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R 1585

AUTOMOBILES

ENGINE TEST CODE

NET POWER

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BRIEF HISTORY

The ISO Recommendation R 1585, *Automobiles – Engine test code – Net power,* was drawn up by Technical Committee ISO/TC 22, *Automobiles,* the Secretariat of which is held by the Association Française de Normalisation (AFNOR).

Work on this question led to the adoption of Draft ISO Recommendations No. 1585 and No. 1972, which were circulated to all the ISO Member Bodies in July 1968 and March 1970 respectively. Draft No. 1585 was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Belgium	Italy	Sweden
Chile	Netherlands	Switzerland
Czechoslovakia	Poland	Thailand
France	Portugal	U.A.R.
Germany	Romania	United Kingdom
Hungary	South Africa, Rep. of	U.S.S.R.
Israel	Spain	Yugoslavia

The following Member Bodies opposed the approval of the Draft :

Japan
U.S.A.

Draft No. 1972 was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	Ireland	Sweden
Belgium	Japan	U.A.R.
Czechoslovakia	Netherlands	United Kingdom
France	Peru	U.S.A.
Germany	Poland	U.S.S.R.
Greece	Portugal	
Hungary	South Africa, Rep. of	

The following Member Body opposed the approval of the Draft :

Switzerland

These Draft ISO Recommendations were then combined into a single document. The latter was submitted by correspondence to the ISO Council, which decided to accept it as an ISO RECOMMENDATION.

ISO Recommendation | R 1585 | March 1971

AUTOMOBILES

ENGINE TEST CODE

NET POWER

1. SCOPE

This ISO Recommendation describes a method for testing engines designed for automobile vehicles, applicable to the measurement 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.

2. FIELD OF APPLICATION

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

- Internal combustion engine (spark ignition 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.

It applies only to the net power study.

3. DEFINITIONS

3.1 *Net 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 with the standard production auxiliaries necessary to its operation for the particular application.

3.2 *Auxiliaries.* The equipment and devices listed in Table 1.

3.3 *Standard production equipment.* Equipment normally provided by the manufacturer for a particular engine application.

4. ACCURACY OF MEASUREMENTS

4.1 Torque

The dynamometer must be such that the first quarter of its scale is not used. It must give an accuracy within ± 0.5 % of the maximum scale value (excluding the first quarter).

4.2 Engine speed

Engine speed should be measured preferably with a revolution counter and an automatically synchronized chronometer (or counter timer). The accuracy of the measured value should be ± 0.5 %.

4.3 Fuel consumption

± 1 % overall for the apparatus used.

4.4 Engine inlet air temperature

± 1 °C.

4.5 Barometric pressure

± 0.666 mbar.

4.6 Pressure in exhaust extraction duct (see Note (1) to Table 1)

± 0.245 mbar.

* ISO Recommendations are to be prepared concerning the specifications relating to engines for motor-cycles and agricultural tractors. ISO Recommendation R 2288, *Engine test code (bench test) for agricultural tractors – Net power*, is at present at the stage of Draft ISO Recommendation.

5. TESTS

5.1 Auxiliaries

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

The engine should be equipped only with the auxiliaries necessary to make it acceptable for service in the vehicle. (See clauses 5.1.1, 5.1.2 and 5.1.3.)

5.1.1 *Auxiliaries to be fitted.* The auxiliaries which should be fitted during the test for determination of the net power of the engine are listed in Table 1.

5.1.2 *Auxiliaries to be removed.* Certain vehicle accessories necessary only for the operation of the vehicle and which may be mounted on the engine should 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.

TABLE 1 – **Installation of auxiliaries during test for determination of net power of engine**

No.	Auxiliaries	If fitted for net power test
1	Intake system Intake manifold Air filter Intake silencer Crankcase emission control system Speed limiting device	Yes, standard production equipment
2	Induction heating device of intake manifold	Yes, standard production equipment
3	Exhaust system Exhaust purifier Manifold Connecting pipes (1) Silencer Tail pipe (1) Exhaust brake (2)	Yes, standard production equipment
4	Fuel supply pump (3)	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 fitted (4)	Yes, standard production equipment

TABLE 1 – **Installation of auxiliaries during test for determination of net power of engine** *(concluded)*

No.	Auxiliaries	If fitted for net power test
7	Liquid cooling equipment	
	Engine bonnet Bonnet air outlet	No
	Radiator Fan (6)(7) Fan cowl Water pump Thermostat (8)	Yes(5), standard production equipment
8	Air cooling	
	Cowl Fan (6)(7)	Yes, standard production equipment
	Auxiliary test bed fan	Yes, if necessary
	Temperature regulating device	Yes, standard production equipment
9	Electrical equipment	Yes(9), standard production equipment
10	Supercharging equipment (if fitted)	
	Compressor driven either directly or indirectly by the engine, and/or by the exhaust gases Intercooler (10) Coolant pump or fan (engine driven) Coolant flow control device (if fitted)	Yes, standard production equipment
	Auxiliary test bed fan	Yes, if necessary

NOTES TO TABLE 1

(1) If it is impracticable to fit the standard exhaust connecting pipe(s), pipes of equivalent lengths and diameters may be fitted for the test.

In the test laboratory, the exhaust extraction system at the point where the vehicle exhaust system is connected should not, with the engine in operation, create at the exhaust extraction duct a pressure differing from the atmospheric pressure by more than ± 7.35 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 fuel feed pressure may be adjusted, if necessary, to reproduce pressures existing in the particular engine application (particularly where a "fuel return" system is used).

(4) The air intake valve is the control valve for the pneumatic governor of the injection pump.

(5) The radiator, the fan, the fan cowl, the water pump and the thermostat should be located on the test bed in the same relative positions that they will occupy on the vehicle. The cooling liquid circulation should be operated by the engine water pump only.

Cooling may be produced either by the engine radiator or by an external circuit, provided that the pressure loss of this circuit remains substantially the same as that of the engine cooling system. The radiator shutter, if incorporated, should be in the open position.

(6) Where a disconnectable fan is incorporated, the net power should be determined firstly with the fan disconnected, then with the fan connected.

(7) Where a fixed fan, electrically or mechanically operated, cannot be fitted on the test bed, the power absorbed by the fan should be determined at the same engine speeds as those used for the measurement of the engine power. This power should be deducted from the corrected power to obtain the net power.

(8) The thermostat may be fixed in the fully open position.

(9) Minimum power of the generator : the power of the generator should be limited to that necessary for the operation of accessories which are indispensable for the operation of the engine. There should be no charging of the battery during the test.

(10) The temperature of the air at the inlet manifold should be that specified by the engine manufacturer, if such a specification is given.

5.1.3 *Diesel engine starting auxiliaries.* For the auxiliaries used in the starting of Diesel engines, the two following cases should be considered :

(*a*) ELECTRICAL STARTING. The generator is fitted and supplies, where necessary, the auxiliaries indispensable to the operation of the engine.

(*b*) STARTING OTHER THAN ELECTRICAL. If there are any electrically operated accessories indispensable to the operation of the engine, the generator is fitted to supply these accessories. Otherwise, it is removed.

In either case, the system for producing and accumulating the energy necessary for starting is fitted and operates in the unloaded condition.

5.2 Setting conditions

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

TABLE 2 – Setting conditions

1	Setting of carburettor(s)	Set in accordance with the manufacturer's production specifications and used without further alteration for the particular application
2	Setting of injection pump delivery system	Set in accordance with the manufacturer's production specifications and used without further alteration for the particular application
3	Ignition or injection timing	Standard production timing curve specified by the manufacturer and used without further alteration for the particular application

5.3 Test conditions

The net power test should 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.

Performance data should be obtained under stabilized normal operating conditions, with an adequate fresh air supply to the engine. The engines should be run-in in accordance with the manufacturer's recommendations. Combustion chambers of engines may contain deposits, but in limited quantity. Test conditions such as inlet air temperature should be selected as near to reference conditions (see clause 6.2) as possible in order to minimize the magnitude of the correction factor.

The temperature of the inlet air to the engine (ambient air), should 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 should be shielded from radiant heat and located directly in the air stream. It should also be shielded from fuel spray-back. A sufficient number of locations should be used to give a representative average inlet temperature.

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

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

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

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

The coolant outlet temperature in liquid-cooled engines should be controlled at 80 ± 5 °C unless otherwise specified by the manufacturer.

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

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

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

5.4 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.

5.5 Data to be recorded

Data to be recorded are those indicated in section 8.

6. CORRECTION FACTORS

6.1 Definition

Correction factor. A factor K by which the observed power must be multiplied to determine the engine power under the reference atmospheric conditions specified in clause 6.2.

6.2 Reference atmospheric conditions

6.2.1 *Temperature* : 20 °C.

6.2.2 *Total pressure* : 1013 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.

6.3 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 should 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.

6.4 Determination of correction factors

6.4.1 *Spark ignition engines (carburettor or injection) – Factor K_a.* Within the limits defined in clause 6.3, the correction factor is obtained by applying formula (1) :

$$K_a = \left(\frac{1013}{p}\right) \left(\frac{T}{293}\right)^{0.5} \quad \ldots \quad (1)$$

where

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

p is the total atmospheric pressure, in millibars.

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

6.4.2 *Diesel engines – Factor K_d.* Although the formulae given below are recommended at present, they should be considered only as provisional. Studies are being made to establish more accurate formulae which will take into account particularly the fuel/air ratio.

6.4.2.1 CORRECTION FACTOR FOR NATURALLY ASPIRATED DIESEL ENGINES. The correction factor, which applies only at constant fuel delivery, is calculated by means of formula (2) :

$$K_d = \left(\frac{1013}{p}\right)^{0.65} \left(\frac{T}{293}\right)^{0.5} \quad \ldots \quad (2)$$

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

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

where $A = 0.064(1013 - p) + 0.17(T - 293)$

NOTE. – 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 mm^3/litre swept volume or more than 75 mm^3/litre swept volume, the correction should 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 mm^3/litre should be stated in the test report.

6.4.2.2 CORRECTION FACTOR FOR 4-STROKE EXHAUST TURBOCHARGED DIESEL ENGINES. A correction factor equal to 1 should be applied when the ambient air density does not vary by more than ± 5 % from the density under the reference conditions (20 °C, 1013 mbar).

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

NOTE. – *4-stroke mechanically supercharged engines.* For the correction factor of mechanically supercharged engines, the formula applicable to naturally aspirated engines should be used, provided that the following ratio is within the limits specified for naturally aspirated engines :

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

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.

7. MEASUREMENT OF SMOKE VALUE

The smoke value should be measured and recorded at every test point. The opacimeter used, and its installation, should be designed in accordance with ISO Recommendation R . . .*, *Apparatus for measurement of the opacity of exhaust gas from Diesel engines.*

* At present at the stage of draft proposal.

8. TEST REPORT

8.1 Engine data

8.1.1 *Reciprocating engines*

Engine : . . . . 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. : . . . . .

8.1.2 *Rotary trochoidal engines*

Engine : . . . . 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. : . . . . .

* Delete where inapplicable

8.2 Fuel supply

Pump : Make : . . . . . Type : . . . . . Serial No. : . . . . . .

Prefilter : yes* or no* Filter : yes* or no*

8.3 Carburettor

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

Number : . . . . . Detailed specifications : . . . . . .

8.4 Injection pumps or devices

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

Static timing : . . . . . Advance device : . . . . . .

Manufacturer's code : . . . . . .

8.5 Injection nozzles and nozzle holders

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

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

8.6 Governor

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

Cutting-in speed under load : . . . . . rev/min

Maximum no-load speed : . . . . . rev/min

8.7 Ignition system

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

Static timing : . . . . . Advance device : . . . . . .

Maximum range of advance device : . . . . . .

Distributor contact breaker gap : . . . . . .

* Delete where inapplicable.

8.8 Sparking plugs

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

Number per cylinder : . . . . . Electrodes gap : . . . . . .

8.9 Ignition coils

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

Number : . . . . . .

8.10 Heating plugs

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

Number : . . . . . .

8.11 Interference suppressor

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

8.12 Intake system

Intake manifold : . . . . Description : . . . . . .

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

Intake silencer : Make : . . . Type : . . . . . Serial No. : . . . . . .

8.13 Valve gear

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

8.14 Crankcase emission control system

Crankcase emission control system : yes* or no*

Brief description : . . . . . .

Emission valve : open* or closed*

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

8.15 Induction heating device

Type : . . . . . Brief description : . . . . . .

* Delete where inapplicable.

8.16 Exhaust system

Manifold : standard* or not*

Purifier : yes* or no* Brief description : . . . . . .

Pipes : standard* or not* Brief description if not : . . . . . .

Exhaust brake : Make : . . . Type : . . . . . Serial No. : . . . . . .

Silencer : Make : . . . . . Type : . . . . . Serial No. : . . . . . .

8.17 Cooling system

8.17.1 *Liquid*

Nature of the liquid : . . . . . Circulating pump : yes* or no*

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

Radiator : Make : . . . . Type : . . . . . Serial No. : . . . . . .

Pressurizing valve : Make : . . Type : . . . . . Pressure setting : . . . . . .

Fan: Make : . . . . . Type : . . . . . Serial No. : . . . . . .

Fan drive system : . . . . . Drive ratio : . . . .

Fan cowl : yes* or no*

8.17.2 *Air*

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

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

Auxiliary test bed fan : yes* or no*

Temperature regulating system : yes* or no* Brief description : . . . . . .

8.18 Oil cooler yes* or no*

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

8.19 Electrical equipment

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

* Delete where inapplicable.