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# Motorcycles — Methods for setting running resistance on a chassis dynamometer

*Motocycles — Méthodes pour fixer la résistance à l'avancement sur un banc dynamométrique*



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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11486 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 22, *Motorcycles*.



This second edition cancels and replaces the first edition (ISO 11486:1993), which has been technically revised.

## Introduction

While ISO 11486:1993 gave only a running resistance setting method by coastdown method for the purpose of fuel consumption measurement, this edition of ISO 11486 has been prepared with the aim of establishing the general setting method that is usable for both exhaust emission testing and fuel consumption testing covering high-speed range driving.

In addition to the coastdown method, the table method is introduced in this edition of ISO 11486. In the coastdown method, the running resistance of each motorcycle is measured individually on the road, and the measured running resistance is reproduced on a chassis dynamometer. The table method is a simple setting method, where the running resistance value of the motorcycle is determined only with its equivalent inertia mass.

When this International Standard is applied to the exhaust emission test or the fuel consumption test, it is essential to follow the requirements specified in those test methods.

# Motorcycles — Methods for setting running resistance on a chassis dynamometer

## 1 Scope

This International Standard specifies the measurement method for determining the motorcycle running resistance on the road, and two methods of setting the chassis dynamometer with the motorcycle running resistance. It is applicable to motorcycles as defined in ISO 3833.

## 2 Normative references

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

ISO 3833, *Road vehicles — Types — Terms and definitions*

ISO 7117, *Motorcycles — Measurement of maximum speed*



## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

**3.1**
**running resistance**
$F$
total force resistant to a running motorcycle which, when measured by the coastdown method, includes the friction forces in the drive-train

**3.2**
**reference speed**
$v_0$
motorcycle speed at which the running resistance of the motorcycle is calculated and then used for setting the chassis dynamometer

**3.3**
**specified speed**
$v$
motorcycle speed at which the running resistance on the road is measured to determine the running resistance curve

**3.4**
**motorcycle kerb mass**
$m_k$
motorcycle dry mass to which is added the mass of the following:

— fuel: tank filled at least to 90 % of the capacity specified by the manufacturer;

— oils and coolant: filled as specified by the manufacturer;

— auxiliary equipment usually supplied by the manufacturer in addition to that necessary for normal operation [tool-kit, carrier(s), windscreen(s), protective equipment, etc.]

**3.5**
**motorcycle reference mass**
$m_{ref}$
kerb mass of the motorcycle increased by a uniform figure of 75 kg, which represents the mass of a rider

## 4 Symbols

For the purposes of this document, the symbols in Table 1 apply.

**Table 1 — Symbols**

| Symbol | Definition | Unit |
|---|---|---|
| $a$ | The coefficient of polygonal function | — |
| $b$ | The coefficient of polygonal function | — |
| $c$ | The coefficient of polygonal function | — |
| $a_T$ | The rolling resistance force of front wheel | N |
| $b_T$ | The coefficient of aerodynamic | N/(km/h)$^2$ |
| $d_T$ | The relative air density under test conditions | — |
| $d_0$ | The standard ambient relative air density | — |
| $F$ | The running resistance force | N |
| $F_E$ | The set running resistance force on the chassis dynamometer | N |
| $F_E(v_0)$ | The set running resistance force at the reference speed on the chassis dynamometer | N |
| $F_E(v_i)$ | The set running resistance force at the specified speed on the chassis dynamometer | N |
| $F_f$ | The total friction loss | N |
| $F_f(v_0)$ | The total friction loss at the reference speed | N |
| $F_j$ | The running resistance force | N |
| $F_j(v_0)$ | The running resistance force at the reference speed | N |
| $F_{pau}$ | The braking force of the power absorbing unit | N |
| $F_{pau}(v_j)$ | The braking force of the power absorbing unit at the specified speed | N |
| $F_{pau}(v_0)$ | The braking force of the power absorbing unit at the reference speed | N |
| $F_T$ | The running resistance force obtained from the running resistance table | N |
| $F^*$ | The target running resistance force | N |
| $F^*_j$ | The target running resistance force at the specified speed | N |
| $F^*(v_0)$ | The target running resistance force at the reference speed on the chassis dynamometer | N |
| $F^*(v_i)$ | The target running resistance force at the specified speed on the chassis dynamometer | N |
| $f_0$ | The rolling resistance | N |
| $f^*_0$ | The corrected rolling resistance in the standard ambient conditions | N |
| $f_2$ | The coefficient of aerodynamic drag | N/(km/h)$^2$ |
| $f^*_2$ | The corrected coefficient of aerodynamic drag in the standard ambient conditions | N/(km/h)$^2$ |

**Table 1** (*continued*)

| Symbol | Definition | Unit |
|---|---|---|
| $K_0$ | The temperature correction factor for rolling resistance | — |
| $m$ | The test motorcycle mass | kg |
| $m_a$ | The actual mass of the test motorcycle | kg |
| $m_i$ | The equivalent inertia mass | kg |
| $m_{fi}$ | The flywheel equivalent inertia mass | kg |
| $m_k$ | The motorcycle kerb mass | kg |
| $m_r$ | The equivalent inertia mass of all the wheels | kg |
| $m_{ref}$ | The motorcycle reference mass | kg |
| $m_{rid}$ | The rider mass | kg |
| $m_{rf}$ | The rotating mass of the front wheel | kg |
| $m_{r1}$ | The equivalent inertia mass of the rear wheel and the motorcycle parts rotating with the wheel | kg |
| $p_0$ | The standard ambient pressure | kPa |
| $p_T$ | The mean ambient pressure during the test | kPa |
| $T_T$ | The mean ambient temperature during the test | K |
| $T_0$ | The standard ambient temperature | K |
| $v$ | The specified speed | km/h |
| $v_j$ | The specified speeds which are selected for coastdown time measurement | km/h |
| $v_0$ | The reference speed | km/h |
| $v_1$ | The speed at which the measurement of the coastdown time begins | km/h |
| $v_2$ | The speed at which the measurement of the coastdown time ends | km/h |
| $\Delta T_E$ | The corrected coastdown time at the inertia mass ($m_i$+$m_{r1}$) | s |
| $\Delta T_i$ | The average coastdown time at the specified speed | s |
| $\Delta T_j$ | The average coastdown time of the two tests | s |
| $\Delta T_{road}$ | The target coastdown time | s |
| $\Delta t$ | The coastdown time | s |
| $\overline{\Delta t}$ | The mean coastdown time on the chassis dynamometer without absorption | s |
| $\Delta t_E$ | The mean coastdown time on the chassis dynamometer at the reference speed | s |
| $\Delta t_{ai}$ | The coastdown time measured during the first road test | s |
| $\Delta t_{bi}$ | The coastdown time measured during the second road test | s |
| $\Delta t_i$ | The coastdown time corresponding to the reference speed | s |
| $\Delta v$ | The coastdown speed interval ($2\Delta v = v_1 - v_2$) | km/h |
| $\varepsilon$ | The chassis dynamometer setting error | — |
| $\rho_0$ | The standard relative ambient air volumetric mass | kg/m$^3$ |



## 5 Test motorcycle, chassis dynamometer and instruments

A full description of the motorcycle shall be provided in accordance with Annex A.

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

## 6 Required accuracy of measurements

Measurements shall be made to the accuracies as specified in Table 2.

**Table 2 — Required accuracy of measurements**

| Parameter | At measured value | Resolution |
|---|---|---|
| a) Running resistance force, $F$ | +2 % | — |
| b) Motorcycle speed ($v_1$,$v_2$) | ±1 % | 0,45 km/h |
| c) Coastdown speed interval [$2\Delta v = v_1 - v_2$] | ±1 % | 0,10 km/h |
| d) Coastdown time ($\Delta t$) | ±0,5 % | 0,01 s |
| e) Total motorcycle mass [$m_k + m_{rid}$] | ±1,0 % | 1,4 kg |
| f) Wind speed | ±10 % | 0,1 m/s |
| g) Wind direction | — | 5 deg. |
| h) Ambient temperature | — | 2 K |
| i) Barometric pressure | — | 0,2 kPa |

## 7 Road test



### 7.1 Requirement for road

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



### 7.2 Ambient conditions for the road test

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 coastdown is representative.

The ambient conditions shall be within the following limits:

— maximum wind speed: 3 m/s;

— maximum wind speed for gusts: 5 m/s;

— average wind speed, parallel: 3 m/s;

— average wind speed, perpendicular: 2 m/s;

— maximum relative humidity: 95 %;

— air temperature: 278 K to 308 K.

Standard ambient conditions shall be as follows:

— pressure, $p_0$: 100 kPa;

— temperature, $T_0$: 293 K;

— relative air density, $d_T$: 0,9197;

— air volumetric mass, $\rho_0$: 1,189 kg/m$^3$.

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

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

$$d_T = d_0 \times \frac{p_T}{p_0} \times \frac{T_0}{T_T} \quad (1)$$

### 7.3 Reference speed

The reference speed or speeds shall be as defined in the test cycle.

### 7.4 Specified speed

The specified speed, $v$, is required to prepare the running resistance curve. To determine the running resistance as a function of motorcycle speed in the vicinity of the reference speed, $v_0$, running resistances shall be measured using at least four specified speeds, including the reference speed(s). 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 $\Delta v$, as defined in 7.6. 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. From the running resistance curve, the running resistance at the reference speed(s) can be calculated.



### 7.5 Coastdown starting speed



The coastdown starting speed shall be more than 5 km/h above the highest speed at which coastdown time measurement begins, since sufficient time is required, for example to settle the positions of both the motorcycle and rider and to cut the transmitted engine power off before the speed is reduced to $v_1$, the speed at which the measurement of the coastdown time is started.

### 7.6 Coastdown time measurement beginning speed and ending speed

To ensure accuracy in measuring the coastdown time, $\Delta t$, and coastdown speed interval, $2\Delta v$, the beginning speed, $v_1$, and ending speed, $v_2$, in kilometres per hour, the following requirements shall be met:

$$v_1 = v + \Delta v \quad (2)$$

$$v_2 = v - \Delta v \quad (3)$$

$\Delta v$ shall be 5 km/h when $v$ is less than 60 km/h, and shall be 10 km/h when $v$ is 60 km/h or more.

### 7.7 Preparation of test motorcycle

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

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

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

**7.7.4** The kerb mass of the motorcycle shall be as defined in 3.4.

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

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

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

## 7.8 Rider and riding position

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

**7.8.2** The rider in the conditions given in 7.8.1 shall have a mass of 75 kg ± 5 kg and be 1,75 m ± 0,05 m tall.

**7.8.3** 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 coastdown test.

The position of the rider shall remain unchanged during the whole measurement period.



## 7.9 Measurement of coastdown time

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



**7.9.2** 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 coastdown starting speed. When the coastdown test is reproduced on the chassis dynamometer, the transmission and clutch shall be in the same condition as during the road test.

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

**7.9.4** The first coastdown time, $\Delta t_{ai}$, corresponding to the specified speed, $v_j$, shall be measured as the elapsed time from the motorcycle speed $v_j + \Delta v$ to $v_j - \Delta v$.

**7.9.5** The procedure from 7.9.1 to 7.9.4 shall be repeated in the opposite direction to measure the second coastdown time, $\Delta t_{bi}$.

**7.9.6** The average $\Delta T_i$ of the two coastdown times $\Delta t_{ai}$ and $\Delta t_{bi}$ shall be calculated by the following equation:

$$\Delta T_i = \frac{\Delta t_{ai} + \Delta t_{bi}}{2} \tag{4}$$

**7.9.7** At least four tests shall be performed and the average coastdown time, $\Delta T_j$, calculated by the following equation:

$$\Delta T_j = \frac{1}{n}\sum_{i=1}^{n} \Delta T_i \tag{5}$$