International Standard ISO 7860

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Road vehicles — Motorcycles — Method of measuring fuel consumption

Véhicules routiers — Motocycles — Méthode de mesurage de la consommation de carburant

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 7860 was developed by Technical Committee ISO/TC 22, *Road vehicles*, and was circulated to the member bodies in May 1982.

It has been approved by the member bodies of the following countries :

Austria	Hungary	Poland
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China	Japan	Spain
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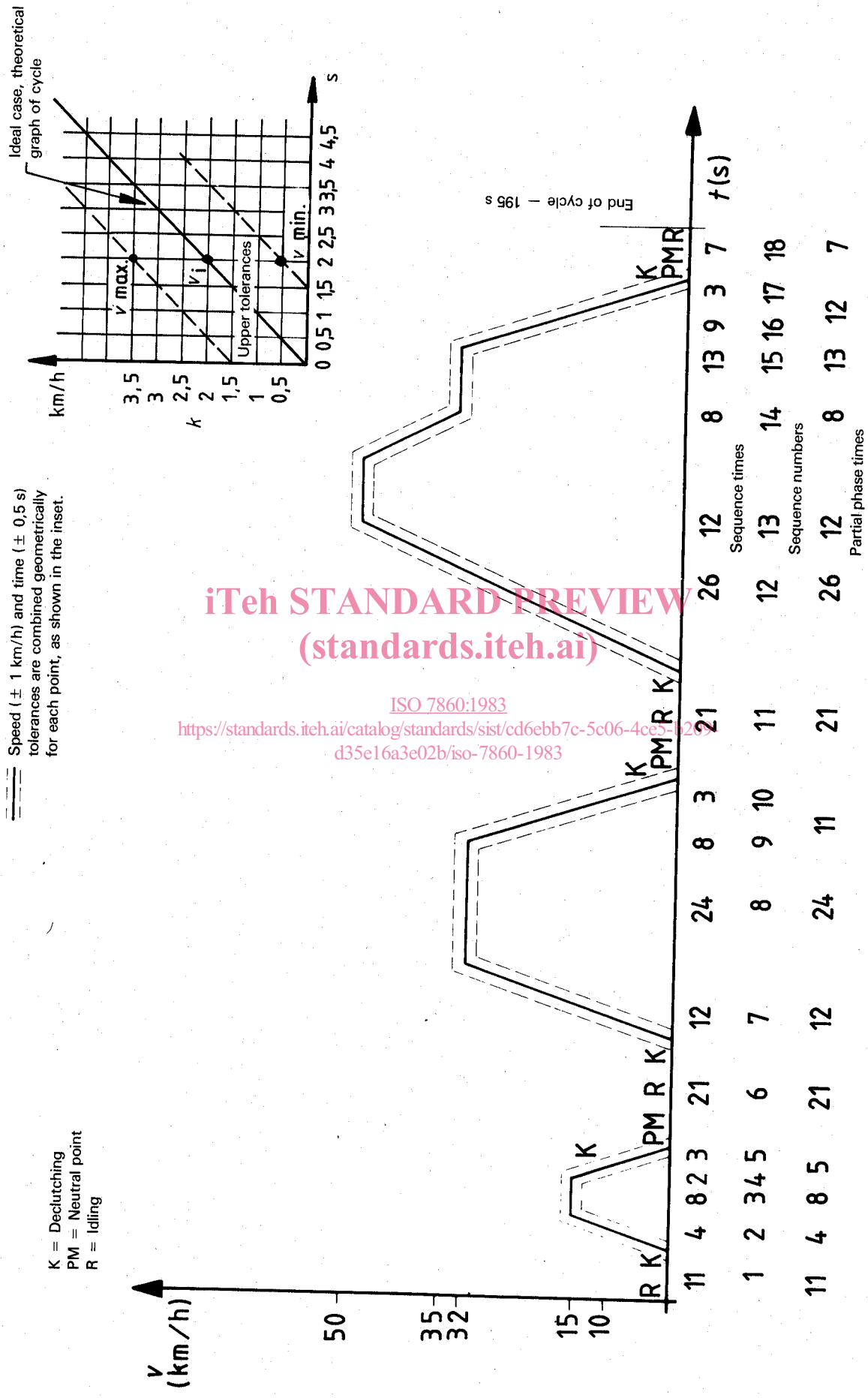


Figure 1 — Operating cycle on the roller bench
(Type 1 test)

7.1.4 Tolerances

7.1.4.1 A tolerance of ± 1 km/h on the theoretical speed shall be allowed during acceleration, during steady speed, and during deceleration. If the motorcycle decelerates more rapidly without the use of the brakes, the requirements of 7.5.5.3 shall apply.

Speed tolerances greater than those prescribed shall be accepted during phase changes provided that the tolerances are never exceeded for more than 0,5 s on any one occasion.

7.1.4.2 The time tolerance shall be ± 0,5 s.

7.1.4.3 The speed and time tolerances shall be combined as indicated in figure 1.

7.2 Engine fuel and lubricants

For the test, the reference fuels CEC RF-05-T-79 or CEC RF-03-T-80 shall be used. The lubrication of the engine, including engines lubricated by mixture, shall comply, as to grade and quantity of oil, with the manufacturer's recommendation.

7.3 Test equipment

7.3.1 Roller bench

The main characteristics of the roller bench shall be as follows[1] :

- Number of points of contact between tyre(s) and roller(s) : one to each driven wheel
- Roller diameter : ⩾ 400 mm
- Roller surface : polished metallic
- Equation of the power absorption curve :

the power absorbed (P_a) by the brake and the internal frictions of the bench shall be :

- $0 < P_a < kv_{12}^3 + 0{,}05\ kv_{12}^3 + 0{,}05\ P_{v50}$ for speeds less than 12 km/h
- $P_a = kv^3 \pm 0{,}05\ kv^3 \pm 0{,}05\ P_{v50}$ (without being negative) for speeds greater than 12 km/h

NOTE — It can be assumed that the power lost between the tyre(s) and the roller(s) equals the loss between the tyre(s) and the road.

7.3.2 For measuring the fuel consumption, one of the following methods may be used depending on the characteristics of each method and on the type of test to be performed (conventional driving cycle or constant speed) :

a) volumetric method;

b) gravimetric method;

c) flowmeter method;

d) carbon balance method (for four-stroke engines only).

Other methods can be used if it can be proved that the results given are equivalent.

7.3.2.1 Fuel shall be supplied to the engine by a device capable of measuring the quantity of fuel supplied with an accuracy of ± 2 %, which does not interfere with the supply of fuel to the engine. Where the measuring system is volumetric, the temperature of fuel in the device or in the outlet of the device shall be measured.

Switching from the normal supply system to the measuring supply system shall be effected by a valve system and shall take no more than 0,2 s.

7.3.2.2 For the carbon balance method, the test equipment shall be in compliance with ISO 6460.

7.3.3 Annex B gives the description and the methods of use of the appropriate devices.

7.4 Preparing the test

7.4.1 Setting of brake

The brake shall be so adjusted as to absorb a power equivalent to that of the motorcycle on the level at 50 km/h (see method of setting in ISO 6460).

If it is not possible to carry out this power measurement, the brake shall be adjusted in accordance with table 2.

7.4.2 Adjustment of equivalent inertias to the motorcycle translatory inertias

The inertia simulation system shall be adjusted to obtain a total inertia of the rotating masses representing the motorcycle kerb weight, in accordance with the limits given in table 2.

7.4.3 Conditioning of motorcycle

7.4.3.1 Adjustment of the tyre pressures

The tyre pressures shall be those recommended by the manufacturer for normal road use conditions.

7.4.3.2 Load on the driving wheel

The load on the driving wheel shall be within ± 3 % of that of a motorcycle in normal road use with a rider of 75 ± 5 kg in the upright position.

1) A detailed description is given in ISO/TR 6970.

Table 2 — Setting of brake

Motorcycle kerb weight m, kg	Equivalent inertia M, kg	Power absorbed by the brake P_{v50}, kW
$m \leqslant 30$	100	0,88
$30 < m \leqslant 40$	110	0,90
$40 < m \leqslant 50$	120	0,91
$50 < m \leqslant 60$	130	0,93
$60 < m \leqslant 70$	140	0,94
$70 < m \leqslant 90$	150	0,96
$90 < m \leqslant 110$	170	0,99
$110 < m \leqslant 130$	190	1,02
$130 < m \leqslant 150$	210	1,05
$150 < m \leqslant 170$	230	1,09
$170 < m \leqslant 195$	260	1,14
$195 < m \leqslant 225$	280	1,17
$225 < m \leqslant 255$	310	1,21
$255 < m \leqslant 285$	340	1,26
$285 < m \leqslant 320$	380	1,33
$320 < m \leqslant 360$	410	1,37
$360 < m \leqslant 400$	450	1,44

NOTE — Additional masses may be replaced by another device, provided that it is demonstrated that the results obtained are equivalent.

7.5 Procedure for tests on the roller bench

7.5.1 Special conditions for carrying out the cycle

7.5.1.1 The temperature in the room housing the roller bench shall be between 20 and 30 °C throughout the test and approximate as closely as possible that of the room in which the motorcycle was conditioned for the test.

7.5.1.2 The motorcycle shall be as nearly level as possible when tested in order to prevent abnormal fuel distribution and where appropriate, engine oil distribution.

7.5.1.3 Throughout the test, a variable speed cooling blower shall be positioned in front of the motorcycle, so as to direct cooling air to the engine 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 roller speeds of less than 10 km/h, air velocity may be zero. With the manufacturer's agreement, engine cooling can be effected by a constant speed blower giving a current of air delivered at a speed between 20 and 50 km/h. 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 15 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 in the middle of the stream at 20 cm from the air outlet. This velocity shall be as nearly as possible steady across the whole of the blower outlet surface.

7.5.1.4 When the cycle is carried out, the speed considered shall be that of the rollers. During the test, the speed shall be plotted against time so that the validity of the cycles performed can be assessed.

7.5.2 Starting up the engine

The engine shall be started up by means of the devices provided for this purpose, such as the choke, the starter valve, etc., according to the manufacturer's instructions.

7.5.3 Idling

7.5.3.1 Manual change gear-box.

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

7.5.3.1.2 To enable acceleration to be performed according to the normal cycle, the motorcycle shall be placed in first gear, with the clutch disengaged, within 5 s before the acceleration following the idling period considered.

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

7.5.3.1.4 For the idling periods in the middle of each cycle, the corresponding times shall be 16 s in neutral and 5 s in first gear with the clutch disengaged. These times may be modified if necessary when the motorcycle tested has not sufficient accelerative capacity to follow the theoretical driving cycle (see 7.1.2.2).

7.5.3.1.5 The idling period between two successive cycles shall comprise 13 s in neutral with the clutch engaged (except for the cases considered in 7.1.2.2).

7.5.3.2 Automatic gear-box and torque converter.

The gear selector shall be locked at the start of the test and shall remain in the position defined in 7.1.3.2 throughout the whole of the test.

7.5.4 Acceleration

7.5.4.1 Acceleration shall be so performed that the rate of acceleration is as constant as possible throughout the phase.

7.5.4.2 If acceleration cannot be carried out in the prescribed time, the motorcycle shall be driven in accordance with the method prescribed in 7.1.2.2.

7.5.5 Deceleration

7.5.5.1 All deceleration shall be effected by closing the throttle completely, the clutch remaining engaged. The clutch shall be disengaged independently of gear selection, at a speed of 10 km/h or before the engine starts to idle roughly.

7.5.5.2 If the rate of deceleration is slower than that prescribed for the corresponding phase, the motorcycle brake shall be used to enable the cycle to be followed.

7.5.5.3 If the rate of deceleration is faster than that prescribed for the corresponding phase, the timing of the theoretical cycle shall be restored by a period of constant speed or idling speed merging into the following operation.

7.5.5.4 At the end of the deceleration periods (the motorcycle being stationary on the roller), the gears shall be in neutral and the clutch engaged.

7.5.6 Constant speed

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

7.5.6.2 Periods of constant speed shall be achieved by keeping the throttle position fixed.

7.6 Measurement of fuel consumption

Fuel consumption shall be determined by measuring the quantity of fuel consumed during two consecutive operating cycles.

7.7 Calculation of results

7.7.1 If the fuel consumption is measured gravimetrically, the consumption C shall be expressed, in litres per 100 km, by converting the measurement M (fuel consumed expressed in kilograms) by means of the formula :

$$C = \frac{M}{D \times \varrho} \text{ 100 litres/100 km}$$

where

ϱ is the density (mass/volume) of the fuel in the reference conditions (20 °C), in kilograms per cubic decimetre;

D is the distance covered during the test in kilometres.

7.7.2 If the fuel consumption is measured volumetrically, the consumption C shall be expressed in litres per 100 km by the formula :

$$C = \frac{V[1 + \alpha (T_o - T_F)]}{D} \times 100$$

where

V is the measured volume of fuel consumed in litres;

α is the coefficient of volumetric expansion for the fuel; for both diesel and petrol fuel this is 0,001 K^{-1};

T_o is the reference temperature expressed in kelvins;

T_F is the fuel temperature measured at the burette expressed in kelvins.

7.7.3 If the fuel consumption is measured by the carbon balance method, the following formula shall be used where the masses of CO, HC and CO_2 are measured according to paragraph 7.3.2.2 :

$$C_1 = \frac{1\,000 \times d \times 0{,}866}{(0{,}429 \times \text{CO}) + (0{,}866 \times \text{HC}) + (0{,}273 \times \text{CO}_2)}$$

where

d is the relative density of the fuel;

CO is the the mass of carbon monoxide, expressed in grams per kilometre;

HC is the mass of hydrocarbons, expressed in grams per kilometre;

CO_2 is the mass of carbon dioxide, expressed in grams per kilometre.

In this case the consumption C_1 is expressed in kilometres per litre.

7.7.4 Case of fuel/oil mixture

The volume of oil used during the test shall be deducted.

7.7.5 Whatever the measuring method used, the results shall be expressed in litres per 100 km.

7.8 Presentation of results

7.8.1 The fuel consumption on a conventional driving cycle shall be determined by establishing the arithmetic mean of the amount of fuel consumed, measured in accordance with 7.6 and 7.7 above, during three consecutive measurements. Between consecutive pairs of cycles, there may be an idling period of not more than 60 s during which no fuel consumption is measured.

7.8.2 If the difference between the extreme measurements is more than 5 % of the mean value of the three measurements, further measurements shall immediately be made to obtain a degree of accuracy of measurement at least equal to 5 %.

7.8.3 The accuracy of measurement shall be calculated by the formula :

$$\text{Accuracy} = K \times \frac{S}{\sqrt{n}} \times \frac{100}{\overline{C}} \%$$

where

K is found from the following table :

Number of measurements	4	5	6	7	8	9	10
K	3,2	2,8	2,6	2,5	2,4	2,3	2,3

n is the number of measurements;

$$S = \sqrt{\frac{\sum_{i=1}^{n} (\bar{C} - C_i)^2}{n - 1}}$$

C_i is the amount of fuel consumed during the ith measurement;

$\bar{C}$ is the arithmetic mean of n values of C.

7.8.4 If an accuracy of measurement at least equal to 5 % is not obtained after ten measurements, the test shall be carried out with another motorcycle of the same type.

8 Constant speed test

8.1 General requirements

8.1.1 Measurement of fuel consumption of a motorcycle based on the constant speed method shall be performed on a road.

8.1.2 Fuel shall be supplied to the engine by a device capable of measuring the quantity of fuel supplied with an accuracy of ± 2 %, which does not interfere with the supply of fuel to the engine. Where the measuring system is volumetric, the temperature of fuel in the device or in the outlet of the device shall be measured.

8.1.3 Switching from the normal supply system to the measuring supply system shall be effected by a valve system and shall take no more than 0,2 s.

8.1.4 Annex B gives the description and the methods of use of the appropriate devices.

8.2 Rider and riding position

8.2.1 The rider shall wear a well-fitting suit (one-piece) or similar clothing and a protective helmet.

8.2.2 The rider shall have a mass between 75 and 80 kg and be between 1,70 and 1,80 m tall.

8.2.3 He shall be seated on the seat provided for the rider, with his feet on the foot-rests and his arms normally extended.

This position shall, nevertheless, allow the rider at all times to have proper control of the motorcycle during the test.

The position of the rider should remain unchanged during the whole measurement; the description of the position shall be indicated in the test report or shall be replaced by photographs.

8.3 Test track

8.3.1 The test track shall allow a steady speed to be maintained. It shall form a closed circuit of at least 2 000 m in length, have a minimum radius of 200 m and the surface shall be in good condition (closed circuit track).

The measurement of consumption shall be performed driving a number of complete laps.

8.3.2 A straight road may be used however provided that a minimum run of 500 m is made in both directions. The gradient shall not exceed 2 %.

The test track shall be clean, smooth, covered with asphalt, concrete or a similar material.

The test track shall be free of any significant film of water.

8.4 Atmospheric conditions

- Relative humidity : less than 95 %
- Maximum wind speed : 3 m/s
- Maximum wind speed for gusts : 8 m/s
- Air temperature : 278 to 303 K

Reference conditions :

- Pressure : H_0 = 1 000 mbar
- Temperature : T_0 = 293 K
- Relative air density : d_0 = 0,919 7

The relative air density when the motorcycle is tested, calculated as described below, shall not differ by more than 7,5 % from the air density under the reference conditions.

The relative air density shall be calculated by the formula :

$$d_T = d_0 \times \frac{H_T}{H_0} \times \frac{T_0}{T_T}$$

where

d_T is the relative air density at test conditions;

H_T is the test pressure;

T_T is the absolute temperature during the test in kelvins.

8.5 Test method

8.5.1 The test shall be performed at a constant speed in the highest gear. The maximum speed of the motorcycle shall be measured as described in ISO 7117.

The test shall be carried out at the speeds defined in table 3.

Table 3

Maximum speed of the motorcycle, v km/h	Test speed km/h
$130 < v$	120 and 90
$100 < v \leqslant 130$	90 and 60
$70 < v \leqslant 100$	60 and 45
$v \leqslant 70$	45

8.5.2 For the test, the reference fuel shall be used. The lubrication of the engine including lubrication by mixture shall comply with the manufacturer's recommendation.

8.5.3 Determination of the consumption

8.5.3.1 To determine the consumption at a steady reference speed (see figure 2), four tests shall be made; two at an average speed less than the reference speed and two at an average speed exceeding the reference speed. During each test run, the speed shall be kept steady within ± 2 km/h; a tolerance of ± 3 km/h is permissible for the 120 km/h test.

The average speed for each test shall not differ from the reference speed by more than 2 km/h.

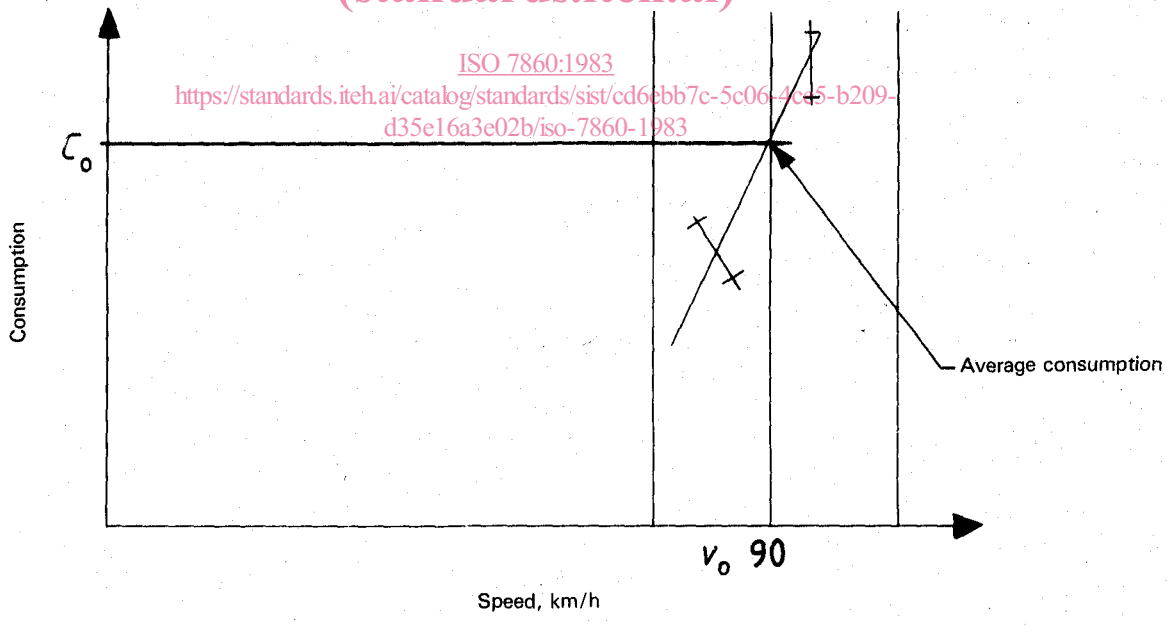
The fuel consumption for each test run shall be calculated from the formula in 8.5.4.

8.5.3.2 The difference between the two lower calculated values shall be not greater than 5 % of the average value of these two and the same condition shall apply for the two higher calculated values. The value of the fuel consumption at the appropriate reference speed shall be calculated by linear interpolation as shown in the diagram in figure 2.

8.5.3.3 If the condition in 8.5.3.2 is not achieved for either pair of calculated values then the four test runs shall be repeated. If after ten attempts the required consistency has not been achieved another motorcycle shall be selected and subjected to all the tests specified in this procedure.

8.5.4 Calculation or the results

The calculation shall be made in the same manner as in 7.7.



The four crosses correspond to the calculated values for each test run. C_0 is the value calculated for the consumption, at the reference speed v_0 over the test distance.

Figure 2 — Example of calculation for an average speed of 90 km/h

Annex A

Motorcycle description

(This annex forms an integral part of the standard.)

Trade name (mark) : .....

Model : .....

Manufacturer's name and address : .....

If applicable, name and address of manufacturer's representative : .....

Motorcycle mass :

- unladen : .....
- reference : .....
- maximum : .....

Gear-box : manual/automatic [1]

Number of gear ratios (speeds) : .....

Gear ratios [2] :

- first gear : .....
- second gear : .....
- third gear : .....
- fourth gear : .....
- fifth gear : .....
- sixth gear : .....

Drive ratios :

- primary : .....
- final : .....

Tyres :

- dimensions : .....
- dynamic rolling circumference : .....

Engine description [3] [4]

Make : .....

Model : .....

Cycle : two-stroke/four-stroke [1]

Number and layout of cylinders : .....

Engine size :

- bore : ..... mm
- stroke : ..... mm
- cubic capacity : ..... cm^3

1) Strike out as applicable.

2) In the case of power-driven vehicles equipped with automatic shift gear-boxes, give all pertinent technical data.

3) In the case of unconventional engines and systems, particulars equivalent to those mentioned here shall be supplied.

4) Drawings of the combustion chamber and of the piston, including the piston rings shall be supplied.