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Note by the secretariat: As part of the secretariat's efforts to reduce expenditure, this voluminous informal document No. 15 will not be distributed during the 46th GRPE session. Delegates are kindly requested to bring their copies of this document to the meeting.

Worldwide Harmonised Motorcycle Emissions Certification Procedure

[DRAFT GLOBAL TECHNICAL REGULATION (GTR)]

UN/ECE-WP 29 - GRPE
WMTC Working Group

Whilst this document is presented in the format of a draft GTR as defined by WP.29 / 883, the WMTC FEG / WMTC informal group / GRPE recognise that the issue of GTR's and specific performance requirements / limit values is still being considered. Accordingly WMTC FEG / WMTC informal group / GRPE will finalise the document once WP.29 / AC.3 has reached a decision.

Indications for missing parts or parts that need to be modified are written in blue starting with "xxxxx".

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World Forum for Harmonisation of Vehicle Regulations (WP.29)

[DRAFT GLOBAL TECHNICAL REGULATION (GTR)]
UNIFORM PROVISIONS CONCERNING THE MEASUREMENT PROCEDURE FOR MOTORCYCLES EQUIPPED WITH A POSITIVE -IGNITION ENGINE WITH REGARD TO THE EMISSION OF GASEOUS POLLUTANTS, CO_2 EMISSIONS AND FUEL CONSUMPTION BY THE ENGINE

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Content **Page**

A. Statement of Technical Rationale and Justification

1. Technical and Economic Feasibility

The objective is to establish a harmonised Global Technical Regulation (GTR) on the certification procedure for motorcycle exhaust-emissions. The basis will be the harmonised test procedure, developed by the WMTC informal group of GRPE (see draft technical report, informal document no. 9 to 45th GRPE).

Regulations governing the exhaust-emissions from all road vehicles have been in existence for many years but the methods of measurement vary significantly. To be able to correctly determine a vehicle's impact on the environment in terms of exhaust emissions and its fuel consumption, the test procedure and consequently the GTR needs to adequately represent real-world vehicle operation.

The proposed regulation is based on new research into the world-wide pattern of real motorcycle use. From this data a representative test cycle in three parts has been created, covering different road types. Based on real life data a gearshift procedure was developed. The general laboratory conditions for the emission test have been brought up to date by an expert committee in ISO and now reflect the latest technologies.

This basic test procedure reflects world wide on-road motorcycle operation as closely as possible and enables a realistic assessment of existing and future motorcycle exhaust-emissions.

The weighting factors for calculating the overall emission results from the several cycle parts were calculated from the widest possible statistical basis worldwide. The classification of vehicles reflects the general categories of use and real world driving behaviour.

The performance levels (emissions and fuel consumption results) to be achieved in the GTR will be discussed on the basis of the most recently agreed legislation in the Contracting Party countries, required by the 1998 Agreement. On the basis of measurement results according to this GTR it will be possible to propose limit values that are compatible to existing limit values in different regions/countries.

The question of harmonised off cycle emissions requirements will be considered and appropriate measures introduced in due course.

2. Anticipated Benefits

Increasingly, motorcycles are vehicles, which are prepared for the world market. It is economically inefficient for manufacturers to have to prepare substantially different models in order to meet different emission regulations and methods of measuring CO2 / fuel consumption, which are, in principle, aimed at achieving the same objective. To enable manufacturers to develop new models most effectively it is desirable that a GTR should be developed.

Compared to the measurement methods defined in existing legislation in Contracting Party countries the method defined in this GTR is much more representative of motorcycle in-use driving behaviour with respect to the following parameters:

- Max. cycle speed,
- Vehicle acceleration,
- Gearshift prescriptions,
- Cold start consideration.

As a consequence, it can be expected that the application of this GTR for emissions limitation within the type approval procedure will result in a higher severity and higher correlation with in-use emissions.

3. [Potential cost effectiveness]

xxxxx not yet clear whether this is requested or not

B. Text of Regulation

1 Scope and Purpose

This regulation provides a world-wide harmonised method for the determination of the levels of gaseous pollutant emissions, the emissions of carbon dioxide and the fuel consumption of two -wheel motor vehicles that are representative for real world vehicle operation.
The results can build the basis for the limitation of gaseous pollutants and carbon dioxide and for the fuel consumption indicated by the manufacturer within regional type approval procedures.

2 Application

This Regulation applies to the emission of gaseous pollutants, carbon dioxide emissions and fuel consumption of two-wheeled motor cycles having a maximum design speed exceeding 50 km/h or cylinder capacity exceeding 50 cm³.

3 Definitions

For the purposes of this Regulation,

3.1 Vehicle Type

"Vehicle type" means a category of power-driven vehicles that do not differ in the following essential respects as:

3.1.1 Equivalent Inertia

The equivalent inertia determined in relation to the reference weight as prescribed in paragraph 6.4.2 to this Regulation, and

3.1.2 Engine and Vehicle Characteristics

The engine and vehicle characteristics as defined in annex 9.1 to this Regulation.

3.2 Vehicle Mass

3.2.1 Kerb Mass

The kerb mass of motorcycle shall be as follows:

Motorcycle dry mass to which is added the mass of the following:

- fuel: tank filled at least to 90 % of the capacity specified by the manufacturer;
- oils and coolant: filled as specified by the manufacturer;
- auxiliary equipment usually supplied by the manufacturer in addition to that necessary for normal operation tool-kit, carrier(s), windscreen(s), protective equipment, etc.

3.3 Reference Mass

"Reference mass" means the kerb mass of the vehicle increased by a uniform figure of 75 kg.

3.4 Engine Crank-case

“Engine crank-case" means the spaces in or external to an engine which are connected to the oil sump by internal or external ducts through which gases and vapours can escape.

3.5 Gaseous Pollutants

“Gaseous pollutants” means carbon monoxide, oxides of nitrogen expressed in terms of nitrogen dioxide (NO2) equivalence, and hydrocarbons, assuming a ratio of:

$C_1H_{1.85}$ for petrol

$C_1H_{1.86}$ for diesel

3.6 CO2 Emissions

“CO2 emissions” means carbon dioxide.

3.7 Fuel Consumption

[“Fuel consumption” means the amount of fuel consumed, calculated by the carbon balance method.]

3.8 Maximum Vehicle Speed v_{max}

[v_{max} is the maximum speed of the vehicle as declared by the manufacturer, measured in accordance with EU directive 95/1/EC.]

3.9 Symbols used

The symbols used in this regulation are summarised in Table 1 to Table 3.

Xxxxx Standardise unit system

Symbols	Definition	Unit
a	The coefficient of polygonal function	-
a_T	The rolling resistance force of front wheel	N
b	The coefficient of polygonal function	-
b_T	The coefficient of aerodynamic	N/(km/h)2
c	The coefficient of polygonal function	-
C_{CO}	Concentration of carbon monoxide	vol-%
$C_{CO}corr$	corrected Concentration of carbon monoxide	vol-%
CO_2c	carbon dioxide concentration of diluted gases, corrected to take account of the diluent air	%
CO_2d	carbon dioxide concentration in the sample of diluent air collected in bag B	%
CO_2e	carbon dioxide concentration in the sample of diluted gases collected in bag A	%
CO_2m	mass of carbon dioxide emitted during the test part	g/km
COc	carbon monoxide concentration of diluted gases, corrected to take account of the diluent air	ppm
COd	carbon monoxide concentration in the sample of diluent air collected in bag B	ppm
COe	carbon monoxide concentration in the sample of diluted gases collected in bag A	ppm
COm	mass of carbon monoxide emitted during the test part	g/km
d_0	The standard ambient relative air density	-
dCO	density of the carbon monoxide at a temperature of 0°C and a pressure of 101,3 kPa	kg/m³
dCO_2	density of the carbon dioxide at a temperature of 0°C and a pressure of 101,3 kPa	kg/m³
DF	dilution factor	-
dHC	density of the hydrocarbons at a temperature of 0°C and a pressure of 101,3 kPa	kg/m³
dist	distance driven in a cycle part	km
dNOx	density of the nitrogen oxides at a temperature of 0°C and a pressure of 101,3 kPa	kg/m³
d_T	The relative air density under test conditions	-
Δt	The coastdown time	s
Δt_{ai}	The coastdown time measured during the first road test	s
Δt_{bi}	The coastdown time measured during the second road test	s
ΔT_E	The corrected coastdown time at the inertia mass (m_i+m_{r1})	s
Δt_E	The mean coastdown time on the chassis dynamometer at the reference speed	s
ΔT_i	The average coastdown time at the specified speed	s
Δt_i	The coastdown time corresponding to the reference speed	s
ΔT_j	The average coastdown time of the two tests	s
ΔT_{road}	The target coastdown time	s
$\overline{\Delta t}$	The mean coastdown time on the chassis dynamometer without absorption	s
Δv	The coastdown speed interval ($2\Delta v = v_1 - v_2$)	km/h

Table 1: Symbols used (1/3)

Symbols	Definition	Unit
F	The running resistance force	N
F^*	The target running resistance force	N
$F^*(v_0)$	The target running resistance force at the reference speed on the chassis dynamometer	N
$F^*(v_i)$	The target running resistance force at the specified speed on the chassis dynamometer	N
f^*_0	The corrected rolling resistance in the standard ambient conditions	N
f^*_2	The corrected coefficient of aerodynamic drag in the standard ambient conditions	$N/(km/h)^2$
F^*_j	The target running resistance force at the specified speed	N
f_0	The rolling resistance	N
f_2	The coefficient of aerodynamic drag	$N/(km/h)^2$
F_E	The set running resistance force on the chassis dynamometer	N
$F_E(v_0)$	The set running resistance force at the reference speed on the chassis dynamometer	N
$F_E(v_i)$	The set running resistance force at the specified speed on the chassis dynamometer	N
F_f	The total friction loss	N
$F_f(v_0)$	The total friction loss at the reference speed	N
F_j	The running resistance force	N
$F_j(v_0)$	The running resistance force at the reference speed	N
F_{pau}	The braking force of the power absorbing unit	N
$F_{pau}(v_0)$	The braking force of the power absorbing unit at the reference speed	N
$F_{pau}(v_j)$	The braking force of the power absorbing unit at the specified speed	N
F_T	The running resistance force obtained from the running resistance table	N
H	absolute humidity	g/kg
HC_c	concentration of diluted gases, expressed in carbon equivalent, corrected to take account of the diluent air	ppm
HC_d	concentration of hydrocarbons expressed in carbon equivalent, in the sample of diluent air collected in bag B	ppm
HC_e	concentration of hydrocarbons expressed in carbon equivalent, in the sample of diluted gases collected in bag A	ppm
HC_m	mass of hydrocarbons emitted during the test part	g/km
K_0	The temperature correction factor for rolling resistance	-
K_h	humidity correction factor	-
m	The test motorcycle mass	kg
m_a	The actual mass of the test motorcycle	kg
m_{fi}	The flywheel equivalent inertia mass	kg
m_i	The equivalent inertia mass	kg
m_k	The motorcycle kerb mass	kg
m_k	kerb mass of the vehicle	kg
m_r	The equivalent inertia mass of all the wheels	kg
m_{r1}	The equivalent inertia mass of the rear wheel and the motorcycle parts rotating with the wheel	kg
m_{ref}	The motorcycle reference mass	kg
m_{ref}	reference mass	kg
m_{rf}	The rotating mass of the front wheel	kg
m_{rid}	The rider mass	kg
m_{rid}	riders mass	kg

Table 2: Symbols used (continued, 2/3)

Symbols	Definition	Unit
n	engine speed	min^{-1}
N	number of revolutions made by pump P	-
n_idle	idling speed	min^{-1}
n_max_acc(1)	Upshift speed from 1. to 2. gear during acceleration phases	min^{-1}
n_max_acc(i)	Upshift speed from i. to i+1. gear during acceleration phases, i > 1	min^{-1}
n_min_acc(i)	minimum engine speed for cruising or deceleration phases in gear I	min^{-1}
NOxc	nitrogen oxides concentration of diluted gases, corrected to take account of the diluent air	ppm
NOxd	nitrogen oxides concentration in the sample of diluent air collected in bag B	ppm
NOxe	nitrogen oxides concentration in the sample of diluted gases collected in bag A	ppm
NOxm	mass of nitrogen oxides emitted during the test part	g/km
p_0	The standard ambient pressure	kPa
P_a	ambient pressure	kPa
Pa	atmospheric pressure	kPa
Pd	saturated pressure of water at the test temperature	kPa
P_i	average under-pressure during the test part in the intake section of pump P	kPa
Pn	rated engine power	kW
p_T	The mean ambient pressure during the test	kPa
R	final test result of pollutant emissions, carbon dioxide emissions or fuel consumption	g/km, l/100km
r(i)	gear ratio in gear I	-
R1cold	Test result of pollutant emissions, carbon dioxide emissions or fuel consumption for cycle part1 with cold start	g/km, l/100km
R1hot	Test result of pollutant emissions, carbon dioxide emissions or fuel consumption for cycle part1 in hot condition	g/km, l/100km
R2	Test result of pollutant emissions, carbon dioxide emissions or fuel consumption for cycle part2	g/km, l/100km
R3	Test result of pollutant emissions, carbon dioxide emissions or fuel consumption for cycle part3	g/km, l/100km
s	rated engine speed	min^{-1}
T_0	The standard ambient temperature	K
T_p	temperature of the diluted gases during the test part, measured in the intake section of pump P	°C
T_T	The mean ambient temperature during the test	K
U	percentage humidity	%
v	The specified speed	km/h
V	total volume of diluted gas	m^3
v_0	The reference speed	km/h
V_0	volume of gas displaced by pump P during one revolution	m^3/revolution
v_1	The speed at which the measurement of the coastdown time begins	km/h
v_2	The speed at which the measurement of the coastdown time ends	km/h
v_j	The specified speeds which are selected for coastdown time measurement	km/h
w1cold	weighting factor of cycle part 1 with cold start	-
w1hot	weighting factor of cycle part 1 in hot condition	-
w2	weighting factor of cycle part 2	-
w3	weighting factor of cycle part 3	-
ε	The chassis dynamometer setting error	-
P_0	The standard relative ambient air volumetric mass	kg/m_3

Table 3: Symbols used (continued, 3/3)

4 General Requirements

The components liable to affect the emission of gaseous pollutants, carbon dioxide emissions and fuel consumption shall be so designed, constructed and assembled as to enable the vehicle in normal use, despite the vibration to which it may be subjected, to comply with the provisions of this Regulation.

5 [Performance Requirements]

xxxxx decision of AC.3 required

6 Test Conditions

6.1 Test Vehicle

6.1.1 General

The motorcycle shall conform in all its components with the production series, or, if the motorcycle is different from the production series, a full description shall be given in the test report.

6.1.2 Run-in

The motorcycle must be presented in good mechanical condition. It must have been run in and driven at least 1 000 km before the test.

The engine, transmission and motorcycle shall be properly run in, in accordance with the manufacturer's requirements.

6.1.3 Adjustments

The motorcycle shall be adjusted in accordance with the manufacturer's requirements, e.g. the viscosity of the oils, or, if the motorcycle is different from the production series, a full description shall be given in the test report.

6.1.4 Test Mass and Load Distribution

The total test mass including the masses of the rider and the instruments shall be measured before the beginning of the tests.

The distribution of the load between the wheels shall be in conformity with the manufacturer's instructions.

6.1.5 Tyres

The tyres shall be of a type specified as original equipment by the vehicle manufacturer.

The tyre pressures shall be adjusted to the specifications of the manufacturer or to those where the speed of the motorcycle during the road test and the motorcycle speed obtained on the chassis dynamometer are equalized.

The tyre pressure shall be indicated in the test report.

6.2 [Vehicle Classification

6.2.1 Class 1

Vehicles that fulfil the following specifications belong to class 1:

Engine capacity <= 50 cm³ and 50 km/h < v_{max} < 60 km/h or

50 cm³ < Engine capacity < 150 cm³ and v_{max} <= 50 km/h or

Vehicles with engine capacity < 150 cm³ and v_{max} < 100 km/h.

v_{max} is the maximum vehicle speed.

6.2.2 Class 2

Vehicles that fulfil the following specifications belong to class 2:

Engine capacity < 150 cm³ and v_{max} >= 100 km/h or

Engine capacity >= 150 cm³ and v_{max} < 130 km/h.

v_{max} is the maximum vehicle speed.

6.2.3 Class 3

Vehicles with engine capacity >= 150 cm³ and v_{max} >= 130 km/h belong to class 3.

v_{max} is the maximum vehicle speed.]

6.3 Specification of Reference Fuel

The appropriate reference fuels as defined in annex 10 to Regulation No. 83 must be used for testing.

For the purpose of calculation mentioned in paragraph 8.1.2.5, for petrol and diesel fuel the density measured at 15° C will be used.

6.3.1 TECHNICAL DATA OF THE REFERENCE FUEL TO BE USED FOR TESTING VEHICLES EQUIPPED WITH POSITIVE-IGNITION ENGINES

Type: Unleaded petrol

Parameter	Unit	Limits (1)		Test Method	Publication
		Minimum	Maximum		
Research octane number, RON		95.0		EN 25164	1993
Motor octane number, MON		85.0		EN 25163	1993
Density at 15°C	kg/m^3	748	762	ISO 3675	1995
Reid vapour pressure	kPa	56.0	60.0	EN 12	1993
Distillation:					
- initial boiling point	°C	24	40	EN-ISO 3205	1988
- evaporated at 100 °C	per cent v/v	49.0	57.0	EN-ISO 3205	1988
- evaporated at 150 °C	per cent v/v	81.0	87.0	EN-ISO 3205	1988
- final boiling point	°C	190	215	EN-ISO 3205	1988
Residue	per cent		2	EN-ISO 3205	1988
Hydrocarbon analysis:					
- olefins	per cent v/v		10	ASTM D 1319	1995
- aromatics(3)	per cent v/v	28.0	40.0	ASTM D 1319	1995
- benzene	per cent v/v		1.0	pr. EN 12177	[1998](2)
- saturates	per cent v/v		balance	ASTM D 1319	1995
Carbon/hydrogen ratio		report	report		
Oxidation stability(4)	min.	480		EN-ISO 7536	1996
Oxygen content(5)	per cent m/m		2.3	EN 1601	[1997](2)
Existent gum	mg/ml		0.04	EN-ISO 6246	[1997](2)
Sulphur content(6)	mg/kg		100	pr.EN-ISO/DIS 14596	[1998](2)
Copper corrosion at 50 °C			1	EN-ISO 2160	1995
Lead content	g/l		0.005	EN 237	1996
Phosphorus content	g/l		0.0013	ASTM D 3231	1994

(1) The values quoted in the specification are "true values". In establishment of their limit values the terms of ISO 4259 "Petroleum products - Determination and application of precision data in relation to methods of test,' have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum

difference is 4R (R = reproducibility).

Notwithstanding this measure, which is necessary for statistical reasons, the manufacturer of fuels should nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

(2) The month of publication will be completed in due course.

(3) The reference fuel used shall have a maximum aromatics content of 35 per cent v/v.

(4) The fuel may contain oxidation inhibitors and metal deactivators normally used to stabilise refinery gasoline streams, but detergent/dispersive additives and solvent oils shall not be added.

(5) The actual oxygen content of the fuel for the tests shall be reported. In addition the maximum oxygen content of the reference fuel shall be 2.3 per cent.

(6) The actual sulphur content of the fuel used for the tests shall be reported. In addition the reference fuel shall have a maximum sulphur content of 50 ppm.

6.3.2 TECHNICAL DATA OF THE REFERENCE FUEL TO BE USED FOR TESTING VEHICLES EQUIPPED WITH A DIESEL ENGINE

Type: Diesel fuel

Parameter	Unit	Limits (1)		Test Method	Publication
		Minimum	Maximum		
Cetane number(2)		52.0	54.0	EN-ISO 5165	1998(3)
Density at 15°C	kg/m³	833	837	EN-ISO 3675	1995
Distillation:					
- 50 per cent point	°C	245	-	EN-ISO 3405	1988
- 95 per cent	°C	345	350	EN-ISO 3405	1988
- final boiling point	°C	-	370	EN-ISO 3405	1988
Flash point	°C	55	-	EN 22719	1993
CFPP	°C	-	-5	EN 116	1981
Viscosity at 40 °C	mm²/s	2.5	3.5	EN-ISO 3104	1996
Polycyclic aromatic hydrocarbons	per cent m/m	3	6.0	IP 391	1995
Sulphur content(4)	mg/kg	-	300	pr. EN-ISO/DIS 14596	1998(3)
Copper corrosion		-	1	EN-ISO 2160	1995
Conradson carbon residue (10 per cent DR)	per cent m/m	-	0.2	EN-ISO 10370	1995
Ash content	per cent m/m	-	0.01	EN-ISO 6245	1995
Water content	per cent m/m	-	0.05	EN-ISO 12937	[1998](3)
Neutralisation (strong acid) number	mg KOH/g	-	0,02	ASTM D 974-95	1998(3)
Oxidation stability(5)	mg/ml	-	0.025	EN-ISO 12205	1996

(1) The values quoted in the specification are 'true values". In establishment of their limit values the terms of ISO 4259 "Petroleum products - Determination and application of precision data in relation to methods of test" have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility).

Notwithstanding this measure, which is necessary for statistical reasons, the manufacturer of fuels should nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

(2) The range for the cetane number is not in accordance with the requirement of a minimum range of 4R. However, in the case of a dispute between fuel supplier and fuel user, the terms in ISO 4259 may be used to resolve such disputes provided replicate measurements, of sufficient number to archive the necessary precision, are made in preference to single determinations.

(3) The month of publication will be completed in due course.

(4) The actual sulphur content of the fuel used for the Type I test shall be reported. In addition the reference fuel used to approve a vehicle against the limit values set out in Row II of the table in paragraph 5.3.1.4. of this Regulation shall have a maximum sulphur content of 50 ppm.

(5) Even though oxidation stability is controlled, it is likely that shelf life will be limited. Advice should be sought from the supplier as to storage conditions and life.

6.3.3 Specification of Gaseous Reference Fuel

6.3.3.1 Technical Data of LPG Reference Fuels

Characteristics	Units	Fuel A	Fuel B	Test method
Composition	per cent vol.			ISO 7941
C3	per cent vol.	30 _2	85 _2	
C4	per cent vol.	Balance	Balance	
< C3, >C4	per cent vol.	max. 2 per cent	max. 2 per cent	
Olefins	per cent vol.	9 _3	12 _3	
Evaporative residue	ppm	max. 50	max. 50	NFM 41-015
Water content		None	None	Visual inspection
Sulphur content	ppm mass (1)	Max. 50	Max. 50	EN 24260
Hydrogen sulphide		None	None	
Copper corrosion	Rating	Class 1	Class 1	ISO 625 I (2)
Odour		Characteristic	Characteristic	
MON		Min. 89	Min. 89	EN 589 annex B

(1) Value to be determined at standard conditions, i.e. 293.2 K (20 C) and 101.3 kPa.

(2) This method may not accurately determine the presence of corrosive materials if the sample contains corrosion inhibitors or other chemicals that diminish the corrosivity of the sample to the copper strip. Therefore, the addition of such compounds for the sole purpose of biasing the test method is prohibited.

6.3.3.2 Technical data of NG Reference Fuels

Reference fuel G20

Characteristics	Units	Basis	Limits		Test Method
			Minimum	Maximum	
Composition:					
Methane		100	99	100	
Balance	per cent mole	-	-	1	ISO 6974
[Inerts + C_2/C_2+]					
N_2					
Sulphur content	mg/m^3 (1)	-	-	50	ISO 6326-5

Reference fuel G25

Characteristics	Units	Basis	Limits		Test Method
			Minimum	Maximum	
Composition:					
Methane		86	84	88	
Balance	per cent mole	-	-	1	ISO 6974
[Inerts + C_2/C_2+]					
N_2		14	12	16	
Sulphur content	mg/m^3 (1)	-	-	50	ISO 6326-5

(1) Value to be determined at standard conditions, i.e. 293.2 K (20 C) and 101.3 kPa.

The Wobbe Index is the ratio of the calorific value of gas per unit volume and the square root of its relative density under the same reference conditions:

$$\text{Wobbe index} = H_{gas}\ \gamma\rho_{air}/\gamma\rho_{gas}$$

with

H_{gas} = calorific value of the fuel in MJ/m^3 at 0 □C

ρ_{air} = density of air at 0 C

ρ_{gas} = density of fuel at 0 C

The Wobbe Index is said to be gross or net according to whether the calorific value is the gross or net calorific value.

6.4 Type I Tests

6.4.1 Rider

The rider shall have a mass of 75 kg ± 5 kg.

6.4.2 Test Bench Specifications and Settings

6.4.2.1 The dynamometer shall have a single roll with a diameter of at least 0,400 m.

6.4.2.2 The dynamometer shall be equipped with a roll revolution counter for measuring actual distance travelled.

6.4.2.3 Flywheels or other means shall be used to stimulate the inertia specified in 7.2.2.

6.4.2.4 Cooling fan specifications as follows:

6.4.2.4.1 Throughout the test, a variable speed cooling blower shall be positioned in front of the motorcycle, so as to direct the cooling air to the motorcycle in a manner, which simulates actual operating conditions. The blower speed shall be such that, within the operating range of 10 to 50 km/h, the linear velocity of the air at the blower outlet is within ±5 km/h of the corresponding roller speed. And at the range of over 50 km/h, the linear velocity of the air shall be within ±10%. At roller speeds of less than 10 km/h, air velocity may be zero.

6.4.2.4.2 The above mentioned air velocity shall be determined as an averaged value of 9 measuring points which are located at the centre of each rectangle dividing whole of the blower outlet into 9 areas (dividing both of horizontal and vertical sides of the blower outlet into 3 equal parts). Each value at those 9 points shall be within 10% of the averaged value of themselves.

6.4.2.4.3 The blower outlet shall have a cross section area of at least 0,4 m^2 and the bottom of the blower outlet shall be between 5 and 20 cm above floor level. The blower outlet shall be perpendicular to the longitudinal axis of the motorcycle between 30 and 45 cm in front of its front wheel. The device used to measure the linear velocity of the air shall be located at between 0 and 20 cm from the air outlet.

6.4.2.5 The chassis dynamometer rollers shall be clean, dry and free from anything, which might cause the tyre to slip.

6.4.3 Exhaust Gas Measurement System

Xxxxx Drawings have to be added.

6.4.3.1 The gas-collection device shall be a closed type device that can collect all exhaust gases at the motorcycle exhaust outlet(s) on condition that it satisfies the back pressure condition of ±125 mm H_2O. An open system may be used as well if it is confirmed that all the exhaust gases are collected. The gas collection shall be such that there is no condensation, which could appreciably modify that nature of exhaust gases at the test temperature.

6.4.3.2 A connecting tube between the device and the exhaust gas sampling system. This tube, and the device shall be made of stainless steel, or of some other material, which does not affect the composition of the gases collected, and which withstands the temperature of these gases.

6.4.3.3 A heat exchanger capable of limiting the temperature variation of the diluted gases in the pump intake to ±5 °C throughout the test. This exchanger shall be equipped with a preheating system able to bring the exchanger to its operating temperature (with the tolerance of ±5 °C) before the test begins.

6.4.3.4 A positive displacement pump to draw in the dilute exhaust mixture. This pump is equipped with a motor having several strictly controlled uniform speeds. The pump capacity shall be large enough to ensure the intake of the exhaust gases. A device using a critical flow Venturi may also be used.

6.4.3.5 A device to allow continuous recording of the diluted exhaust mixture entering the pump.

6.4.3.6 Two gauges; the first to ensure the pressure depression of the dilute exhaust mixture entering the pump, relative to atmospheric pressure, the other to measure the dynamic pressure variation of the positive displacement pump.

6.4.3.7 A probe located near to, but outside the gas-collecting device, to collect, through a pump, a filter and a flow meter, samples of the dilution air stream, at constant flow rates throughout the test.

6.4.3.8 A sample probe pointed upstream into the dilute exhaust mixture flow, upstream of the positive displacement pump to collect, through a pump, a filter and a flow meter, samples of the dilute exhaust mixture, at constant flow rates, throughout the test.

The minimum sample flow rate in the two sampling devices described above and in 6.4.3.7 shall be at least 150 l/h.

6.4.3.9 Three way valves on the sampling system described in 6.4.3.7 and 6.4.3.8 to direct the samples either to their respective bags or to the outside throughout the test.

6.4.3.10 Gas-tight collection bags for dilution air and dilute exhaust mixture of sufficient capacity so as not to impede normal sample flow and which will not change the nature of the pollutants concerned.

6.4.3.11 The bags shall have an automatic self-locking device and shall be easily and tightly fastened either to the sampling system or the analysing system at the end of the test.

6.4.3.12 A revolution counter to count the revolutions of the positive displacement pump throughout the test.

NOTE 1 Good care shall be taken on the connecting method and the material or configuration of the connecting parts because there is a possibility that each section (e.g. the adapter and the coupler) of the sampling system becomes very hot. It the measurement cannot be performed normally due to heat-damages of the sampling system, an auxiliary cooling device may be used as long as the exhaust gases are not affected.

NOTE 2 Open type devices have risks of incomplete gas collection and gas leakage into the test cell. It is necessary to make sure there is no leakage throughout the sampling period.

NOTE 3 If a constant CVS flow rate is used throughout the test cycle that includes low and high speeds all in one (i.e. Part 1, 2 and 3 cycles of WMTC validation test step 2 mode), special attention should be paid because of higher risk of water condensation in high speed range.

6.4.4 Driving Schedules

6.4.4.1 Test Cycles

The test cycle for the type I test consists of up to three parts. Depending on the vehicle class (see paragraph 6.2) the following parts have to be run:

Vehicle class 1: **part 1, reduced speed** in cold condition followed by part 1, reduced speed in hot condition, if

Engine capacity <= 50 cm³ and 50 km/h < v_{max} < 60 km/h or

50 cm³ < Engine capacity < 150 cm³ and v_{max} <= 50 km/h.

part 1 in cold condition followed by part 1 in hot condition, if

v_{max} >= 60 km/h

v_{max} is the maximum vehicle speed.

Vehicle class 2: **part 1 in cold condition followed by part 2, reduced speed** in hot condition, if

v_{max} < 115 km/h

part 1 in cold condition followed by part 2 in hot condition, if

v_{max} >= 115 km/h

v_{max} is the maximum vehicle speed.

Vehicle class 3: **part 1 in cold condition followed by part 2 and part 3, reduced speed** in hot condition, if

v_{max} < 140 km/h

part 1 in cold condition followed by part 2 and part 3 in hot condition, if

v_{max} >= 140 km/h

v_{max} is the maximum vehicle speed.

The vehicle speed pattern is shown in annex 9.2.

6.4.4.2 Speed Tolerances

The speed tolerance at any given time on the test cycle prescribed in 6.4.4.1 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 second of the given time. The lower limit is 3,2 km/h lower than the lowest point on the trace within 1 second of the given time. Speed variations greater than the tolerances (such as may occur during gear changes) are acceptable provided they occur for less than 2 seconds on any occasion. Speeds lower than those prescribed are acceptable provided the vehicle is operated at maximum available power during such occurrences. Figure 1 shows the range of acceptable speed tolerances for typical points.

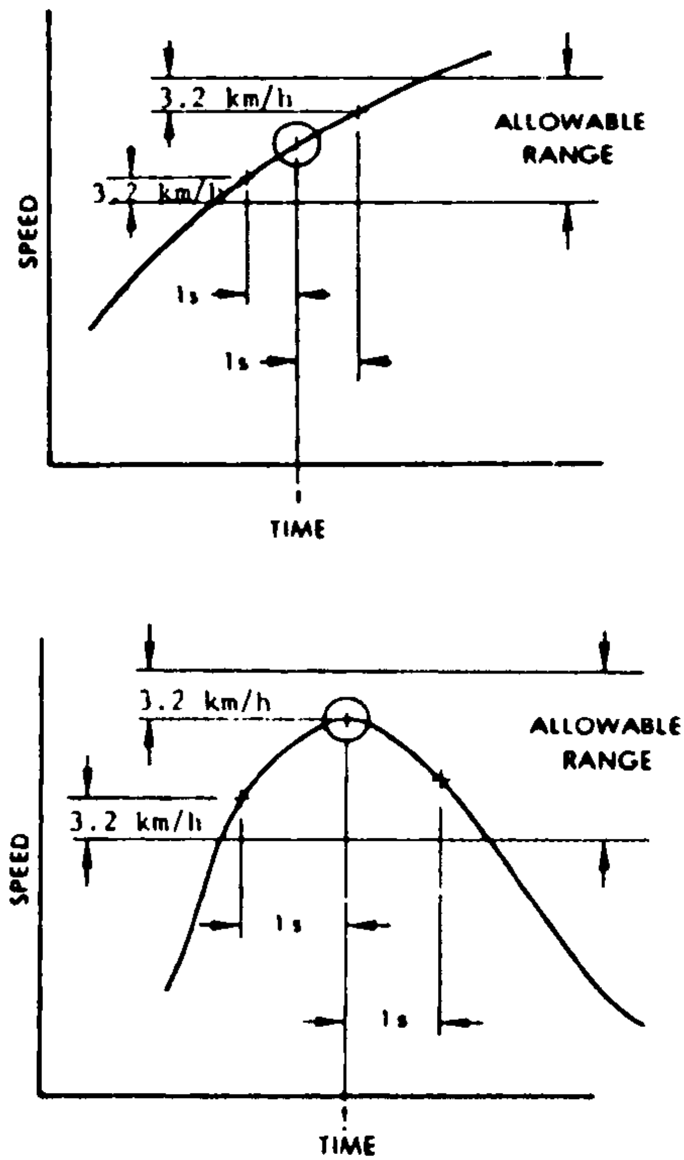

Figure 1: Drivers trace, allowable range

6.4.5 Gearshift Prescriptions

6.4.5.1 Vehicles with automatic transmission

Vehicles 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.

6.4.5.2 Vehicles with manual transmission

Idle modes shall be run with manual transmissions in 1. gear with the clutch disengaged.

For acceleration phases manual transmissions shall be shifted from 1. to 2. gear when the engine speed reaches a value according to the following formula:

$$n\_max\_acc(1) = (0{,}5753*\exp(-1{,}9*(Pn/(m_k + 75\ kg)) - 0{,}10)*(s - n\_idle) + n\_idle \qquad \textbf{equation 1}$$

Pn - rated power in kW

m_k – kerb mass in kg
n – engine speed in min^{-1}
n_idle – idling speed in min^{-1}
s - rated engine speed in min^{-1}

Upshifts for higher gears have to be carried out during acceleration phases when the engine speed reaches a value according to the following formula:

$$n\_max\_acc(i) = (0,\ 5753*\exp(-1{,}9*(Pn/(m_k + 75\ kg)))*(s - n\_idle) + n\_idle \qquad \textbf{equation 2}$$

Pn - rated power in kW

m_k – kerb mass in kg
n – engine speed in min^{-1}
n_idle – idling speed in min^{-1}
s - rated engine speed in min^{-1} at max. power
i – gear number (>= 2)

The minimum engine speeds for acceleration phases in gear 2 or higher gears are accordingly defined by the following formula:

$$n\_min\_acc(i) = n\_max\_acc(i-1)*r(i)/r(i-1) \qquad \textbf{equation 3}$$

r(i) – ratio of gear i

The minimum engine speeds for deceleration phases or cruising phases in gear 2 or higher gears are defined by the following formula:

$$n\_min\_dec(i) = n\_min\_acc(i-1)*r(i)/r(i-1) \qquad \textbf{equation 4}$$

r(i) – ratio of gear I

When reaching these values during deceleration phases the manual transmission has to be shifted to the next lower gear (see Figure 2).

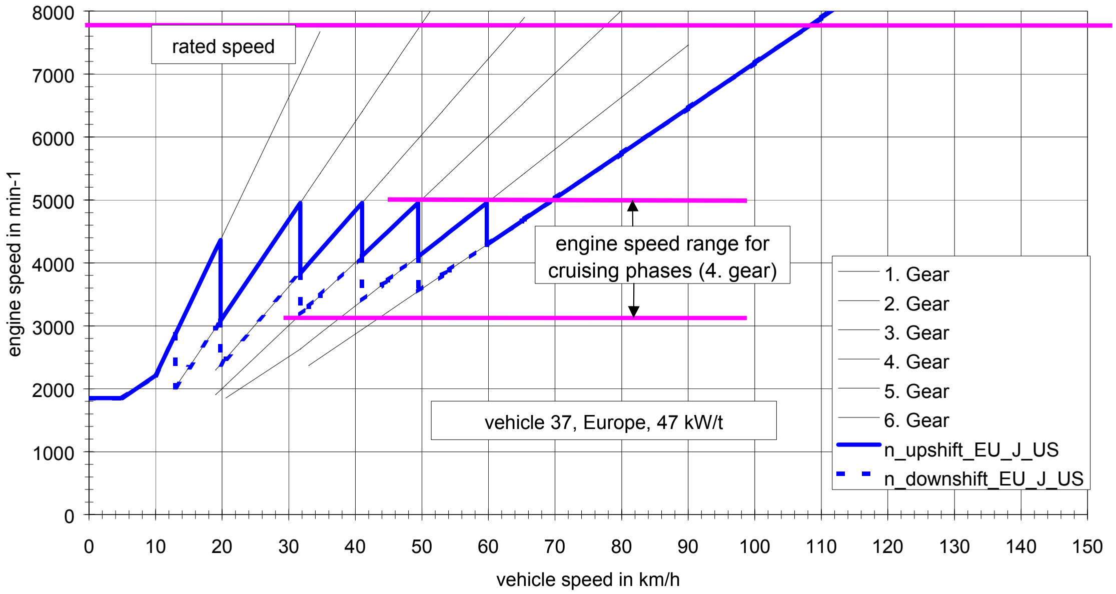

Figure 2: Example for gearshift points

There are fixed allocations for acceleration, cruising and deceleration phases (see annex 9.2)

Gearshifts are prohibited for indicated cycle sections (see annex 9.2)

Downshifts to the 1. gear are prohibited for those modes, which require the vehicle to decelerate to zero.

Manual transmissions gearshifts shall be accomplished with minimum time with the operator closing the throttle during each shift.

The 1. gear should only be used when starting from standstill.

For those modes that require the vehicle to decelerate to zero, manual transmission clutches shall be disengaged when the speed drops below 10 km/h, when the engine speed reaches idling speed, when engine roughness is evident, or when engine stalling is imminent.

While the clutch is disengaged the vehicle shall be shifted to the appropriate gear for starting the next mode.

In general it is allowed to use higher shift speeds than derived from the formulas above.

Xxxxx add a more clear description of the procedure, flowchart.

6.4.6 Dynamometer Settings

A full description of the chassis dynamometer and instruments shall be provided in accordance with annex 9.3

Measurements shall be made to the accuracies as specified in paragraph 6.4.7, Table 5.

The running resistance force for the chassis dynamometer settings can be derived either from on road cost down measurements or from a running resistance table.

6.4.6.1 Chassis dynamometer setting derived from on-road coast down measurements

To use this alternative on road cost down measurements have to be carried out as specified in annex 9.4.

6.4.6.1.1 Requirements for the equipment

The instrumentation for the speed and time measurement shall have the accuracies as specified in paragraph 6.4.6.

The chassis dynamometer rollers shall be clean, dry and free from anything, which might cause the tyre to slip.

6.4.6.1.2 Inertia mass setting

The equivalent inertia mass for the chassis dynamometer shall be the flywheel equivalent inertia mass, m_{fi}, closest to the actual mass of the motorcycle, m_a. The actual mass, m_a, is obtained by adding the rotating mass of the front wheel, m_{rf}, to the total mass of the motorcycle, rider and instruments measured during the road test. Alternatively, the equivalent inertia mass m_i can be derived from Table 4. The value of m_{rf} , in kilograms, may be measured or calculated as appropriate, or may be estimated as 3% of m.

If the actual mass m_a cannot be equalized to the flywheel equivalent inertia mass m_i, to make the target running resistance force F^* equal to the running resistance force F_E (which is to be set to the chassis dynamometer), the corrected coast down time ΔT_E may be adjusted in accordance with the total mass ratio of the target coast down time ΔT_{road} in the following sequence:

$$\Delta T_{road} = \frac{1}{3,6}\left(m_a + m_{r1}\right)\frac{2\Delta v}{F^*} \qquad \textbf{equation 5}$$

$$\Delta T_E = \frac{1}{3,6}\left(m_i + m_{r1}\right)\frac{2\Delta v}{F_E} \qquad \textbf{equation 6}$$

$$F_E = F^* \qquad \textbf{equation 7}$$

$$\Delta T_E = \Delta T_{road} \times \frac{m_i + m_{r1}}{m_a + m_{r1}} \qquad \textbf{equation 8}$$

with $0,95 < \frac{m_i + m_{r1}}{m_a + m_{r1}} < 1,05$

NOTE m_{r1} may be measured or calculated, in kilograms, as appropriate. As an alternative, m_{r1} may be estimated as 4% of m.

6.4.6.2 Running resistance force derived from a running resistance table

Alternatively the running resistance force for the chassis dynamometer settings can be taken from Table 4. In this case the chassis dynamometer shall be set by the reference mass regardless of particular motorcycle characteristics.

The flywheel equivalent inertia mass m_{fi} shall be the equivalent inertia mass m_i specified in Table 4. The chassis dynamometer shall be set by the rolling resistance a and the aero drug coefficient b as specified in Table 4.

The running resistance force on the chassis dynamometer F_E shall be determined from the following equation:

$$F_E = F_T = a + b \times v^2$$ **equation 9**

Reference mass m_{ref} Kg	Equivalent inertia mass m_i Kg	Rolling resistance of front wheel a N	Aero drag coefficient b N/(km/h)^2
$95<m_{ref}≤105$	100	8.8	0.0215
$105<m_{ref}≤115$	110	9.7	0.0217
$115<m_{ref}≤125$	120	10.6	0.0218
$125<m_{ref}≤135$	130	11.4	0.0220
$135<m_{ref}≤145$	140	12.3	0.0221
$145<m_{ref}≤155$	150	13.2	0.0223
$155<m_{ref}≤165$	160	14.1	0.0224
$165<m_{ref}≤175$	170	15.0	0.0226
$175<m_{ref}≤185$	180	15.8	0.0227
$185<m_{ref}≤195$	190	16.7	0.0229
$195<m_{ref}≤205$	200	17.6	0.0230
$205<m_{ref}≤215$	210	18.5	0.0232
$215<m_{ref}≤225$	220	19.4	0.0233
$225<m_{ref}≤235$	230	20.2	0.0235
$235<m_{ref}≤245$	240	21.1	0.0236
$245<m_{ref}≤255$	250	22.0	0.0238
$255<m_{ref}≤265$	260	22.9	0.0239
$265<m_{ref}≤275$	270	23.8	0.0241
$275<m_{ref}≤285$	280	24.6	0.0242
$285<m_{ref}≤295$	290	25.5	0.0244
$295<m_{ref}≤305$	300	26.4	0.0245
$305<m_{ref}≤315$	310	27.3	0.0247
$315<m_{ref}≤325$	320	28.2	0.0248
$325<m_{ref}≤335$	330	29.0	0.0250
$335<m_{ref}≤345$	340	29.9	0.0251
$345<m_{ref}≤355$	350	30.8	0.0253
$355<m_{ref}≤365$	360	31.7	0.0254
$365<m_{ref}≤375$	370	32.6	0.0256
$375<m_{ref}≤385$	380	33.4	0.0257
$385<m_{ref}≤395$	390	34.3	0.0259

Reference mass m_{ref} Kg	Equivalent inertia mass m_i Kg	Rolling resistance of front wheel a N	Aero drag coefficient b N/(km/h)^2
395<m_{ref}≤405	400	35.2	0.0260
405<m_{ref}≤415	410	36.1	0.0262
415<m_{ref}≤425	420	37.0	0.0263
425<m_{ref}≤435	430	37.8	0.0265
435<m_{ref}≤445	440	38.7	0.0266
445<m_{ref}≤455	450	39.6	0.0268
455<m_{ref}≤465	460	40.5	0.0269
465<m_{ref}≤475	470	41.4	0.0271
475<m_{ref}≤485	480	42.2	0.0272
485<m_{ref}≤495	490	43.1	0.0274
495<m_{ref}≤505	500	44.0	0.0275
At every 10 kg	At every 10 kg	$a = 0.088 m_i$ [a]	$b = 0.000015 m_i + 0.0200$ [b]

[a] The value shall be rounded to two decimal places.

[b] The value shall be rounded to five decimal places.

Table 4: Classification of equivalent inertia mass and running resistance

6.4.7 Measurement Accuracies

Measurements have to be carried out using equipment that fulfil the accuracy requirements as described in the table below:

		At measured value	Resolution
a)	Running resistance force, F	+ 2%	-
b)	Motorcycle speed (v_1, v_2)	± 1%	0,2 km/h
c)	Coast down speed interval [$2\Delta v = v_1 - v_2$]	± 1%	0,1 km/h
d)	Coast down time (Δt)	± 0,5%	0,01 s
e)	Total motorcycle mass [$m_k + m_{rid}$]	± 0,5%	1,0 kg
f)	Wind speed	± 10%	0,1 m/s
g)	Wind direction	-	5 deg.
h)	Temperatures	± 1 °C	1 °C
i)	Barometric pressure	-	0,2 kPa
j)	Distance	± 0,1%	1 m
k)	Time	± 0,1 s	0,1 s
k)	Fuel consumption	± 2%	

Table 5: Required accuracy of measurements

(m_k – vehicle kerb mass, m_{rid} – rider's mass)

6.5 Type II Tests

6.5.1 Application

This requirement applies to all vehicles powered by a positive-ignition engine.

6.5.2 Test Fuel.

The fuel shall be the reference fuel whose specifications are given in paragraph 6.3 to this Regulation.

6.5.3 Measured Gaseous Pollutant.

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

6.5.4 Engine Test Speeds

Xxxxx check whether text is in line with directive 97/24 EC.

The test has to be carried out with the engine at normal idling speed and at "high idle" speed.

High idle speed is defined as 2000 min^{-1}, if dual normal idling speed is equal or below 2000 min^{-1}, or as dual normal idling speed, if this value is higher than 2000 min^{-1}.

6.5.5 Gear Lever Position

In the case of vehicles 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 vehicles with automatic-shift gearboxes, the test shall be carried out with the gear selector in either the "zero" or the "park" position.

7 Test Procedures

7.1 Description of Tests.

The vehicle shall be subjected, according to its category, to tests of two types, I and II, as specified below.

7.1.1 Type-I Test (verifying the average emission of gaseous pollutants, CO_2 emissions and fuel consumption in a characteristic driving cycle).

7.1.1.1 The test shall be carried out by the method described in paragraph 7.1 to this Regulation. The gases shall be collected and analysed by the prescribed methods.

7.1.1.2 Subject to the provisions of paragraph 7.1 below, the test shall be repeated three times. In each test, the mass of the carbon monoxide, the mass of the hydrocarbons, the mass of the nitrogen oxides, the mass of carbon dioxide and the mass of the fuel, consumed during the test shall be determined.

7.1.2 Type-II Test (test of carbon monoxide at idling speed) and emissions data required for roadworthiness testing.

The carbon monoxide content of the exhaust gases emitted shall be checked by a test with the engine at normal idling speed and at “high idle” speed (i.e. > 2000 min^{-1}) carried out by the method described in paragraph 7.3 to this Regulation.

7.2 Type I Tests

7.2.1 Overview

The type I test consists of prescribed sequences of dynamometer preparation, fuelling, parking, and operating conditions.

The test is designed to determine hydrocarbon, carbon monoxide, oxides of nitrogen, carbon dioxide mass emissions and fuel consumption while simulating real world operation. The test consists of engine start-ups and motorcycle operation on a chassis dynamometer, through a specified driving cycle. A proportional part of the diluted exhaust emissions is collected continuously for subsequent analysis, using a constant volume (variable dilution) sampler.

Except in cases of component malfunction or failure, all emission control systems installed on or incorporated in a new motorcycle shall be functioning during all procedures.

Background concentrations are measured for all species for which emissions measurements are made. For exhaust testing, this requires sampling and analysis of the dilution air.

7.2.2 Dynamometer Settings and Verification

7.2.2.1 Vehicle Preparation

The manufacturer shall provide additional fittings and adapters, as required to accommodate a fuel drain at the lowest point possible in the tank(s) as installed on the vehicle and to provide for exhaust sample collection.

The tyre pressures shall be adjusted to the specifications of the manufacturer or to those at which the speed of the motorcycle during the road test and the motorcycle speed obtained on the chassis dynamometer are equal.

The test motorcycle shall be warmed up on the chassis dynamometer.

7.2.2.2 Dynamometer Preparation

The chassis dynamometer shall be appropriately warmed up to the stabilized frictional force F_f.

The load on the chassis dynamometer F_E is, in view of its construction, composed of the total friction loss F_f which is the sum of the chassis dynamometer rotating frictional resistance, the tyre rolling resistance, the frictional resistance of the rotating parts in the driving system of the motorcycle and the braking force of the power absorbing unit (pau) F_{pau}, as shown in the following equation:

$$F_E = F_f + F_{pau}$$ **equation 10**

The target running resistance force F^* derived from 6.4.6 should be reproduced on the chassis dynamometer in accordance with the motorcycle speed. Namely:

$$F_E(v_i) = F^*(v_i)$$ **equation 11**

The total friction loss F_f on the chassis dynamometer shall be measured by the method in 7.2.2.2.1 or 7.2.2.2.

7.2.2.2.1 Motoring by chassis dynamometer

This method applies only to chassis dynamometers capable of driving a motorcycle. The motorcycle shall be driven by the chassis dynamometer steadily at the reference speed v_0 with the transmission engaged and the clutch disengaged. The total friction loss $F_f(v_0)$ at the reference speed v_0 is given by the chassis dynamometer force.

7.2.2.2.2 Coast down without absorption

The method of measuring the coast down time is the coast down method for the measurement of the total friction loss F_f.

The motorcycle coast down shall be performed on the chassis dynamometer by the procedure described in 9.4.6 with zero chassis dynamometer absorption, and the coast down time Δt_i corresponding to the reference speed v_0 shall be measured.

The measurement shall be carried out at least three times, and the mean coast down time $\overline{\Delta t}$ shall be calculated by the following equation:

$$\overline{\Delta t} = \frac{1}{n}\sum_{i=1}^{n} \Delta t_i$$ **equation 12**

7.2.2.3 Total friction loss

The total friction loss $F_f(v_0)$ at the reference speed v_0 is calculated by the following equation:

$$F_f(v_0) = \frac{1}{3,6}(m_i + m_{r1})\frac{2\Delta v}{\Delta t}$$ **equation 13**

7.2.2.4 Calculation of power absorption unit force

The force $F_{pau}(v_0)$ to be absorbed by the chassis dynamometer at the reference speed v_0 is calculated by subtracting $F_f(v_0)$ from the target running resistance force $F^*(v_0)$ as shown in the following equation:

$$F_{pau}(v_0) = F^*(v_0) - F_f(v_0)$$ **equation 14**

7.2.2.5 Chassis dynamometer setting

According to its type, the chassis dynamometer shall be set by one of the methods described in 7.2.2.5.1 to 7.2.2.5.4. The chosen setting shall be applied to the pollutant emissions measurements as well as to the CO2 emission measurements.

7.2.2.5.1 Chassis dynamometer with polygonal function

In the case of a chassis dynamometer with polygonal function, in which the absorption characteristics are determined by load values at several speed points, at least three specified speeds, including the reference speed, shall be chosen as the setting points. At each setting point, the chassis dynamometer shall be set to the value $F_{pau}(v_j)$ obtained in 7.2.2.4.

7.2.2.5.2 Chassis dynamometer with coefficient control

In the case of a chassis dynamometer with coefficient control, in which the absorption characteristics are determined by given coefficients of a polynomial function, the value of $F_{pau}(v_j)$ at each specified speed shall be calculated by the procedure in 7.2.2.3 and 7.2.2.4.

Assuming the load characteristics to be:

$$F_{pau}(v) = av^2 + bv + c$$ **equation 15**

the coefficients a, b and c shall be determined by the polynomial regression method.

The chassis dynamometer shall be set to the coefficients a, b and c obtained by the polynomial regression method.

7.2.2.5.3 Chassis dynamometer with F^* polygonal digital setter

In the case of a chassis dynamometer with a polygonal digital setter, where a CPU is incorporated in the system, F^* is input directly, and Δt_i, F_f and F_{pau} are automatically measured and calculated to set the chassis dynamometer to the target running resistance force $F^*=f^*_0+f^*_2v^2$.

In this case, several points in succession are directly input digitally from the data set of F^*_j and v_j, the coast down is performed and the coast down time Δt_i is measured. After the coast down test has been repeated several times, F_{pau} is automatically calculated and set at motorcycle speed intervals of 0,1 km/h, in the following sequence:

$$F^{*} + F_{f} = \frac{1}{3{,}6}\left(m_{i} + m_{r1}\right)\frac{2\Delta v}{\Delta t_{i}}$$ **equation 16**

$$F_{f} = \frac{1}{3{,}6}\left(m_{i} + m_{r1}\right)\frac{2\Delta v}{\Delta t_{i}} - F^{*}$$ **equation 17**

$$F_{pau} = F^{*} - F_{f}$$ **equation 18**

7.2.2.5.4 Chassis dynamometer with f^*_0, f^*_2 coefficient digital setter

In the case of a chassis dynamometer with a coefficient digital setter, where a CPU is incorporated in the system, the target running resistance force $F^*=f^*_0+f^*_2v^2$ is automatically set on the chassis dynamometer.

In this case, the coefficients f^*_0 and f^*_2 are directly input digitally; the coast down is performed and the coast down time Δt_i is measured. F_{pau} is automatically calculated and set at motorcycle speed intervals of 0,06 km/h, in the following sequence:

$$F^{*} + F_{f} = \frac{1}{3{,}6}\left(m_{i} + m_{r1}\right)\frac{2\Delta v}{\Delta t_{i}}$$ **equation 19**

$$F_{f} = \frac{1}{3{,}6}\left(m_{i} + m_{r1}\right)\frac{2\Delta v}{\Delta t_{i}} - F^{*}$$ **equation 20**

$$F_{pau} = F^{*} - F_{f}$$ **equation 21**

7.2.2.6 Dynamometer settings verification

7.2.2.6.1 Verification test

Immediately after the initial setting, the coast down time Δt_E on the chassis dynamometer corresponding to the reference speed (v_0), shall be measured by the same procedure as in 9.4.6.

The measurement shall be carried out at least three times, and the mean coast down time Δt_E shall be calculated from the results.

The set running resistance force at the reference speed, $F_E(v_0)$ on the chassis dynamometer is calculated by the following equation:

$$F_{E}\left(v_{0}\right) = \frac{1}{3{,}6}\left(m_{i} + m_{r1}\right)\frac{2\Delta v}{\Delta t_{E}}$$ **equation 22**

7.2.2.6.2 Calculation of setting error

The setting error, ε is calculated by the following equation:

$$\varepsilon = \frac{\left|F_{E}\left(v_{0}\right) - F^{*}\left(v_{0}\right)\right|}{F^{*}\left(v_{0}\right)} \times 100$$ **equation 23**

The chassis dynamometer shall be readjusted if the setting error does not satisfy the following criteria:

$\varepsilon \leq 2\%$ for $v_0 \geq 50$ km/h

$\varepsilon \leq 3\%$ for 30 km/h$\leq v_0 < 50$ km/h

$\varepsilon \leq 10\%$ for $v_0 < 30$ km/h

The procedure in 7.2.2.6.1 to 7.2.2.6.2 shall be repeated until the setting error satisfies the criteria.

The chassis dynamometer setting and the observed errors shall be recorded. The examples of the record forms are given in annex 9.6 or annex 9.7.

7.2.3 Calibration of Analysers

The quantity of gas at the indicated pressure compatible with the correct functioning of the equipment shall be injected into the analyser with the aid of the flow metre and the pressure-reducing valve mounted on each gas cylinder. The apparatus shall be adjusted to indicate as a stabilized value the value inserted on the standard gas cylinder. Starting from the setting obtained with the gas cylinder of greatest capacity, a curve shall be drawn of the deviations of the apparatus according to the content of the various standard cylinders used. The flame ionisation analyser shall be recalibrated periodically, at intervals of not more than one month, using air/propane or air/hexane mixtures with nominal hydrocarbon concentrations equal to 50 per cent and 90 per cent of full scale.

Non-dispersive infrared absorption analysers shall be checked at the same intervals using nitrogen/C0 and nitrogen/CO_2 mixtures in nominal concentrations equal to 10, 40, 60, 85 and 90 per cent of full scale.

To calibrate the NO_X chemiluminescence analyser, nitrogen/nitrogen oxide (NO) mixtures with nominal concentrations equal to 50 per cent and 90 per cent of full scale shall be used. The calibration of all three types of analysers shall be checked before each series of tests, using mixtures of the gases, which are measured in a concentration equal to 80 per cent of full scale. A dilution device can be applied for diluting a 100 per cent calibration gas to required concentration.

7.2.4 Vehicle Preconditioning

The vehicle shall be moved to the test area and the following operations performed:

- The fuel tank(s) shall be drained through the provided fuel tank(s) drain(s) and charged with the test fuel as specified in 6.3 to half the tank(s) capacity.
- The vehicle shall be placed, either by being driven or pushed, on a dynamometer and operated through the cycles as specified in 6.4.4. The vehicle need not be cold, and may be used to set dynamometer power.

Practice runs over the prescribed driving schedule may be performed at test points, provided an emission sample is not taken, for the purpose of finding the minimum throttle action to maintain the proper speed-time relationship, or to permit sampling system adjustments.

Within five (5) minutes of completion of preconditioning, the vehicle shall be removed from the dynamometer and may be driven or pushed to the soak area to be parked. The vehicle shall be stored for not less than 12 hours prior to the cold start exhaust test or until oil T^a, cooling T^a or spark plug T^a equals the air temperature of the soak area.

7.2.5 Emissions Tests

7.2.5.1 Engine Starting and Restarting

The engine shall be started according to the manufacturer's recommended starting procedures. The test cycle run shall begin when the engine starts.

Vehicles equipped with automatic chokes shall be operated according to the instructions in the manufacturer's operating instructions or owner's manual including choke setting and "kick-down" from cold fast idle. The transmission shall be placed in gear 15 seconds after the engine is started. If necessary, braking may be employed to keep the drive wheels from turning.

Vehicles equipped with manual chokes shall be operated according to the manufacturer's operating instructions or owner's manual. Where times are provided in the instructions, the point for operation may be specified, within 15 seconds of the recommended time.

The operator may use the choke, throttle etc. where necessary to keep the engine running.

If the manufacturer's operating instructions or owner's manual do not specify a warm engine starting procedure, the engine (automatic and manual choke engines) shall be started by opening the throttle about half way and cranking the engine until it starts.

If, during the cold start, the vehicle does not start after 10 seconds of cranking, or ten cycles of the manual starting mechanism, cranking shall cease and the reason for failure to start determined. The revolution counter on the constant volume sampler shall be turned off and the sample solenoid valves placed in the "standby" position during this diagnostic period. In addition, either the CVS blower shall be turned off or the exhaust tube disconnected from the tailpipe during the diagnostic period.

If failure to start is an operational error, the vehicle shall be rescheduled for testing from a cold start. If failure to start is caused by vehicle malfunction, corrective action (following the unscheduled maintenance provisions) of less than 30 minutes duration may be taken and the test continued. The sampling system shall be reactivated at the same time cranking is started. When the engine starts, the driving schedule timing sequence shall begin. If failure to start is caused by vehicle malfunction and the vehicle cannot be started, the test shall be voided, the vehicle removed from the dynamometer, corrective action taken (following the unscheduled maintenance provisions), and the vehicle rescheduled for test. The reason for the malfunction (if determined) and the corrective action taken shall be reported.

If the vehicle does not start during the hot start after ten seconds of cranking, or ten cycles of the manual starting mechanism, cranking shall cease, the test shall be voided, the vehicle removed from the dynamometer, corrective action taken in accordance with **Subpart E, Sec. 86.428 or 86.429**, and the vehicle rescheduled for test. The reason for the malfunction (if determined) and the corrective action taken shall be reported.

If the engine "false starts", the operator shall repeat the recommended starting procedure (such as resetting the choke, etc.)

7.2.5.2 Stalling

If the engine stalls during an idle period, the engine shall be restarted immediately and the test continued. If the engine cannot be started soon enough to allow the vehicle to follow the next acceleration as prescribed, the driving schedule indicator shall be stopped. When the vehicle restarts, the driving schedule indicator shall be reactivated.

If the engine stalls during some operating mode other than idle, the driving schedule indicator shall be stopped, the vehicle shall then be restarted and accelerated to the speed required at that point in the driving schedule and the test continued. During acceleration to this point, shifting shall be performed in accordance with paragraph 6.4.5.

If the vehicle will not restart within one minute, the test shall be voided, the vehicle removed from the dynamometer, corrective action taken, and the vehicle rescheduled for test. The reason for the malfunction (if determined) and the corrective action taken shall be reported.

7.2.6 Drive Instructions

The vehicle shall be driven with minimum throttle movement to maintain the desired speed. No simultaneous use of brake and throttle shall be permitted.

If the vehicle cannot accelerate at the specified rate, the vehicle shall be operated with the throttle fully opened until the vehicle speed reaches the value prescribed for that time in the driving schedule.

7.2.7 Dynamometer Test Runs

The complete dynamometer test consists of consecutive parts as described in 6.4.4.

The following steps shall be taken for each test:

1. Place drive wheel of vehicle on dynamometer without starting engine.
2. Activate vehicle cooling fan.
3. For all vehicles, with the sample selector valves in the "standby" position connect evacuated sample collection bags to the dilute exhaust and dilution air sample collection systems.
4. The measurement system for the fuel consumed, for the distance covered and for the time shall be engaged simultaneously. If necessary, a valve system shall be used for rapid changeover from the normal fuel supply line to the measuring system. The changeover shall not take longer than 0,2 s.
5. Start the CVS (if not already on), the sample pumps and the temperature recorder. (The heat exchanger of the constant volume sampler, if used, and sample lines should be preheated to their respective operating temperatures before the test begins.)
6. Adjust the sample flow rates to the desired flow rate and set the gas flow measuring devices to zero.
   - For gaseous bag samples (except hydrocarbon samples), the minimum flow rate is 0.08 l/s.
   - For hydrocarbon samples, the minimum FID (or HFID in the case of methanol-fuelled vehicles) flow rate is 0.031 l/s.

6. Attach the flexible exhaust tube to the vehicle tailpipe(s).
7. Start the gas flow measuring device, position the sample selector valves to direct the sample flow into the "transient" exhaust sample bag, the "transient" dilution air sample bag, turn the key on, and start cranking the engine.
8. Fifteen seconds after the engine starts, place the transmission in gear.
9. Twenty seconds after the engine starts, begin the initial vehicle acceleration of the driving schedule.
10. Operate the vehicle according to the driving cycles specified in 6.4.4.
11. At the end of the part 1 (or part 1, reduced speed in case of class 1, special vehicles) in “cold” condition, simultaneously switch the sample flows from the 1. bags and samples to the 2. bags and samples, switch off gas flow measuring device No. 1 and start gas flow measuring device No. 2.
12. In case of class 3 vehicles, at the end of part 2 (or part 1 in case of class 1 vehicles or part 1, reduced speed in case of class 1, special vehicles), simultaneously switch

the sample flows from the 2. bags and samples to the 3. bags and samples, switch off gas flow measuring device No. 2 and, start gas flow measuring device No. 3.

13. Before starting a new part, record the measured roll or shaft revolutions and reset the counter or switch to a second counter. As soon as possible, transfer the exhaust and dilution air samples to the analytical system and process the samples according to paragraph 8.1.2, obtaining a stabilised reading of the exhaust bag sample on all analysers within 20 minutes of the end of the sample collection phase of the test.
14. Turn the engine off 2 seconds after the end of the last part of the test.
15. Immediately after the end of the sample period, turn off the cooling fan.
16. Turn off the CVS or CFV or disconnect the exhaust tube from the tailpipe(s) of the vehicle.
17. Disconnect the exhaust tube from the vehicle tailpipe(s) and remove the vehicle from dynamometer.
18. For comparison and analysis reasons besides the bag results also second by second data of the emissions (diluted gas) have to be monitored. For the same reasons also the temperatures of the cooling water and the crankcase oil as well as the catalyst temperature shall be recorded.
19. Each test shall be repeated at least twice.

7.2.8 Records required

The following information shall be recorded with respect to each test:

1. Test number,
2. System or device tested (brief description),
3. Date and time of day for each part of the test schedule,
4. Instrument operator,
5. Driver or operator,
6. *Vehicle:* Make, Vehicle identification number, Model year, Transmission type, Odometer reading at initiation of preconditioning, Engine displacement, Engine family, Emission control system, Recommended idle RPM, Nominal fuel tank capacity, Inertial loading, Actual curb mass recorded at 0 kilometres, and Drive wheel tire pressure.
7. *Dynamometer serial number:* As an alternative to recording the dynamometer serial number, a reference to a vehicle test cell number may be used, with the advance approval of the Administrator, provided the test cell records show the pertinent instrument information.
8. All pertinent instrument information such as tuning-gain-serial number-detector number-range. As an alternative, a reference to a vehicle test cell number may be used, with the advance approval of the Administrator, provided test cell calibration records show the pertinent instrument information.
9. Recorder Charts: Identify zero, span, exhaust gas, and dilution air sample traces.
10. Test cell barometric pressure, ambient temperature and humidity.

Note: A central laboratory barometer may be used; *Provided,* that individual test cell barometric pressures are shown to be within ±0.1 percent of the barometric pressure at the central barometer location.

11. Pressure of the mixture of exhaust and dilution air entering the CVS metering device, the pressure increase across the device, and the temperature at the inlet. The temperature should be recorded continuously or digitally to determine temperature variations.

12. The number of revolutions of the positive displacement pump accumulated during each test phase while exhaust samples are being collected. The number of standard cubic meters metered by a critical flow venturi during each test phase would be the equivalent record for a CFV-CVS.
13. The humidity of the dilution air.

Note: If conditioning columns are not used this measurement can be deleted. If the conditioning columns are used and the dilution air is taken from the test cell, the ambient humidity can be used for this measurement.

14. The emissions results for each part of the test.
15. The driving distance for each part of the test, calculated from the measured roll or shaft revolutions.
16. The actual vehicle speed pattern of the test.
17. The second by second emission values.

7.3 Type II Tests

7.3.1 Conditions of Measurement

The Type II test specified in paragraph 6.5 must be measured immediately after the Type I test with the engine at normal idling speed and at high idle.

The following parameters must be measured and recorded at normal idling speed and at high idle speed:

- the carbon monoxide content by volume of the exhaust gases emitted,
- the carbon dioxide content by volume of the exhaust gases emitted,
- the engine speed during the test, including any tolerances,
- the engine oil temperature at the time of the test.

7.3.2 Sampling of Exhaust Gases

The exhaust outlets shall be provided with an air-tight extension, so that the sample probe used to collect exhaust gases may be inserted into the exhaust outlet at least 60 cm, without increasing the back pressure of more than 125 mm H_20, and without disturbance of the vehicle running. The shape of this extension shall however be chosen in order to avoid, at the location of the sample probe, any appreciable dilution of exhaust gases in the air. Where a motorcycle is equipped with an exhaust system having multiple outlets, either these shall be joined to a common pipe or the content of carbon monoxide must be collected from each of them, the result of the measurement being reached from the arithmetical average of these contents.

The concentrations in CO (C_{CO}) and CO_2 (C_{CO2}) shall be determined from the measuring instrument readings or recordings, by use of appropriate calibration curves. The results have to be corrected according to paragraph 8.2.

8 <u>Analysis of Results</u>

8.1 Type I Tests

8.1.1 Speed Tolerances

The deviations of the roller speed from the set speed of the cycles must meet the requirements of paragraph 6.4.4.2. If not, the test results shall not be used for the further analysis and the run has to be repeated.

8.1.2 Exhaust Emission and Fuel Consumption Analysis

8.1.2.1 Analysis of the samples contained in the bags

The analysis shall begin as soon as possible, and in any event not later than 20 minutes after the end of the tests, in order to determine:

- The concentrations of hydrocarbons, carbon monoxide, nitrogen oxides and carbon dioxide in the sample of dilution air contained in bags B;
- The concentrations of hydrocarbons, carbon monoxide, nitrogen oxides and carbon dioxide in the sample of diluted exhaust gases contained in bags A.

8.1.2.2 Calibration of analysers and concentration results

The analysis of the results has to be carried out in the following steps:

1. Prior to each sample analysis the analyser range to be used for each pollutant must be set to zero with the appropriate zero gas.
2. The analysers are then set to the calibration curves by means of span gases of nominal concentrations of 70 to 100% of the range.
3. The analysers' zeros are then rechecked. If the reading differs by more than 2% of range from that set in 2, the procedure is repeated.
4. The samples are then analysed.
5. After the analysis, zero and span points are rechecked using the same gases. If these rechecks are within 2% of those in 3, the analysis is considered acceptable.
6. At all points in this Section the flow-rates and pressures of the various gases must be the same as those used during calibration of the analysers.
7. The figure adopted for the concentration of each pollutant measured in the gases is that read off after stabilisation on the measuring device.

8.1.2.3 Measuring the distance covered

The distance actually covered for a test part shall be arrived at by multiplying the number of revolutions read from the cumulative counter (see paragraph 7.2.7) by the circumference of the roller. This distance shall be measured in km.

8.1.2.4 Determination of the quantity of gas emitted

The reported test results shall be computed for each test and each cycle part by use of the following formulas. The results of all emission tests shall be rounded, using the "Rounding-Off Method" specified in [ASTM E 29-67], to the number of places to the right of the decimal point indicated by expressing the applicable standard to three significant figures.

8.1.2.4.1 Total volume of diluted gas

The total volume of diluted gas, expressed in m^3/cycle part, adjusted to the reference conditions of O°C (273°K) and 101,3 kPa is calculated by

$$V = V_0 * N * (P_a – P_i) * 273,2 / 101,3 / (T_p + 273,2) \quad \text{equation 24}$$

where

V_0 is the volume of gas displaced by pump P during one revolution, expressed in m^3/revolution. This volume is a function of the differences between the intake and output sections of the pump,

N is the number of revolutions made by pump P during each part of the test;

P_a is the ambient pressure in kPa;

P_i is the average under-pressure during the test part in the intake section of pump P, expressed in kPa;

T_p is the temperature of the diluted gases during the test part in °C, measured in the intake section of pump P.

8.1.2.4.2 Hydrocarbons

The mass of unburned hydrocarbons emitted by the vehicle's exhaust during the test shall be calculated by means of the following formula:

$$\mathbf{HCm = HCc * V * dHC / dist / 10^6} \qquad \textbf{equation 25}$$

where

HCm is the mass of hydrocarbons emitted during the test part, in g/km

dist is the distance defined in paragraph 8.1.2.3 above;

dHC is the density of the hydrocarbons at a temperature of 0°C and a pressure of 101,3 kPa, where the average carbon/hydrogen ratio is 1:1.85; dHC = 0.619 kg/m^3,

HCc is the concentration of diluted gases, expressed in parts per million of carbon equivalent (e.g. the concentration in propane multiplied by 3), corrected to take account of the dilution air by:

$$\mathbf{HCc = HCe - Hcd * (1 – 1/DF)} \qquad \textbf{equation 26}$$

where

HCe is the concentration of hydrocarbons expressed in parts per million of carbon equivalent, in the sample of diluted gases collected in bag A,

HCd is the concentration of hydrocarbons expressed in parts per million of carbon equivalent, in the sample of dilution air collected in bag B,

DF is the coefficient defined in paragraph 8.1.2.4.6 below,

V is the total volume, see paragraph 8.1.2.4.1.

8.1.2.4.3 Carbon Monoxide

The mass of carbon monoxide emitted by the vehicle's exhaust during the test shall be calculated by means of the following formula:

$$\mathbf{COm = COc * V * dCO / dist / 10^6} \qquad \textbf{equation 27}$$

where

COm is the mass of carbon monoxide emitted during the test part, in g/km

dist is the distance defined in paragraph 8.1.2.3 above;

dCO is the density of the carbon monoxide at a temperature of 0°C and a pressure of 101,3 kPa, dCO = 1.250 kg/m^3,

COc is the concentration of diluted gases, expressed in parts per million of carbon monoxide, corrected to take account of the dilution air by:

$$\mathbf{COc = COe - COd * (1 – 1/DF)} \qquad \textbf{equation 28}$$

where

COe is the concentration of carbon monoxide expressed in parts per million, in the sample of diluted gases collected in bag A,

COd is the concentration of carbon monoxide expressed in parts per million, in the sample of dilution air collected in bag B,

DF is the coefficient defined in paragraph 8.1.2.4.6 below,

V is the total volume, see paragraph 8.1.2.4.1.

8.1.2.4.4 Nitrogen Oxides

The mass of nitrogen oxides emitted by the vehicle's exhaust during the test shall be calculated by means of the following formula:

$$NOxm = NOxc * Kh * V * dNO_2 / dist / 10^6 \quad \text{equation 29}$$

where

NOxm is the mass of nitrogen oxides emitted during the test part, in g/km

dist is the distance defined in paragraph 8.1.2.3 above;

dNO_2 is the density of the nitrogen oxides in the exhaust gases, assuming that they will be in the form of nitric oxide, at a temperature of 0°C and a pressure of 101,3 kPa, dNO_2 = 0.619 kg/m^3,

NOxc is the concentration of diluted gases, expressed in parts per million, corrected to take account of the dilution air by:

$$NOxc = NOxe - NOxd * (1 – 1/DF) \quad \text{equation 30}$$

where

NOxe is the concentration of nitrogen oxides expressed in parts per million of nitrogen oxides, in the sample of diluted gases collected in bag A,

NOxd is the concentration of nitrogen oxides expressed in parts per million of nitrogen oxides, in the sample of dilution air collected in bag B,

DF is the coefficient defined in paragraph 8.1.2.4.6 below,

V is the total volume, see paragraph 8.1.2.4.1,

Kh is the humidity correction factor

$$Kh = 1 / (1 – 0{,}0329 * (H – 10{,}7)) \quad \text{equation 31}$$

where

H is the absolute humidity in g of water per kg of dry air,

$$H \text{ in g/kg} = 6{,}211 * U * Pd / (Pa – Pd * U / 100) \quad \text{equation 32}$$

where

U is the percentage humidity,

Pd is the saturated pressure of water at the test temperature, in kPa,

Pa is atmospheric pressure in kPa.

8.1.2.4.5 Carbon Dioxide

The mass of carbon dioxide emitted by the vehicle's exhaust during the test shall be calculated by means of the following formula:

$$CO_2m = CO_2c * V * dCO_2 / dist / 10^2 \quad \text{equation 33}$$

where

CO_2m is the mass of carbon dioxide emitted during the test part, in g/km

dist is the distance defined in paragraph 8.1.2.3 above;

dCO_2 is the density of the carbon dioxide at a temperature of 0°C and a pressure of 101,3 kPa, dCO_2 = 1830 g/m^3,

CO_2c is the concentration of diluted gases, expressed in percent carbon dioxide equivalent, corrected to take account of the dilution air by:

$$CO_2c = CO_2e - CO_2d * (1 - 1/DF) \qquad \text{equation 34}$$

where

CO_2e is the concentration of carbon dioxide expressed in percent, in the sample of diluted gases collected in bag A,

CO_2d is the concentration of carbon dioxide expressed in percent, in the sample of dilution air collected in bag B,

DF is the coefficient defined in paragraph 8.1.2.4.6 below,

V is the total volume, see paragraph 8.1.2.4.1.

8.1.2.4.6 DF

DF (dilution factor) is a coefficient expressed by the formula

$$DF = 31{,}4 / (CO_2 + (CO + HC)*10^{-4}) \text{ in vol-\%} \qquad \text{equation 35}$$

“CO, CO_2 and HC" are the concentrations of carbon monoxide and hydrocarbons, expressed in ppm and carbon dioxide, expressed in per cent, in the sample of diluted gases contained in bag A.

8.1.2.5 Fuel Consumption Calculation

The fuel consumption, expressed in litres per 100 km is calculated by means of the following formulae:

8.1.2.5.1 Vehicles with a positive ignition engine fuelled with petrol

$$FC = (0.1154 / D) * (0.866 * HC + 0.429 * CO + 0.273 * CO2) \qquad \text{equation 36}$$

where

FC is the fuel consumption in l/100 km

HC is the measured emission of hydrocarbons in g/km

CO is the measured emission of carbon monoxide in g/km

CO2 is the measured emission of carbon dioxide in g/km

D is the density of the test fuel.

In the case of gaseous fuels this is the density at 15°C.

8.1.2.5.2 Vehicles with a compression ignition engine

$$FC = (0.1155 / D) * (0.866 * HC + 0.429 * CO + 0.273 * CO2) \qquad \text{equation 37}$$

where

FC is the fuel consumption in l/100 km

HC is the measured emission of hydrocarbons in g/km

CO is the measured emission of carbon monoxide in g/km

CO2 is the measured emission of carbon dioxide in g/km

D is the density of the test fuel.

In the case of gaseous fuels this is the density at 15°C.

8.1.2.6 Weighting of Results

The emission results in g/km and the fuel consumption in l/100 km obtained by the calculation method described in paragraph 8.1.2 of the three tests are averaged for each cycle part. The final result shall be calculated by means of the following formulae, depending on the vehicle class as defined in paragraph 6.2:

Class 1 $$R = R1cold * w1cold + R1hot * w1hot \quad \text{equation 38}$$

Class 2 $$R = R1cold * w1 + R2 * w2$$

Class 3 $$R = R1cold * w1 + R2 * w2 + R3 * w3$$

for each pollutant, the carbon dioxide emission and the fuel consumption using the weightings shown in Table 6.

vehicle class	cycle	weighting
class 1	part 1, cold	50%
	part 1, hot	50%
class 2	part 1, cold	30%
	part 2	70%
class 3	part 1, cold	25%
	part 2	50%
	part 3	25%

Table 6: Weighting factors for the final emission and fuel consumption results

8.2 Type II Tests

The corrected concentration for carbon monoxide regarding two-stroke engines is:

$$C_{CO}corr = C_{CO} * 10 / (C_{CO} + C_{CO2}) \text{ in vol-\%} \quad \text{equation 39}$$

The corrected concentration for carbon monoxide regarding four-stroke engines is:

$$C_{CO}corr = C_{CO} * 15 / (C_{CO} + C_{CO2}) \text{ in vol-\%} \quad \text{equation 40}$$

The concentration in C_{CO} measured according to paragraph 7.3.2 need not be corrected if the total of the concentrations measured ($C_{CO} + C_{CO2}$) is at least 10 for two-stroke engines and 15 for four-stroke engines.

9 Annexes

9.1 ESSENTIAL CHARACTERISTICS OF THE ENGINE, the reduction systems AND INFORMATION CONCERNING THE CONDUCT OF TESTS

1. Description of Engine 1

1.1. Manufacturer:

1.1.1. Manufacturer's engine code (as marked on the engine or other means of identification):

1.2. Internal combustion engine:

1.2.1. Specific engine information:

1.2.1.1. Working principle: positive-ignition / compression-ignition, four stroke / two stroke 1

1.2.1.2. Number, arrangement and firing order of cylinders:

1.2.1.2.1. Bore 2: mm

1.2.1.2.2. Stroke 2: mm

1.2.1.3. Engine capacity 3: cm3

1.2.1.4. Volumetric compression ratio 4 :

1.2.1.5. Drawing(s) of combustion chamber and piston crown:

1.2.1.6. Idle speed 4:

1.2.1.7. Carbon monoxide content by volume in the exhaust gas with the engine idling: .... per cent (according to the manufacturer's specifications) 4

1.2.1.8. Maximum net power: .... kW at: min-1

1.2.2. Fuel: leaded petrol / unleaded petrol / diesel 1

1.2.3. RON unleaded petrol:

1.2.4. Fuel feed:

1.2.4.1. By carburettor(s): yes / no 1

1.2.4.1.1. Make(s):

1.2.4.1.2. Type(s):

1.2.4.1.3. Number fitted:

1.2.4.1.4. Adjustments 4:

1.2.4.1.4.1. Jets:

1.2.4.1.4.2. Venturis:

1.2.4.1.4.3. Float-chamber level:

1.2.4.1.4.4. Mass of float:

1.2.4.1.4.5. Float needle:

1.2.4.1.5. Cold start system: manual / automatic 1

1.2.4.1.5.1. Operating principle:

1 ______________________________

1 Strike out what does not apply.

2 This value must be rounded to the nearest tenth of a mm.

3 This value must be calculated with $\pi = 3.141$ and rounded down to the nearest cm^3.

4 Specify the tolerance.

1.2.4.1.5.2. Operating limits/settings 1, 4:

1.2.4.2. By fuel injection (compression-ignition only): yes / no 1

1.2.4.2.1. System description:

1.2.4.2.2. Working principle: direct injection / pre-chamber / swirl chamber 1:

1.2.4.2.3. Injection pump.

1.2.4.2.3.1. Make(s):

1.2.4.2.3.2. Type(s):

1.2.4.2.3.3. Maximum fuel delivery 1, 4: .... mm3/stroke or cycle at a pump speed of 1, 4: .... min-1 or characteristic diagram:

1.2.4.2.3.4. Injection timing 4:

1.2.4.2.3.5. Injection advance curve 4:

1.2.4.2.3.6. Calibration procedure: test bench / engine 1

1.2.4.2.4. Governor.

1.2.4.2.4.1. Type:

1.2.4.2.4.2. Cut-off point:

1.2.4.2.4.3. Cut-off point under load: min-1

1.2.4.2.4.4. Cut-off point without load: min-1

1.2.4.2.4.5. Idling speed: min-1

1.2.4.2.5. Injector(s):

1.2.4.2.5.1. Make(s):

1.2.4.2.5.2. Type(s):

1.2.4.2.5.3. Opening pressure 4: ..... kPa or characteristic diagram:

1.2.4.2.6. Cold start system.

1.2.4.2.6.1. Make(s):

1.2.4.2.6.2. Type(s):

1.2.4.2.6.3. Description:

1.2.4.2.7. Auxiliary starting aid.

1.2.4.2.7.1. Makes(s):

1.2.4.2.7.2. Type(s):

1.2.4.2.7.3. Description:

1.2.4.3. By fuel, injection (positive-ignition only): yes / no 1

1.2.4.3.1. System description:

1.2.4.3.2. Working principle 1: intake manifold (single / multi-point) / direct injection / other - specify)

o Control unit - type or No.	)
o Fuel regulator - type	) Information to be
o Air flow sensor - type	) given in the case of
o Fuel distributor - type	) continuous injection;
o Pressure regulator - type	) in the case of other
o Microswitch - type	) systems, equivalent
o Idle adjusting screw - type	) details.
o Throttle housing - type	)

- o Water temperature sensor - type)
- o Air temperature sensor - type)
- o Air temperature switch - type)
- o Electromagnetic interference protection.
- o Description and/or drawing:

1.2.4.3.3. Makes(s):

1.2.4.3.4. Type(s):

1.2.4.3.5. Injector(s): Opening pressure 4: .... kPa or characteristic diagram 4/:

1.2.4.3.6. Injection timing:

1.2.4.3.7. Cold start system:

1.2.4.3.7.1. Operating principle(s):

1.2.4.3.7.2. Operating limits / settings 1, 4 :

1.2.4.4. Feed pump.

1.2.4.4.1. Pressure 4/: ...... kPa or characteristic diagram:

1.2.5. Ignition.

1.2.5.1. Make(s):

1.2.5.2. Type(s):

1.2.5.3. Working principle:

1.2.5.4. Ignition advance curve 4:

1.2.5.5. Static ignition timing 4: .... degrees before TDC

1.2.5.6. Contact point gap 4:

1.2.5.7. Dwell angle 4:

1.2.5.8. Spark plugs:

1.2.5.8.1. Make:

1.2.5.8.2. Type:

1.2.5.8.3. Spark plug gap setting: mm

1.2.5.9. Ignition coil.

1.2.5.9.1. Make:

1.2.5.9.2. Type:

1.2.5.10. Ignition condenser.

1.2.5.10.1. Make:

1.2.5.10.2. Type:

1.2.6. Cooling system: liquid / air 1

1.2.7. Intake system:

1.2.7.1. Pressure charger: yes / no 1

1.2.7.1.1. Make(s):

1.2.7.1.2. Type(s):

1.2.7.1.3. Description of the system (maximum charge pressure: ...... kPa, wastegate:)

1.2.7.2. Intercooler: yes / no 1

1.2.7.3. Description and/or drawings of inlet pipes and their accessories (plenum chamber, heating device, additional air intakes etc.):

1.2.7.3.1. Intake manifold description (include drawings and/or photographs):

1.2.7.3.2. Air filter, drawings, or,

1.2.7.3.2.1. Make(s):

1.2.7.3.2.2. Type(s):

1.2.7.3.3. Intake silencer, drawings, or,

1.2.7.3.3.1. Make(s):

1.2.7.3.3.2. Type(s):

1.2.8. Exhaust system.

1.2.8.1. Description and drawings of the exhaust system:

1.2.9. Valve timing or equivalent data.

1.2.9.1. Maximum lift of valves, angles of operating and closing or timing details of alternative distribution systems, in relation to dead centres:

1.2.9.2. Reference and/or setting ranges 1:

1.2.10. Lubricant used.

1.2.10.1. Make:

1.2.10.2. Type:

1.2.11. Measures taken against air pollution.

1.2.11.1. Device for recycling crankcase gases (description and/or drawings):

1.2.11.2. Additional pollution control devices (if any, and if not covered by another heading):

1.2.11.2.1. Catalytic converter: yes / no 1

1.2.11.2.1.1. Number of catalytic converters and elements:

1.2.11.2.1.2. Dimensions and shape of the catalytic converter(s) (volume, ...):

1.2.11.2.1.3. Type of catalytic action:

1.2.11.2.1.4. Total charge of precious metal:

1.2.11.2.1.5. Relative concentration:

1.2.11.2.1.6. Substrate (structure and material):

1.2.11.2.1.7. Cell density:

1.2.11.2.1.8. Type of casing for catalytic converter(s):

1.2.11.2.1.9. Positioning of the catalytic converter(s) (Place and reference distances in the exhaust system):

1.2.11.2.1.10. Oxygen sensor: type:

1.2.11.2.1.10.1. Location of oxygen sensor:

1.2.11.2.1.10.2. Control range of oxygen sensor:

1.2.11.2.2. Air injection: yes / no 1

1.2.11.2.2.1. Type (pulse air, air pump, ...):

1.2.11.2.3. EGR: yes / no 1

1.2.11.2.3.1. Characteristics (flow, ...):

1.2.11.2.4. Evaporative emission control system.

Complete detailed description of the devices and their state of tune:

Drawing of the evaporative control system:

Drawing of the carbon canister:

Drawing of the fuel tank with indication of capacity and material:

1.2.11.2.5. Particulate trap: yes / no 1

1.2.11.2.5.1. Dimensions and shape of the particulate trap (capacity):

1.2.11.2.5.2. Type of particulate trap and design:

1.2.11.2.5.3. Location of the particulate trap (reference distances in the exhaust system):

1.2.11.2.5.4. Regeneration system/method. Description and drawing:

1.2.11.2.6. Other systems (description and working principles):

9.2 Driving Cycles for Type I Tests

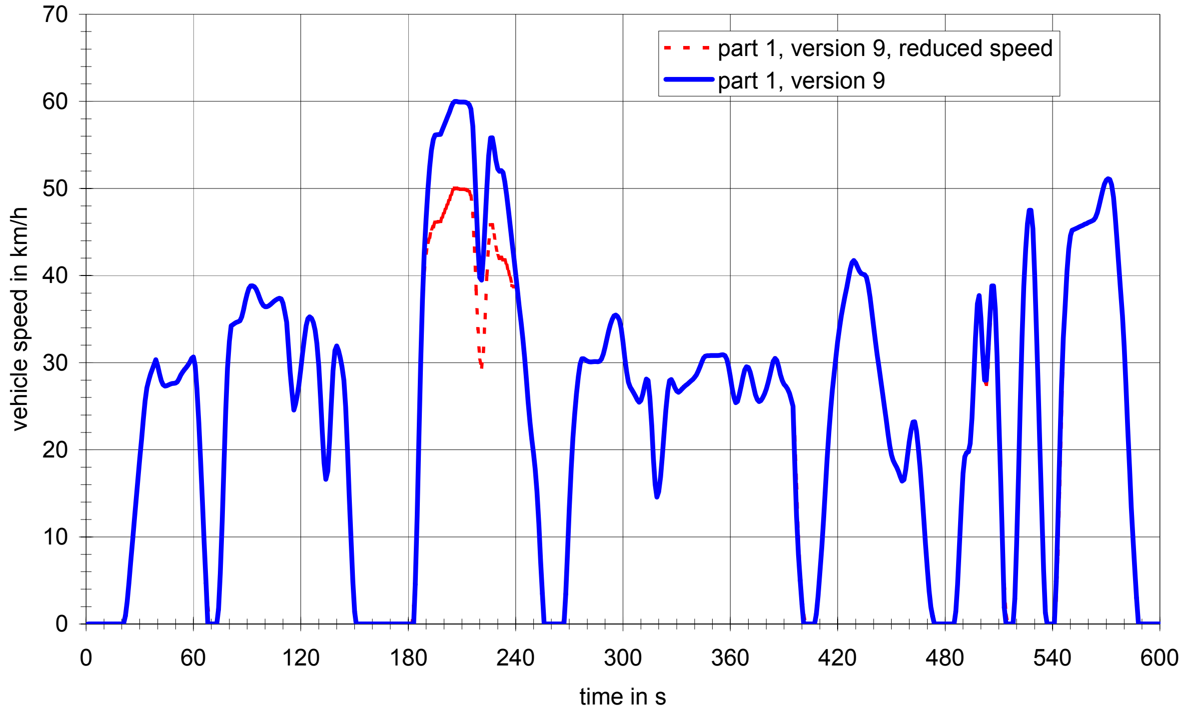

Figure 3: Cycle part 1

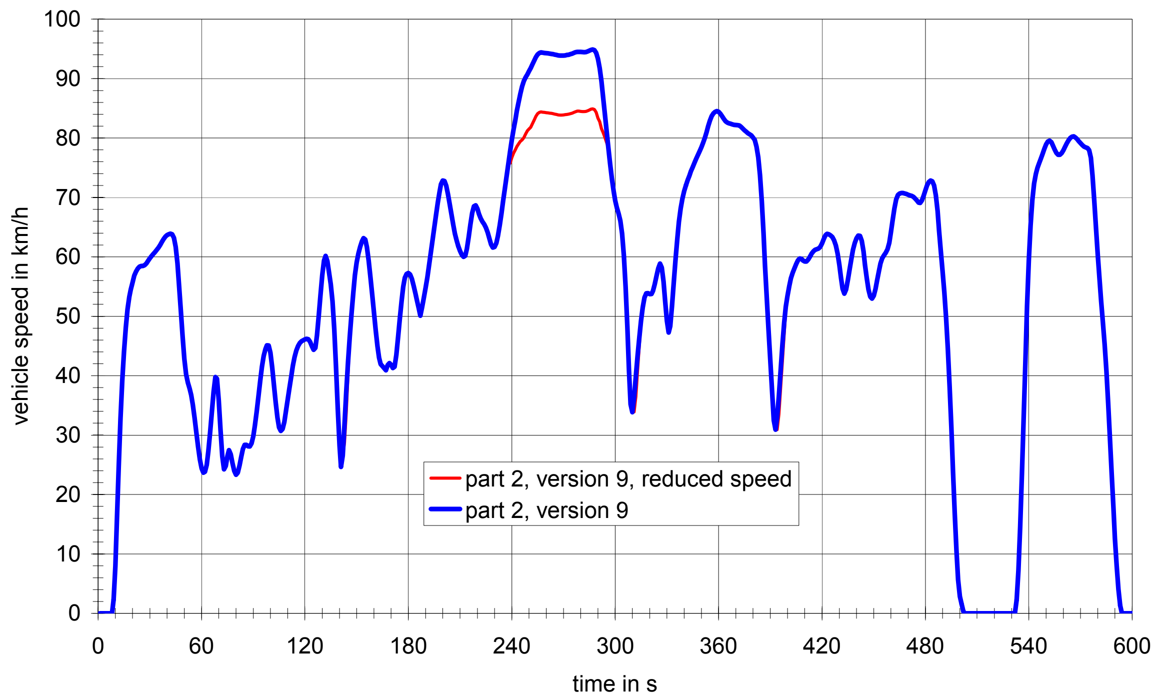

Figure 4: Cycle part 2 for vehicle classes 2 and 3

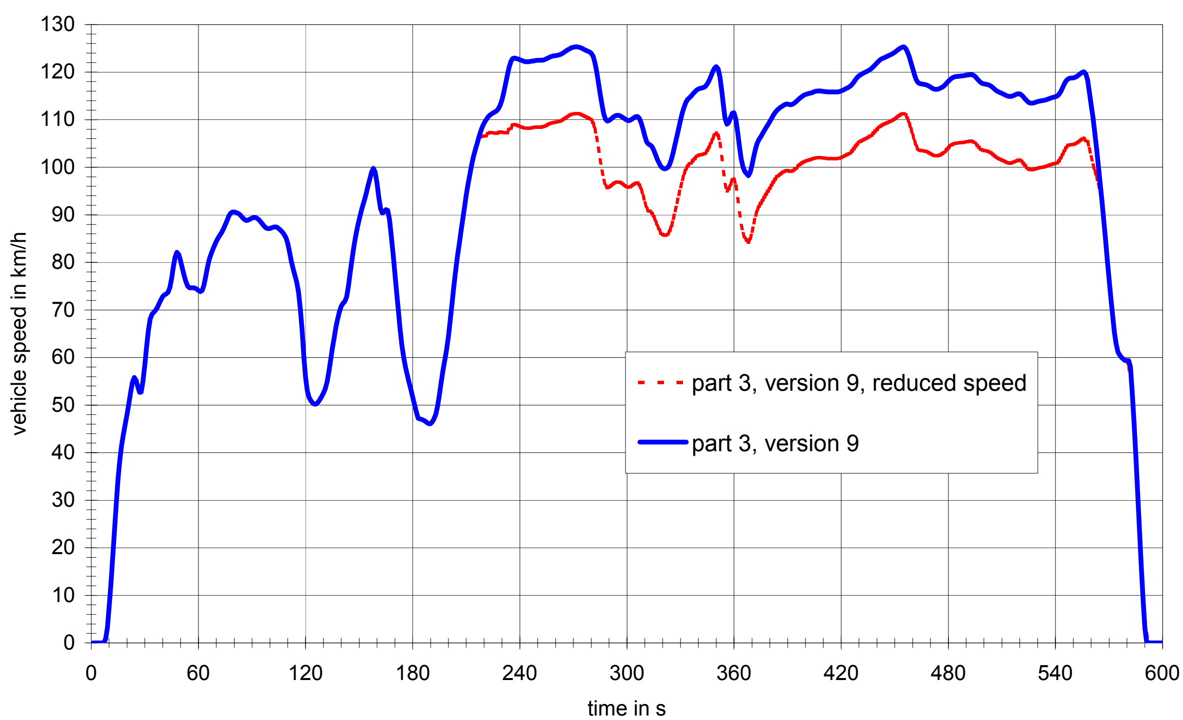

Figure 5: Cycle part 3 for vehicle class 3

	v in km/h									v in km/h							
time	nor-mal	redu-ced speed	stop	acc	crui-se	decel	no gear-shift	no 1. gear	time	nor-mal	redu-ced speed	stop	acc	crui-se	decel	no gear-shift	no 1. gear
1	0.0	0.0	x						61	29.7	29.7				x		
2	0.0	0.0	x						62	26.9	26.9				x		
3	0.0	0.0	x						63	23.0	23.0				x		
4	0.0	0.0	x						64	18.7	18.7				x		
5	0.0	0.0	x						65	14.2	14.2				x		
6	0.0	0.0	x						66	9.4	9.4				x		
7	0.0	0.0	x						67	4.9	4.9				x		
8	0.0	0.0	x						68	2.0	2.0	x					
9	0.0	0.0	x						69	0.0	0.0	x					
10	0.0	0.0	x						70	0.0	0.0	x					
11	0.0	0.0	x						71	0.0	0.0	x					
12	0.0	0.0	x						72	0.0	0.0	x					
13	0.0	0.0	x						73	0.0	0.0	x					
14	0.0	0.0	x						74	1.7	1.7		x				
15	0.0	0.0	x						75	5.8	5.8		x				
16	0.0	0.0	x						76	11.8	11.8		x				
17	0.0	0.0	x						77	18.3	18.3		x				
18	0.0	0.0	x						78	24.5	24.5		x				
19	0.0	0.0	x						79	29.4	29.4		x				
20	0.0	0.0	x						80	32.5	32.5		x				
21	0.0	0.0	x						81	34.2	34.2		x				
22	1.0	1.0		x					82	34.4	34.4		x				
23	2.6	2.6		x					83	34.5	34.5		x				
24	4.8	4.8		x					84	34.6	34.6		x				
25	7.2	7.2		x					85	34.7	34.7		x				
26	9.6	9.6		x					86	34.8	34.8		x				
27	12.0	12.0		x					87	35.2	35.2		x				
28	14.3	14.3		x					88	36.0	36.0		x				
29	16.6	16.6		x					89	37.0	37.0		x				
30	18.9	18.9		x					90	37.9	37.9		x				
31	21.2	21.2		x					91	38.5	38.5		x				
32	23.5	23.5		x					92	38.8	38.8		x				
33	25.6	25.6		x					93	38.8	38.8		x				
34	27.1	27.1		x					94	38.7	38.7		x				
35	28.0	28.0		x					95	38.4	38.4		x				
36	28.7	28.7		x					96	38.0	38.0			x			
37	29.2	29.2		x					97	37.4	37.4			x			
38	29.8	29.8				x			98	36.9	36.9			x			
39	30.3	30.3				x		x	99	36.6	36.6			x			
40	29.6	29.6				x		x	100	36.4	36.4			x			
41	28.7	28.7				x		x	101	36.4	36.4			x			
42	27.9	27.9				x	x	x	102	36.5	36.5			x			
43	27.5	27.5			x		x	x	103	36.7	36.7			x			
44	27.3	27.3			x		x	x	104	36.9	36.9			x			
45	27.3	27.3			x		x	x	105	37.0	37.0			x			
46	27.4	27.4			x		x	x	106	37.2	37.2			x			
47	27.5	27.5			x		x	x	107	37.3	37.3			x			
48	27.6	27.6			x		x	x	108	37.4	37.4			x			
49	27.6	27.6			x		x	x	109	37.3	37.3			x			
50	27.7	27.7			x		x	x	110	36.8	36.8			x			
51	27.8	27.8		x				x	111	35.8	35.8				x		
52	28.1	28.1		x				x	112	34.6	34.6				x		
53	28.6	28.6		x				x	113	31.8	31.8				x		
54	28.9	28.9		x				x	114	28.9	28.9				x		
55	29.2	29.2		x				x	115	26.7	26.7		x				x
56	29.4	29.4		x				x	116	24.6	24.6		x				x
57	29.7	29.7		x				x	117	25.2	25.2		x				x
58	30.1	30.1		x				x	118	26.2	26.2		x				x
59	30.5	30.5		x				x	119	27.5	27.5		x				x
60	30.7	30.7		x				x	120	29.2	29.2		x				x

Table 7: Cycle part 1, 1 to 120 s

	v in km/h									v in km/h							
time	nor-mal	redu-ced speed	stop	acc	crui-se	decel	no gear-shift	no 1. gear	time	nor-mal	redu-ced speed	stop	acc	crui-se	decel	no gear-shift	no 1. gear
121	31.0	31.0		x				x	181	0.0	0.0	x					
122	32.8	32.8		x				x	182	0.0	0.0	x					
123	34.3	34.3		x				x	183	2.0	2.0	x					
124	35.1	35.1		x					184	6.0	6.0		x				
125	35.3	35.3		x					185	12.4	12.4		x				
126	35.1	35.1		x					186	21.4	21.4		x				
127	34.6	34.6		x					187	30.0	30.0		x				
128	33.7	33.7				x			188	37.1	37.1		x				
129	32.2	32.2				x			189	42.5	40.5		x				
130	29.6	29.6				x			190	46.6	42.6		x				
131	26.0	26.0				x			191	49.8	43.8		x				
132	22.0	22.0				x			192	52.4	44.4		x				
133	18.5	18.5		x					193	54.4	45.4		x				
134	16.6	16.6		x					194	55.6	45.6		x				
135	17.5	17.5		x					195	56.1	46.1		x				
136	20.9	20.9		x					196	56.2	46.2		x				
137	25.2	25.2		x					197	56.2	46.2			x			
138	29.1	29.1		x					198	56.2	46.2			x			
139	31.4	31.4		x					199	56.7	46.7			x			
140	31.9	31.9		x					200	57.2	47.2			x			
141	31.4	31.4				x			201	57.7	47.7			x			
142	30.6	30.6				x			202	58.2	48.2			x			
143	29.5	29.5				x			203	58.7	48.7			x			
144	27.9	27.9				x			204	59.3	49.3			x			
145	24.9	24.9				x			205	59.8	49.8			x			
146	20.2	20.2				x			206	60.0	50.0			x			
147	14.8	14.8				x			207	60.0	50.0			x			
148	9.5	9.5				x			208	59.9	49.9			x			
149	4.8	4.8				x			209	59.9	49.9			x			
150	1.4	1.4				x			210	59.9	49.9			x			
151	0.0	0.0	x						211	59.9	49.9			x			
152	0.0	0.0	x						212	59.9	49.9			x			
153	0.0	0.0	x						213	59.8	49.8			x			
154	0.0	0.0	x						214	59.6	49.6			x			
155	0.0	0.0	x						215	59.1	49.1			x			
156	0.0	0.0	x						216	57.1	47.1				x		
157	0.0	0.0	x						217	53.2	43.2				x		
158	0.0	0.0	x						218	48.3	38.3				x		
159	0.0	0.0	x						219	43.9	33.9				x		
160	0.0	0.0	x						220	40.3	30.3		x				
161	0.0	0.0	x						221	39.5	29.5		x				
162	0.0	0.0	x						222	41.3	31.3		x				
163	0.0	0.0	x						223	45.2	35.2		x				
164	0.0	0.0	x						224	50.1	40.1		x				
165	0.0	0.0	x						225	53.7	43.7		x				
166	0.0	0.0	x						226	55.8	45.8		x				
167	0.0	0.0	x						227	55.8	45.8		x				
168	0.0	0.0	x						228	54.7	44.7				x		
169	0.0	0.0	x						229	53.3	43.3				x		
170	0.0	0.0	x						230	52.2	42.2				x		
171	0.0	0.0	x						231	52.0	42.0				x		
172	0.0	0.0	x						232	52.1	42.1				x		
173	0.0	0.0	x						233	51.8	41.8				x		
174	0.0	0.0	x						234	50.8	41.8				x		
175	0.0	0.0	x						235	49.2	41.2				x		
176	0.0	0.0	x						236	47.4	40.4				x		
177	0.0	0.0	x						237	45.7	39.7				x		
178	0.0	0.0	x						238	43.9	38.9				x		
179	0.0	0.0	x						239	42.0	38.7				x		
180	0.0	0.0	x						240	40.2	38.7				x		

Table 8: Cycle part 1, 121 to 240 s

	v in km/h									v in km/h							
time	nor-mal	redu-ced speed	stop	acc	crui-se	decel	no gear-shift	no 1. gear	time	nor-mal	redu-ced speed	stop	acc	crui-se	decel	no gear-shift	no 1. gear
241	38.3	38.3				x			301	30.6	30.6			x		x	
242	36.4	36.4				x			302	28.9	28.9			x			
243	34.6	34.6				x			303	27.8	27.8			x			
244	32.7	32.7				x			304	27.2	27.2			x			
245	30.6	30.6				x			305	26.9	26.9			x			
246	28.1	28.1				x			306	26.5	26.5			x			
247	25.4	25.4				x			307	26.1	26.1			x			
248	23.1	23.1				x			308	25.7	25.7			x			
249	21.2	21.2				x			309	25.5	25.5			x			
250	19.5	19.5				x			310	25.7	25.7			x			
251	17.8	17.8				x			311	26.4	26.4			x			
252	15.2	15.2				x			312	27.3	27.3			x			
253	11.5	11.5				x			313	28.1	28.1			x			
254	7.2	7.2				x			314	27.9	27.9				x		
255	2.5	2.5				x			315	26.0	26.0				x		
256	0.0	0.0	x						316	22.7	22.7				x		
257	0.0	0.0	x						317	19.0	19.0				x		
258	0.0	0.0	x						318	16.0	16.0		x				
259	0.0	0.0	x						319	14.6	14.6		x				
260	0.0	0.0	x						320	15.2	15.2		x				
261	0.0	0.0	x						321	16.9	16.9		x				
262	0.0	0.0	x						322	19.3	19.3		x				
263	0.0	0.0	x						323	22.0	22.0		x				
264	0.0	0.0	x						324	24.6	24.6		x				
265	0.0	0.0	x						325	26.8	26.8		x				
266	0.0	0.0	x						326	27.9	27.9		x				
267	0.5	0.5	x						327	28.1	28.1		x				
268	2.9	2.9		x					328	27.7	27.7			x			
269	8.2	8.2		x					329	27.2	27.2			x			
270	13.2	13.2		x					330	26.7	26.7			x			
271	17.8	17.8		x					331	26.6	26.6			x			
272	21.4	21.4		x					332	26.8	26.8			x			
273	24.1	24.1		x					333	27.0	27.0			x			
274	26.4	26.4		x					334	27.2	27.2			x			
275	28.4	28.4		x					335	27.4	27.4			x			
276	29.9	29.9		x					336	27.5	27.5			x			
277	30.4	30.4		x					337	27.7	27.7			x			
278	30.5	30.5			x				338	27.9	27.9			x			
279	30.3	30.3			x				339	28.1	28.1			x			
280	30.2	30.2			x				340	28.3	28.3			x			
281	30.1	30.1			x				341	28.6	28.6			x			
282	30.1	30.1			x				342	29.0	29.0			x			
283	30.1	30.1			x				343	29.5	29.5			x			
284	30.1	30.1			x				344	30.1	30.1			x			
285	30.1	30.1			x				345	30.5	30.5			x			
286	30.1	30.1			x				346	30.7	30.7			x			
287	30.2	30.2			x				347	30.8	30.8			x			
288	30.4	30.4			x		x		348	30.8	30.8			x			
289	31.0	31.0			x		x		349	30.8	30.8			x			
290	31.8	31.8			x		x		350	30.8	30.8			x			
291	32.7	32.7			x		x		351	30.8	30.8			x			
292	33.6	33.6			x		x		352	30.8	30.8			x			
293	34.4	34.4			x		x		353	30.8	30.8			x			
294	35.0	35.0			x		x		354	30.9	30.9			x			
295	35.4	35.4			x		x		355	30.9	30.9			x		x	x
296	35.5	35.5			x		x		356	30.9	30.9			x		x	x
297	35.3	35.3			x		x		357	30.8	30.8			x		x	x
298	34.9	34.9			x		x		358	30.4	30.4			x		x	x
299	33.9	33.9			x		x		359	29.6	29.6			x			x
300	32.4	32.4			x		x		360	28.4	28.4			x			x

Table 9: Cycle part 1, 241 to 360 s

	v in km/h									v in km/h							
time	nor-mal	redu-ced speed	stop	acc	crui-se	decel	no gear-shift	no 1. gear	time	nor-mal	redu-ced speed	stop	acc	crui-se	decel	no gear-shift	no 1. gear
361	27.1	27.1			x			x	421	34.0	34.0		x				
362	26.0	26.0			x			x	422	35.4	35.4		x				
363	25.4	25.4			x			x	423	36.5	36.5		x				
364	25.5	25.5			x		x	x	424	37.5	37.5		x				
365	26.3	26.3			x		x	x	425	38.6	38.6		x				
366	27.3	27.3			x		x	x	426	39.7	39.7		x				
367	28.4	28.4			x		x	x	427	40.7	40.7		x				
368	29.2	29.2			x		x	x	428	41.5	41.5		x				
369	29.5	29.5			x		x	x	429	41.7	41.7		x				
370	29.4	29.4			x		x	x	430	41.5	41.5				x		
371	28.9	28.9			x		x	x	431	41.0	41.0				x		
372	28.1	28.1			x		x	x	432	40.6	40.6				x		
373	27.2	27.2			x		x	x	433	40.3	40.3				x		
374	26.3	26.3			x		x	x	434	40.1	40.1				x		
375	25.7	25.7			x		x	x	435	40.1	40.1				x		
376	25.5	25.5			x		x	x	436	39.8	39.8				x		
377	25.6	25.6			x		x	x	437	38.9	38.9				x		
378	26.0	26.0			x		x	x	438	37.5	37.5				x		
379	26.4	26.4			x		x	x	439	35.8	35.8				x		
380	27.0	27.0			x		x	x	440	34.2	34.2				x		
381	27.7	27.7			x		x	x	441	32.5	32.5				x		
382	28.5	28.5			x		x	x	442	30.9	30.9				x		
383	29.4	29.4			x		x	x	443	29.4	29.4				x		
384	30.2	30.2			x		x	x	444	28.0	28.0				x		
385	30.5	30.5			x		x	x	445	26.5	26.5				x		
386	30.3	30.3			x		x		446	25.0	25.0				x		
387	29.5	29.5			x		x		447	23.4	23.4				x		
388	28.7	28.7			x		x		448	21.9	21.9				x		
389	27.9	27.9			x		x		449	20.4	20.4				x		
390	27.5	27.5			x				450	19.4	19.4				x		
391	27.3	27.3			x				451	18.8	18.8				x		
392	27.0	27.0			x				452	18.4	18.4				x		
393	26.5	26.5			x				453	18.0	18.0				x		
394	25.8	25.8			x				454	17.5	17.5				x		
395	25.0	25.0				x			455	16.9	16.9		x				
396	21.5	21.5				x			456	16.4	16.4		x				
397	16.0	16.0				x			457	16.6	16.6		x				
398	10.0	10.0				x			458	17.7	17.7		x				
399	5.0	5.0				x			459	19.3	19.3		x				
400	2.2	2.2				x			460	20.9	20.9		x				
401	1.0	1.0	x						461	22.3	22.3		x				
402	0.0	0.0	x						462	23.2	23.2				x		
403	0.0	0.0	x						463	23.2	23.2				x		
404	0.0	0.0	x						464	22.2	22.2				x		
405	0.0	0.0	x						465	20.3	20.3				x		
406	0.0	0.0	x						466	17.9	17.9				x		
407	0.0	0.0	x						467	15.2	15.2				x		
408	1.2	1.2		x					468	12.3	12.3				x		
409	3.2	3.2		x					469	9.3	9.3				x		
410	5.9	5.9		x					470	6.4	6.4				x		
411	8.8	8.8		x					471	3.8	3.8				x		
412	12.0	12.0		x					472	1.9	1.9				x		
413	15.4	15.4		x					473	0.9	0.9				x		
414	18.9	18.9		x					474	0.0	0.0	x					
415	22.1	22.1		x					475	0.0	0.0	x					
416	24.7	24.7		x					476	0.0	0.0	x					
417	26.8	26.8		x					477	0.0	0.0	x					
418	28.7	28.7		x					478	0.0	0.0	x					
419	30.6	30.6		x					479	0.0	0.0	x					
420	32.4	32.4		x					480	0.0	0.0	x					

Table 10: Cycle part 1, 361 to 480 s

	v in km/h									v in km/h							
time	nor-mal	redu-ced speed	stop	acc	crui-se	decel	no gear-shift	no 1. gear	time	nor-mal	redu-ced speed	stop	acc	crui-se	decel	no gear-shift	no 1. gear
481	0.0	0.0	x						541	0.0	0.0	x					
482	0.0	0.0	x						542	2.7	2.7		x				
483	0.0	0.0	x						543	8.0	8.0		x				
484	0.0	0.0	x						544	16.0	16.0		x				
485	0.0	0.0	x						545	24.0	24.0		x				
486	1.4	1.4		x					546	32.0	32.0		x				
487	4.5	4.5		x					547	37.2	37.2		x				
488	8.8	8.8		x					548	40.4	40.4		x				
489	13.4	13.4		x					549	43.0	43.0		x				
490	17.3	17.3		x					550	44.6	44.6		x				
491	19.2	19.2		x					551	45.2	45.2			x			
492	19.7	19.7		x					552	45.3	45.3			x			
493	19.8	19.8		x					553	45.4	45.4			x			
494	20.7	20.7		x					554	45.5	45.5			x			
495	23.6	23.6		x					555	45.6	45.6			x			
496	28.1	28.1		x					556	45.7	45.7			x			
497	32.8	32.8		x					557	45.8	45.8			x			
498	36.3	36.3		x					558	45.9	45.9			x			
499	37.1	37.1				x			559	46.0	46.0			x			
500	35.1	35.1				x		x	560	46.1	46.1			x			
501	31.1	31.1				x		x	561	46.2	46.2			x			
502	28.0	28.0				x		x	562	46.3	46.3			x			
503	27.5	27.5		x				x	563	46.4	46.4			x			
504	29.5	29.5		x				x	564	46.7	46.7			x			
505	34.0	34.0		x				x	565	47.2	47.2			x			
506	37.0	37.0		x				x	566	48.0	48.0			x			
507	38.0	38.0				x		x	567	48.9	48.9			x			
508	36.1	36.1				x			568	49.8	49.8			x			
509	31.5	31.5				x			569	50.5	50.5			x			
510	24.5	24.5				x			570	51.0	51.0			x			
511	17.5	17.5				x			571	51.1	51.1			x			
512	10.5	10.5				x			572	51.0	51.0				x		
513	4.5	4.5				x			573	50.4	50.4				x		
514	1.0	1.0	x						574	49.0	49.0				x		
515	0.0	0.0	x						575	46.7	46.7				x		
516	0.0	0.0	x						576	44.0	44.0				x		
517	0.0	0.0	x						577	41.1	41.1				x		
518	0.0	0.0	x						578	38.3	38.3				x		
519	2.9	2.9		x					579	35.4	35.4				x		
520	8.0	8.0		x					580	31.8	31.8				x		
521	16.0	16.0		x					581	27.3	27.3				x		
522	24.0	24.0		x					582	22.4	22.4				x		
523	32.0	32.0		x					583	17.7	17.7				x		
524	38.8	38.8		x					584	13.4	13.4				x		
525	43.1	43.1		x					585	9.3	9.3				x		
526	46.0	46.0		x					586	5.5	5.5				x		
527	47.5	47.5		x					587	2.0	2.0				x		
528	47.5	47.5				x			588	0.0	0.0	x					
529	44.8	44.8				x			589	0.0	0.0	x					
530	40.1	40.1				x			590	0.0	0.0	x					
531	33.8	33.8				x			591	0.0	0.0	x					
532	27.2	27.2				x			592	0.0	0.0	x					
533	20.0	20.0				x			593	0.0	0.0	x					
534	12.8	12.8				x			594	0.0	0.0	x					
535	7.0	7.0				x			595	0.0	0.0	x					
536	2.2	2.2				x			596	0.0	0.0	x					
537	0.0	0.0	x						597	0.0	0.0	x					
538	0.0	0.0	x						598	0.0	0.0	x					
539	0.0	0.0	x						599	0.0	0.0	x					
540	0.0	0.0	x						600	0.0	0.0	x					

Table 11: Cycle part 1, 481 to 600 s

Xxxxx tables for part 2 and part 3 need to be inserted

Table 12: Cycle part 2 for vehicle classes 2 and 3, 1 to 120 s

Table 13: Cycle part 2 for vehicle classes 2 and 3, 121 to 240 s

Table 14: Cycle part 2 for vehicle classes 2 and 3, 241 to 360 s

Table 15: Cycle part 2 for vehicle classes 2 and 3, 361 to 480 s

Table 16: Cycle part 2 for vehicle classes 2 and 3, 481 to 600 s

Table 17: Cycle part 3 for vehicle class 3, 1 to 120 s

Table 18: Cycle part 3 for vehicle class 3, 121 to 240 s

Table 19: Cycle part 3 for vehicle class 3, 241 to 360 s

Table 20: Cycle part 3 for vehicle class 3, 361 to 480 s

Table 21: Cycle part 3 for vehicle class 3, 481 to 600 s

9.3 Chassis Dynamometer and Instruments Description

9.3.1 Chassis Dynamometer

Trade name (-mark) and model: ....

Diameter of roller: .... m

Chassis dynamometer type: DC/ED

Capacity of power absorbing unit (pau): .... kW

Speed range .... km/h

Power absorption system: polygonal function/coefficient control

Resolution: .... N

Type of inertia simulation system: mechanical /electrical

Inertia equivalent mass: .... kg,

in steps of .... kg

Coast down timer: digital/analogue/stop-watch

9.3.2 Speed Sensor

Trade name (-mark) and model: ....

Principle: ....

Range: ....

Position of installed sensor: ....

Resolution: ....

Output: ....

9.3.3 Coast down Meter

Trade name (-mark) and model: ....

v_1, v_2 speed: — Speed setting: ....

— Accuracy: ....

— Resolution: ....

— Speed acquisition time: ....

Coast down time: — Range: ....

— Accuracy: ....

— Resolution: ....

— Display output: ....

— Number of channels:

9.4 Road Tests for the Determination of Test Bench Settings

9.4.1 Requirements for the Rider

9.4.1.1 The rider shall wear a well-fitting suit (one-piece) or similar clothing, and a protective helmet, eye protection, boots and gloves.

9.4.1.2 The rider in the conditions given in 9.4.1.1 shall have a mass of 75 kg ± 5 kg and be 1,75 m ± 0,05 m tall.

9.4.1.3 The rider shall be seated on the seat provided, with his feet on the footrests and his arms normally extended. This position shall allow the rider at all times to have proper control of the motorcycle during the tests.

9.4.2 Requirement for the Road and Ambient Conditions

The test road shall be flat, level, straight and smoothly paved. The road surface shall be dry and free of obstacles or wind barriers that might impede the measurement of the running resistance. The slope of the surface shall not exceed 0,5 % between any two points at least 2 m apart.

During data collecting periods, the wind shall be steady. The wind speed and the direction of the wind shall be measured continuously or with adequate frequency at a location where the wind force during coast down is representative.

The ambient conditions shall be within the following limits:

- maximum wind speed: 3 m/s
- maximum wind speed for gusts: 5 m/s
- average wind speed, parallel: 3 m/s
- average wind speed, perpendicular: 2 m/s
- maximum relative humidity: 95 %
- air temperature: 278 K to 308 K

Standard ambient conditions shall be as follows:

- pressure, p_0: 100 kPa
- temperature, T_0: 293 K
- relative air density, d_0: 0,9197
- air volumetric mass, ρ_0: 1,189 kg/m^3

The relative air density when the motorcycle is tested, calculated in accordance with the formula below, shall not differ by more than 7,5 % from the air density under the standard conditions.

The relative air density, d_T, shall be calculated by the following formula:

$$d_T = d_0 \times \frac{p_T}{p_0} \times \frac{T_0}{T_T}$$ **equation 41**

9.4.3 Condition of the Vehicle

The vehicle shall comply with the conditions described in paragraph 6.1.

When installing the measuring instruments on the test motorcycle, care shall be taken to minimise their effects on the distribution of the load between the wheels. When installing the speed sensor outside the motorcycle, care shall be taken to minimise the additional aerodynamic loss.

9.4.4 Rider and Riding Position

As specified in paragraph 6.4.1

9.4.5 Specified Coast down Speeds

The coast down times have to be measured between v1 and v2 as specified in Table 22 depending on the vehicle class as defined in paragraph 6.2.

Vehicle class	vj in km/h	v1 in km/h	v2 in km/h
1	50	55	45
	40	45	35
	30	35	25
	20	25	15
2	100	110	90
	80 *)	90	70
	60 *)	70	50
	40 *)	45	35
	20)*	25	15
3	120	130	110
	100 *)	110	90
	80 *)	90	70
	60 *)	70	50
	40 *)	45	35
	20 *)	25	15
*) denotes specified coast down speeds for motorcycles that have to drive the cycle parts in "reduced speed" version			

Table 22: Coast down time measurement beginning speed and ending speed. (For reduced speed version specifications see paragraph 6.4.4.1)

9.4.6 Measurement of Coast down Time

After a warm-up period, the motorcycle shall be accelerated to the coast down starting speed, at which point the coast down measurement procedure shall be started.

Since it can be dangerous and difficult from the viewpoint of its construction to have the transmission shifted to neutral, the coasting may be performed solely with the clutch disengaged. For those motorcycles that have no way of cutting the transmitted engine power off prior to coasting, the motorcycle may be towed until it reaches the coast down starting speed. When the coast down test is reproduced on the chassis dynamometer, the transmission and clutch shall be in the same condition as during the road test.

The motorcycle steering shall be altered as little as possible and the brakes shall not be operated until the end of the coast down measurement period.

The first coast down time Δt_{ai} corresponding to the specified speed v_j shall be measured as the elapsed time from the motorcycle speed $v_j+\Delta v$ to $v_j-\Delta v$.

The procedure from 7.9.1 to 7.9.4 shall be repeated in the opposite direction to measure the second coast down time Δt_{bi}.

The average ΔT_i of the two coast down times Δt_{ai} and Δt_{bi} shall be calculated by the following equation:

$$\Delta T_i = \frac{\Delta t_{ai} + \Delta t_{bi}}{2}$$ **equation 42**

At least four tests shall be performed and the average coast down time ΔT_j calculated by the following equation:

$$\Delta T_j = \frac{1}{n} \sum_{i=1}^{n} \Delta T_i$$ **equation 43**

Tests shall be performed until the statistical accuracy, P, is equal to or less than 3 % ($P \leq 3$ %).

The statistical accuracy, P, as a percentage, is calculated by the following equation:

$$P = \frac{t\,s}{\sqrt{n}} \times \frac{100}{\Delta T_j}$$ **equation 44**

where

t is the coefficient given in Table 23;

s is the standard deviation given by the following formula:

$$s = \sqrt{\sum_{i=1}^{n} \frac{(\Delta T_i - \Delta T_j)^2}{n-1}}$$ **equation 45**

n is the number of tests.

n	t	$\frac{t}{\sqrt{n}}$
4	3,2	1,60
5	2,8	1,25
6	2,6	1,06
7	2,5	0,94
8	2,4	0,85
9	2,3	0,77
10	2,3	0,73
11	2,2	0,66
12	2,2	0,64
13	2,2	0,61
14	2,2	0,59
15	2,2	0,57

Table 23: Coefficients for the statistical accuracy

In repeating the test, care shall be taken to start the coast down after observing the same warm-up procedure and at the same coast down starting speed.

The measurement of the coast down times for multiple specified speeds may be made by a continuous coast down. In this case, the coast down shall be repeated after observing the same warm-up procedure and at the same coast down starting speed.

The coast down time shall be recorded. The example of the record form is given in annex 9.5.

9.4.7 Data Processing

9.4.7.1 Calculation of running resistance force

The running resistance force F_j, in newtons, at the specified speed v_j shall be calculated by the following equation:

$$F_j = \frac{1}{3,6} \times \left(m + m_r\right) \times \frac{2\Delta v}{\Delta T_j}$$ **equation 46**

NOTE m_r should be measured or calculated as appropriate. As an alternative, m_r may be estimated as 7 % of the unladen motorcycle mass.

The running resistance force F_j shall be corrected in accordance with paragraph 9.4.7.2.

9.4.7.2 Running resistance curve fitting

The running resistance force, F, shall be calculated as follows:

This following equation shall be fitted to the data set of F_j and v_j obtained above by linear regression to determine the coefficients f_0 and f_2,

$$F = f_0 + f_2 v^2$$ **equation 47**

The coefficients f_0 and f_2 determined shall be corrected to the standard ambient conditions by the following equations:

$$f_0^* = f_0 \left[1 + K_0 \left(T_T - T_0\right)\right]$$ **equation 48**

$$f_2^* = f_2 \times \frac{T_T}{T_0} \times \frac{p_0}{p_T}$$ **equation 49**

NOTE K_0 may be determined based on the empirical data for the particular motorcycle and tyre tests, or may be assumed as follows if the information is not available: K_0=6X10^{-3} K^{-1}.

9.4.7.3 Target running resistance force for chassis dynamometer setting

The target running resistance force $F^*(v_0)$ on the chassis dynamometer at the reference motorcycle speed (v_0), in newtons, is determined by the following equation:

$$F^*\left(v_0\right) = f_0^* + f_2^* \times v_0^2$$ **equation 50**

9.5 Form for the Record of Coast down Time

Tradename:.. Production number (Body):..

Date:...../...../...... Place of the test:.............................. Name of recorder..............................

Climate:.................. Atmospheric pressure:..................kPa Atmospheric temperature:................K

Wind speed (parallel/perpendicular):........../..........m/s

Rider height:............m

Motorcycle speed km/h	Coast down time(s) s					Statistical accuracy %	Average coast down time s	Running resistance N	Target running resistance N	note
	First									
	Second									
	First									
	Second									
	First									
	Second									
	First									
	Second									
	First									
	Second									
	First									
	Second									
	First									
	Second									
	First									
	Second									
	First									
	Second									

Curve fitting: F^*=....+....v^2

9.6 Record of chassis dynamometer setting (by coast down method)

Tradename:.. Production number (Body):..

Date ....../....../........ Place of the test:.................................... Name of recorder:..................................

Motorcycle speed km/h	Coast down time(s) s				Running resistance N		Setting error	note
	Test 1	Test 2	Test 3	Average	Setting value	Target value	□	

Curve fitting: F^*=.....+.....v^2

9.7 Record of chassis dynamometer setting (by table method)

Tradename:.. Production number (Body):..

Date ....../....../........ Place of the test:.................................... Name of recorder:...............................

Motorcycle speed	Coast down time(s) s				Running resistance N		Setting error	note
km/h	Test 1	Test 2	Test 3	Average	Setting value	Target value	□	

Curve fitting: F^*=.....+.....v^2

9.8 Record of Type I Test Results

				distance driven	Emissions in g				fuel cons
class	**Cycle part**	**start cond**	**run**	**in km**	**HC**	**CO**	**NOx**	**CO_2**	**in l**
1S	1,reduced speed	cold	1						
1S	1,reduced speed	cold	2						
1S	1,reduced speed	cold	3						
1S	1,reduced speed	cold	average						
1S	1,reduced speed	hot	1						
1S	1,reduced speed	hot	2						
1S	1,reduced speed	hot	3						
1S	1,reduced speed	hot	average						
1, 2 or 3	1	cold	1						
1, 2 or 3	1	cold	2						
1, 2 or 3	1	cold	3						
1, 2 or 3	1	cold	average						
1	1	hot	1						
1	1	hot	2						
1	1	hot	3						
1	1	hot	average						
2 or 3	2	hot	1						
2 or 3	2	hot	2						
2 or 3	2	hot	3						
2 or 3	2	hot	average						
3	3	hot	1						
3	3	hot	2						
3	3	hot	3						
3	3	hot	average						
					Emissions in g/km				**fuel cons**
class	**Cycle part**		**run**	**weighting**	**HC**	**CO**	**NOx**	**CO_2**	**in l/100 km**
1S	1,reduced speed	cold	average	50%					
1S	1,reduced speed	hot	average	50%					
				final result					
1	1	cold	average	50%					
1	1, hot		average	50%					
				final result					
2	1	cold	average	30%					
2	2	hot	average	70%					
				final result					
3	1	cold	average	25%					
3	2	hot	average	50%					
3	3	hot	average	25%					
				final result					

9.9 Record of Type II Test Results

idling speed in min^{-1}			engine oil temperature in °C	CO content in vol-%	CO_2 content in vol-%	corrected CO content in vol-%
min	average	max				
high idle speed in min^{-1}			engine oil temperature in °C	CO content in vol-%	CO_2 content in vol-%	corrected CO content in vol-%
min	average	max				

9.10 Gear Use Calculation Routine

Xxxxx needs to be added.