

INTERNATIONAL STANDARD



2534

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Road vehicles — Engine test code — Gross power

Véhicules routiers — Code d'essai des moteurs — Puissance brute

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

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 2534 was drawn up by Technical Committee ISO/TC 22, *Road vehicles*, and circulated to the Member Bodies in July 1973.

It has been approved by the Member Bodies of the following countries :

Australia	Japan	Sweden
Belgium	Netherlands	Switzerland
Bulgaria	New Zealand	Thailand
Czechoslovakia	Poland	United Kingdom
Germany	Portugal	Yugoslavia
Hungary	Romania	
Ireland	South Africa, Rep. of	
Italy	Spain	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

France
U.S.A.

Road vehicles — Engine test code — Gross power

1 SCOPE

This International Standard specifies a method for testing engines designed for automobile vehicles, applicable to the evaluation of their performances with a view, in particular, to presenting curves of power and specific fuel consumption at full load as a function of engine speed.

It applies only to the gross power study.

2 FIELD OF APPLICATION

This International Standard concerns internal combustion engines used for the propulsion of private cars and other motor vehicles (excluding motor-cycles and agricultural tractors¹⁾) normally travelling on roads and included in one of the following categories :

- internal combustion engines (spark ignition, fuel injection or diesel) but excluding free piston engines;
- rotary piston engines;

These engines may be fitted with a supercharging device using a mechanical supercharger or a turbo-charger.

3 REFERENCE

ISO 3173, *Road vehicles — Apparatus for measurement of the opacity of exhaust gas from diesel engines operating under steady state conditions.*²⁾

4 DEFINITIONS

4.1 gross power : The power obtained on a test bed at the crankshaft or its equivalent, at the engine speed specified by the manufacturer, the engine being equipped only with the standard production auxiliaries necessary to its operation on the test bed.

4.2 auxiliaries : The equipment and devices listed in table 1.

4.3 standard production equipment : Any equipment normally provided by the manufacturer for a particular type of engine. All experimental equipment is excluded.

5 ACCURACY OF MEASUREMENTS

5.1 Torque

The dynamometer must be such that the first quarter of its scale is not used. It must give an accuracy within $\pm 0,5\%$ of the maximum scale value.

5.2 Engine speed

Engine speed shall be measured preferably with a revolution counter and an automatically synchronized chronometer (or counter timer). The accuracy of the measured value shall be $\pm 0,5\%$.

5.3 Fuel consumption

$\pm 1\%$ overall for the apparatus used.

5.4 Engine inlet air temperature

$\pm 1^\circ\text{C}$.

5.5 Barometric pressure

$\pm 70\text{ Pa}$ (0,70 mbar*).

5.6 Pressure in exhaust extraction duct (see note 1 to table 1.)

$\pm 25\text{ Pa}$ (0,25 mbar).

1) International Standards are to be prepared concerning the specifications relating to engines for motor-cycles and agricultural tractors.

2) At present at the stage of draft.

* $1\text{ bar} = 10^5\text{ Pa}$.

TABLE 1 — Installation of auxiliaries during test
for determination of gross power of engine

No.	Auxiliaries	Fitted for gross power test
1	Intake system Intake manifold Air filter Intake silencer Crankcase emission control system Speed limiting device	Yes Optional No } } } standard production equipment
2	Induction heating device of intake manifold	Yes, standard production equipment. If possible, to be set in the most favourable condition.
3	Exhaust system Exhaust purifier Manifold Connecting pipes Silencer¹⁾ Tail pipe¹⁾ Exhaust brake²⁾	Optional Yes, standard production equipment Test bed system No } } }
4	Fuel supply pump	Yes, standard production equipment
5	Carburettor	Yes, standard production equipment
6	Fuel injection equipment (petrol and diesel) Prefilter Filter Pump High pressure pipe Injector Air intake valve, if fitted³⁾ Governor (if fitted)	Yes, standard production equipment, or test bed equipment Yes, standard production equipment Yes (fully open position) May be removed, or standard production equipment set at maximum speed setting. } } } } }
7	Liquid cooling equipment Engine bonnet Bonnet air outlet Radiator Fan Fan cowl Water pump Thermostat⁴⁾	No Yes, standard production equipment } } } } }
8	Air cooling Cowl⁵⁾ Fan⁶⁾ Auxiliary test bed fan⁷⁾ Temperature regulating device	Yes, standard production equipment Yes, if necessary No } } }
9	Electrical equipment ⁸⁾	Yes, standard production equipment, if necessary

TABLE 1 — Installation of auxiliaries during test
for determination of gross power of engine (concluded)

No.	Auxiliaries	Fitted for gross power test
10	Supercharging equipment (if fitted) Compressor driven either directly or indirectly by the engine, and/or by the exhaust gases } Intercooler⁹⁾ Coolant pump or fan (engine driven)⁶⁾ Coolant flow control device (if fitted) Auxiliary test bed fan⁷⁾	Yes, standard production equipment No Yes, if necessary
11	Anti-pollution device	If incorporated in the engine, yes at normal setting, if not, optional

NOTES TO TABLE 1

- 1) In the test laboratory, the exhaust extraction system at the point where the test bed 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 (7,40 mbar), unless the manufacturer has accepted a higher back pressure prior to the test.
- 2) If an exhaust brake is incorporated in the engine, the throttle valve may be removed or fixed in a fully open position.
- 3) The air intake valve is the control valve for the pneumatic governor of the injection pump.
- 4) The thermostat may be fixed in the fully open position.
- 5) The air cooling system shall be fixed in the fully open position.
- 6) The power absorbed by the fan shall be determined at the same engine speeds as those used for the measurement of the engine power. The power of the engine shall be shown on the performance curves, as measured and as corrected, and including the power absorbed by the fan. It is advised that, in addition the power of the engine as measured and corrected, without the power absorbed by the fan, may be shown on the performances curves.
- 7) The test bed auxiliary fan(s) may be used, if necessary, to maintain the working temperature of the engine.
- 8) The power of the generator shall be limited to that necessary for the operation of accessories which are indispensable for the operation of the engine. There shall be no charging of the battery during the test.
- 9) The standard production intercooler may be replaced by an alternative type, provided that the pressure loss and temperature after the intercooler are the same as specified by the manufacturer.

6 TESTS

6.1 Auxiliaries

During the test, the auxiliaries specified below shall be installed on the test bed, as far as possible, in the same position as in the intended application.

6.1.1 Auxiliaries to be fitted

The auxiliaries which shall be fitted during the test for determination of the gross power of the engine are listed in table 1.

6.1.2 Auxiliaries to be removed

Certain vehicle accessories necessary only for the operation of the vehicle, and which may be mounted on the engine,

shall be removed for the test. The following partial list is given as a sample :

- air compressor for brakes;
- power steering compressor;
- suspension compressor;
- air conditioning system.

Where accessories cannot be removed, the power absorbed by them in the unloaded condition may be determined and added to the measured engine power.

6.2 Setting conditions

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

TABLE 2 — Setting conditions

1	Setting of carburettor(s)	In accordance with the manufacturer's specification for the highest acceptable power used on production engines.
2	Setting of injection pump delivery system	
3	Ignition or injection timing (timing curve)	
4	Governor setting	

6.3 Test conditions

6.3.1 The gross power test shall consist of a run at full throttle for spark ignition engines and at fixed full load fuel pump setting for diesel engines, the engine being equipped as specified in table 1.

6.3.2 Performance data shall be obtained under stabilized normal operating conditions, with an adequate fresh air supply to the engine. The engines must have been run-in in accordance with the manufacturer's recommendations. Combustion chambers of spark ignition engines may contain deposits, but in limited quantity. Test conditions such as inlet air temperature shall be selected as near to reference conditions (see 7.2) as possible in order to minimize the magnitude of the correction factor.

6.3.3 The temperature of the inlet air to the engine (ambient air) shall be measured within 0,15 m maximum 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 air stream. It shall also be shielded from fuel spray-back. A sufficient number of locations shall be used to give a representative average inlet temperature.

6.3.4 No data shall be taken until torque, speed and temperature have been maintained substantially constant for at least 1 min.

6.3.5 The engine speed during a run or reading shall not deviate from the selected speed by more than $\pm 1\%$ or ± 10 rev/min, whichever is greater.

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

6.3.7 A time of measurement of not less than 30 s shall be used when measuring speed and fuel consumption with an automatically synchronized counter timer combination; for hand operation, the time of measurement shall be not less than 60 s.

6.3.8 The coolant outlet temperature in liquid-cooled engines shall be controlled at $80 \pm 5^\circ\text{C}$ unless otherwise specified by the manufacturer.

For air-cooled engines, the temperature at a point indicated by the manufacturer shall be kept within -20°C of the maximum value specified by the manufacturer.

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

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

6.3.11 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). This temperature shall be maintained within the limits established by the engine manufacturer.

6.3.12 For diesel engines, the fuel shall be one supplied and delivered by the refinery to the customer without any supplementary smoke suppressant additives. In cases of dispute, tests shall be made with the CEC reference fuel CEC RF-03-T-69. For spark ignition engines, in cases of dispute, tests shall be carried out using CEC reference fuel CEC RF-01-T-69 (see annexes A and B).

6.4 Test procedure

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

6.5 Data to be recorded

Data to be recorded are those indicated in clause 9.

7 CORRECTION FACTORS

7.1 Definition of factor *K*

A factor by which the observed power must be multiplied to determine the engine power under the reference atmospheric conditions specified in 7.2.

7.2 Reference atmospheric conditions

7.2.1 Temperature

25°C (298 K).

7.2.2 Total pressure

100 kPa (1 000 mbar), humidity being neglected.

NOTE — Within the temperature range 10 to 35°C , 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.

7.3 Limitations in use of correction formula

The correction formula is only applicable where the correction factor is between 0,96 and 1,04.

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

NOTE — The tests may be carried out in air-conditioned test rooms where the atmospheric conditions may be controlled.

7.4 Determination of correction factors

7.4.1 Spark ignition engines (carburettor or injection) — Factor K_a

Within the limits defined in 7.3, the correction factor is obtained by applying the formula

$$K_a = \left(\frac{100}{p} \right) \left(\frac{T}{298} \right)^{0,5} \quad \dots (1)$$

where

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

p is the total atmospheric pressure, in kilopascals.

This formula is applied to the observed brake power, without taking into account the mechanical efficiency of the engine.

7.4.2 Diesel engines¹⁾ — Factor K_d

7.4.2.1 CORRECTION FACTOR FOR NATURALLY ASPIRATED 4-STROKE AND SCAVENGE BLOW 2-STROKE DIESEL ENGINES

The correction factor, which applies only at constant fuel delivery, is calculated by means of the formula

$$K_d = \left(\frac{100}{p} \right)^{0,65} \left(\frac{T}{298} \right)^{0,5} \quad \dots (2)$$

The following formula, which is nearly equivalent, may also be used :

$$K_d = 1 + \frac{A}{100}$$

where $A = 0,65 (100 - p) + 0,17 (T - 298)$

In the above formulae, T and p have the same meaning as in 7.4.1.

If the correction factor exceeds 1,04 or is less than 0,96, or if the fuel delivery, measured during the engine test, is less than 50 mm³ per litre swept volume or more than 75 mm³ per litre swept volume, the correction shall be made using the correction factor K_d , but the value of this coefficient, the pressure and temperature conditions during the test, and the specific fuel delivery in mm³ per litre shall be stated in the test report.

7.4.2.2 CORRECTION FACTOR FOR PRESSURE-CHARGED DIESEL ENGINES

7.4.2.2.1 Exhaust turbo-charged engines

A correction factor equal to 1 shall be applied when the ambient air density does not vary by more than $\pm 5\%$ from the density under the reference conditions (25 °C, 100 kPa).

When the ambient air density is beyond these limits, no correction should be applied, but the test conditions shall be stated in the test report.

7.4.2.2.2 Mechanically supercharged engines

For the correction factor of mechanically supercharged engines, the formula applicable to naturally aspirated engines shall be used, provided that the following ratio is within the limits of fuel delivery specified for naturally aspirated engines (see 7.4.2.1).

$$\frac{\text{fuel delivery}}{\text{swept volume } (p_2/p_1) (T_1/T_2)}$$

where

p_1 is the ambient pressure;

p_2 is the pressure at the inlet manifold;

T_1 is the ambient temperature, in kelvins;

T_2 is the temperature at the inlet manifold, in kelvins.

8 MEASUREMENT OF SMOKE VALUE

The smoke value shall be measured and recorded at every test point. The opacimeter used, and its installation, shall be designed in accordance with ISO 3173.

1) Although the formulae given above are recommended at present, they must be considered only as provisional. Studies are being made to establish more accurate formulae which will take into account particularly the fuel/air ratio.

9 TEST REPORT

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

9.1 Engine data

9.1.1 Reciprocating engines

Make :	Type :	Serial No. :
Bore :	Stroke :	Swept volume of one cylinder :
Number of cylinders :	Arrangement of cylinders :	
Total swept volume of the cylinders :	Ignition : spark* or compression* firing or injection order :	
Compression ratio :	Cycle : 2* or 4* strokes	
Supercharging device :	Make :	Type : Serial No. :

9.1.2 Rotary trochoidal engines

Make :	Type :	Serial No. :
Epitrochoidal* or Hypotrochoidal*		
Envelope : internal* or external*		
Number of gas-tight chambers between the rotor and the stator, i.e. number of peripheral sealing devices per rotor or stator :		
Eccentricity :	Generating radius :	
Operating width :	Swept volume of one gas-tight chamber :	
Number of rotors :	Ignition : spark* or compression* firing or injection order :	
Compression ratio :	Cycle : 2* or 4* strokes	
Supercharging device :	Make :	Type : Serial No. :

9.2 Fuel supply

Pump :	Make :	Type :	Serial No. :
Prefilter : yes* or no*	Filter : yes* or no*		

9.3 Carburettor

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

• Delete where inapplicable.

9.4 Injection pumps or devices

Make : Type : Serial No. :

Static timing : Advance device :

Manufacturer's code :

9.5 Injection nozzles and nozzle holders

Make : Type : Serial No. :

Setting pressure : Injection high pressure pipes { lengths
inside diameter :

9.6 Governor

Make : Type : Serial No. :

Cutting-in speed under load : rev/min

Maximum no-load speed : rev/min

9.7 Ignition distributor

Make : Type : Serial No. :

Static timing : Advance device :

Timing at rev/min : (as specified by the manufacturer)

Maximum range of advance device :

Distributor contact breaker gap :

9.8 Spark plugs

Make : Type : Serial No. :

Number per cylinder : Electrodes gap :

9.9 Ignition coils

Make : Type : Serial No. :

Number :

9.10 Glow plugs

Make : Type : Serial No. :

Number :

9.11 Interference suppressor

Make : **Type :** **Serial No.:**

9.12 Intake system

Intake manifold : Description :

Air filter : Make : **Type :** **Serial No. :**

Intake silencer : Make : Type : Serial No. :

Inlet maximum depression at full flow
recommended by the manufacturer : . . . kPa (mbar)

9.13 Valve gear

Type of valve gear : Brief description :

Valve timing : Tappet clearances (hot* or cold*) :

9.14 Crankcase emission control system

Brief description :

Make : Type : Serial No. :

9.15 Induction heating device

Type : Brief description :

9.16 Exhaust system

Brief description :

Exhaust brake : Make : Type : Serial No. :

Silencer : standard* or not* : Type : Serial No. :

9.17 Cooling system

9.17.1 Liquid

Nature of the liquid :

Circulating pump : Make : . . . Type : Serial No. : . . . Drive ratio :

Thermostat: Make: Type: Serial No.: Setting:

• Delete where inapplicable.

9.17.2 Air

Fan : Make : Type : Serial No. : Drive ratio :

Air ducting (standard production) : yes* or no*

Auxiliary test bed fan : yes* or no*

9.18 Oil cooler yes* or no*

Make : Type : Serial No. :

9.19 Electrical equipment

Generator* or Alternator* : Make : Type : Serial No. :

9.20 Anti-pollution systems (Brief description) :

9.21 Other test equipment

(Enumerate, with brief description if necessary.)

9.22 Specific test conditions

Barometric pressure : kPa (mbar)

Relative humidity : % (for information)

Temperature of the test laboratory : °C (for information)

Cooling liquid outlet temperature specified by the manufacturer : °C

Oil temperature range specified by the manufacturer : °C min. °C max.

Fuel temperature range specified by the manufacturer at inlet of the carburettor
or of the injection pump : °C min. °C max.

Exhaust temperature (measured at a point in the exhaust pipe(s) adjacent to the outlet
flange(s) of the exhaust manifold(s)) recommended by the manufacturer : °C

Idling speed : rev/min (for information)

Laboratory extraction system for the exhaust gases :

Over-pressure or maximum depression : ± Pa, at full load

Dynamometer : Make : Type : Serial No. :

Constant :

* Delete where inapplicable.

Fuel consumption measuring apparatus : gravimetric* or volumetric*

Smoke opacity measuring apparatus (diesel) : Make : Type :

Measuring point or installation :

9.23 Fuels and lubricants

Liquid fuel

Make : Type : Octane RON** No. :

Cetane No. :

Distillation : Temperatures at which the distillate volume is equal to : 10 % . . 50 % . . 90 % . . End point . .

Density : g/cm³ at °C

Lower calorific value kJ/kg

Other fuels : Characteristics :

Lubricant : Make : Type : SAE viscosity :

9.24 Results

Maximum gross power : kW at rev/min

Maximum gross torque : N·m at rev/min

Specific fuel consumption

— at maximum gross power : g/kWh

— at maximum gross torque : g/kWh

* Delete where inapplicable.
** RON : Research octane number.

9.25 Statements of results (gross power)

The characteristic curves of the corrected torque and power, of the specific fuel consumption and of the exhaust smoke emission shall be drawn as a function of the engine speed.

Engine speed	Observed torque	Observed power	Test conditions		Correction factor	Corrected torque	Corrected power	Specific fuel consumption ¹⁾	Fuel delivery ²⁾	Temperature of engine cooling liquid at outlet	Temperature of oil at measuring point	Exhaust temperature	Smoke value observed
			Barometric pressure	Temperature of inlet air									
rev/min	N·m	kW	kPa	°C		N·m	kW	g/kWh	mm ³ /stroke	°C	°C	°C	

- 1) Spark ignition engine : without correction of power. Compression ignition engine : with correction of power.
2) For diesel engines.

For pressure-charged engines, add the following columns :

Pressure charging			
Temperature		Pressure	
After pressure charger	After intercooler	After pressure charger	After intercooler
°C	°C	kPa	kPa

10 UNITS OF DESIGNATION

10.1 Units

Unit of mass : gram (g)

Unit of power : kilowatt (kW)

Unit of torque : newton metre (N·m)

Unit of volume of injected fuel : cubic millimetre (mm³)

10.2 Designation

When the performances (power curves, torque and specific fuel consumption) of a heat engine are measured according to the specification of this International Standard, reference shall be made to the method used by stating "measured according to International Standard ISO 2534".

10.2.1 Indication of gross power

Qualify "gross power" by the word "ISO".

Example :

ISO gross power : ... kW at : ... rev/min (measured according to International Standard ISO 2534)

10.2.2 Indication of gross torque

Qualify "gross torque" by the word "ISO"

Example :

ISO gross torque : ... N·m at ... rev/min (measured according to International Standard ISO 2534)

10.2.3 Indication of specific fuel consumption

Mention "ISO gross power" between parentheses after "specific fuel consumption".

Example :

ISO specific fuel consumption (gross power — International Standard ISO 2534) : ... g/kWh.

g/kWh.

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