INTERNATIONAL STANDARD

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Second edition
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Motorcycles — Engine test code — Net power

Motocycles — Code d'essai des moteurs — Puissance nette

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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.

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.

International Standard ISO 4106 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Sub-Committee SC 22, *Motorcycles*.

This second edition cancels and replaces the first edition (ISO 4106:1978), of which it constitutes a technical revision.

NOTE 1 This International Standard has been based on ISO 1585:1992, *Road vehicles — Engine test code — Net power*, which is also the basis for the following parallel documents:

a) ISO 2288:1989, *Agricultural tractors and machines — Engine test code (bench test) — Net power*

b) ISO 4164:1978, *Road vehicles — Mopeds — Engine test code — Net power*

c) ISO 9249:1989, *Earth-moving machinery — Engine test code — Net power*

Annex A forms an integral part of this International Standard. Annexes B, C and D are for information only.

International Organization for Standardization
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Motorcycles — Engine test code — Net power

1 Scope

This International Standard specifies a method for testing engines designed for motorcycles, as defined in ISO 3833:1977, definition 3.5. It applies to the evaluation of their performance with a view, in particular, to presenting curves of power and specific fuel consumption at full load as a function of engine rotational speed.

It applies only to net power assessment.

This International Standard concerns internal combustion engines used for propulsion of motorcycles and included in one of the following categories:

— reciprocating internal combustion engines (spark-ignition) but excluding free piston engines;

— rotary piston engines.

These engines may be naturally aspirated or pressure-charged, either using a mechanical supercharger or turbocharger.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2710:1978, *Reciprocating internal combustion engines — Vocabulary*.

ISO 3833:1977, *Road vehicles — Types — Terms and definitions*.

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 2710 and ISO 3833 and the following definitions apply.

3.1 net power: Power obtained on a test bench at the end of the crankshaft or its equivalent[1)] at the corresponding engine speed with the equipment and auxiliaries listed in table 1.

3.2 torque: Torque measured under the same conditions as defined in 3.1.

3.3 specific fuel consumption: Amount of fuel consumed per unit of power output and per hour, with the amount of the lubricants excluded when they are used with a mixture of fuels.

1) If the power measurement can only be carried out with a mounted gear-box, the losses in the gear-box should be added to the measured power to give the engine power.

3.4 auxiliaries: Equipment and devices listed in table 1.

3.5 standard production equipment: Any equipment provided by the manufacturer for a particular engine application.

4 Accuracy of measuring equipment and instruments

4.1 Torque

The dynamometer torque-measuring system shall have an accuracy within ± 1 % in the range of scale values required for the test.

The torque-measuring system shall be calibrated to take into account friction losses. The accuracy may be ± 2 % for measurements carried out at power less than 50 % of maximum power. However, for the maximum torque measurement, the accuracy shall remain at ± 1 %.

4.2 Engine speed (rotational frequency)

The engine speed (rotational frequency) measuring system shall have an accuracy of ± 0,5 %.

4.3 Fuel consumption

The fuel consumption (flow) measuring system shall have an accuracy of ± 1 %.

4.4 Engine inlet air temperature

The air temperature measuring system shall have an accuracy of ± 1 K.

4.5 Barometric pressure

The barometric pressure measuring system shall have an accuracy of ± 70 Pa[2].

4.6 Back pressure in exhaust system

The system used to measure the back pressure in the exhaust system shall have an accuracy of ± 25 Pa.

5 Tests

5.1 Auxiliaries

During the test auxiliaries necessary to make the engine acceptable for service in the intended application (as listed in table 1) shall be installed on the test bench, as far as possible in the same position as in the intended application.

5.2 Setting conditions

The setting conditions for the test for determination of net power are indicated in table 2.

2) 1 bar = 10^5 Pa

Table 1 — Installation of equipment and auxiliaries during test

No.	Auxiliaries	Fitted for net power test
1	Inlet system Inlet manifold Crankcase emission control system Air filter Inlet silencer Speed-limiting device Electro-control devices (if fitted)	Yes, standard production equipment
2	Induction heating device of inlet manifold	Yes, standard production equipment. If possible, to be set in the most favourable position.
3	Exhaust system Manifold Connecting pipes Silencer Tail pipe Pressure-charging devices Electro-control devices (if fitted)	Yes, standard production equipment
4	Fuel supply pump	Yes, standard production equipment
5	Carburettor	Yes, standard production equipment
6	Fuel injection equipment Prefilter Filter Pump High-pressure pipe Injector	Yes, standard production equipment
7	Liquid cooling equipment Engine cowling Radiator Fan Fan cowl Water pump Thermostat	No (Engine cowling) Yes, standard production equipment (Radiator, Fan, Fan cowl, Water pump, Thermostat)
8	Air cooling Cowl Fan or blower Temperature regulating device	Yes, standard production equipment
9	Electrical equipment	Yes, standard production equipment
10	Pressure-charging equipment (if fitted) Compressor driven either directly by the engine, and/or by the exhaust gases Charge-air-cooler Coolant pump or fan (engine-driven) Coolant flow control device (if fitted)	Yes, standard production equipment
11	Anti-pollution devices	Yes, standard production equipment
12	Oil cooler (if fitted)	Yes, standard production equipment

Table 2 — Setting conditions

<table>
<tr><td>1</td><td>Setting of carburettor</td><td rowspan="3">In accordance with the manufacturer's production specifications for the approval of the maximum output of the engine.</td></tr>
<tr><td>2</td><td>Setting of injection pump delivery system</td></tr>
<tr><td>3</td><td>Ignition or injection timing (timing curve)</td></tr>
</table>

5.3 Test conditions

5.3.1 The net power test shall consist of a run at full throttle, the engine being equipped as specified in table 1.

5.3.2 Performance data shall be obtained under stabilized normal operating conditions.

Where the cooling system of the test bench satisfies the minimum conditions for a good installation but still cannot reproduce adequate cooling conditions of the engine and therefore does not allow measurement in normal and stable working conditions, the method described in annex A may be used.

The minimum conditions to be satisfied by the installation shall be as follows:

$v_2 \geqslant v_1$ and $\varphi \geqslant 0{,}25$ m^2

where

v_1 is the maximum speed of the vehicle;

v_2 is the maximum speed of the flux of cooling air at the fan exit;

φ is the cross-section of the flux of cooling air.

If $v_2 < v_1$ and/or $\varphi < 0{,}25$ m^2,

a) and if it is possible to stabilize the operating conditions, the method in 5.3.2 is applied;

b) and if it is not possible to stabilize the operating conditions:

   1) if $v_2 \geqslant 120$ km/h and $\varphi \geqslant 0{,}25$ m^2, the installation satisfies the minimum conditions and the method described in annex A may be applied,

   2) if $v_2 < 120$ km/h and/or $\varphi < 0{,}25$ m^2, the installation does not satisfy the minimum conditions and the cooling installation of the test equipment shall be improved.

The engine shall have been run-in, started and warmed up in accordance with the manufacturer's recommendations. Combustion chambers of spark-ignition engines may contain deposits, but in limited quantity which avoids the presence of hot-spot ignition. Test conditions such as inlet air temperature shall be selected as near to reference conditions (see 6.2) as possible in order to minimize the correction factor.

5.3.3 The temperature of the inlet air to the engine (ambient air) shall be measured within 0,15 m of the point of entry to the air cleaner, or, if no air cleaner is used, within 0,15 m of the air inlet horn.

The thermometer or thermocouple shall be shielded from radiant heat and located directly in the airstream. It shall also be shielded from fuel sprayback. A sufficient number of locations shall be used to give a representative average inlet temperature.

5.3.4 No data shall be taken until torque, engine speed and temperature have been maintained substantially constant for at least 30 s.

5.3.5 The engine speed during a run or reading shall not deviate from the selected rotational speed by more than ± 1 %.

5.3.6 Observed brake load, fuel consumption and inlet air temperature data shall be taken virtually simultaneously and shall, in each case, be the average of two stabilized consecutive readings which do not vary more than 2 % for brake load and fuel consumption.

5.3.7 A measurement time of not less than 10 s shall be used when measuring engine speed and fuel consumption with an automatically synchronized counter-timer combination; for hand operation, the time of measurement shall be not less than 20 s.

5.3.8 The coolant outlet temperature in liquid-cooled engines shall be controlled at 353 K ± 5 K, unless otherwise specified by the manufacturer.

For air-cooled engines, the temperature at a point indicated by the manufacturer shall be kept within $_{-20}^{\ 0}$ K of the maximum value specified by the manufacturer.

5.3.9 The fuel temperature at the inlet of the injection pump or carburettor shall be maintained within the limits established by the engine manufacturer.

5.3.10 The lubricating oil temperature measured in the oil sump or at the oil cooler outlet, if fitted, shall be maintained within the limits established by the engine manufacturer.

5.3.11 The exhaust temperature shall be measured at a point in the exhaust pipe(s) adjacent to the outlet flange(s) of the exhaust manifold(s) or ports.

5.3.12 In case of the fuel being disputed, tests shall be made with one of the following CEC[3] reference fuels:

CEC RF-01-A-80

CEC RF-08-A-85.

(See annexes B and C.)

5.3.13 If it is impracticable to fit the standard exhaust system, a system permitting the normal engine running characteristics in accordance with the manufacturer's specification shall be fitted for the test. In particular in the test laboratory, the exhaust extraction system at the point where the test bench exhaust system is connected shall not, with the engine in operation, create at the exhaust extraction duct a pressure differing from the atmospheric pressure by more than ± 740 Pa (7,4 mbar), unless the manufacturer has specifically prescribed the back pressure prior to the test, in which case the lower of the two pressures shall be used.

5.4 Test procedure

Record data at a sufficient number of operating rotational speeds to define completely the power curve between the lowest and the maximum engine rotational speeds recommended by the manufacturer.

5.5 Data to be recorded

Data to be recorded shall be those indicated in clause 7.

6 Determination of net power

6.1 Definition of factors α_1 and α_2

These are the factors by which the observed power shall be multiplied to determine the engine power, taking into account the efficiency of the transmission (α_1 factor) which might have been used during the test and the reference atmospheric conditions specified in 6.2.1 (α_2 factor).

The corrected power (i.e. power under reference conditions and at the end of the crankshaft, P_o, is given by the following equation:

$$P_o = \alpha_1 \alpha_2 P$$

3) Co-ordinating European Council for the Development of Performance Tests for Lubricants and Engine Fuels.

where

α_1 is the correction factor for efficiency of the transmission;

α_2 is the correction factor for reference atmospheric conditions (α_{2a} or α_{2b});

P is the measured power (first power).

6.2 Atmospheric conditions

6.2.1 Reference atmospheric conditions

The reference atmospheric conditions shall be as given in 6.2.1.1 to 6.2.1.3.

6.2.1.1 Temperature

The reference temperature, T_{ref}, is 298 K (25 °C).

6.2.1.2 Dry pressure

The reference dry pressure, $p_{d, ref}$, is 99 kPa.

NOTE 2 The dry pressure is based on a total pressure of 100 kPa and a water vapour pressure of 1 kPa.

$$p_{d, ref} = p_{ao} - p_{wo}$$

where

p_{ao} is the reference total pressure (100 kPa);

p_{wo} is the reference water vapour pressure (1 kPa).

6.2.1.3 Reference total pressure

The reference total pressure, p_{ao}, is 100 kPa (1 000 mbar), with humidity being neglected for two-stroke engines.

NOTE 3 Within the temperature range 283 K to 318 K, the effects of humidity on the correction factor value may be neglected (though in some cases these effects may not be negligible), taking into account the accuracy of the measurements.

6.2.2 Test atmospheric temperature

The atmospheric temperature, T (or θ, in degrees Celsius) shall be within the following values during the test:

$$283 \text{ K} \leqslant T \leqslant 318 \text{ K} \ (10 \text{ °C} \leqslant \theta \leqslant 45 \text{ °C})$$

6.3 Determination of power correction factors

6.3.1 Determination of α_1 factor

Where the measurement point is the crankshaft exit, this factor is equal to 1.

Where the measurement point is not the crankshaft exit, this factor is calculated with the formula:

$$\alpha_1 = \frac{1}{\eta_t}$$

where η_t is the efficiency of the transmission which is located between the crankshaft and the measurement point.

This efficiency of the transmission, η_t, is determined from the product of efficiency η_i of each element constituting the transmission:

$$\eta_t = \eta_1 \times \eta_2 \times \ldots \times \eta_i$$

The efficiency η_i of each element constituting the transmission is given in table 3.

Table 3 — Transmission component efficiencies

Component	Type	Efficiency
Gear	Spur gear	0,98
	Helical gear	0,98
	Bevel gear	0,98
Chain	Roller	0,95
	Silent	0,98
Belt	Toothed	0,95
	V-belt	0,94
Hydraulic coupler or converter	Hydraulic coupler	0,92
	Non-locked hydraulic converter	0,92

6.3.2 Determination of α_2 factors

The test may be carried out in air-conditioned test rooms where the atmospheric conditions are controlled to equal the reference conditions.

6.3.2.1 Symbols for correction factors α_{2a} and α_{2b}

T is the absolute temperature, in kelvins, at the engine air inlet;

p_d is the dry atmospheric pressure, in kilopascals, i.e. the total barometric pressure minus the water vapour pressure;

p_a is the total atmospheric pressure.

6.3.2.2 Four-stroke engines

The correction factor α_{2a} for four-stroke engines shall be as calculated by the formula:

$$\alpha_{2a} = \left(\frac{99}{p_d}\right)^{1,2} \left(\frac{T}{298}\right)^{0,6}$$

This formula only applies if

$$0,95 \leqslant \alpha_{2a} \leqslant 1,05$$

If these limits are exceeded, the corrected value obtained shall be given, and the test conditions (temperature and pressure) precisely related in the test report.

6.3.2.3 Two-stroke engines

The correction factor α_{2b} for two-stroke engines shall be as calculated by the formula:

$$\alpha_{2b} = \frac{100}{p_a} \sqrt{\left(\frac{T}{298} \right)}$$

This formula only applies if

$$0,96 \leqslant \alpha_{2b} \leqslant 1,04$$

If these limits are exceeded, the corrected value obtained shall be given, and the test conditions (temperature and total pressure) precisely stated in the test report.

7 Test report

(State "NONE" where not applicable, or delete.)

7.1 Engine data

7.1.1 Reciprocating engines

Make: .... Type: .... Serial No.: ....
Bore: .... mm Stroke: .... mm
Swept volume of one cylinder: .... cm^3
Number of cylinders: ....
Arrangement of cylinders: ....
Total swept volume of the cylinders: .... cm^3
Firing order: ....
Compression ratio: .... Cycle: two-stroke/four-stroke[4)]

7.1.2 Rotary trochoidal engines

Make: .... Type: .... Serial No.: ....
Epitrochoidal/hypotrochoidal[4)]
Envelope: internal/external[4)]
Number of gas-tight chambers between the rotor and the stator, i.e. number of peripheral sealing devices per rotor or stator: ....
Eccentricity: .... mm Generating radius: .... mm
Operating width: .... mm Swept volume of one gas-tight chamber: .... cm^3
Number of rotors: .... Firing order: ....
Compression ratio: .... Cycle: two-stroke/four-stroke[4)]

7.1.3 Transmission gear ratio

$$\text{Reduction gear ratio} = \frac{\text{Crankshaft rotational speed}}{\text{Power take-off shaft rotational speed}}$$

7.2 Fuel supply

Pump: Make: .... Type: .... Serial No.: ....
Prefilter: yes/no[4)] Filter: yes/no[4)]

7.3 Carburettor

Make: .... Type: .... Serial No.: ....
Number: .... Detailed specifications: ....

7.4 Injection pumps or devices

Make: .... Type: .... Serial No.: ....
Static timing: .... Advance device: ....
Manufacturer's code: ....

4) Delete where inapplicable.