleration phase to a deceleration phase. The gear that was used for the last second of the acceleration phase shall be kept for the following deceleration phase unless the speed drops below a downshift speed.

b) There shall be no upshifts or downshifts by more than one gear, except from gear 2 to neutral during decelerations down to stop.(Example: Gear 4→4→4→4→3→3→3→3→1→1→1→1 will be replaced by gear 4→4→4→4→3→3→3→3→2→1→1→1.)

c) Upshifts or downshifts for up to 4 s are replaced by the gear before, if the gears before and after are identical. (Examples: Gear 2→3→3→3→2 will be replaced by gear 2→2→2→2→2; gear 4→3→3→3→3→4 will be replaced by gear 4→4→4→4→4→4.)

   In the cases of consecutive circumstances, the gear used longer takes over. (Example: Gear 2→2→2→3→3→3→2→2→2→2→3→3→3 will be replaced by 2→2→2→2→2→2→2→2→2→2→3→3→3.)

   If used for the same time, dominate a series of succeeding gears with a series of preceding gears. (Example: 2→2→2→3→3→3→2→2→2→3→3→3 will be replaced by 2→2→2→2→2→2→2→2→2→3→3→3.)

d) There shall be no downshift during an acceleration phase.

4.4.2.2.2 Optional provisions

The gear choice may be modified according to the following provisions.

— The use of lower gears than determined by the requirements described in 4.4.2.2.1 is permitted in any cycle phase. Manufacturers' recommendations for gear use shall be followed, if they do not result in higher gears than determined by the requirements described in 4.4.2.2.1.

NOTE The calculation program to be found on the UN website at the URL below can be used as an aid for the gear selection: http://www.unece.org/trans/main/wp29/wp29wgs/wp29grpe/wmtc.html. Explanations are given in Annex 13 of the global technical regulations No.2 (WMTC), United Nations Economic Commission for Europe, ECE/TRANS/180/Add.2/Corr.3.

4.5 Type 2 tests

4.5.1 Application

This requirement only applies to all test motorcycles powered by a positive-ignition engine.

4.5.2 Measured gaseous pollutant

The content by volume of carbon monoxide shall be measured immediately after the type 1 test.

4.5.3 Engine test speeds

The test shall be carried out with the engine at normal idling speed and at "high idle" speed. High idle speed is defined by the manufacturer but it shall be higher than 2 000 min^{-1}.

4.5.4 Gear lever position

In the case of test motorcycles with manually operated or semi-automatic shift gearboxes, the test shall be carried out with the gear lever in the "neutral" position and with the clutch engaged. In the case of test motorcycles with automatic-shift gearboxes, the test shall be carried out with the gear selector in either the "zero" or the "park" position.

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