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PROPOSAL FOR NEW DRAFT GLOBAL TECHNICAL REGULATION (GTR)

UNIFORM PROVISIONS CONCERNING THE MEASUREMENT PROCEDURE FOR MOTORCYCLES EQUIPPED WITH A POSITIVE – OR COMPRESSION IGNITION ENGINE WITH REGARD TO THE EMISSION OF GASEOUS POLLUTANTS, CO_2 EMISSIONS AND FUEL CONSUMPTION BY THE ENGINE

Transmitted by the Working Party on Pollution and Energy (GRPE)

Note: The text reproduced below was adopted by GRPE at its forty-eighth session and is transmitted for consideration to WP.29 and AC.3 (TRANS/WP.29/GRPE/48, para. 17). It is based on document TRANS/WP.29/GRPE/2004/11, not amended.

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A. STATEMENT OF TECHNICAL RATIONALE AND JUSTIFICATION

1. Technical and economic feasibility

The objective is to establish a harmonized global technical regulation (gtr) on the certification procedure for motorcycle exhaust-emissions. The basis will be the harmonized test procedure, developed by the GRPE informal working group on Worldwide Harmonized Motorcycle Emissions Certification Procedure (WMTC) (see technical report TRANS/WP.29/GRPE/2004/10).

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 worldwide 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 worldwide 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 Parties, 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 harmonized 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 CO_2 / 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 Parties the method defined in this gtr is much more representative of motorcycle in-use driving behaviour with respect to the following parameters:

- Maximum test 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

(To be added at a later time point.)

B. TEXT OF THE REGULATION

1. Scope and purpose

This regulation provides a worldwide-harmonized 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 and carbon dioxide emissions and fuel consumption of two-wheeled motor vehicles having a maximum design speed exceeding 50 km/h or cylinder capacity exceeding 50 cm^3.

3. Definitions

For the purposes of this regulation,

3.1. Vehicle type

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

3.1.1. Equivalent inertia

"Equivalent inertia" determined in relation to the reference mass as prescribed in paragraph 6.4.6.1.2., to this regulation, and

3.1.2. Engine and vehicle characteristics

The engine and vehicle characteristics as defined in Annex 4 to this regulation.

3.2. Vehicle mass

3.2.1. Kerb mass m_k

"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 per cent 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 m_{ref}

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

3.4. Gaseous pollutants

"Gaseous pollutants" means carbon monoxide (CO), oxides of nitrogen expressed in terms of nitrogen dioxide (NO_2) equivalence, and hydrocarbons (HC), assuming a ratio of:

$C_1H_{1.85}$ for petrol,
$C_1H_{1.86}$ for diesel fuel.

3.5. CO_2 emissions

"CO_2 emissions" means carbon dioxide.

3.6. Fuel consumption

"Fuel consumption" means the amount of fuel consumed, calculated by the carbon balance method.

3.7. Maximum vehicle speed v_{max}

"Maximum vehicle speed" (v_{max}) is the maximum speed of the vehicle as declared by the manufacturer, measured in accordance with European Union (EU) Directive 95/1/EC (on the maximum design speed, maximum torque and maximum net engine power of two- or three-wheel motor vehicles).

3.8. Symbols used

The symbols used in this regulation are summarized in Annex 1.

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

To be added later.

6. Test conditions

6.1. Test vehicle

6.1.1. General

The test vehicle (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

Figure 6-1 gives an overview of the vehicle classification in terms of engine capacity and maximum vehicle speed.

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	subclass 1-1,
50 cm³ < engine capacity < 150 cm³ and v_{max} < 50 km/h	subclass 1-2,
engine capacity < 150 cm³ and 50 km/h ≤ v_{max} < 100 km/h, but not including subclass 1-1	subclass 1-3.

6.2.2. Class 2

Vehicles that fulfil the following specifications belong to class 2:

engine capacity < 150 cm³ and 100 km/h ≤ v_{max} < 115 km/h or engine capacity ≥150 cm³ and v_{max} < 115 km/h	subclass 2-1,
115 km/h ≤ v_{max} < 130 km/h	subclass 2-2.

6.2.3. Class 3

Vehicles that fulfil the following specifications belong to class 3:

130 ≤ v_{max} < 140 km/h	subclass 3-1,
v_{max} ≥ 140 km/h	subclass 3-2.

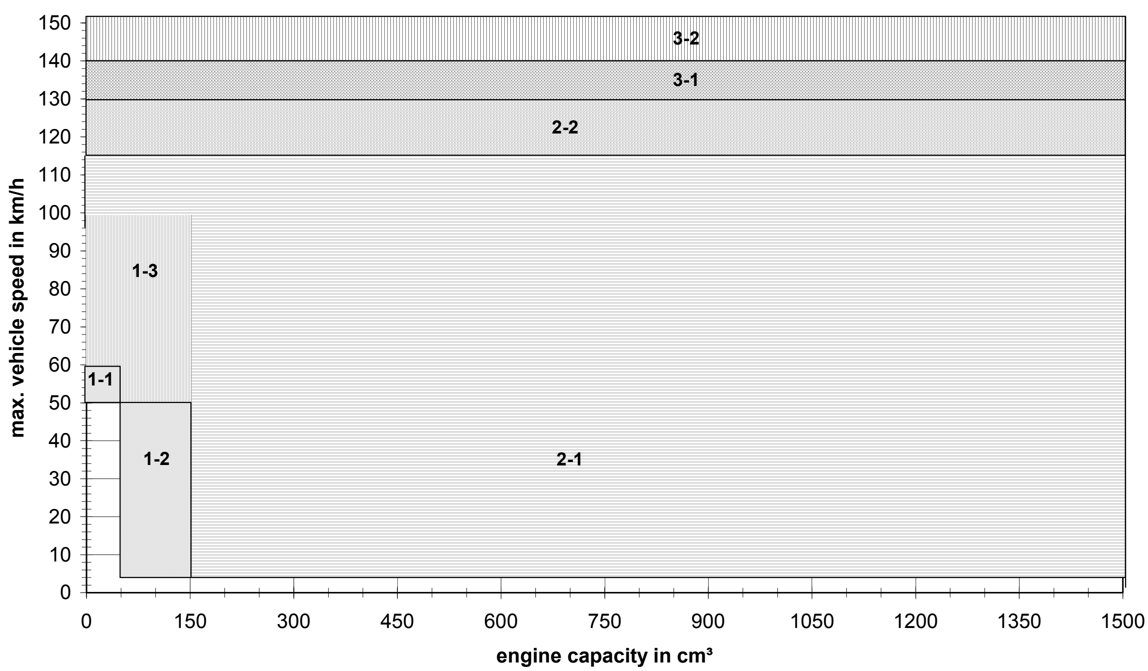


Figure 6-1: vehicle classification

6.3. Specification of the reference fuel

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

For the purpose of calculation mentioned in paragraph 8.1.1.5., for petrol and diesel fuel the density measured at 15 °C will be used.

The technical data of the reference fuel to be used for testing vehicles are specified in Annex 2.

6.4. Type I tests

6.4.1. Rider

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

6.4.2.1. 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 simulate the inertia specified in paragraph 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 (fan) 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. At the range of over 50 km/h, the linear velocity of the air shall be within ±10 per cent. 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 the 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 per cent 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

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 backpressure 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 diluted 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 venture (CFV) 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 paragraph 6.4.3.7. shall be at least 150 litre/hour.

6.4.3.9. Three way valves on the sampling system described in paragraphs 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. If 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 that 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) 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 test cycle parts have to be run:

Class 1:

Subclasses 1-1 and 1-2:	part 1, reduced speed in cold condition, followed by part 1, reduced speed in hot condition.
Subclass 1-3:	part 1 in cold condition, followed by part 1 in hot condition.

Class 2:

Subclass 2-1:	part 1 in cold condition, followed by part 2, reduced speed in hot condition.
Subclass 2-2:	part 1 in cold condition, followed by part 2 in hot condition.

Class 3:

Subclass 3-1: part 1 in cold condition, followed by part 2 in hot condition, followed by part 3, reduced speed in hot condition.

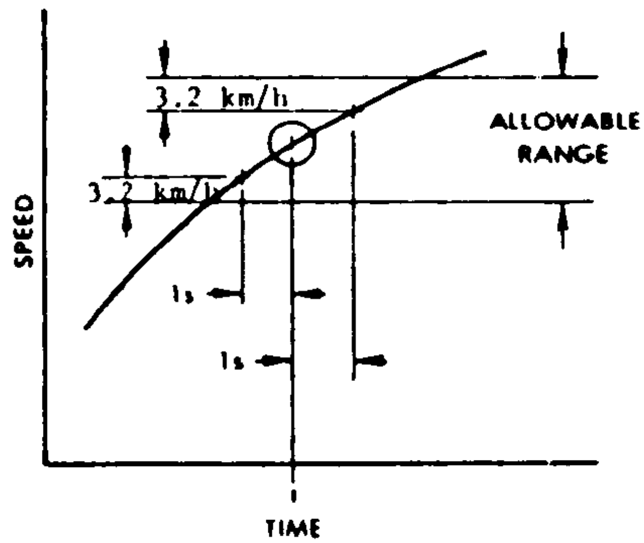
Subclass 3-2: part 1 in cold condition, followed by part 2 in hot condition, followed by part 3 in hot condition.

The test cycle parts (vehicle speed pattern) are shown in Annex 5.

6.4.4.2. Speed tolerances

The speed tolerance at any given time on the test cycle prescribed in paragraph 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 6-2 shows the range of acceptable speed tolerances for typical points.

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



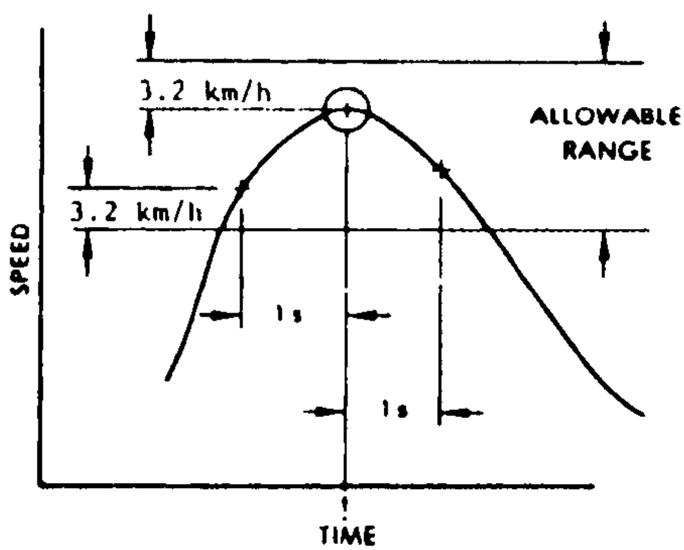


Figure 6-2: Drivers trace, allowable range

6.4.5. Gearshift prescriptions

6.4.5.1. Test vehicles (motorcycles) 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. Test vehicles (motorcycles) with manual transmission

6.4.5.2.1. Step 1 – Calculation of shift speeds

Upshift speeds v in km/h during acceleration phases are calculated using the following formulas:

Equation 6-1:

$$v_{1 \to 2} = \left[(0.5753 \times e^{(-1.9 \times \frac{P_n}{m_k + 75})} - 0.1) \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_1}$$

Equation 6-2:

$$v_{i \to i+1} = \left[(0.5753 \times e^{(-1.9 \times \frac{P_n}{m_k + 75})}) \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_1}, \quad i = 2 \text{ to } ng-1$$

where:

i	is the gear number (≥ 2),
ng	is the total number of forward gears,
P_n	is the rated power in kW,
m_k	is the kerb mass in kg,
n	is the engine speed in min^{-1},
n_{idle}	is the idling speed in min^{-1},
s	is the rated engine speed in min^{-1},
ndv_i	is the ratio between engine speed in km/h and vehicle speed in min^{-1} in gear i.

Downshift speeds in km/h during cruise or deceleration phases in gears 3 to n are calculated using the following formula:

Equation 6-3:

$$v_{i \rightarrow i-1} = \left[(0.5753 \times e^{(-1.9 \times \frac{P_n}{m_k + 75})}) \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_{i-2}}, \quad i = 3 \text{ to } ng$$

The gear lever shall be set to first gear but the clutch shall be disengaged, if:
- the vehicle speed drops below 10 km/h or
- the engine speed drops below $n_{idle} + 0.03 \times (s - n_{idle})$,
- engine roughness is evident,
- engine stalling is imminent.

6.4.5.2.2. Step 2 – Gear choice for each cycle sample

The appropriate gear for each sample shall then be calculated according to phase indicators in the tables in Annex 5 for the cycle parts appropriate for the test vehicle as follows:

Gear lever in neutral and clutch disengaged;

The gear lever shall be set to first gear and the clutch shall be disengaged, if the following conditions are met:
- During stop phases,
- During cruise or deceleration phases, if:
  the vehicle speed drops below 10 km/h or
  the engine speed drops below $n_{idle} + 0.03 \times (s - n_{idle})$;

Gear choice for acceleration phases:
Gear = 6, if $v > v_{5\rightarrow6}$,
Gear = 5, if $v > v_{4\rightarrow5}$,
Gear = 4, if $v > v_{3\rightarrow4}$,
Gear = 3, if $v > v_{2\rightarrow3}$,
Gear = 2, if $v > v_{1\rightarrow2}$,
Gear = 1, if $v \leq v_{1\rightarrow2}$.

Gear choice for deceleration or cruise phases:
Gear = 6, if $v > v_{4\rightarrow5}$,
Gear = 5, if $v > v_{3\rightarrow4}$,
Gear = 4, if $v > v_{2\rightarrow3}$,
Gear = 3, if $v > v_{1\rightarrow2}$,
Gear = 2, if $v \leq v_{1\rightarrow2}$.

6.4.5.2.3. Step 3 – Corrections according to additional requirements

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

a) No gearshift at a transition from an acceleration phase to a deceleration phase: keep the gear that was used for the last second of the acceleration phase also for the following deceleration phase unless the speed drops below a downshift speed.
b) No upshifts during deceleration phases.
c) No gearshift in cycle phases, where "no gearshift" is indicated.
d) No downshift to first gear at a transition from a deceleration or a cruise phase to an acceleration phase, if "no use of 1. gear" is indicated.
e) If a gear is used for only one second, this gear shall also be assigned to the following second. Since it could happen that the modifications according to this criterion create new phases where a gear is used for only one second, this modification step has to be applied several times.

To give the test engineer more flexibility and to assure driveability, the use of lower gears than calculated with the routines above are permitted in any cycle phase. Manufacturers recommendations for gear use shall be followed, if they do not lead to higher gears than calculated with the routines above.

Explanations about the approach and the gearshift strategy and a calculation example are given in Annex 13.

6.4.6. Dynamometer settings

A full description of the chassis dynamometer and instruments shall be provided in accordance with Annex 6.

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

The running resistance force for the chassis dynamometer settings can be derived either from on-road coast down measurements or from a running resistance table (see Annex 3).

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 7.

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 6.4.7.

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 Annex 3. The value of m_{rf}, in kilograms, may be measured or calculated as appropriate, or may be estimated as 3 per cent 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:

$$\Delta T_{road} = \frac{1}{3.6}(m_a + m_{r1})\frac{2\Delta v}{F^*}$$ Equation 6-4

$$\Delta T_E = \frac{1}{3.6}(m_i + m_{r1})\frac{2\Delta v}{F_E}$$ Equation 6-5

$$F_E = F^*$$ Equation 6-6

$$\Delta T_E = \Delta T_{road} \times \frac{m_i + m_{r1}}{m_a + m_{r1}}$$ Equation 6-7

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 per cent of m.

6.4.6.2. Running resistance force derived from a running resistance table

The chassis dynamometer can be set by the use of the running resistance table instead of the running resistance force obtained by the coast down method. In this table method, the chassis dynamometer shall be set by the reference mass regardless of particular motorcycle characteristics.

Note Cares should be taken for the application of this method to motorcycles having extraordinary characteristics.

The flywheel equivalent inertia mass m_{fi} shall be the equivalent inertia mass m_i specified in Annex 3. The chassis dynamometer shall be set by the rolling resistance of the front wheel a and the aero drag coefficient b as specified in Annex 3.

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 6-8

The target running resistance force F^* shall be equal to the running resistance force obtained from the running resistance table F_T, because the correction for the standard ambient conditions is not necessary.

6.4.7. Measurement accuracies

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

Table 6-1: Required accuracy of measurements

Measurement Items	At measured value	Resolution
a) Running resistance force, F	+ 2 per cent	-
b) Motorcycle speed (v_1, v_2)	± 1 per cent	0.2 km/h
c) Coast down speed interval ($2\Delta v = v_1 - v_2$)	± 1per cent	0.1 km/h
d) Coast down time (Δt)	± 0.5 per cent	0.01 s
e) Total motorcycle mass ($m_k + m_{rid}$)	± 0.5 per cent	1.0 kg
f) Wind speed	± 10 per cent	0.1 m/s
g) Wind direction	-	5 deg.
h) Temperatures	± 1 °C	1 °C
i) Barometric pressure	-	0.2 kPa
j) Distance	± 0.1per cent	1 m
k) Time	± 0.1 s	0.1 s

6.5. Type II tests

6.5.1. Application

This requirement applies to all test vehicles (motorcycles) 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

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

High idle speed is defined by the manufacturer but it has to be higher than 2,000 min^{-1}.

6.5.5. Gear lever position

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

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

7. <u>Test procedures</u>

7.1. Description of tests.

The test vehicle (motorcycle) 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. Number of tests

The number of tests shall be determined as shown in figure 7-1. R_{i1} to R_{i3} describe the final measurement results for test No. 1 to test No. 3 and the gaseous pollutant, the carbon dioxide emission or fuel consumption as defined in paragraph 8.1.1.6. L is the limit value as defined in paragraph 5.

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.

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. > 2,000 min^{-1}) carried out by the method described in paragraph 7.3. to this regulation.

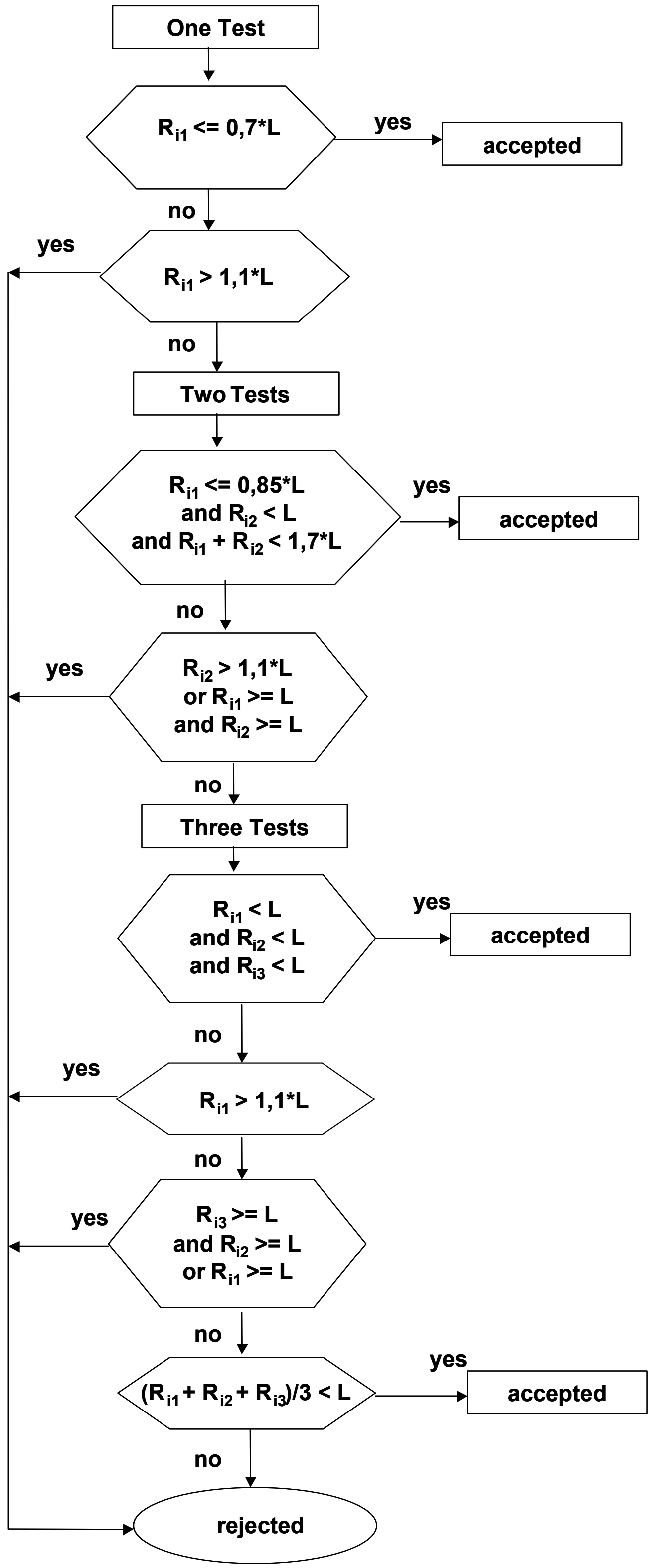


Figure 7-1: Flowchart for the number of Type I tests

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 (CVS).

Except in cases of component malfunction or failure, all emission control systems installed on or incorporated in a tested 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. Test vehicle (motorcycle) 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 vehicle shall be warmed up on the chassis dynamometer to the same condition as it was during the road test.

7.2.2.2. Dynamometer preparation, if settings are derived from on-road coast down measurements

Before the test, 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 7-1

The target running resistance force F^* derived from paragraph 6.3. of Annex 7 shall be reproduced on the chassis dynamometer in accordance with the motorcycle speed. Namely:

$$F_E(v_i) = F^*(v_i)$$ Equation 7-2

The total friction loss F_f on the chassis dynamometer shall be measured by the method in paragraph 7.2.2.2.1. or 7.2.2.2.2.

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 paragraph 5. of Annex 7 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 7-3

7.2.2.2.3. 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 7-4

7.2.2.2.4. 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:

$$F_{pau}(v_0) = F^*(v_0) - F_f(v_0) \qquad \text{Equation 7-5}$$

7.2.2.2.5. Chassis dynamometer setting

According to its type, the chassis dynamometer shall be set by one of the methods described in paragraphs 7.2.2.2.5.1. to 7.2.2.2.5.4. The chosen setting shall be applied to the pollutant emissions measurements as well as to the CO_2 emission measurements.

7.2.2.2.5.1. 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 paragraph 7.2.2.2.4.

7.2.2.2.5.2. 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 should be calculated by the procedure in paragraph 7.2.2.2.

Assuming the load characteristics to be:

$$F_{pau}(v) = a \times v^2 + b \times v + c \qquad \text{Equation 7-6}$$

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.

7.2.2.2.5.3. Chassis dynamometer with F^* polygonal digital setter

In the case of a chassis dynamometer with a polygonal digital setter, where a central processor unit (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 $F^* = f^* + f^*_2 \times v^2$.

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_j 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:

$$F^* + F_f = \frac{1}{3.6}(m_i + m_{r1})\frac{2\Delta v}{\Delta t_i}$$ Equation 7-7

$$F_f = \frac{1}{3.6}(m_i + m_{r1})\frac{2\Delta v}{\Delta t_i} - F^*$$ Equation 7-8

$$F_{pau} = F^* - F_f$$ Equation 7-9

7.2.2.2.5.4. 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 (central processor unit) is incorporated in the system, the target running resistance force $F^* = f^*_0 + f^*_2 \times v^2$ 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:

$$F^* + F_f = \frac{1}{3.6}(m_i + m_{r1})\frac{2\Delta v}{\Delta t_i}$$ Equation 7-10

$$F_f = \frac{1}{3.6}(m_i + m_{r1})\frac{2\Delta v}{\Delta t_i} - F^*$$ Equation 7-11

$$F_{pau} = F^* - F_f$$ Equation 7-12

7.2.2.2.6. Dynamometer settings verification

7.2.2.2.6.1. 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 paragraph 5. of Annex 7.

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:

$$F_E(v_0) = \frac{1}{3.6}(m_i + m_{r1})\frac{2\Delta v}{\Delta t_E}$$ Equation 7-13

7.2.2.2.6.2. Calculation of setting error

The setting error ε is calculated by the following equation:

$$\varepsilon = \frac{\left|F_E(v_0) - F^*(v_0)\right|}{F^*(v_0)} \times 100$$ Equation 7-14

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

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

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

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

The procedure in paragraphs 7.2.2.2.6.1. to 7.2.2.2.6.2. 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.

7.2.2.3. Dynamometer preparation, if settings are derived from a running resistance table

7.2.2.3.1. The specified speed for the chassis dynamometer

The running resistance on the chassis dynamometer shall be verified at the specified speed v. At least four specified speeds should be verified. The range of specified speed points (the interval between the maximum and minimum points) shall extend either side of the reference speed or the reference speed range, if there is more than one reference speed, by at least Δv, as defined in paragraph 4. of Annex 7. The specified speed points, including the reference speed point(s), shall be no greater than 20 km/h apart and the interval of specified speeds should be the same.

7.2.2.3.2. Verification of chassis dynamometer

Immediately after the initial setting, the coast down time on the chassis dynamometer corresponding to the specified speed shall be measured. The motorcycle shall not be set up on the chassis dynamometer during the coast down time measurement. When the chassis dynamometer speed exceeds the maximum speed of the test cycle, the coast down time measurement shall start.

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 $F_E(v_j)$ at the specified speed on the chassis dynamometer is calculated by the following equation:

$$F_E(v_j) = \frac{1}{3.6} \times m_i \times \frac{2\Delta v}{\Delta t_E}$$ Equation 7-15

The setting error ε at the specified speed is calculated by the following equation:

$$\varepsilon = \frac{|F_E(v_j) - F_T|}{F_T} \times 100$$ Equation 7-16

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

$\varepsilon \leq 2$ per cent for $v \geq 50$ km/h
$\varepsilon \leq 3$ per cent for 30 km/h $\leq v < 50$ km/h
$\varepsilon \leq 10$ per cent for $v < 30$ km/h

The procedure described above shall be repeated until the setting error satisfies the criteria.

The chassis dynamometer setting and the observed errors shall be recorded. An example of the record form is given in Annex 10.

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/CO 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. Test vehicle (motorcycle) preconditioning

The test 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 paragraph 6.3. to half the tank(s) capacity.

- The test vehicle shall be placed, either by being driven or pushed, on a dynamometer and operated through the cycles as specified in paragraph 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 5 minutes of completion of preconditioning, the test 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 6 hours and not more than 36 hours prior to the cold start Type I test or until the engine oil temperature T^{O} or the coolant temperature T^{C} 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.

Test 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.

Test 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 test 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 test 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 test 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 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 test 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 test 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 test 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 test vehicle cannot accelerate at the specified rate, it shall be operated with the throttle fully opened until the roller 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 paragraph 6.4.4.

The following steps shall be taken for each test:

a) Place drive wheel of vehicle on dynamometer without starting engine.
b) Activate vehicle cooling fan.
c) For all test 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.
d) 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.)
e) 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 litre/second.
    - For hydrocarbon samples, the minimum flame ionization detection (FID) (or heated flame ionization detection (HFID) in the case of methanol-fuelled vehicles) flow rate is 0.031 litre/second.
f) Attach the flexible exhaust tube to the vehicle tailpipe(s).
g) 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.
h) Fifteen seconds after the engine starts, place the transmission in gear.
i) Twenty seconds after the engine starts, begin the initial vehicle acceleration of the driving schedule.
j) Operate the vehicle according to the driving cycles specified in paragraph 6.4.4.
k) At the end of the part 1 or part 1, reduced speed in "cold" condition, simultaneously switch the sample flows from the first bags and samples to the second bags and samples, switch off gas flow measuring device No. 1 and start gas flow measuring device No. 2.
l) In case of class 3 vehicles, at the end of part 2 simultaneously switch the sample flows from the second bags and samples to the third bags and samples, switch off gas flow measuring device No. 2 and, start gas flow measuring device No. 3.
m) 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 8.1.1., 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.

n) Turn the engine off 2 seconds after the end of the last part of the test.
o) Immediately after the end of the sample period, turn off the cooling fan.
p) Turn off the constant volume sampler (CVS) or critical flow venturi (CFV) or disconnect the exhaust tube from the tailpipe(s) of the vehicle.
q) Disconnect the exhaust tube from the vehicle tailpipe(s) and remove the vehicle from dynamometer.
r) 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.

7.3. Type II tests

7.3.1. Conditions of measurement

The Type II test specified in paragraph 0 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:

a) the carbon monoxide content by volume of the exhaust gases emitted,
b) the carbon dioxide content by volume of the exhaust gases emitted,
c) the engine speed during the test, including any tolerances,
d) 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 H20, 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 (CCO) and CO2 (CCO2) 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. Exhaust emission and fuel consumption analysis

8.1.1.1. 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.

8.1.1.2. Calibration of analysers and concentration results

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

a) Prior to each sample analysis the analyser range to be used for each pollutant must be set to zero with the appropriate zero gas.
b) The analysers are then set to the calibration curves by means of span gases of nominal concentrations of 70 per cent to 100 per cent of the range.
c) The analysers' zeros are then rechecked. If the reading differs by more than 2 per cent of range from that set in b), the procedure is repeated.
d) The samples are then analysed.
e) After the analysis, zero and span points are rechecked using the same gases. If these rechecks are within 2 per cent of those in c), the analysis is considered acceptable.
f) 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.
g) The figure adopted for the concentration of each pollutant measured in the gases is that read off after stabilisation on the measuring device.

8.1.1.3. 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.

8.1.1.4. 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.

8.1.1.4.1. Total volume of diluted gas

The total volume of diluted gas, expressed in m^3/cycle part, adjusted to the reference conditions of 0 °C (273 K) and 101.3 kPa is calculated by

$$V = \frac{273.2 \times V_0 \times N \times (P_a - P_i)}{101.3 \times (T_p + 273.2)}$$ Equation 8-1

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.

8.1.1.4.2. Hydrocarbons

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

$$HC_m = \frac{HC_c \times V \times dHC}{dist \times 10^6}$$ Equation 8-2

where:

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

dist is the distance defined in paragraph 8.1.1.3. above;

V is the total volume, defined in paragraph 8.1.1.4.1.,

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,

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

$$HC_c = HC_e - HC_d \times (1 - \frac{1}{DF})$$ Equation 8-3

where:

HC_e is the concentration of hydrocarbons expressed in parts per million (ppm) of carbon equivalent, in the sample of diluted gases collected in bag A,

HC_d is the concentration of hydrocarbons expressed in parts per million (ppm) of carbon equivalent, in the sample of dilution air collected in bag B,

DF is the coefficient defined in paragraph 8.1.1.4.6. below.

8.1.1.4.3. 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:

$$CO_m = \frac{CO_c \times V \times dCO}{dist \times 10^6}$$ Equation 8-4

where:

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

dist is the distance defined in paragraph 8.1.1.3.,

V is the total volume defined in paragraph 8.1.1.4.1.,

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,

CO_c s the concentration of diluted gases, expressed in parts per million (ppm) of carbon monoxide, corrected to take account of the dilution air by the following equation:

$$CO_c = CO_e - CO_d \times (1 - \frac{1}{DF})$$ Equation 8-5

where:

CO_e is the concentration of carbon monoxide expressed in parts per million (ppm), in the sample of diluted gases collected in bag A,

CO_d is the concentration of carbon monoxide expressed in parts per million (ppm), in the sample of dilution air collected in bag B,

DF is the coefficient defined in paragraph 8.1.1.4.6. below.

8.1.1.4.4. 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:

$$NO_{xm} = \frac{NO_{xc} \times K_h \times V \times dNO_2}{dist \times 10^6}$$ Equation 8-6

where:

NO_{xm} is the mass of nitrogen oxides emitted during the test part, in g/km

dist is the distance defined in paragraph 8.1.1.3.,

V is the total volume defined in paragraph 8.1.1.4.1.,

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 = 2.05 kg/m^3,

NO_{xc} is the concentration of diluted gases, expressed in parts per million (ppm), corrected to take account of the dilution air by the following equation:

$$NO_{xc} = NO_{xe} - NO_{xd} \times (1 - \frac{1}{DF})$$ Equation 8-7

where:

NO_{xe} is the concentration of nitrogen oxides expressed in parts per million (ppm) of nitrogen oxides, in the sample of diluted gases collected in bag A,

NO_{xd} is the concentration of nitrogen oxides expressed in parts per million (ppm) of nitrogen oxides, in the sample of dilution air collected in bag B,

DF is the coefficient defined in paragraph 0 below,

K_h is the humidity correction factor, calculated by the following formula:

$$K_h = \frac{1}{1 - 0.0329 \times (H - 10.7)}$$ Equation 8-8

where:

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

$$H = \frac{6.211 \times U \times P_d}{P_a - P_d \times \frac{U}{100}}$$ Equation 8-9

where:

U is the humidity in per cent,

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

P_a is the atmospheric pressure in kPa.

8.1.1.4.5. 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:

$$CO_{2m} = \frac{CO_{2c} \times V \times dCO_2}{dist \times 10^2}$$ Equation 8-10

where:

CO_{2m} is the mass of carbon dioxide emitted during the test part, in g/km

dist is the distance defined in paragraph 8.1.1.3.,

V is the total volume defined in paragraph 8.1.1.4.1.,

dCO_2 is the density of the carbon dioxide at a temperature of 0 °C and a pressure of 101.3 kPa, dCO_2 = 1,830 g/m^3,

CO_{2c} is the concentration of diluted gases, expressed in per cent carbon dioxide equivalent, corrected to take account of the dilution air by the following equation:

$$CO_{2c} = CO_{2e} - CO_{2d} \times (1 - \frac{1}{DF})$$ Equation 8-11

where:

CO_{2e} is the concentration of carbon dioxide expressed in per cent, in the sample of diluted gases collected in bag A,

CO_{2d} is the concentration of carbon dioxide expressed in per cent, in the sample of dilution air collected in bag B,

DF is the coefficient defined in paragraph 8.1.1.4.6. below.

8.1.1.4.6. Dilution factor DF

The dilution factor DF (in per cent vol.) is a coefficient expressed by the formula

$$DF = \frac{14.5}{CO_2 + 0.5 \times CO + HC}$$ Equation 8-12

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

8.1.1.5. Fuel consumption calculation

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

8.1.1.5.1. Test vehicles (motorcycles) with a positive ignition engine fuelled with petrol

$$FC = \frac{0.1154}{D} \div (0.866 \times HC + 0.429 \times CO + 0.273 \times CO_2)$$ Equation 8-13

where:

FC is the fuel consumption in litre/100 km

HC is the measured emission of hydrocarbons in g/km

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

CO_2 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.

Test vehicles (motorcycles) with a compression ignition engine

$$FC = \frac{0.1155}{D} \div (0.866 \times HC + 0.429 \times CO + 0.273 \times CO_2)$$ Equation 8-14

where:

FC is the fuel consumption in litre/100 km

HC is the measured emission of hydrocarbons in g/km

CO is the measured emission of carbon monoxide in g/km
CO_2 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.

8.1.1.6. Weighting of results

In case of repeated measurements (see paragraph 7.1.1.1.) the emission results in g/km and the fuel consumption in litre/100 km obtained by the calculation method described in paragraph 8.1.1. are averaged for each cycle part.

The (average) result of part 1 or part 1, reduced speed is named R_1, the (average) result of part 2 or part 2, reduced speed is named R_2 and the (average) result of part 3 or part 3, reduced speed is named R_3. Using these emission results in g/km and the fuel consumption in litre/100 km; the final result R, depending on the vehicle class as defined in paragraph 6.2., shall be calculated by means of the following equation:

Class 1 $R = R_1 \times w_1 + R_{1\,hot} \times w_{1\,hot}$

Class 2 $R = R_1 \times w_1 + R_2 \times w_2$

Class 3 $R = R_1 \times w_1 + R_2 \times w_2 + R_3 \times w_3$

Equation 8-15

For each pollutant, the carbon dioxide emission and the fuel consumption the weightings shown in table 8-1 shall be used.

Table 8-1: Weighting factors for the final emission and fuel consumption results

Vehicle class	Cycle	Weighting	
Class 1	Part 1, cold	w_1	50 per cent
	Part 1, hot	w_{1hot}	50 per cent
Class 2	Part 1, cold	w_1	30 per cent
	Part 2, hot	w_2	70 per cent
Class 3	Part 1, cold	w_1	25 per cent
	Part 2, hot	w_2	50 per cent
	Part 3, hot	w_3	25 per cent

8.2. Type II tests

The corrected concentration for carbon monoxide (C_{COcorr} in per cent vol.) is:

$$C_{COcorr} = 10 \times \frac{C_{CO}}{C_{CO} + C_{CO_2}}$$ Equation 8-16

for two stroke engines, and

$$C_{COcorr} = 15 \times \frac{C_{CO}}{C_{CO} + C_{CO_2}} \qquad \text{Equation 8-17}$$

for four stroke engines.

The concentration in C_{CO} measured according to paragraph 7.3.2. need not be corrected if the total of the concentrations measured ($C_{CO} + C_{CO_2}$) is at least 10 for two-stroke engines and 15 for four-stroke engines.

9. Records required

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

a) Test number,
b) System or device tested (brief description),
c) Date and time of day for each part of the test schedule,
d) Instrument operator,
e) Driver or operator,
f) Test 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 tyre pressure.
g) 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 Administration, provided the test cell records show the pertinent instrument information.
h) 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 Administration, provided test cell calibration records show the pertinent instrument information.
i) Recorder charts: Identify zero, span, exhaust gas, and dilution air sample traces.
j) 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 per cent of the barometric pressure at the central barometer location.
k) 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.
l) 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 (CFV) during each test phase would be the equivalent record for a CFV-CVS.
m) 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.

n) The driving distance for each part of the test, calculated from the measured roll or shaft revolutions.
o) The actual roller speed pattern of the test.
p) The gear use schedule of the test.
q) The emissions results of the Type I test for each part of the test (see Annex 11).
r) The second by second emission values of the Type I tests, if necessary.
s) The emissions results of the Type II test (see Annex 12).

Annex 1

SYMBOLS USED

Symbol	Definition	Unit
a	Coefficient of polygonal function	-
a_T	Rolling resistance force of front wheel	N
b	Coefficient of polygonal function	-
b_T	Coefficient of aerodynamic function	$N/(km/h)^2$
c	Coefficient of polygonal function	-
C_{CO}	Concentration of carbon monoxide	per cent vol.
$C_{CO\ corr}$	Corrected concentration of carbon monoxide	per cent vol.
$CO_{2\ c}$	Carbon dioxide concentration of diluted gas, corrected to take account of diluents air	per cent
$CO_{2\ d}$	Carbon dioxide concentration in the sample of diluents air corrected to in bag B	per cent
$CO_{2\ e}$	Carbon dioxide concentration in the sample of diluents air corrected to in bag A	per cent
$CO_{2\ m}$	Mass of carbon dioxide emitted during the test part	g/km
CO_c	Carbon monoxide concentration of diluted gas, corrected to take account of diluents air	ppm
CO_d	Carbon monoxide concentration in the sample of diluents air, corrected to in bag B	ppm
CO_e	Carbon monoxide concentration in the sample of diluents air, corrected to in bag A	ppm
CO_m	Mass of carbon dioxide emitted during the test part	g/km
d_0	Standard ambient relative air density	-
d_{CO}	Density of carbon monoxide	kg/m^3
d_{CO_2}	Density of carbon dioxide	kg/m^3
DF	Dilution factor	-
d_{HC}	Density of hydrocarbon	kg/m^3
dist	Distance driven in a cycle part	km
d_{NO_X}	Density of nitrogen oxide	kg/m^3
d_T	Relative air density under test condition	-
Δt	Coast down time	s
$\Delta t_{a\ i}$	Coast down time measured the first road test	s
$\Delta t_{b\ i}$	Coast down time measured the second road test	s
ΔTE	Corrected coast down time for the inertia mass (m_T+ m_{rf})	s
Δt_E	Mean coast down time on the chassis dynamometer at the reference speed	s
ΔT_i	Average coast down time at specified speed	s
Δt_i	Coast down time corresponding speed	s
ΔT_j	Average coast down time at specified speed	s

Symbol	Definition	Unit
ΔT_{road}	Target coast down time	s
$\overline{\Delta t}$	Mean coast down time on the chassis dynamometer without absorption	s
Δv	Coast down speed interval ($2\Delta v = v_1 - v_2$)	km/h
ε	Chassis dynamometer setting error	per cent
F	Running resistance force	N
F^*	Target running resistance force	N
$F^*(v_0)$	Target running resistance force at reference speed on chassis dynamometer	N
$F^*(v_i)$	Target running resistance force at specified speed on chassis dynamometer	N
f^*_0	Corrected rolling resistance in the standard ambient condition	N
f^*_2	Corrected coefficient of aerodynamic drag in the standard ambient condition	$N/(km/h)^2$
F^*_j	Target running resistance force at specified speed	N
f_0	Rolling resistance	N
f_2	Coefficient of aerodynamic drag	$N/(km/h)^2$
F_E	Set running resistance force on the chassis dynamometer	N
$F_E(v_0)$	Set running resistance force at the reference speed on the chassis dynamometer	N
$F_E(v_2)$	Set running resistance force at the specified speed on the chassis dynamometer	N
F_f	Total friction loss	N
$F_f(v_0)$	Total friction loss at the reference speed	N
F_j	Running resistance force	N
$F_j(v_0)$	Running resistance force at the reference speed	N
F_{pau}	Braking force of the power absorbing unit	N
$F_{pau}(v_0)$	Braking force of the power absorbing unit at the reference speed	N
$F_{pau}(v_j)$	Braking force of the power absorbing unit at the specified speed	N
F_T	Running resistance force obtained from the running resistance table	N
H	Absolute humidity	g/km
HC_c	Concentration of diluted gases expressed in the carbon equivalent, corrected to take account of diluents air	ppm
HC_d	Concentration of hydrocarbons expressed in the carbon equivalent, in the sample of diluents air corrected to in bag B	ppm
HC_e	Concentration of hydrocarbons expressed in the carbon equivalent, in the sample of diluents air corrected to in bag A	ppm
HC_m	Mass of hydrocarbon emitted during the test part	g/km
K_0	Temperature correction factor for rolling resistance	-
K_h	Humidity correction factor	-
L	Limit values of gaseous emission	g/km
m	Test motorcycle mass	kg
m_a	Actual mass of the test motorcycle	kg

Symbol	Definition	Unit
m_{fi}	Flywheel equivalent inertia mass	kg
m_i	Equivalent inertia mass	kg
m_k	Kerb mass of the vehicle (motorcycle)	kg
m_r	Equivalent inertia mass of all the wheel	kg
m_{ri}	Equivalent inertia mass of all the rear wheel and motorcycle parts rotating with wheel	kg
m_{ref}	Reference mass of the vehicle (motorcycle)	kg
m_{rf}	Rotating mass of the front wheel	kg
m_{rid}	Rider mass	kg
n	Engine speed	min^{-1}
n	Number of data regarding the emission or the test	-
N	Number of revolution made by pump P	-
ng	Number of foreward gears	-
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 in gear 1	min^{-1}
NOx_c	Nitrogen oxides concentration of diluted gases, corrected to take account of diluents air	ppm
NOx_d	Nitrogen oxides concentration in the sample of diluents air corrected to in bag B	ppm
NOx_e	Nitrogen oxides concentration in the sample of diluents air corrected to in bag A	ppm
NOx_m	Mass of nitrogen oxides emitted during the test part	g/km
P_0	Standard ambient pressure	kPa
P_a	Ambient/Atmospheric pressure	kPa
P_d	Saturated pressure of water at the test temperature	kPa
P_i	Average under-pressure during the test part in the section of pump P	kPa
P_n	Rated engine power	kW
P_T	Mean ambient pressure during the test	kPa
ρ_0	Standard relative ambient air volumetric mass	kg/m^3
r (i)	Gear ratio in the gear i	-
R	Final test result of pollutant emissions, carbon dioxide or fuel consumption	g/km, 1/100km
R_1	Test results of pollutant emissions, carbon dioxide emission or fuel consumption for cycle part 1 with cold start.	g/km, 1/100km
$R_{1\ hot}$	Test results of pollutant emissions, carbon dioxide emission or fuel consumption for cycle part 2 with hot condition.	g/km, 1/100km
R_2	Test results of pollutant emissions, carbon dioxide emission or fuel consumption for cycle part 3 with hot condition.	g/km, 1/100km
R_3	Test results of pollutant emissions, carbon dioxide emission or fuel consumption for cycle part 1 with hot condition.	g/km, 1/100km

Symbol	Definition	Unit
R_{i1}	First Type I test results of pollutant emissions	g/km
R_{i2}	Second Type I test results of pollutant emissions	g/km
R_{i3}	Third Type I test results of pollutant emissions	g/km
s	Rated engine speed	min^{-1}
T^C	Temperature of the coolant	°C
T^O	Temperature of the engine oil	°C
T^P	Temperature of the spark plug seat/gasket	°C
T_0	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	Mean ambient temperature during the test	K
U	humidity	per cent
v	Specified speed	
V	Total volume of diluted gas	m^3
v_{max}	Maximum speed of test vehicle (motorcycle)	km/h
v_0	Reference speed	km/h
V_0	Volume of gas displaced by pump P during one revolution	m^3/rev.
v_1	Speed at which the measurement of the coast down time begins	km/h
v_2	Speed at which the measurement of the coast down time ends	km/h
v_i	Specified speed which are selected for the coast down time measurement.	km/h
w_1	Weighting factor of cycle part 1 with cold start	-
$w_{1\ hot}$	Weighting factor of cycle part 1 with hot condition	-
w_2	Weighting factor of cycle part 2 with hot condition	-
w_3	Weighting factor of cycle part 3 with hot condition	-

Annex 2

A2.1. TECHNICAL DATA OF THE REFERENCE FUEL TO BE USED FOR TESTING VEHICLES EQUIPPED WITH POSITIVE IGNITION ENGINES (UNLEADED PETROL PROPERTIES)

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/m3	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.

A2.2. TECHNICAL DATA OF THE REFERENCE FUEL TO BE USED FOR TESTING VEHICLES EQUIPPED WITH DIESEL ENGINES (DIESEL FUEL PROPERTIES)

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 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.

Annex 3

CLASSIFICATION OF EQUIVALENT INERTIA MASS AND RUNNING RESISTANCE

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

CLASSIFICATION OF EQUIVALENT INERTIA MASS AND RUNNING RESISTANCE (CONTINUED)

Reference mass m_{ref} in kg	Equivalent inertia mass m_i in kg	Rolling resistance of front wheel a in N	Aero drag coefficient b in $N/(km/h)^2$
$355 < m_{ref} \leq 365$	360	31.7	0.0254
$365 < m_{ref} \leq 375$	370	32.6	0.0256
$375 < m_{ref} \leq 385$	380	33.4	0.0257
$385 < m_{ref} \leq 395$	390	34.3	0.0259
$395 < m_{ref} \leq 405$	400	35.2	0.0260
$405 < m_{ref} \leq 415$	410	36.1	0.0262
$415 < m_{ref} \leq 425$	420	37.0	0.0263
$425 < m_{ref} \leq 435$	430	37.8	0.0265
$435 < m_{ref} \leq 445$	440	38.7	0.0266
$445 < m_{ref} \leq 455$	450	39.6	0.0268
$455 < m_{ref} \leq 465$	460	40.5	0.0269
$465 < m_{ref} \leq 475$	470	41.4	0.0271
$475 < m_{ref} \leq 485$	480	42.2	0.0272
$485 < m_{ref} \leq 495$	490	43.1	0.0274
$495 < m_{ref} \leq 505$	500	44.0	0.0275
At every 10 kg	At every 10 kg	$a = 0.088 \times m_i$ */	$b = 0.000015 \times m_i + 0.02$ **/

*/ The value shall be rounded to one decimal place.
**/ The value shall be rounded to four decimal places.

Annex 4

ESSENTIAL CHARACTERISTICS OF THE ENGINE, THE REDUCTION SYSTEMS AND INFORMATION CONCERNING THE CONDUCT OF TESTS

1. General
1.1. Make: . . . .
1.2. Type (state any possible variants and versions: each variant and each version must be identified by a code consisting of numbers or a combination of letters and numbers): ……..
1.2.1. Commercial name (where applicable): . . . .
1.2.2. Vehicle category 1/): . . . .
1.3. Name and address of manufacturer: . . . .
1.3.1. Name(s) and address(es) of assembly plants: . . . .
1.4. Name and address of manufacturer's authorised representative, if any: . . . .

2. Masses (in kg) 2/)
2.1. Unladen mass 3/): . . . .
2.2. Mass of vehicle in running order 4/: . . . .
2.2.1. Distribution of that mass between the axles: . . . .
2.3. Mass of vehicle in running order, together with rider 5/: . . . .
2.3.1. Distribution of that mass between the axles: . . . .
2.4. Maximum technically permissible mass declared by the manufacturer 6/: . . . .

1/ Classification in accordance with paragraph 6.2.
2/ State tolerance(s)
3/ mass of vehicle ready for normal use and equipped as follows:
- additional equipment required solely for the normal use under consideration;
- complete electrical equipment, including the lighting and light-signalling devices supplied by the manufacturer;
- instruments and devices required by the laws under which the unladen mass of the vehicle has been measured;
- the appropriate amounts of liquids in order to ensure the proper operation of all parts of the vehicle;
- the fuel and the fuel/oil mixture are not included in the measurement, but components such as the battery acid, the hydraulic fluid, the coolant and the engine oil must be included.

4/ unladen mass to which the mass of the following components is added:
- fuel: tank filled to at least 90 per cent of the capacity stated by the manufacturer;
- additional equipment normally supplied by the manufacturer in addition to that needed for normal operation (tool kit, luggage carrier, windscreen, protective equipment, etc.);
- in the case of a vehicle operating with a fuel/oil mixture:
  (a) when the fuel and oil are pre-mixed the word "fuel" must be interpreted as meaning a pre-mixture of fuel and oil of this type;
  (b) when the fuel and oil are put in separately the word "fuel" must be interpreted as meaning only the petrol. In this case, the oil is already included in the measurement of the unladen mass.

5/ The mass of the rider is taken to be a round figure of 75 kg.

2.4.1. Division of that mass between the axles: . . . .
2.4.2. Maximum technically permissible mass on each of the axles: . . . .
3. Engine 7/
3.1. Manufacturer: . . . .
3.2. Make: . . . .
3.2.1. Type (stated on the engine, or other means of identification): . . . .
3.2.2. Location of engine number (if applicable): . . . .
3.3. Spark- or compression-ignition engine 8/
3.3.1. Specific characteristics of the engine
3.3.1.1. Operating cycle (four or two-stroke, spark or compression ignition) 8/
3.3.1.2. Number, arrangement and firing order of cylinders: . . . .
3.3.1.2.1. Bore: . . . . mm 9/
3.3.1.2.2. Stroke: . . . . mm 9/
3.3.1.3. Cylinder capacity: . . . . . . cm^3 10/
3.3.1.4. Compression ratio 2/: . . . .
3.3.1.5. Drawings of cylinder head, piston(s), piston rings and cylinder(s): . . . .
3.3.1.6. Idling speed 2/: . . . . min^{-1}
3.3.1.7. Maximum net power output: . . . . kW at . . . . min^{-1}
3.3.1.8. Net maximum torque: . . . . Nm at . . . . min^{-1}
3.3.2. Fuel: diesel/petrol/mixture/LPG/other 8/
3.3.3. Fuel supply
3.3.3.1. Via carburettor(s): yes/no 8/
3.3.3.1.1. Make(s): . . . .
3.3.3.1.2. Type(s): . . . .
3.3.3.1.3. Number fitted: . . . .
3.3.3.1.4. Settings 2/
i.e. of
3.3.3.1.4.1. Diffusers: . . . .
3.3.3.1.4.2. Level in float chamber: . . . .
3.3.3.1.4.3. Mass of float: . . . .
3.3.3.1.4.4. Float needle: . . . .
or
3.3.3.1.4.5. Fuel curve as a function of the airflow and setting required in order to maintain that curve: . . . .
3.3.3.1.5. Cold-starting system: manual/automatic 8/
3.3.3.1.5.1. Operating principle(s): . . . .
3.3.3.2. By fuel injection (solely in the case of compression ignition): yes/no 8/
3.3.3.2.1. Description of system: . . . .
3.3.3.2.2. Operating principle: direct/indirect/turbulence chamber injection 8/

6/ Mass calculated by the manufacturer for specific operating conditions, taking account of factors such as the strength of the materials, loading capacity of the tyres, etc.
7/ Where unconventional engines and systems are fitted, information equivalent to that referred under this heading must be supplied by their manufacturer.
8/ Delete where inappropriate.
9/ This figure should be to the nearest tenth of a millimetre.
10/ This value should be calculated with p = 3.1416 to the nearest cm^3

3.3.3.2.3. Injection pump

either:

3.3.3.2.3.1. Make(s): . . . .

3.3.3.2.3.2. Type(s): . . . .

or

3.3.3.2.3.3. Maximum fuel flow rate 2/ . . . . mm^3 /per stroke or cycle 8/ at a pump rotational speed of: . . . . min^{-1} or characteristic diagram: . . . .

3.3.3.2.3.4. Injection advance 2/:. . . . .

3.3.3.2.3.5. Injection advance curve 2/: . . . .

3.3.3.2.3.6. Calibration procedure: test bench/engine 8/

3.3.3.2.4. Regulator

3.3.3.2.4.1. Type: . . . .

3.3.3.2.4.2. Cut-off point

3.3.3.2.4.2.1. Cut-off point under load: . . . . min^{-1}

3.3.3.2.4.2.2. Cut-off point under no load: . . . . min^{-1}

3.3.3.2.4.3. Idling speed: . . . . min^{-1}

3.3.3.2.5. Injection pipework

3.3.3.2.5.1. Length: . . . . mm

3.3.3.2.5.2. Internal diameter: . . . . mm

3.3.3.2.6. Injector(s)

either

3.3.3.2.6.1. Make(s): . . . .

3.3.3.2.6.2. Type(s): . . . .

or

3.3.3.2.6.3. Opening pressure 2/: . . . . kPa or characteristic diagram 2/: . . . . . .

3.3.3.2.7. Cold starting system (if applicable)

either:

3.3.3.2.7.1. Make(s): . . . .

3.3.3.2.7.2. Type(s): . . . .

or

3.3.3.2.7.3. Description: . . . .

3.3.3.2.8. Secondary starting device (if applicable)

either:

3.3.3.2.8.1. Make(s): . . . .

3.3.3.2.8.2. Type(s): . . . .

or

3.3.3.2.8.3. Description of system: . . . .

3.3.3.3. By fuel injection (solely in the case of spark-ignition): yes/no 8/

either:

3.3.3.3.1. Description of system: . . . .

3.3.3.3.2. Operating principle: injection into induction manifold (single/multiple point) 8/ /direct injection/other
(state which): . . . .

or

3.3.3.3.2.1. Make(s) of the injection pump: . . . .

3.3.3.3.2.2. Type(s) of the injection pump: . . . .

3.3.3.3.3. Injectors: opening pressure 2/: . . . . kPa

or characteristic diagram 2/: . . . .
3.3.3.3.4. Injection advance: . . . .
3.3.3.3.5. Cold-starting system
3.3.3.3.5.1. Operating principle(s): . . . .
3.3.3.3.5.2. Operating/setting limits 8/, 2/: . . . .
3.3.3.4. Fuel pump: yes/no 8/
3.3.4. Ignition
3.3.4.1. Make(s): . . . .
3.3.4.2. Type(s): . . . .
3.3.4.3. Operating principle: . . . .
3.3.4.4. Ignition advance curve or operating set point 2/: . . . .
3.3.4.5. Static timing 2/: . . . . before TDC
3.3.4.6. Points gap 2/: . . . . mm
3.3.4.7. Dwell angle 2/: . . . . degrees
3.3.5. Cooling system (liquid/air) 8/
3.3.5.1. Nominal setting for the engine-temperature control device: . . . .
3.3.5.2. Liquid
3.3.5.2.1. Nature of liquid: . . . .
3.3.5.2.2. Circulating pump(s): yes/no 8/
3.3.5.3. Air
3.3.5.3.1. Blower: yes/no 8/
3.3.6. Induction system
3.3.6.1. Supercharging: yes/no 8/
3.3.6.1.1. Make(s): . . . .
3.3.6.1.2. Type(s): . . . .
3.3.6.1.3. Description of system (example: maximum boost pressure . . . . kPa, waste gate (where appropriate))
3.3.6.2. Intercooler: with/without 8/
3.3.6.3. Description and drawings of induction pipework and accessories (plenum chamber, heating device, additional air intakes, etc.): . . . .
3.3.6.3.1. Description of induction manifold (with drawings and/or photos): . . . .
3.3.6.3.2. Air filter, drawings: . . . .
or
3.3.6.3.2.1. Make(s): . . . .
3.3.6.3.2.2. Type(s): . . . .
3.3.6.3.3. Inlet silencer, drawings: . . . .
or
3.3.6.3.3.1. Make(s): . . . .
3.3.6.3.3.2. Type(s): . . . .
3.3.7. Exhaust system
3.3.7.1. Drawing of complete exhaust system: . . . .
3.3.8. Minimum cross-section of the inlet and exhaust ports: . . . .
3.3.9. Induction system or equivalent data
3.3.9.1. Maximum valve lift, opening and closing angles in relation to the dead centres, or data concerning the settings of other possible systems: . . . .
3.3.9.2. Reference and/or setting ranges 8/: . . . .
3.3.10. Anti-air pollution measures adopted

3.3.10.1. Crankcase-gas recycling device, solely in the case of four-stroke engines (description and drawings):

3.3.10.2. Additional anti-pollution devices (where present and not included under another heading):

3.3.10.2.1. Description and/or drawings: . . . .

3.3.11. Location of the coefficient of absorption symbol (compression-ignition engines only): . . . .

3.4. Cooling system temperatures permitted by the manufacturer

3.4.1. Liquid cooling

3.4.1.1. Maximum temperature at outlet: . . . . °C

3.4.2. Air cooling

3.4.2.1. Reference point: . . . .

3.4.2.2. Maximum temperature at reference point: . . . . °C

3.5. Lubrication system

3.5.1. Description of system: . . . .

3.5.1.1. Location of oil reservoir (if any): . . . .

3.5.1.2. Feed system (pump/injection into induction system/mixed with the fuel, etc.) 8/: . . . .

3.5.2. Lubricant mixed with the fuel

3.5.2.1. Percentage: . . . .

3.5.3. Oil cooler: yes/no 8/

3.5.3.1. Drawing(s): . . . .

or

3.5.3.1.1. Make(s): . . . .

3.5.3.1.2. Type(s): . . . .

4. Transmission 11/

4.1. Diagram of transmission system: . . . .

4.2. Type (mechanical, hydraulic, electrical, etc.): . . . .

4.3. Clutch (type): . . . .

4.4. Gearbox

4.4.1. Type: automatic/manual 8/

4.4.2. Method of selection: by hand/foot 8/

11/ The information requested should be supplied for a possible variant.

4.5. Gear ratios

Number of gear	Ratio 1	Ratio 2	Ratio 3	Ratio t
Minimum continuously variable transmission				
1				
2				
3				
4				
5				
6				
Maximum continuously variable transmission				
Reverse gear				

Ratio 1 = primary ratio (ratio of engine speed to rotational speed of primary gearbox shaft).
Ratio 2 = secondary ratio (ratio of rotational speed of primary shaft to rotational speed of secondary shaft in gearbox).
Ratio 3 = final drive ratio (ratio of rotational speed of gearbox output shaft to rotational speed of driven wheels).
Ratio t = overall ratio.

4.5.1. Brief description of the electrical and/or electronic components used in the transmission: . . . .

4.6. Maximum speed of vehicle and gear in which it is reached (in km/h) 12/: . . . .

12/ A tolerance of 5 per cent is permitted

Annex 5

DRIVING CYCLES FOR TYPE I TESTS

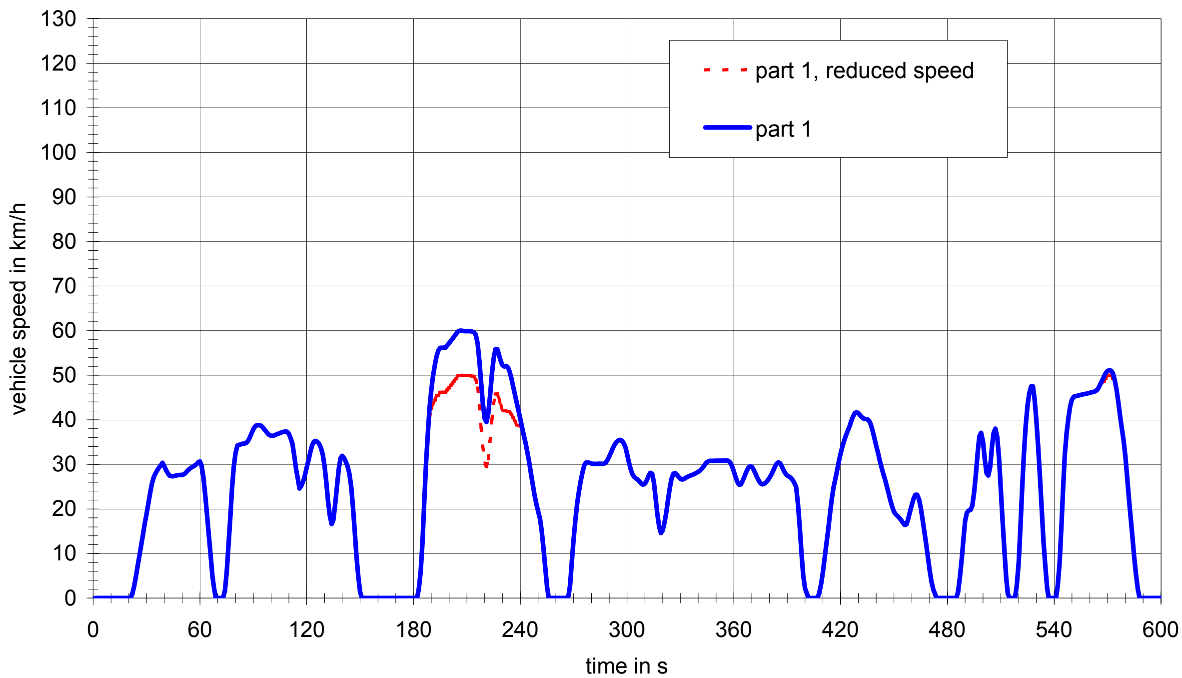


Figure A5-1: Cycle part 1

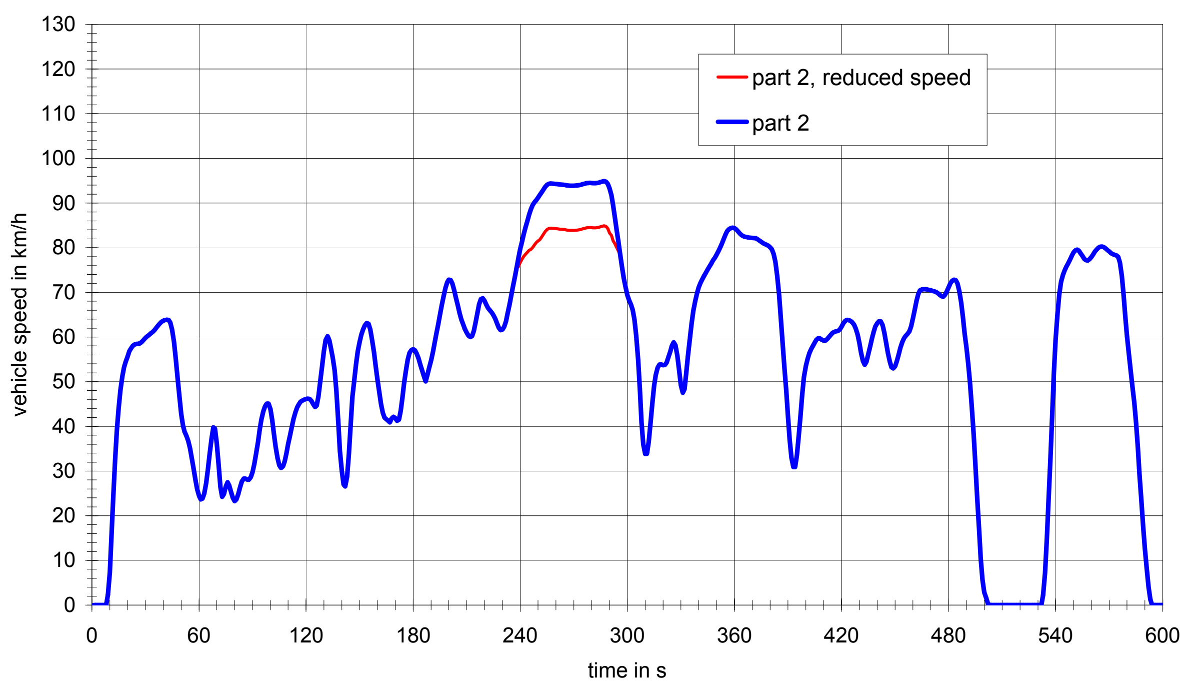


Figure A5-2: Cycle part 2 for vehicle classes 2 and 3

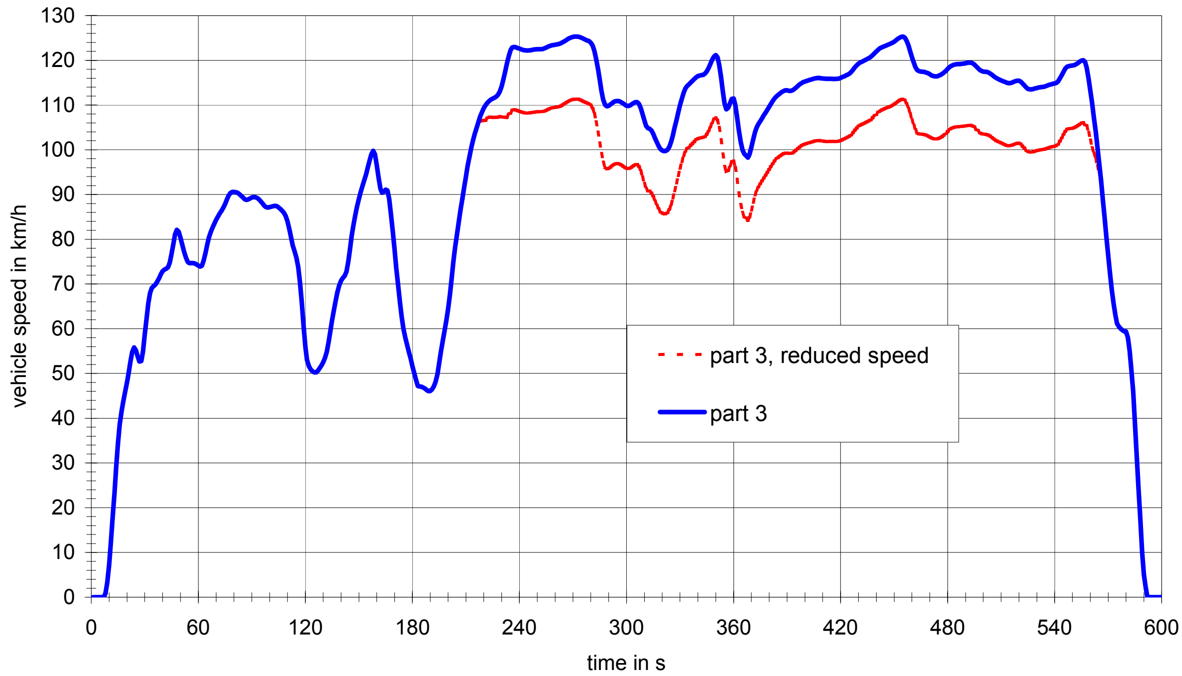


Figure A5-3: Cycle part 3 for vehicle class 3

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	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 A5-1: Cycle part 1, 1 to 120 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	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 A5-2: Cycle part 1, 121 to 240 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	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 A5-3: Cycle part 1, 241 to 360 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	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 A5-4: Cycle part 1, 361 to 480 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	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	48.4			x			
508	36.1	36.1				x			568	49.8	48.6			x			
509	31.5	31.5				x			569	50.5	49.4			x			
510	24.5	24.5				x			570	51.0	49.8			x			
511	17.5	17.5				x			571	51.1	50.0			x			
512	10.5	10.5				x			572	51.0	49.9				x		
513	4.5	4.5				x			573	50.4	49.3				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 A5-5: Cycle part 1, 481 to 600 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
1	0.0	0.0	x						61	23.7	23.7		x				x
2	0.0	0.0	x						62	23.8	23.8		x				x
3	0.0	0.0	x						63	25.0	25.0		x				x
4	0.0	0.0	x						64	27.3	27.3		x				x
5	0.0	0.0	x						65	30.4	30.4		x				x
6	0.0	0.0	x						66	33.9	33.9		x				x
7	0.0	0.0	x						67	37.3	37.3		x				x
8	0.0	0.0	x						68	39.8	39.8		x				x
9	2.3	2.3	x						69	39.5	39.5				x		
10	7.3	7.3		x					70	36.3	36.3				x		
11	15.2	15.2		x					71	31.4	31.4				x		
12	23.9	23.9		x					72	26.5	26.5				x		
13	32.5	32.5		x					73	24.2	24.2		x				x
14	39.2	39.2		x					74	24.8	24.8		x				x
15	44.1	44.1		x					75	26.6	26.6		x				x
16	48.1	48.1		x					76	27.5	27.5				x		x
17	51.2	51.2		x					77	26.8	26.8				x		x
18	53.3	53.3		x					78	25.3	25.3				x		x
19	54.5	54.5		x					79	24.0	24.0		x				x
20	55.7	55.7			x				80	23.3	23.3		x				x
21	56.8	56.8			x				81	23.7	23.7		x				x
22	57.5	57.5			x				82	24.9	24.9		x				x
23	58.0	58.0			x				83	26.4	26.4		x				x
24	58.4	58.4			x				84	27.7	27.7		x				x
25	58.5	58.5			x				85	28.3	28.3		x				x
26	58.5	58.5			x				86	28.3	28.3		x				x
27	58.6	58.6			x		x		87	28.1	28.1		x				x
28	58.9	58.9			x		x		88	28.1	28.1		x				x
29	59.3	59.3			x		x		89	28.6	28.6		x				x
30	59.8	59.8			x		x		90	29.8	29.8		x				x
31	60.2	60.2			x		x		91	31.6	31.6		x				x
32	60.5	60.5			x		x		92	33.9	33.9		x				x
33	60.8	60.8			x		x		93	36.5	36.5		x				
34	61.1	61.1			x		x		94	39.1	39.1		x				
35	61.5	61.5			x		x		95	41.5	41.5		x				
36	62.0	62.0			x		x		96	43.3	43.3		x				
37	62.5	62.5			x		x		97	44.5	44.5		x				
38	63.0	63.0			x		x		98	45.1	45.1		x				
39	63.4	63.4			x		x		99	45.1	45.1				x		
40	63.7	63.7			x		x		100	43.9	43.9				x		
41	63.8	63.8			x		x		101	41.4	41.4				x		
42	63.9	63.9			x		x		102	38.4	38.4				x		
43	63.8	63.8			x		x		103	35.5	35.5				x		
44	63.2	63.2				x	x		104	32.9	32.9				x		
45	61.7	61.7				x	x		105	31.3	31.3				x		
46	58.9	58.9				x	x		106	30.7	30.7		x				x
47	55.2	55.2				x			107	31.0	31.0		x				x
48	51.0	51.0				x			108	32.2	32.2		x				x
49	46.7	46.7				x			109	34.0	34.0		x				x
50	42.8	42.8				x			110	36.0	36.0		x				
51	40.2	40.2				x			111	37.9	37.9		x				
52	38.8	38.8				x			112	39.8	39.8		x				
53	37.9	37.9				x			113	41.6	41.6		x				
54	36.7	36.7				x			114	43.1	43.1		x				
55	35.1	35.1				x			115	44.3	44.3		x				
56	32.9	32.9				x			116	45.0	45.0		x				
57	30.4	30.4				x			117	45.5	45.5		x				
58	28.0	28.0				x			118	45.8	45.8		x			x	
59	25.9	25.9				x			119	46.0	46.0		x			x	
60	24.4	24.4		x				x	120	46.1	46.1		x			x	

Table A5-6: Cycle part 2 for vehicle classes 2 and 3, 1 to 120 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
121	46.2	46.2		x			x		181	57.0	57.0				x		
122	46.1	46.1		x			x		182	56.3	56.3				x		
123	45.7	45.7		x			x		183	55.2	55.2				x		
124	45.0	45.0		x					184	53.9	53.9				x		
125	44.3	44.3		x					185	52.6	52.6				x		
126	44.7	44.7		x					186	51.3	51.3		x				
127	46.8	46.8		x					187	50.1	50.1		x				
128	50.1	50.1		x					188	51.5	51.5		x				
129	53.6	53.6		x					189	53.1	53.1		x				
130	56.9	56.9		x					190	54.8	54.8		x				
131	59.4	59.4		x					191	56.6	56.6		x				
132	60.2	60.2				x			192	58.5	58.5		x				
133	59.3	59.3				x			193	60.6	60.6		x				
134	57.5	57.5				x			194	62.8	62.8		x				
135	55.4	55.4				x			195	64.9	64.9		x				
136	52.5	52.5				x			196	67.0	67.0		x				
137	47.9	47.9				x			197	69.1	69.1		x				
138	41.4	41.4				x			198	70.9	70.9		x				
139	34.4	34.4				x			199	72.2	72.2		x				
140	30.0	30.0		x				x	200	72.8	72.8				x		
141	27.0	27.0		x				x	201	72.8	72.8				x		
142	26.5	26.5		x				x	202	71.9	71.9				x		
143	28.7	28.7		x				x	203	70.5	70.5				x		
144	33.8	33.8		x					204	68.8	68.8				x		
145	40.3	40.3		x					205	67.1	67.1				x		
146	46.6	46.6		x					206	65.4	65.4				x		
147	50.4	50.4		x					207	63.9	63.9				x		
148	53.9	53.9		x					208	62.7	62.7				x		
149	56.9	56.9		x					209	61.8	61.8				x		
150	59.1	59.1		x					210	61.0	61.0				x		
151	60.6	60.6		x					211	60.4	60.4				x	x	
152	61.7	61.7		x					212	60.0	60.0				x	x	
153	62.6	62.6		x					213	60.2	60.2		x			x	
154	63.1	63.1				x			214	61.4	61.4		x			x	
155	62.9	62.9				x			215	63.3	63.3		x			x	
156	61.6	61.6				x			216	65.5	65.5		x			x	
157	59.4	59.4				x			217	67.4	67.4		x			x	
158	56.6	56.6				x			218	68.5	68.5		x			x	
159	53.7	53.7				x			219	68.7	68.7				x	x	
160	50.7	50.7				x			220	68.1	68.1				x	x	
161	47.7	47.7				x			221	67.2	67.2				x	x	
162	45.0	45.0				x			222	66.5	66.5				x	x	
163	43.0	43.0				x			223	65.9	65.9				x	x	
164	41.9	41.9				x			224	65.5	65.5				x	x	
165	41.6	41.6				x			225	64.9	64.9				x	x	
166	41.3	41.3		x					226	64.1	64.1				x	x	
167	40.9	40.9		x					227	63.0	63.0				x	x	
168	41.8	41.8		x					228	62.1	62.1				x	x	
169	42.1	42.1		x					229	61.6	61.6		x			x	
170	41.8	41.8		x					230	61.7	61.7		x			x	
171	41.3	41.3		x					231	62.3	62.3		x			x	
172	41.5	41.5		x					232	63.5	63.5		x			x	
173	43.5	43.5		x					233	65.3	65.3		x			x	
174	46.5	46.5		x					234	67.3	67.3		x			x	
175	49.7	49.7		x					235	69.3	69.3		x			x	
176	52.6	52.6		x					236	71.4	71.4		x			x	
177	55.0	55.0		x					237	73.5	73.5		x				
178	56.5	56.5		x					238	75.6	75.6		x				
179	57.1	57.1		x					239	77.7	75.7		x				
180	57.3	57.3				x			240	79.7	76.7		x				

Table A5-7: Cycle part 2 for vehicle classes 2 and 3, 121 to 240 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
241	81.5	77.5		x					301	68.3	68.3				x		
242	83.0	78.0		x					302	67.3	67.3				x		
243	84.5	78.5		x					303	66.1	66.1				x		
244	86.0	79.0		x					304	63.9	63.9				x		
245	87.4	79.4		x					305	60.2	60.2				x		
246	88.7	79.7		x					306	54.9	54.9				x		
247	89.6	80.1		x					307	48.1	48.1				x		
248	90.2	80.7		x					308	40.9	40.9				x		
249	90.7	81.2		x					309	36.0	36.0				x		
250	91.2	81.5		x					310	33.9	33.9				x		
251	91.8	81.8		x					311	33.9	33.9		x				
252	92.4	82.4		x					312	36.5	36.5		x				
253	93.0	83.0		x					313	41.0	41.0		x				
254	93.6	83.6		x					314	45.3	45.3		x				
255	94.1	84.1			x				315	49.2	49.2		x				
256	94.3	84.3			x				316	51.5	51.5		x				
257	94.4	84.4			x				317	53.2	53.2		x				
258	94.4	84.4			x				318	53.9	53.9		x				
259	94.3	84.3			x				319	53.9	53.9		x				
260	94.3	84.3			x				320	53.7	53.7		x				
261	94.2	84.2			x				321	53.7	53.7		x				
262	94.2	84.2			x		x		322	54.3	54.3		x				
263	94.2	84.2			x		x		323	55.4	55.4		x				
264	94.1	84.1			x		x		324	56.8	56.8		x				
265	94.0	84.0			x		x		325	58.1	58.1		x				
266	94.0	84.0			x		x		326	58.8	58.8				x		
267	93.9	83.9			x		x		327	58.2	58.2				x		
268	93.9	83.9			x		x		328	55.8	55.8				x		
269	93.9	83.9			x		x		329	52.6	52.6				x		
270	93.9	83.9			x		x		330	49.2	49.2				x		
271	93.9	83.9			x		x		331	47.6	47.6		x				
272	94.0	84.0			x		x		332	48.4	48.4		x				
273	94.0	84.0			x		x		333	51.8	51.8		x				
274	94.1	84.1			x		x		334	55.7	55.7		x				
275	94.2	84.2			x				335	59.6	59.6		x				
276	94.3	84.3			x				336	63.0	63.0		x				
277	94.4	84.4			x				337	65.9	65.9		x				
278	94.5	84.5			x				338	68.1	68.1		x				
279	94.5	84.5			x				339	69.8	69.8		x				
280	94.5	84.5			x				340	71.1	71.1		x				
281	94.5	84.5			x				341	72.1	72.1		x				
282	94.4	84.4			x				342	72.9	72.9		x				
283	94.5	84.5			x				343	73.7	73.7		x				
284	94.6	84.6			x				344	74.4	74.4		x				
285	94.7	84.7			x				345	75.1	75.1		x				
286	94.8	84.8			x				346	75.8	75.8		x				
287	94.9	84.9			x				347	76.5	76.5		x				
288	94.8	84.8			x				348	77.2	77.2		x				
289	94.3	84.3				x			349	77.8	77.8		x				
290	93.3	83.3				x			350	78.5	78.5		x				
291	91.7	82.7				x			351	79.2	79.2		x				
292	89.6	81.6				x			352	80.0	80.0		x				
293	87.0	81.0				x			353	81.0	81.0		x				
294	84.1	80.1				x			354	82.0	82.0		x				
295	81.2	79.2				x			355	82.9	82.9		x				
296	78.4	78.4				x			356	83.7	83.7		x				
297	75.7	75.7				x			357	84.2	84.2			x			
298	73.2	73.2				x			358	84.4	84.4			x			
299	71.1	71.1				x			359	84.5	84.5			x			
300	69.5	69.5				x			360	84.4	84.4			x			

Table A5-8: Cycle part 2 for vehicle classes 2 and 3, 241 to 360 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
361	84.1	84.1			x				421	63.0	63.0			x		x	
362	83.7	83.7			x				422	63.6	63.6			x		x	
363	83.2	83.2			x				423	63.9	63.9			x		x	
364	82.8	82.8			x				424	63.8	63.8			x		x	
365	82.6	82.6			x				425	63.6	63.6			x		x	
366	82.5	82.5			x				426	63.3	63.3				x	x	
367	82.4	82.4			x				427	62.8	62.8				x	x	
368	82.3	82.3			x				428	61.9	61.9				x	x	
369	82.2	82.2			x				429	60.5	60.5				x	x	
370	82.2	82.2			x				430	58.6	58.6				x	x	
371	82.2	82.2			x				431	56.5	56.5				x	x	
372	82.1	82.1			x				432	54.6	54.6				x	x	
373	81.9	81.9			x				433	53.8	53.8		x			x	
374	81.6	81.6			x				434	54.5	54.5		x			x	
375	81.3	81.3			x				435	56.1	56.1		x			x	
376	81.1	81.1			x				436	57.9	57.9		x			x	
377	80.8	80.8			x				437	59.6	59.6		x			x	
378	80.6	80.6			x				438	61.2	61.2		x			x	
379	80.4	80.4			x				439	62.3	62.3		x			x	
380	80.1	80.1			x				440	63.1	63.1		x			x	
381	79.7	79.7			x				441	63.6	63.6				x	x	
382	78.6	78.6			x				442	63.5	63.5				x	x	
383	76.8	76.8			x				443	62.7	62.7				x	x	
384	73.7	73.7				x			444	60.9	60.9				x	x	
385	69.4	69.4				x			445	58.7	58.7				x	x	
386	64.0	64.0				x			446	56.4	56.4				x	x	
387	58.6	58.6				x			447	54.5	54.5				x	x	
388	53.2	53.2				x			448	53.3	53.3		x			x	
389	47.8	47.8				x			449	53.0	53.0		x			x	
390	42.4	42.4				x			450	53.5	53.5		x			x	
391	37.0	37.0				x			451	54.6	54.6		x			x	
392	33.0	33.0		x					452	56.1	56.1		x			x	
393	30.9	30.9		x					453	57.6	57.6		x			x	
394	30.9	30.9		x					454	58.9	58.9		x			x	
395	33.5	33.5		x					455	59.8	59.8		x			x	
396	38.0	38.0		x					456	60.3	60.3		x			x	
397	42.5	42.5		x					457	60.7	60.7		x			x	
398	47.0	47.0		x					458	61.3	61.3		x			x	
399	51.0	51.0		x					459	62.3	62.3		x			x	
400	53.5	53.5		x					460	64.1	64.1		x			x	
401	55.1	55.1		x					461	66.2	66.2		x			x	
402	56.4	56.4		x					462	68.1	68.1		x			x	
403	57.3	57.3		x					463	69.7	69.7		x			x	
404	58.1	58.1		x					464	70.4	70.4		x			x	
405	58.8	58.8		x					465	70.7	70.7		x			x	
406	59.4	59.4		x					466	70.7	70.7			x			
407	59.8	59.8			x				467	70.7	70.7			x			
408	59.7	59.7			x				468	70.7	70.7			x			
409	59.4	59.4			x				469	70.6	70.6			x			
410	59.2	59.2			x				470	70.5	70.5			x			
411	59.2	59.2			x				471	70.3	70.3			x			
412	59.5	59.5			x				472	70.2	70.2			x			
413	60.0	60.0			x				473	70.1	70.1			x			
414	60.5	60.5			x				474	69.8	69.8			x			
415	61.0	61.0			x				475	69.5	69.5			x			
416	61.2	61.2			x				476	69.1	69.1			x			
417	61.3	61.3			x				477	69.1	69.1			x			
418	61.4	61.4			x				478	69.5	69.5			x			
419	61.7	61.7			x				479	70.3	70.3			x		x	
420	62.3	62.3			x				480	71.2	71.2			x		x	

Table A5-9: Cycle part 2 for vehicle classes 2 and 3, 361 to 480 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
481	72.0	72.0			x		x		541	65.3	65.3		x				
482	72.6	72.6			x		x		542	69.6	69.6		x				
483	72.8	72.8			x		x		543	72.3	72.3		x				
484	72.7	72.7			x		x		544	73.9	73.9		x				
485	72.0	72.0				x	x		545	75.0	75.0		x				
486	70.3	70.3				x			546	75.7	75.7		x				
487	67.7	67.7				x			547	76.5	76.5		x				
488	64.4	64.4				x			548	77.3	77.3		x				
489	61.0	61.0				x			549	78.2	78.2		x				
490	57.6	57.6				x			550	78.9	78.9		x				
491	54.0	54.0				x			551	79.4	79.4		x				
492	49.7	49.7				x			552	79.6	79.6			x			
493	44.4	44.4				x			553	79.3	79.3			x			
494	38.2	38.2				x			554	78.8	78.8			x			
495	31.2	31.2				x			555	78.1	78.1			x			
496	24.0	24.0				x			556	77.5	77.5			x			
497	16.8	16.8				x			557	77.2	77.2			x			
498	10.4	10.4				x			558	77.2	77.2			x			
499	5.7	5.7				x			559	77.5	77.5			x			
500	2.8	2.8	x						560	77.9	77.9			x			
501	1.6	1.6	x						561	78.5	78.5			x			
502	0.3	0.3	x						562	79.1	79.1			x			
503	0.0	0.0	x						563	79.6	79.6			x			
504	0.0	0.0	x						564	80.0	80.0			x			
505	0.0	0.0	x						565	80.2	80.2			x			
506	0.0	0.0	x						566	80.3	80.3			x			
507	0.0	0.0	x						567	80.1	80.1			x			
508	0.0	0.0	x						568	79.8	79.8			x			
509	0.0	0.0	x						569	79.5	79.5			x			
510	0.0	0.0	x						570	79.1	79.1			x			
511	0.0	0.0	x						571	78.8	78.8			x			
512	0.0	0.0	x						572	78.6	78.6			x			
513	0.0	0.0	x						573	78.4	78.4			x			
514	0.0	0.0	x						574	78.3	78.3			x			
515	0.0	0.0	x						575	78.0	78.0				x		
516	0.0	0.0	x						576	76.7	76.7				x		
517	0.0	0.0	x						577	73.7	73.7				x		
518	0.0	0.0	x						578	69.5	69.5				x		
519	0.0	0.0	x						579	64.8	64.8				x		
520	0.0	0.0	x						580	60.3	60.3				x		
521	0.0	0.0	x						581	56.2	56.2				x		
522	0.0	0.0	x						582	52.5	52.5				x		
523	0.0	0.0	x						583	49.0	49.0				x		
524	0.0	0.0	x						584	45.2	45.2				x		
525	0.0	0.0	x						585	40.8	40.8				x		
526	0.0	0.0	x						586	35.4	35.4				x		
527	0.0	0.0	x						587	29.4	29.4				x		
528	0.0	0.0	x						588	23.4	23.4				x		
529	0.0	0.0	x						589	17.7	17.7				x		
530	0.0	0.0	x						590	12.6	12.6				x		
531	0.0	0.0	x						591	8.0	8.0				x		
532	0.0	0.0	x						592	4.1	4.1				x		
533	2.3	2.3	x						593	1.3	1.3	x					
534	7.2	7.2		x					594	0.0	0.0	x					
535	14.6	14.6		x					595	0.0	0.0	x					
536	23.5	23.5		x					596	0.0	0.0	x					
537	33.0	33.0		x					597	0.0	0.0	x					
538	42.7	42.7		x					598	0.0	0.0	x					
539	51.8	51.8		x					599	0.0	0.0	x					
540	59.4	59.4		x					600	0.0	0.0	x					

Table A5-10: Cycle part 2 for vehicle classes 2 and 3, 481 to 600 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
1	0.0	0.0	x						61	73.9	73.9		x			x	
2	0.0	0.0	x						62	74.1	74.1		x			x	
3	0.0	0.0	x						63	75.1	75.1		x			x	
4	0.0	0.0	x						64	76.8	76.8		x			x	
5	0.0	0.0	x						65	78.7	78.7		x			x	
6	0.0	0.0	x						66	80.4	80.4		x			x	
7	0.0	0.0	x						67	81.7	81.7		x			x	
8	0.9	0.9	x						68	82.6	82.6		x				
9	3.2	3.2		x					69	83.5	83.5		x				
10	7.3	7.3		x					70	84.4	84.4		x				
11	12.4	12.4		x					71	85.1	85.1		x				
12	17.9	17.9		x					72	85.7	85.7		x				
13	23.5	23.5		x					73	86.3	86.3		x				
14	29.1	29.1		x					74	87.0	87.0		x				
15	34.3	34.3		x					75	87.9	87.9		x				
16	38.6	38.6		x					76	88.8	88.8		x				
17	41.6	41.6		x					77	89.7	89.7		x				
18	43.9	43.9		x					78	90.3	90.3			x			
19	45.9	45.9		x					79	90.6	90.6			x			
20	48.1	48.1		x					80	90.6	90.6			x			
21	50.3	50.3		x					81	90.5	90.5			x			
22	52.6	52.6		x					82	90.4	90.4			x			
23	54.8	54.8		x					83	90.1	90.1			x			
24	55.8	55.8		x					84	89.7	89.7			x			
25	55.2	55.2		x					85	89.3	89.3			x			
26	53.8	53.8		x					86	88.9	88.9			x			
27	52.7	52.7		x					87	88.8	88.8			x			
28	52.8	52.8		x					88	88.9	88.9			x			
29	55.0	55.0		x					89	89.1	89.1			x			
30	58.5	58.5		x					90	89.3	89.3			x			
31	62.3	62.3		x					91	89.4	89.4			x			
32	65.7	65.7		x					92	89.4	89.4			x			
33	68.0	68.0		x					93	89.2	89.2			x			
34	69.1	69.1		x					94	88.9	88.9			x			
35	69.5	69.5		x					95	88.5	88.5			x			
36	69.9	69.9		x					96	88.0	88.0			x		x	
37	70.6	70.6		x					97	87.5	87.5			x		x	
38	71.3	71.3		x					98	87.2	87.2			x		x	
39	72.2	72.2		x					99	87.1	87.1			x		x	
40	72.8	72.8		x					100	87.2	87.2			x		x	
41	73.2	73.2		x					101	87.3	87.3			x		x	
42	73.4	73.4		x					102	87.4	87.4			x		x	
43	73.8	73.8		x					103	87.5	87.5			x		x	
44	74.8	74.8		x					104	87.4	87.4			x		x	
45	76.7	76.7		x					105	87.1	87.1			x			
46	79.1	79.1		x					106	86.8	86.8			x			
47	81.1	81.1		x					107	86.4	86.4			x			
48	82.1	82.1				x			108	85.9	85.9			x			
49	81.7	81.7				x	x		109	85.2	85.2			x			
50	80.3	80.3				x	x		110	84.0	84.0				x		
51	78.8	78.8				x	x		111	82.2	82.2				x		
52	77.3	77.3				x	x		112	80.3	80.3				x		
53	75.9	75.9				x	x		113	78.6	78.6				x		
54	75.0	75.0				x	x		114	77.2	77.2				x		
55	74.7	74.7				x	x		115	75.9	75.9				x		
56	74.6	74.6				x	x		116	73.8	73.8				x		
57	74.7	74.7				x	x		117	70.4	70.4				x		
58	74.6	74.6				x	x		118	65.7	65.7				x		
59	74.4	74.4				x	x		119	60.5	60.5				x		
60	74.1	74.1		x			x		120	55.9	55.9				x		

Table A5-11: Cycle part 3 for vehicle class 3, 1 to 120 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
121	53.0	53.0				x			181	50.2	50.2				x		
122	51.6	51.6				x			182	48.7	48.7				x		
123	50.9	50.9				x			183	47.2	47.2				x		
124	50.5	50.5				x			184	47.1	47.1				x		
125	50.2	50.2		x					185	47.0	47.0				x		
126	50.2	50.2		x					186	46.9	46.9				x		
127	50.6	50.6		x					187	46.6	46.6				x		
128	51.2	51.2		x					188	46.3	46.3		x				
129	51.8	51.8		x					189	46.1	46.1		x				
130	52.5	52.5		x					190	46.1	46.1		x				
131	53.4	53.4		x					191	46.4	46.4		x				
132	54.9	54.9		x					192	47.1	47.1		x				
133	57.0	57.0		x					193	48.1	48.1		x				
134	59.4	59.4		x					194	49.8	49.8		x				
135	61.9	61.9		x					195	52.2	52.2		x				
136	64.3	64.3		x					196	54.8	54.8		x				
137	66.4	66.4		x					197	57.3	57.3		x				
138	68.1	68.1		x					198	59.5	59.5		x				
139	69.6	69.6		x					199	61.7	61.7		x				
140	70.7	70.7		x					200	64.3	64.3		x				
141	71.4	71.4		x					201	67.7	67.7		x				
142	71.8	71.8		x					202	71.4	71.4		x				
143	72.8	72.8		x					203	74.9	74.9		x				
144	75.0	75.0		x					204	78.2	78.2		x				
145	77.8	77.8		x					205	81.1	81.1		x				
146	80.7	80.7		x					206	83.9	83.9		x				
147	83.3	83.3		x					207	86.5	86.5		x				
148	85.4	85.4		x					208	89.1	89.1		x				
149	87.3	87.3		x					209	91.6	91.6		x				
150	89.1	89.1		x					210	94.0	94.0		x				
151	90.6	90.6		x					211	96.3	96.3		x				
152	91.9	91.9		x					212	98.4	98.4		x				
153	93.2	93.2		x					213	100.4	100.4		x				
154	94.5	94.5		x					214	102.1	102.1		x				
155	96.0	96.0		x					215	103.6	103.6		x				
156	97.5	97.5		x					216	104.9	104.9		x				
157	98.9	98.9		x					217	106.2	106.2		x				
158	99.8	99.8		x					218	107.4	106.4		x				
159	99.0	99.0				x			219	108.5	106.5		x				
160	96.6	96.6				x			220	109.3	106.6		x				
161	93.7	93.7				x			221	109.9	106.6		x				
162	91.3	91.3				x			222	110.5	107.0		x				
163	90.4	90.4				x			223	110.9	107.3		x				
164	90.6	90.6				x			224	111.2	107.3		x				
165	91.1	91.1				x			225	111.4	107.2		x				
166	90.9	90.9				x			226	111.7	107.2		x				
167	89.0	89.0				x			227	111.9	107.2		x				
168	85.6	85.6				x			228	112.3	107.3		x				
169	81.6	81.6				x			229	113.0	107.5		x				
170	77.6	77.6				x			230	114.1	107.3		x				
171	73.6	73.6				x			231	115.7	107.3		x				
172	69.7	69.7				x			232	117.5	107.3		x				
173	66.0	66.0				x			233	119.3	107.3		x				
174	62.7	62.7				x			234	121.0	108.0		x				
175	60.0	60.0				x			235	122.2	108.2		x				
176	58.0	58.0				x			236	122.9	108.9			x			
177	56.4	56.4				x			237	123.0	109.0			x			
178	54.8	54.8				x			238	122.9	108.9			x			
179	53.2	53.2				x			239	122.7	108.7			x			
180	51.7	51.7				x			240	122.6	108.6			x			

Table A5-12: Cycle part 3 for vehicle class 3, 121 to 240 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
241	122.4	108.4			x				301	109.8	95.8			x			
242	122.3	108.3			x				302	109.9	95.9			x			
243	122.2	108.2			x				303	110.2	96.2			x			
244	122.2	108.2			x				304	110.4	96.4			x			
245	122.2	108.2			x				305	110.7	96.7			x			
246	122.2	108.2			x				306	110.7	96.7				x		
247	122.3	108.3			x				307	110.3	96.3				x		
248	122.4	108.4			x				308	109.3	95.3				x		
249	122.4	108.4			x				309	108.0	94.0				x		
250	122.5	108.5			x				310	106.5	92.5				x		
251	122.5	108.5			x				311	105.4	91.4				x		
252	122.5	108.5			x				312	104.9	90.9				x		
253	122.5	108.5			x				313	104.7	90.7				x		
254	122.6	108.6			x				314	104.3	90.3				x		
255	122.8	108.8			x				315	103.6	89.6				x	x	
256	123.0	109.0			x				316	102.6	88.6				x	x	
257	123.2	109.2			x				317	101.7	87.7				x	x	
258	123.3	109.3			x				318	100.8	86.8				x	x	
259	123.4	109.4			x				319	100.2	86.2				x	x	
260	123.5	109.5			x				320	99.8	85.8				x	x	
261	123.5	109.5			x				321	99.7	85.7				x	x	
262	123.6	109.6			x				322	99.7	85.7				x	x	
263	123.8	109.8			x				323	100.0	86.0				x	x	
264	124.0	110.0			x				324	100.7	86.7		x			x	
265	124.2	110.2			x				325	101.8	87.8		x			x	
266	124.5	110.5			x				326	103.2	89.2		x			x	
267	124.7	110.7			x				327	104.9	90.9		x			x	
268	124.9	110.9			x				328	106.6	92.6		x			x	
269	125.1	111.1			x				329	108.3	94.3		x			x	
270	125.2	111.2			x				330	109.9	95.9		x			x	
271	125.3	111.3			x				331	111.4	97.4		x			x	
272	125.3	111.3			x				332	112.7	98.7		x			x	
273	125.3	111.3			x				333	113.7	99.7		x			x	
274	125.2	111.2			x				334	114.3	100.3		x			x	
275	125.0	111.0			x				335	114.6	100.6		x			x	
276	124.8	110.8			x				336	115.0	101.0		x			x	
277	124.6	110.6			x				337	115.4	101.4		x			x	
278	124.4	110.4			x				338	115.8	101.8		x			x	
279	124.3	110.3				x			339	116.2	102.2		x			x	
280	123.9	109.9				x			340	116.5	102.5		x			x	
281	123.3	109.3				x			341	116.6	102.6		x			x	
282	122.1	108.1				x			342	116.7	102.7		x			x	
283	120.3	106.3				x			343	116.8	102.8		x			x	
284	118.0	104.0				x			344	117.0	103.0		x			x	
285	115.5	101.5				x			345	117.5	103.5		x			x	
286	113.2	99.2				x			346	118.3	104.3		x			x	
287	111.2	97.2				x			347	119.2	105.2		x			x	
288	110.1	96.1				x			348	120.1	106.1		x			x	
289	109.7	95.7			x				349	120.8	106.8		x			x	
290	109.8	95.8			x				350	121.1	107.1				x	x	
291	110.1	96.1			x				351	120.7	106.7				x	x	
292	110.4	96.4			x				352	119.0	105.0				x	x	
293	110.7	96.7			x				353	116.3	102.3				x	x	
294	110.9	96.9			x				354	113.1	99.1				x	x	
295	110.9	96.9			x				355	110.3	96.3				x	x	
296	110.8	96.8			x				356	109.0	95.0				x	x	
297	110.6	96.6			x				357	109.4	95.4				x	x	
298	110.4	96.4			x				358	110.4	96.4				x	x	
299	110.1	96.1			x				359	111.3	97.3				x	x	
300	109.9	95.9			x				360	111.5	97.5				x	x	

Table A5-13: Cycle part 3 for vehicle class 3, 241 to 360 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
361	110.1	96.1				x	x		421	116.2	102.2			x			
362	107.4	93.4				x	x		422	116.4	102.4			x			
363	104.4	90.4				x	x		423	116.6	102.6			x			
364	101.8	87.8				x	x		424	116.8	102.8			x			
365	100.0	86.0				x	x		425	117.0	103.0			x			
366	99.1	85.1				x	x		426	117.4	103.4			x			
367	98.7	84.7				x	x		427	117.9	103.9			x			
368	98.2	84.2		x			x		428	118.4	104.4			x			
369	99.0	85.0		x			x		429	118.8	104.8			x			
370	100.5	86.5		x			x		430	119.2	105.2			x			
371	102.3	88.3		x			x		431	119.5	105.5			x			
372	103.9	89.9		x			x		432	119.7	105.7			x			
373	105.0	91.0		x			x		433	119.9	105.9			x			
374	105.8	91.8		x			x		434	120.1	106.1			x			
375	106.4	92.4		x			x		435	120.3	106.3			x			
376	107.1	93.1		x			x		436	120.5	106.5			x			
377	107.7	93.7		x			x		437	120.8	106.8			x			
378	108.3	94.3		x			x		438	121.1	107.1			x			
379	109.0	95.0		x			x		439	121.5	107.5			x			
380	109.6	95.6		x			x		440	122.0	108.0			x			
381	110.3	96.3		x			x		441	122.3	108.3			x			
382	110.9	96.9		x			x		442	122.6	108.6			x			
383	111.5	97.5		x			x		443	122.9	108.9			x			
384	112.0	98.0		x			x		444	123.1	109.1			x			
385	112.3	98.3		x			x		445	123.2	109.2			x			
386	112.6	98.6		x			x		446	123.4	109.4			x			
387	112.9	98.9		x			x		447	123.5	109.5			x			
388	113.1	99.1		x			x		448	123.7	109.7			x			
389	113.3	99.3		x			x		449	123.9	109.9			x			
390	113.3	99.3		x			x		450	124.2	110.2			x			
391	113.2	99.2		x			x		451	124.4	110.4			x			
392	113.2	99.2		x			x		452	124.7	110.7			x			
393	113.3	99.3		x			x		453	125.0	111.0			x			
394	113.5	99.5		x			x		454	125.2	111.2			x			
395	113.9	99.9		x			x		455	125.3	111.3			x			
396	114.3	100.3		x			x		456	125.1	111.1			x			
397	114.6	100.6		x			x		457	124.4	110.4			x			
398	114.9	100.9		x			x		458	123.3	109.3			x			
399	115.1	101.1			x				459	122.0	108.0			x			
400	115.3	101.3			x				460	120.8	106.8			x			
401	115.4	101.4			x				461	119.5	105.5			x			
402	115.5	101.5			x				462	118.4	104.4			x			
403	115.6	101.6			x				463	117.8	103.8			x			
404	115.8	101.8			x				464	117.6	103.6			x			
405	115.9	101.9			x				465	117.5	103.5			x			
406	116.0	102.0			x				466	117.5	103.5			x			
407	116.0	102.0			x				467	117.4	103.4			x			
408	116.0	102.0			x				468	117.3	103.3			x			
409	116.0	102.0			x				469	117.1	103.1			x			
410	115.9	101.9			x				470	116.9	102.9			x			
411	115.9	101.9			x				471	116.6	102.6			x			
412	115.9	101.9			x				472	116.5	102.5			x			
413	115.8	101.8			x				473	116.4	102.4			x			
414	115.8	101.8			x				474	116.4	102.4			x			
415	115.8	101.8			x				475	116.5	102.5			x			
416	115.8	101.8			x				476	116.7	102.7			x			
417	115.8	101.8			x				477	117.0	103.0			x			
418	115.8	101.8			x				478	117.3	103.3			x			
419	115.9	101.9			x				479	117.7	103.7			x			
420	116.0	102.0			x				480	118.1	104.1			x			

Table A5-14: Cycle part 3 for vehicle class 3, 361 to 480 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
481	118.5	104.5			x				541	115.0	101.0			x			
482	118.8	104.8			x				542	115.3	101.3			x			
483	118.9	104.9			x				543	116.0	102.0			x			
484	119.1	105.1			x				544	116.7	102.7			x			
485	119.1	105.1			x				545	117.5	103.5			x			
486	119.1	105.1			x				546	118.2	104.2			x			
487	119.2	105.2			x				547	118.6	104.6			x			
488	119.2	105.2			x				548	118.7	104.7			x			
489	119.3	105.3			x				549	118.8	104.8			x			
490	119.3	105.3			x				550	118.8	104.8			x			
491	119.4	105.4			x				551	118.9	104.9			x			
492	119.5	105.5			x				552	119.1	105.1			x			
493	119.5	105.5			x				553	119.4	105.4			x			
494	119.3	105.3			x				554	119.7	105.7			x			
495	119.0	105.0			x				555	119.9	105.9			x			
496	118.6	104.6			x				556	120.0	106.0				x		
497	118.2	104.2			x				557	119.6	105.6				x		
498	117.8	103.8			x				558	118.4	105.4				x		
499	117.6	103.6			x				559	115.9	103.9				x		
500	117.5	103.5			x				560	113.2	102.2				x		
501	117.4	103.4			x				561	110.5	100.5				x		
502	117.4	103.4			x				562	107.2	99.2				x		
503	117.3	103.3			x				563	104.0	98.0				x		
504	117.0	103.0			x				564	100.4	96.4				x		
505	116.7	102.7			x				565	96.8	94.8				x		
506	116.4	102.4			x				566	92.8	92.8				x		
507	116.1	102.1			x				567	88.9	88.9				x		
508	115.9	101.9			x				568	84.9	84.9				x		
509	115.7	101.7			x				569	80.6	80.6				x		
510	115.5	101.5			x				570	76.3	76.3				x		
511	115.3	101.3			x				571	72.3	72.3				x		
512	115.2	101.2			x				572	68.7	68.7				x		
513	115.0	101.0			x				573	65.5	65.5				x		
514	114.9	100.9			x				574	63.0	63.0				x		
515	114.9	100.9			x				575	61.2	61.2				x		
516	115.0	101.0			x				576	60.5	60.5				x		
517	115.2	101.2			x				577	60.0	60.0				x		
518	115.3	101.3			x				578	59.7	59.7				x		
519	115.4	101.4			x				579	59.4	59.4				x		
520	115.4	101.4			x				580	59.4	59.4				x		
521	115.2	101.2			x				581	58.0	58.0				x		
522	114.8	100.8			x				582	55.0	55.0				x		
523	114.4	100.4			x				583	51.0	51.0				x		
524	113.9	99.9			x				584	46.0	46.0				x		
525	113.6	99.6			x				585	38.8	38.8				x		
526	113.5	99.5			x				586	31.6	31.6				x		
527	113.5	99.5			x				587	24.4	24.4				x		
528	113.6	99.6			x				588	17.2	17.2				x		
529	113.7	99.7			x				589	10.0	10.0				x		
530	113.8	99.8			x				590	5.0	5.0	x					
531	113.9	99.9			x				591	2.0	2.0	x					
532	114.0	100.0			x				592	0.0	0.0	x					
533	114.0	100.0			x				593	0.0	0.0	x					
534	114.1	100.1			x				594	0.0	0.0	x					
535	114.2	100.2			x				595	0.0	0.0	x					
536	114.4	100.4			x				596	0.0	0.0	x					
537	114.5	100.5			x				597	0.0	0.0	x					
538	114.6	100.6			x				598	0.0	0.0	x					
539	114.7	100.7			x				599	0.0	0.0	x					
540	114.8	100.8			x				600	0.0	0.0	x					

Table A5-15: Cycle part 3 for vehicle class 3, 481 to 600 s

Annex 6

CHASSIS DYNAMOMETER AND INSTRUMENTS DESCRIPTION

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

Speed sensor

Trade name (-mark) and model: ....
Principle: ....
Range: ....
Position of installed sensor: ....
Resolution: ....
Output: ....

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:

____

Annex 7

ROAD TESTS FOR THE DETERMINATION OF TEST BENCH SETTINGS

1. Requirements for the rider

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

1.2. The rider in the conditions given in paragraph 1.1. above shall have a mass of 75 kg ± 5 kg and be 1.75 m ± 0.05 m tall.

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.

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 per cent 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 per cent
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 vehicle (motorcycle) is tested, calculated in accordance with the formula below, shall not differ by more than 7.5 per cent from the air density under the standard conditions.

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

$$d_T = d_0 \times \frac{P_T}{\rho_0} \times \frac{T_0}{T_T}$$ Equation A7-1

where:

p_T is the mean ambient pressure during test, in kPa

T_T is the mean ambient temperature during test, in K.

3. <u>Condition of the test vehicle (motorcycle)</u>

The test vehicle shall comply with the conditions described in paragraph 6.1. of this annex.

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.

4. Specified coast down speeds

The coast down times have to be measured between v_1 and v_2 as specified in table A7-1 depending on the vehicle class as defined in paragraph 6.2. below.

When the running resistance is verified in accordance with paragraph 7.2.2.3.2., the test can be executed at vj ± 5 km/h, if the coast down time accuracy according to paragraph 6.4.7. is secured.

Table A7-1: Coast down time measurement beginning speed and ending speed.

Motorcycle Class	v_j in km/h	v_1 in km/h	v_2 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

*/ Specified coast down speeds for motorcycles that have to drive the part in the "reduced speed" version

(For reduced speed version specifications see paragraph 6.4.4.)

When the running resistance is verified in accordance with paragraph 7.2.2.3.2., the test can be executed at $v_j \pm 5$ km/h, if the coast down time accuracy according paragraph 6.4.7. is secured.

5. 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 above procedure 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:

$$\Delta T_i = \frac{\Delta T_{a\,i} + \Delta T_{b\,i}}{2}$$ Equation A7-2

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

$$\Delta T_j = \frac{1}{n} \times \sum_{i=1}^{n} \Delta T_i$$ Equation A7-3

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

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

$$P = \frac{t \times s}{\sqrt{n}} \times \frac{100}{\Delta T_j}$$ Equation A7-4

where:

t is the coefficient given in table A7-2;

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 A7-5

where:

n is the number of tests.

Table A7-2: Coefficients for the statistical accuracy

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

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 8.

6. Data processing

6.1. Calculation of running resistance force

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

$$F_j = \frac{1}{3.6} \times (m + m_r) \times \frac{2\Delta v}{\Delta T_j}$$ Equation A7-6

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

The running resistance force F_j shall be corrected in accordance with paragraph 6.2. below.

6.2. 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,

$$F = f_0 + f_2 \times v^2 \qquad \text{Equation A7-7}$$

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

$$f^*_0 = f_0\left[1 + K_0\left(T_T - T_0\right)\right] \qquad \text{Equation A7-8}$$

$$f^*_2 = f_2 \times \frac{T_T}{T_0} \times \frac{p_0}{p_T} \qquad \text{Equation A7-9}$$

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: $K_0 = 6 \times 10^{-3}\ K^{-1}$.

6.3. Target running resistance force F^* for chassis dynamometer setting

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

$$F^*\left(v_0\right) = f^*_0 + f^*_2 \times v_0^2 \qquad \text{Equation A7-10}$$

Annex 8

FORM FOR THE RECORD OF COAST DOWN TIME

Trade name:........................ 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 per cent	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: $F^* = \ldots + \ldots v^2$

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Annex 9

RECORD OF CHASSIS DYNAMOMETER SETTING (BY COAST DOWN METHOD)

Trade name:.. 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 ε	note
	Test 1	Test 2	Test 3	Average	Setting value	Target value		

Curve fitting: $F^* = \ldots + \ldots v^2$ → (Setting value)

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Annex 10

RECORD OF CHASSIS DYNAMOMETER SETTING (BY TABLE METHOD)

Trade name:.. 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 ε	note
	Test 1	Test 2	Test 3	Average	Setting value	Target value		

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

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Annex 11

RECORD OF TYPE I TEST RESULTS

Trade name:.. Production number (Body):..............................

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

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

Motorcycle Class	Reduced speed Yes/No	Cycle part	Starting cond.	Test number	Distance driven in km	Emission in g				Fuel cons. in litre
						HC	CO	NO_x	CO_2	
1, 2 or 3		1	Cold	1						
				2						
				3						
				Average						
1		1	Hot	1						
				2						
				3						
				Average						
2 or 3		2	Hot	1						
				2						
				3						
				Average						
3		3	Hot	1						
				2						
				3						
				Average						

Motorcycle Class	Reduced speed Yes/No	Cycle part	Starting condition	Weighting in per cent	Average Emission in g/km				Fuel cons. in litre/100 km
					HC	CO	NO_x	CO_2	
1		1	Cold	50					
		1	Hot	50					
	-	-	-	Final Result					
2		1	Cold	30					
		2	Hot	70					
	-	-	-	Final Result					
3		1	Cold	25					
		2	Hot	50					
		3	Hot	25					
	-	-	-	Final Result					

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Annex 12

RECORD OF TYPE II TEST RESULTS

Trade name:.. Production number (Body):..................................

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

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

Idling speed in min^{-1}			Engine oil temperature in °C	CO content in per cent vol.	CO_2 content in per cent vol.	Corrected CO content in per cent vol.
Minimum	Average	Maximum				

High idling speed in min^{-1}			Engine oil temperature in °C	CO content in per cent vol.	CO_2 content in per cent vol.	Corrected CO content in per cent vol.
Minimum	Average	Maximum				

Annex 13

EXPLANATORY NOTE ON GEARSHIFT PROCEDURE

This explanatory note is not a part of the standard, but explains matters specified or described in the standard or appendix, and matters related thereto.

1. Approach

The development of the gearshift procedure was based on an analysis of the gearshift points in the in-use data. In order to get generalised relations between technical specifications of the vehicles and gearshift speeds the engine speeds were normalised to the utilisable band between rated speed and idling speed.

In a second step the end speeds (vehicle speed as well as normalised engine speed) for upshifts and downshifts were determined and collected in a separate table. The averages of these speeds for each gear and vehicle were calculated and correlated with technical specifications of the vehicles.

The results of these analyses and calculations can be summarised as follows:

- The gearshift behaviour is engine speed related rather than vehicle speed related.
- The best correlation between gearshift speeds and technical data was found for normalised engine speeds and the power to mass ratio [rated power/(kerb mass + 75 kg)].
- The residual variations cannot be explained by other technical data or by different transmission ratios. They are most probably assigned to differences in traffic conditions and individual driver behaviour.
- The best approximation between gearshift speeds and power to mass ratio was found for exponential functions.
- The gearshift function for the first gear is significantly lower than for all other gears.
- The gearshift speeds for all other gears can be approximated by one common function.
- No differences were found between five-speed and six-speed gearboxes.
- The gearshift behaviour in Japan is significantly different from the equal-type gearshift behaviour in the Europe Union (EU) and in the United States of America (USA).

In order to find a balanced compromise between the three regions a new approximation function for normalised upshift speeds versus power to mass ratio was calculated as weighted average of the EU/USA curve (with 2/3 weighting) and the Japanese curve (with 1/3 weighting).

2. Gearshift criteria, additional requirements

Based on this, the gearshift prescriptions can be summarised as follows:

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

Equation A13-1

$$n\_max\_acc(1) = (0.5753 \times e^{(-1.9 \times \frac{P_n}{m_k + 75})} - 0.1) \times (s - n_{idle}) + n_{idle}$$

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

Equation A13-2

$$n\_max\_acc(i) = (0.5753 \times e^{(-1.9 \times \frac{P_n}{m_k + 75})}) \times (s - n_{idle}) + n_{idle}$$

where:

i	is the gear number (≥ 2),
P_n	is the rated power in kW,
m_k	is the kerb mass in kg,
n	is the engine speed in min^{-1},
n_{idle}	is the idling speed in min^{-1},
s	is the rated engine speed in min^{-1}

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

Equation A13-3

$$n\_min\_acc(i) = n\_max\_acc(i-1) \times \frac{r(i)}{r(i-1)}$$

where:

r(i) is the ratio of gear i

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

Equation A13-4

$$n\_min\_dec(i) = n\_min\_dec(i-1) \times \frac{r(i)}{r(i-1)}$$

where:

r(i) is the 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 A13-1). The engine speed values resulting from the formulas above can be rounded to multiples of 100 min^{-1} for practical applications.

Figure A13-1 shows an example for a gearshift sketch for a small vehicle. The solid lines demonstrate the gear use for acceleration phases; the dotted lines show the downshift points for deceleration phases. During cruising phases the whole speed range between downshift speed and upshift speed may be used.

In order to avoid driveability problems these prescriptions had to be supplemented by the following additional requirements, (some of them are general, some are assigned to particular cycle phases):

- There are fixed allocations for acceleration, cruising and deceleration phases (see Annex 5).
- Gearshifts are prohibited for indicated cycle sections (see Annex 5).
- No gearshift if a deceleration phase follows immediately after an acceleration phase.
- Idle modes shall be run with manual transmissions in the first gear with the clutch disengaged.
- Downshifts to the first 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 first 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 drops below $n_{idle} + 0.03*(s - n_{idle})$, 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.
- The minimum time span for a gear sequence is 2 seconds.

To give the test engineer more flexibility and to assure driveability the gearshift regression functions should be treated as lower limits. Higher engine speeds are permitted in any cycle phase.

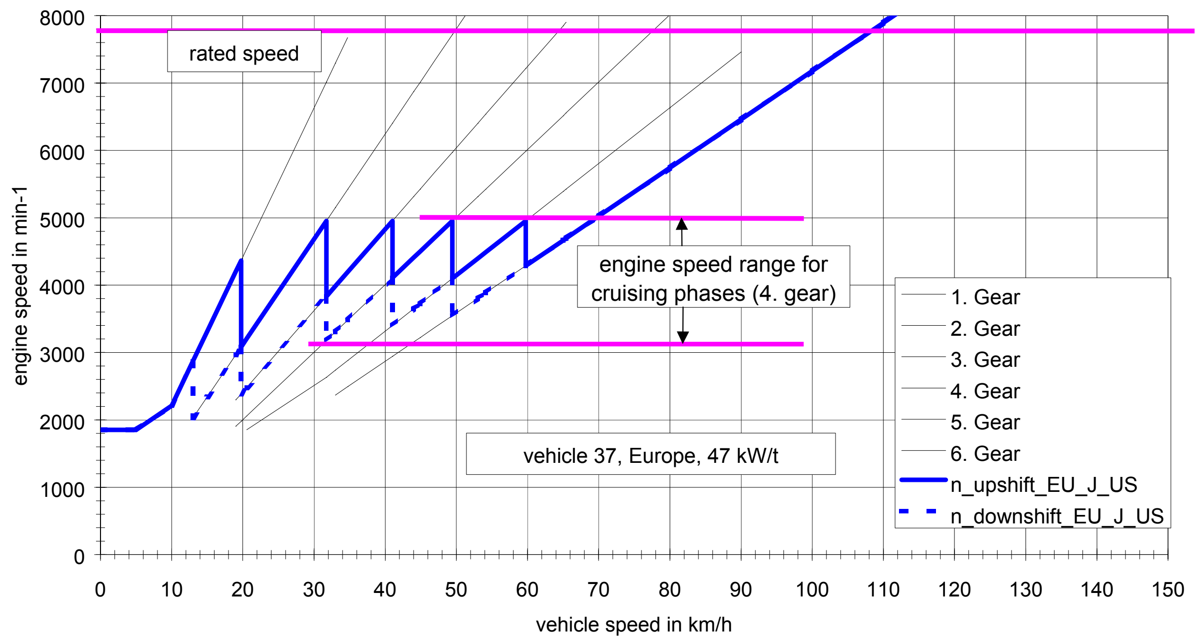

Figure A13-1: Example of a gearshift sketch for a small vehicle

3. Calculation example

An example of input data necessary for the calculation of shift speeds is shown in table A13-1. The upshift speeds for acceleration phases for the first gear and higher gears are calculated using equation A13-1 and equation A13-2. The denormalisation of engine speeds can be executed by using the equation $n = n\_norm * (s - n_{idle}) + n_{idle}$.

The downshift speeds for deceleration phases can be calculated with equation A13-4. The ndv values in table A13-1 can be used as gear ratios. These values can also be used to calculate the affiliated vehicle speeds (vehicle shift speed in gear i = engine shift speed in gear i / ndv_i). The corresponding results are shown in table A13-2 and table A13-3.

In a further step the possibility of a simplification of the above-described gearshift algorithms was examined by additional analyses and calculations. It should especially be checked whether engine shift speeds could be replaced by vehicle shift speeds. The analysis showed that vehicle speeds could not be brought in line with the gearshift behaviour of the in-use data.

Table A13-1: Input data for the calculation of engine and vehicle shift speeds

Engine capacity in cm^3	600
P_n in kW	72
m_k in kg	199
s in min^{-1}	11,800
n_{idle} in min^{-1}	1,150
ndv_1 */	133.66
ndv_2	94.91
ndv_3	76.16
ndv_4	65.69
ndv_5	58.85
ndv_6	54.04
pmr **/ in kW/t	262.8

*/ ndv means the ratio between engine speed in min^{-1} and vehicle speed in km/h

**/ pmr means the power to mass ratio calculated by $P_n / (m_k+75) \times 1,000$; P_n in kW; m_k in kg

Table A13-2: Shift speeds for acceleration phases for the first gear and for higher gears (according to table A13-1)

	EU/USA/Japan driving behaviour	
	n_acc_max (1)	n_acc_max (i)
n_norm */	24.8 per cent	34.8 per cent
n in min^{-1}	3,804	4,869

*/ n_norm means the calculated value by equation A13-1 and equation A13-2.

Table A13-3: Engine and vehicle shift speeds according to table A13-2

Gearshift		EU/USA/Japan driving behaviour		
		v in km/h	n_norm (i) in per cent	n in min^{-1}
Upshift	1→2	28.5	2.49	3,804
	2→3	51.3	34.9	4,869
	3→4	63.9	34.9	4,869
	4→5	74.1	34.9	4,869
	5→6	82.7	34.9	4,869
Downshift	2→cl */	15.5	3.0	1,470
	3→2	28.5	9.6	2,167
	4→3	51.3	20.8	3,370
	5→4	63.9	24.5	3,762
	6→5	74.1	26.8	4,005

*/ "cl" means "Clutch-Off" timing.
