

COMMISSION OF THE EUROPEAN COMMUNITIES

COM (79) 781 final

Brussels, 10 January 1980

TWO PROPOSALS FOR COUNCIL DIRECTIVES ON THE APPROXIMATION OF THE LAWS OF THE MEMBER STATES RELATING TO THE FUEL CONSUMPTION OF MOTOR VEHICLES AND TO THE ENGINE POWER OF MOTOR VEHICLES RESPECTIVELY

(Submitted by the Commission to the Council)

COM (79) 781 final

EXPLANATORY MEMORANDUM

I. GENERAL

On 15 June 1979, under the Community's programme for energy saving, the Commission forwarded to the Council a proposal for a Resolution on new lines of action by the European Community in the field of energy saving (1). In item 3.1 of this proposal it is agreed that "voluntary indicative targets for the fuel consumption of motor cars and light vans should be established at Community level in cooperation with the automobile industry" and that the Commission should accelerate "the completion of the remaining technical work to develop a standard method of measuring fuel consumption by vehicles".

The importance of a Community method of measuring the fuel consumption of a vehicle is beyond question not only as regards the monitoring of the abovementioned targets for the reduction of consumption but also as regards the supply of objective information to customers and users.

Negotiations are under way with the motor-vehicle manufacturers with a view to reaching agreement on voluntary measures by the latter to restrict fuel consumption. As regards the method of measuring this consumption, the Commission is in a position to put forward a proposal for a Directive, since the basis of this essentially technical text is already available.

At the same time, the Commission is likewise in a position to put forward a proposal for a Directive on a method of measuring the engine power of motor vehicles. These two proposed Directives are part of the procedure for EEC type-approval of motor vehicles and their trailers which was the subject of Council Directive 70/156/EEC of 6 February 1970 (2) and in respect of which a proposed amendment was forwarded to the Council by the Commission in January 1977 (3). In adopting these two proposed Directives, the Council must therefore take prior or simultaneous measures to adopt the corresponding

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(1) OJ No C 208, 18.8.1979, p. 4

(2) OJ No L 42, 23.2.1970, p. 1

(3) COM(76)721 Final of 6 January 1977

amendments to Directive 70/156/EEC. The sections in question are 3.2.5 and 3.2.10, Annex I (minor amendments being required in respect of Notes (s) and (t) of this same annex) and 3.2.1 and 3.2.3, Annex II. Lastly, it should be emphasized that, in formulating these two proposed Directives, the Commission took as its basis work already carried out in this area by the Geneva-based Economic Commission for Europe - a fact which, as far as trade is concerned, must be an added advantage, since a very large number of countries are represented in this organization.

II. COMMENTS ON THE TWO PROPOSED DIRECTIVES

As regards the measurement of fuel consumption, the field of application is limited to motor vehicles of Category M₁ (1). As regards the measurement of engine power, the field of application covers motor vehicles of Categories M (1) and N (1) (Articles 1 and items 2 of the annexes).

Article 2 in each case incorporates into the EEC type-approval procedure the provisions relating to methods of measuring fuel consumption and engine power respectively. In the case of certain Member States which do not at present have a national type-approval procedure it has been necessary to introduce provisions under which the use in these countries of vehicles complying with the requirements of the two Directives can be guaranteed.

Article 3 in each case lays down the procedure for the adaptation to technical progress of the requirements of the annexes. This procedure is set out in Article 13 of Directive 70/156/EEC on the EEC type-approval of motor vehicles and their trailers.

Article 4 in each case lays down the deadline for the entry into force of the provisions necessary in order to comply with the two Directives.

Lastly, the Commission must be informed within a reasonable period of any draft provisions drawn up by the Member States in the fields covered by the two Directives, so as to enable it to put forward any comments it may wish to make on these draft provisions (Articles 4, paragraphs 2).

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(1) As defined in Annex I of Directive 70/156/EEC.

III. CONSULTATION OF THE EUROPEAN PARLIAMENT AND THE ECONOMIC AND SOCIAL COMMITTEE

The opinion of these two bodies is required in accordance with the second paragraph of Article 100 of the EEC Treaty.

PROPOSAL FOR A COUNCIL DIRECTIVE
ON THE APPROXIMATION OF THE LAWS OF THE MEMBER STATES
RELATING TO THE FUEL CONSUMPTION OF MOTOR VEHICLES

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community, and in particular Article 100 thereof,

Having regard to the proposal from the Commission,

Having regard to the opinion of the European Parliament,

Having regard to the opinion of the Economic and Social Committee,

Whereas the technical requirements which motor vehicles must satisfy pursuant to national laws relate, inter alia, to the method of measuring fuel consumption which the manufacturer must use to indicate the fuel consumption of a vehicle type;

Whereas those requirements differ from one Member State to another; whereas it is therefore necessary for all Member States to adopt the same requirements either in addition to or in place of their existing rules, in order, in particular, to allow the EEC type-approval procedure which was the subject of Council Directive 70/156/EEC of 6 February 1970 on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers (1), to be introduced in respect of each type of vehicle;

Whereas the Resolution on new lines of action by the European Community in the field of energy saving (2) calls on the Commission to develop a standard method of measuring fuel consumption by vehicles and to establish, in cooperation with the automobile industry, voluntary indicative targets for the reduction of fuel consumption by motor cars and light vans;

Whereas a Community method of measuring fuel consumption is therefore necessary to monitor compliance with the voluntary indicative targets to be established in the very near future by the European manufacturers for reducing fuel consumption by their vehicles, under an agreement with the Community, and to ensure that customers and users are supplied with objective and precise information;

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(1) OJ No L 42, 23.2.1970, p. 1

(2) A draft Resolution is under discussion in the Council and is published in OJ No C 208, 18.8.79, p. 4.

Whereas the provisions of this Directive apply only to motor vehicles of Category M₁, in accordance with the international motor-vehicle classification scheme set out in Directive 70/156/EEC;

whereas a method of measuring the fuel consumption of the other categories of motor vehicle will be developed as soon as certain technical difficulties can be resolved,

HAS ADOPTED THIS DIRECTIVE:

Article 1

For the purposes of this Directive, "vehicle" means any motor vehicle intended for use on the road, with or without bodywork, having at least four wheels and a maximum design speed exceeding 25 km/h, with the exception of vehicles which run on rails and of agricultural tractors and machinery.

Article 2

No Member State may refuse to grant EEC type-approval or national type-approval in respect of a vehicle, nor refuse or prohibit the sale, registration, entry into service or use of a vehicle, on any grounds relating to the fuel consumption of the data that appear in the Information Document (Annex I to Directive 70/156/EEC) have been determined by the method described in the Annex hereto.

Article 3

The amendments necessary for adapting the provisions of the Annex to take account of technical progress shall be adopted in accordance with the procedure laid down in Article 13 of Directive 70/156/EEC.

Article 4

1. Member States shall bring into force the provisions necessary in order to comply with this Directive within eighteen months of its notification. They shall forthwith inform the Commission thereof.
2. Once this Directive has been notified, the Member States shall ensure that the Commission is informed, in sufficient time for it to submit its comments, of any draft laws, regulations or administrative provisions which they propose to adopt in the field covered by this Directive.

Article 5

This Directive is addressed to the Member States.

ANNEX

METHOD OF MEASURING THE FUEL CONSUMPTION

1. OBJECT

These requirements describe a conventional method of measuring the fuel consumption of vehicles of category M₁ as defined in Annex I of Directive 70/156/EEC which provides a basis for comparing the different models of vehicles.

2. SCOPE

This method applies to vehicles of category M₁ equipped with internal combustion engines.

3. GENERAL SPECIFICATIONS

3.1. Fuel consumption shall be determined by the following tests:

3.1.1. Cycle simulating urban driving, as described in Annex III of Directive 70/220/EEC (item 5 below);

3.1.2. Constant speed test at 90 km/h (item 6 below);

3.1.3. Constant speed test at 120 km/h (item 6 below) */

3.2. The results of the tests shall be expressed in litres/100 km.

3.3. Distances shall be measured to within an accuracy of 2 per mil and times to within an accuracy of 2/10 s.

3.4. Test fuel

The fuel used shall be, as the case may require, the reference fuel specified in Annex VI of Directive 70/220/EEC or that specified in Annex V of Directive 72/306/EEC.

*/ This test shall not be made if the vehicle's maximum design speed is less than 130 km/h.

4. TEST CONDITIONS

4.1. General condition of the

4.1.1. The vehicle shall be clean, the windows and air intakes closed, and only the equipment necessary for the operation of the vehicle during the test in use. If there is a manually controlled device on the carburettor inlet for air heating, it shall be in the "summer" position. In general, the auxiliary devices required for the normal operation of the vehicle shall be in use.

4.1.2. If the radiator fan is temperature-controlled, it shall be in the condition of normal operation on the vehicle. The passenger compartment heating system shall be switched off, and so shall the air conditioning system, but its compressor shall function normally.

4.1.3. If a supercharger is fitted it shall be in the normal operating condition for the test condition.

4.1.4. The vehicle shall have been run in and shall have been driven for at least 3,000 km before the test.

4.2. Lubricants

All the lubricants shall be those recommended by the manufacturer of the vehicle and shall be indicated in the report of the test.

4.3. Tyres

The tyres shall be of a type specified as original equipment by the vehicle manufacturer and shall be inflated to the pressure recommended for the test load and speeds (adapted if appropriate, for bench operation at the test condition). These pressures are to be indicated in the test report.

4.4. Fuel Monitoring

4.4.1. Fuel shall be supplied to the engine through a device capable of measuring the quantity consumed to within + 2 per cent; this device shall not interfere with normal supply. If the system of measurement is volumetric, the temperature of the fuel in the burette shall be measured.

4.4.2. A valve system shall be used for rapid change-over from the normal fuel supply line to the measuring system. The change-over shall not take longer than 0.2 s.

4.5. Reference conditions

Pressure: $H_0 = 1,000 \text{ mbar}$
Temperature: $T_0 = 293 \text{ }^\circ\text{K} (20^\circ\text{C})$

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4.5.1. Air density

4.5.1.1. The air density when the vehicle is tested, calculated as described in item 4.5.1.2. below, shall not differ by more than 7.5 per cent from the air density under the reference conditions.

4.5.1.2. The air density shall be calculated by the formula:

$$d_T = d_o \times \frac{H_T}{H_o} \times \frac{T_o}{T_T}, \text{ where}$$

d_T = air density at test conditions;

d_o = air density at reference conditions;

H_T = test pressure;

T_T = absolute temperature during the test. ($^{\circ}$ K)

5. MEASUREMENT OF FUEL CONSUMPTION ON A CYCLE SIMULATING URBAN DRIVING

5.1. The test cycle shall be that described in annex III of directive 70/220/EEC

5.1.1. Reference Weight of the vehicle

The mass of the vehicle shall be the reference mass, as defined in item 1.2. of Annex I of Directive 70/220/EEC

5.2. The dynamometer bench will be set with the equivalent inertia as stipulated in item 4.2. of Annex III of Directive 70/220/EEC

5.3. Measurement of consumption

5.3.1. Consumption shall be determined from the quantity of fuel consumed during two consecutive cycles.

5.3.2. The engine shall be warmed up from a cold start by carrying out five complete cycles before any measurement is made or carried out immediately after the type I and type II tests defined in Directive 70/220/EEC. The temperature shall be kept within the normal operating range for that engine if necessary by using the auxiliary cooling device.

5.3.3. The idling period between consecutive pairs of cycles may be extended by not more than 60s to facilitate fuel measurement.

5.4. Calculation of results

5.4.1. If the fuel consumption is measured gravimetrically, the consumption shall be expressed (in litres/100 km) by converting the measurement M (fuel consumed expressed in kilgrammes) by means of the following formula:

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

where:

Sg = specific mass of the fuel in the reference conditions (kg/dm³);

D = distance covered during the test (km).

5.4.2. If the fuel consumption is measured volumetrically, the consumption shall be expressed (in litres/100 km) by the following formula:

$$C = \frac{V (1 + \alpha (T_o - T_F))}{D} \quad 100 \text{ litres/100 km}$$

where:

V = measured volume in litres of fuel consumed.

α = coefficient of volumetric expansion for the fuel. For both diesel and petrol fuel this is 0.001 per degree C

T_o = Reference Temperature expressed in °C

T_F = Fuel Temperature measured at the burette expressed in °C

5.5. Presentation of results

5.5.1. The standard consumption in urban driving shall be the arithmetic mean of three consecutive measurements carried out in accordance with the procedure described above.

5.5.2. If the extreme measurements differ by more than 5 per cent from the mean value, further tests shall be carried out in accordance with this procedure order to obtain a degree of accuracy of measurement at least equal to 5 per cent.

5.5.3. The accuracy of measurement shall be calculated by the formula:

$$\text{Accuracy} = k \times \frac{S}{\sqrt{n}} \times \frac{100}{\bar{C}} \text{ per cent}$$

where:

C is derived from the formulae in paragraph 5.4.

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

n is the number of measurements taken

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

k is given by 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

5.5.4. If an accuracy of 5 per cent has not been attained after 10 measurements, the consumption shall be determined by using another vehicle if the same type.

6. MEASUREMENT OF FUEL CONSUMPTION AT CONSTANT SPEED

6.1. These tests may be carried out either on a dynamometer bench or on the road.

6.1.1. Mass of the vehicle

The mass of the vehicle shall be the mass in running order, as defined below, plus 180 kg, or plus half the full load if that is more than 180 kg including measuring equipment and occupants. The trim of the vehicle shall be that obtained when the centre of gravity of the load is in the middle of the straight line joining the R points of the front (side) seats.

The mass of the vehicle in running order is its total unladen mass with all tanks except the fuel tank full, the fuel tank being filled to 90 per cent of the capacity specified by the manufacturer, and a set of tools and the spare wheel on board.

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6.2. Gear-box

If the vehicle is fitted with a manual gear change, the gear ratio used shall be the highest recommended by the manufacturer for driving at each of the test speeds.

6.3. Test procedure

6.3.1. Road test

6.3.1.1. Weather conditions

6.3.1.1.1 The relative humidity shall be less than 95 per cent; the road shall be dry; the road surface may, however, bear traces of moisture, provided that there is no appreciable film of water in any area.

6.3.1.1.2 The average wind speed shall be less than 3 m/s and gusts less than 8 m/s.

6.3.1.2. Before any measurements are taken, the vehicle shall travel on the chosen circuit at a speed close to the test speed, a sufficient distance for the running temperature to be reached, but in any case at least 10 km.

6.3.1.3. Test run

The test run shall allow a steady speed to be maintained. The run shall be at least 2 km in length. It shall form a closed circuit and the surface shall be in good condition. A straight road may be used, however provided that the run of 2 km is made in both directions. The gradient shall not exceed ± 2 per cent between any two points.

6.3.1.4. To determine the consumption at a steady reference speed (see graph below), 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.

6.3.1.5. During each test run, the speed shall be kept steady within ± 2 km/h. The average speed for each test shall not differ from the reference speed by more than 2 km/h.

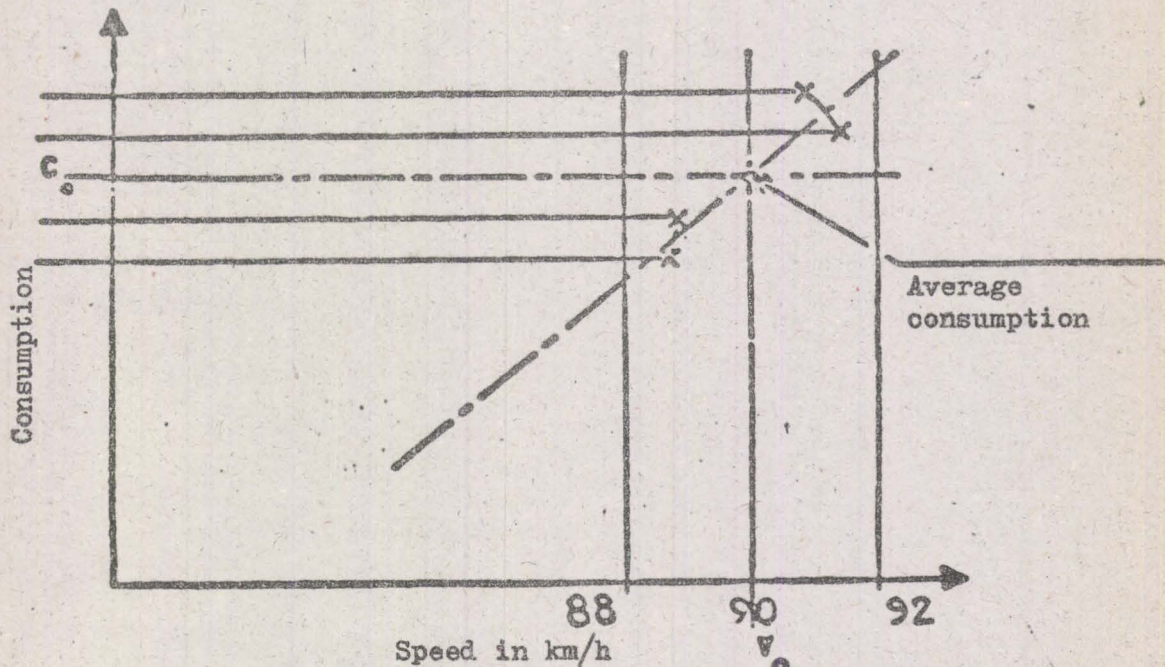
6.3.1.6. The fuel consumption for each test run shall be calculated from the formulae in item 5.4.

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

6.3.1.7.1 If the condition in item 6.3.1.7. 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 vehicle must be selected and subjected to all the tests specified in this procedure.

Example: Calculation for an average speed of 90 km/h .



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.

6.3.2. Dynamometer bench test

6.3.2.1. Dynamometer bench setting

The bench shall be set as described in item 4.1. of Annex III of Directive 70/220/EEC with the following modifications:

- the bench shall be set for the appropriate test speed;
- the condition of the vehicle during the test runs shall be as specified in items 4.1. to 4.3., and the weather conditions during the road test to determine the correct inlet manifold depression setting shall be as specified in item 6.3.1.2.

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6.3.2.2. Cooling

Additional air cooling devices shall be used in order to keep the operating conditions and the temperature of the lubricants and coolant within the range normally obtained at the same speed on the road.

6.3.2.3. Before any measurements are taken, the vehicle shall be run on the bench, at a speed close to the test speed, a sufficient distance for the running temperatures to be reached, but in any case not less than 10 km.

6.3.2.4. The test distance shall not be less than 2 km measured by a revolution counter on the bench.

6.4. The type of test bench used shall be indicated in the test report.

7. PRESENTATION OF RESULTS

7.1. Whatever the method of measurement used, the results shall be expressed in volume under the reference conditions specified in item 4.5.

7.2. The fuel consumption results obtained and also the fuel consumption as a function of speed are indicated in the owner's manual by the vehicle manufacturer.

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HAS ADOPTED THIS DIRECTIVE:

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No Member State may refuse to grant EEC type-approval or national type-approval in respect of a vehicle, nor refuse or prohibit the sale, registration, entry into service or use of a vehicle, on any grounds relating to engine power of the data that appear in the Information Document (Annex I to Directive 70/156/EEC) have been determined by the method described in the Annex hereto.

Article 3

The amendments necessary for adapting the provisions of the Annexes to take account of technical progress shall be adopted in accordance with the procedure laid down in Article 13 of 70/156/EEC.

Article 4

1. Member States shall bring into force the provisions necessary in order to comply with this Directive within eighteen months of its notification. They shall forthwith inform the Commission thereof.
2. Once this Directive has been notified, the Member States shall ensure that the Commission is informed, in sufficient time for it to submit its comments, of any draft laws, regulations or administrative provisions which they propose to adopt in the field covered by this Directive.

Article 5

This Directive is addressed to the Member States.

ANNEX

METHOD OF MEASURING ENGINE POWER

1. PURPOSE

These provisions describe a method of constructing curves of the power of an engine as a function of its speed of revolution.

2. SCOPE

- 2.1. This method concerns internal-combustion engines, used for the propulsion of category M and N vehicles as defined in Annex I to Directive 70/156/EEC, belonging to either of the following types:
 - 2.1.1. Internal-combustion piston engines (positive-ignition or diesel), excluding free-piston engines;
 - 2.1.2. Rotary-piston engines.
- 2.2. These engines may be naturally aspirated or supercharged, fitted with a mechanical supercharger or a turbocharger.

3. DEFINITIONS

For the purposes of this Directive,

- 3.1. "Net power" means the power obtained on the test bed at the end of the crankshaft or its equivalent at the corresponding engine speed with the auxiliaries listed in table 1. If the power measurement can be carried out with a mounted gear-box only, the efficiency of the gear-box shall be taken into account.
- 3.2. "Available power" means that part of the net power, which is calculated according to the provisions of appendix 4;
- 3.3. "Standard-production equipment" means equipment provided by the manufacturer for a particular application.

4. ACCURACY OF THE MEASUREMENTS OF FULL LOAD POWER

4.1. Torque

The capacity of the dynamometer must be such that, with the exception below, the first quarter of its scale is not used. The measuring system must give an accuracy within + 0,5 per cent of the maximum scale value (excluding the first quarter). The scale region from one sixth to one quarter may be used if the system accuracy at one sixth scale is within + 0.25 per cent of the maximum scale value.

4.2. Engine speed

Engine speed shall preferably be measured with an automatically-synchronized revolution counter and chronometer (or counter-timer). The accuracy of measurement shall be ± 0.5 per cent.

4.3. Fuel consumption

± 1 per cent overall for the apparatus used.

4.4. Engine inlet air temperature

$\pm 2.0^{\circ}\text{C}$.

4.5. Barometric pressure

± 2 mbar.

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

4.7. Pressure in intake-duct: ± 0.5 mbar

4.8. Pressure in exhaust duct: ± 2 mbar

5. NET POWER OF THE ENGINE

5.1. Tests

5.1.1. Auxiliaries

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

5.1.1.1. Auxiliaries to be fitted. The auxiliaries to be fitted during the test for determination of the net power of the engine are listed in table 1 below.

5.1.1.2. Auxiliaries to be removed. Certain vehicle accessories which are necessary only for the operation of the vehicle and which may be mounted on the engine shall be removed for the test. The following non-exhaustive list is given as a sample:

- air compressor for brakes;
- power steering compressor;
- suspension compressor;
- air-conditioning system;
- cooling equipment for hydraulic transmission and/or gear-box oil.

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 - Auxiliaries to be fitted for the test to determine 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 ^{1/}
2	Induction heating device (if possible it shall be set in the most favourable position)	Yes, standard-production equipment
3	Exhaust system Exhaust purifier Manifold Connecting pipes Silencer Tail pipe Exhaust brake ^{2/}	Yes, standard-production equipment ^{1/}
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/} Governor/Control System Automatic full-load stop for the control rack depending on atmospheric conditions	Yes, standard-production equipment

(See footnotes at end of table)

TABLE 1 (continued)

No.	Auxiliaries	If fitted for net power test
7	Liquid cooling equipment Engine bonnet Bonnet air outlet Radiator Fan <u>6/</u> Fan cowl Water pump Thermostat <u>7/</u>	No Yes, standard-production equipment <u>5/</u>
8	Air cooling Cowl Blower <u>5/ 6/</u> Temperature regulating device	Yes, standard-production equipment Yes, standard-production equipment
9	Electrical equipment	Yes, standard-production equipment <u>8/</u>
10	Supercharging equipment Compressor driven either directly or indirectly by the engine, and/or by the exhaust gases Intercooler <u>2/</u> Coolant pump or fan (engine-driven) Coolant flow control device	Yes, standard-production equipment
11	Anti-pollution device	Yes, standard production equipment

1/ The complete standard exhaust and intake systems provided for the vehicle must be used in cases where they may have an appreciable effect on the power of the engine (two-stroke engine, positive-ignition engine, etc.) or when the manufacturer so requests. In other cases a check shall be made merely to verify that the back pressure at the outlet of the exhaust manifold does not differ by more than 10 mbar from the maximum back pressure specified by the manufacturer and that the pressure in the intake manifold does not differ by more than 1 mbar from the limit specified by the manufacturer for a clean air filter. These conditions may be created also with the test bed equipment.

(footnotes continued on next page)

When a complete exhaust system is used in the test laboratory, the exhaust extraction system shall not, with the engine in operation, create in the exhaust extraction duct, at the point where it is connected with the exhaust system of the vehicle a pressure differing from the atmospheric pressure by more than 10 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 must be fixed in the fully open position.

3/ The fuel feed pressure may be adjusted, if necessary, to reproduce pressures existing in the particular engine application especially when a "fuel return" system is used.

4/ The air intake valve is the control valve for the pneumatic governor of the injection pump. The governor or the fuel injection equipment may contain other devices which may affect the amount of injected fuel.

5/ The radiator, the fan, the fan cowl, the water pump and the thermostat shall be located in the same relative positions as on the vehicle. The cooling-liquid circulation shall be operated by the engine water pump only. Cooling of the liquid may be produced either by the engine radiator or by an external circuit, provided that the pressure loss of this circuit and the pressure at the pump inlet remain substantially the same as those of the engine cooling system. The radiator shutter, if incorporated, shall be in the open position.

Where the fan, radiator and cowl system cannot conveniently be fitted to the engine, the power absorbed by the fan when separately mounted in its correct position in relation to the radiator and cowl (if used), must be determined at the speeds corresponding to the engine speeds used for measurement of the engine power either by calculation from standard characteristics or by practical tests. This power corrected to the standard atmospheric conditions defined in point 5.2.2. should be deducted from the corrected power.

6/ Where a disconnectable fan or blower is incorporated, the test shall be made with the fan (or blower) connected.

7/ The thermostat may be fixed in the fully open position.

8/ Minimum power of the generator: 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 (including electrically driven cooling fan). If the connexion of a battery is necessary, a fully charged battery in good order must be used.

9/ The temperature of the air at the inlet manifold shall not exceed that specified by the engine manufacturer, if such a specification is given.

Charge air cooler:

Cooling of the charge air may be performed either by the engine charge air cooler or by an external cooling system, provided that the pressure and temperature of the air at the charge air cooler outlet are equivalent to those of the original system specified by the engine manufacturer.

- 5.1.1.3. Diesel engine starting auxiliaries. For the auxiliaries used in the starting of diesel engines, the two following cases shall be considered:
 - 5.1.1.3.1. Electrical starting. The generator is fitted and it supplies, where necessary, the auxiliaries indispensable to the operation of the engine.
 - 5.1.1.3.2. 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.

5.1.2. Setting conditions

The setting conditions for the test to determine 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 of injection timing	Standard-production timing curve specified by the manufacturer and used without further alteration for the particular application
4	Setting of governor	Set in accordance with the manufacturer's production specifications and used without further alteration for the particular application

5.1.3. Net Power Tests

- 5.1.3.1. The net power test shall consist of a run at full throttle for positive-ignition engines and at fixed full-load injection-pump setting for diesel engines, the engine being equipped as specified in table 1.
- 5.1.3.2. Performance data shall be obtained under stabilized operating conditions, with an adequate fresh-air supply to the engine. The engines shall be run-in in accordance with the manufacturer's recommendations. Combustion chambers may contain deposits, but in limited quantity. Test conditions such as inlet air temperature shall be selected as near to reference conditions (see paragraph 5.2) as possible in order to minimize the magnitude of the correction factor.

- 5.1.3.3. The temperature of the inlet air to the engine shall be measured within 0.15 m upstream from 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 placed 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. The air flow shall not be deteriorated by the measuring device.
- 5.1.3.4. No data shall be taken until torque, speed and temperature have been maintained substantially constant for at least 1 minute.
- 5.1.3.5. The engine speed during a run for measurement shall not deviate from the selected speed during the readings by more than ± 1 per cent or ± 10 rev/min, whichever is greater.
- 5.1.3.6. Observed brake load, fuel consumption and inlet air temperature data shall be taken simultaneously and shall be the average of two stabilized values differing by less than 2 per cent for brake load and fuel consumption.
- 5.1.3.7. A time of measurement of not less than 60 seconds shall be used when measuring speed and fuel consumption by hand operation.
- 5.1.3.8. Fuel
- 5.1.3.8.1. In the case of diesel engines, the fuel used shall be as specified in Annex V to Directive 72/306/EEC with the addition, if necessary, of a commercial liquid or gaseous fuel recommended by the manufacturer. The fuel shall not contain any smoke-suppressant additives.
- 5.1.3.8.2. In the case of positive ignition engines, the fuel used shall be a commercial fuel, without any supplementary additive, chosen by the laboratory in accordance with the manufacturer's specifications.
- 5.1.3.9. Cooling of the engine
- 5.1.3.9.1. Liquid-cooled engines The temperature of the coolant at the outlet from the engine shall be kept within $\pm 5^{\circ}\text{C}$ from the upper thermostatic controlled temperature specified by the manufacturer. If no temperature is specified by the manufacturer, the temperature shall be $80 \pm 5^{\circ}\text{C}$.

5.1.3.9.2. Air cooled engines

For air-cooled engines, the temperature at a point indicated by the manufacturer shall be kept between the maximum value T_M specified by the manufacturer and $T_M - 20^\circ\text{C}$.

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

5.1.3.11. 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 manufacturer.

5.1.3.12. The exhaust gas temperature shall be measured at a point in the exhaust pipe(s) adjacent to the outlet flange(s) of the exhaust manifold(s). It must not exceed the value specified by the manufacturer.

5.1.3.13. Auxiliary cooling system

An auxiliary cooling system may be used if necessary to maintain the temperatures within the limits specified in points 5.1.3.9. to 5.1.3.12.

5.1.4. Test procedure

Take measurements at a sufficient number of engine speeds to define the full load power curve completely between the lowest and the highest engine speeds recommended by the manufacturer. This range of speeds must include the speed of revolution at which the engine produces its maximum power. The average of two stabilized measurements is to be determined.

5.1.5. Measurement of smoke index

In the case of diesel engines, the exhaust gases shall be examined during the test for compliance with the conditions set out in Annex VI to Directive 72/306/EEC.

5.2. Correction factors

5.2.1. Definition

The correction factor is the coefficient K by which the observed power must be multiplied to determine the engine power under the atmospheric reference conditions specified in point 5.2.2.

5.2.2. Atmospheric conditions of reference

5.2.2.1. Temperature: 25°C.

5.2.2.2. Total pressure: 1,000 mbar, including water vapour pressure.

5.2.3. Conditions to be complied with in the laboratory

For a test to be valid, the correction factor K must be such that $0.96 \leq K \leq 1.06$.

5.2.4. Determination of correction factors

5.2.4.1. Positive-ignition engines (carburettor or injection) - factor K_a
The correction factor is obtained by applying formula (1):

$$K_a = \frac{(1,000)}{(p)} \left(\frac{T}{298} \right)^{0.5} \dots (1)$$

where

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

p is the atmospheric pressure, in millibars.

5.2.4.2. Diesel engines - factor K_d

5.2.4.2.1. Naturally-aspirated four-stroke diesel engines, and two-stroke diesel engines

The correction factor is calculated by means of formula (2):

$$K_d = \frac{(1,000)}{(p)} 0.65 \left(\frac{T}{298} \right)^{0.5} \dots (2)$$

5.2.4.2.2. Pressure-charged four-stroke diesel engines

5.2.4.2.2.1. Exhaust-driven turbo-supercharged engines

No correction shall be made to the power. However, when the density of the ambient air differs by more than 5 per cent from the air density in the reference conditions (25°C and 1,000 mbar), the test conditions shall be noted in the test report.

5.2.4.2.2.2. Mechanically-supercharged engines

5.2.4.2.2.2.1. The ratio r shall be defined by formula (3):

$$r = \frac{D}{\frac{V(P_2)}{(P_1)} \frac{(T_1)}{(T_2)}} \dots (3)$$

where:

D is the amount of fuel delivered, in mm³, for each engine cycle;

V is the cylinder capacity of the engine, in litres;

P₁ is the ambient pressure;

P₂ is the pressure at the engine inlet manifold;

T₁ is the ambient temperature, in Kelvins (as defined in paragraph 5.1.3.3.)

T₂ is the temperature at the engine inlet manifold, in Kelvins.

5.2.4.2.2.2.2. The correction factor for mechanically-supercharged engines shall be the same as that for naturally aspirated engines, provided r is equal to or greater than 50 mm³/litre, and it shall be equal to 1 if r is less than 50 mm³/litre.

5.3. TEST REPORT

The test report shall contain the results and all the calculations required to find the net power, as listed in appendix 3, together with the characteristics of the engine listed in appendix 1 or appendix 2 to this annex.

5.4. MODIFICATION OF ENGINE TYPE

Any modification of the engine with regard to the characteristics listed in appendix 1 or appendix 2 to this annex must be reported to the competent administration. That administration may then either:

5.4.1. consider that the modifications made are not liable to have any substantial effect on the power of the engine, or

5.4.2. request the laboratory conducting the tests to determine the power of the engine again by carrying out such tests as it deems necessary.

Appendix 1

ESSENTIAL CHARACTERISTICS OF THE ENGINE^{1/}
(Diesel engines)

- 1. Description of engine
- 1.1. Make
- 1.2. Type
- 1.3. Cycle: four-stroke/two-stroke^{2/}
- 1.4. Bore mm
- 1.5. Stroke mm
- 1.6. Number and layout of cylinders and firing order
- 1.7. Cylinder capacity cm³
- 1.8. Compression ratio^{3/}
- 1.9. Drawings of combustion chamber and piston crown
- 1.10. Minimum cross-sectional area of inlet and outlet ports
- 1.11. System of cooling
- 1.11.1. Liquid
- Nature of liquid Circulating pumps: yes/no^{2/}
- Characteristics or make(s) and type(s)
- Drive ratio
- Thermostat: setting:
- Radiator: drawing(s) or make(s) and type(s):
- Relief valve pressure setting:
- Fan: characteristics or make(s) and type(s):
- Fan drive system: Drive ratio:
- Fan cowl:

^{1/} In the case of non-conventional engines and systems, particulars equivalent to those referred to here shall be supplied by the manufacturer.

^{2/} Strike out what does not apply.

^{3/} Specify the tolerance.

- 1.11.2. Air
 Blower: characteristics or make(s) and type(s): Drive ratio:
 Air ducting (standard production):
 Temperature regulation system: yes/no^{2/} Brief description
- 1.11.3. Temperatures permitted by the manufacturer
- 1.11.3.1. Liquid cooling: Maximum temperature at outlet
- 1.11.3.2. Air cooling: Reference point
 Maximum temperature at reference point
- 1.11.3.3. Maximum outlet temperature of the inlet intercooler
- 1.11.3.4. Maximum exhaust temperature at the point indicated in
 point 5.1.3.12. above:
- 1.11.3.5. Fuel temperature: min. max.
- 1.11.3.6. Lubricant temperature: min. max.
- 1.12. Supercharger: with/without^{2/} Description of the system
- 1.13. Intake system
 Intake manifold: Description
- Air filter: Make Type
- Intake silencer: Make Type
- 2. Additional anti-smoke devices (if any, and if not covered by
 another heading)
 Description and diagrams
- 3. Air intake and fuel feed
- 3.1. Description and diagrams of air intakes and their accessories
 (Heating device, intake silencer, etc.)

- 3.2. Fuel feed

^{2/} Strike out what does not apply.

Appendix 2

ESSENTIAL CHARACTERISTICS OF THE ENGINE^{1/}

(Positive-ignition engines)

- 1. Description of engine
- 1.1. Make
- 1.2. Type
- 1.3. Cycle: four-stroke/two-stroke^{2/}
- 1.4. Bore mm
- 1.5. Stroke mm
- 1.6. Number and layout of cylinders and firing order
- 1.7. Cylinder capacity cm³
- 1.8. Compression ratio^{3/}
- 1.9. Drawings of combustion chamber and piston crown
- 1.10. Minimum cross-sectional area of inlet and outlet ports
- 1.11. System of cooling
- 1.11.1 Liquid
- Nature of liquid Circulating pump: yes/no^{2/}
- Characteristics or make(s) and type(s)
- Drive ratio
- Thermostat: setting
- Radiator: Drawing(s) or make(s) and type(s)
- Relief valve: pressure setting:
- Fan: Characteristics or make(s) and type(s):
- Fan drive system: Drive ratio:
- Fan cowl:

^{1/} In the case of non-conventional engines and systems, particulars equivalent to those referred to here shall be supplied by the manufacturer.

^{2/} Strike out what does not apply.

^{3/} Specify the tolerance.

1.11.2. Air

Blower: Characteristics or make(s) and type(s) Drive ratio:
 Air ducting (standard production):
 Temperature regulating system: yes/no^{2/} Brief description

1.11.3. Temperatures permitted by the manufacturer

1.11.3.1. Liquid cooling: Maximum temperature at engine outlet

1.11.3.2. Air cooling: Reference point
 Maximum temperature at reference point

1.11.3.3. Maximum outlet temperature of the inlet intercooler

1.11.3.4. Maximum exhaust temperature at the point indicated in point 5.1.3.12. above

1.11.3.5. Fuel temperature: min. max.

1.11.3.6. Lubricant temperature: min. max.

1.12. Supercharger with/without.^{2/} Description of the system

1.13. Intake system

Intake manifold: Description

Air filter: Make Type

Intake silencer: Make Type

2. Additional anti-pollution devices (if any, and if not covered by another heading)

Description and diagrams

3. Air intake and fuel feed

3.1. Description and diagrams of inlet pipes and their accessories (dash-pot, heating device, additional air intakes, etc.)

3.2. Fuel feed

3.2.1. by carburettor(s)^{2/} Number

^{2/} Strike out what does not apply

- 3.2.1.1. Make
- 3.2.1.2. Type
- 3.2.1.3. Adjustments
 - 3.2.1.3.1. Jets.....) (
 - 3.2.1.3.2. Venturis) (Curve of fuel delivery
 - 3.2.1.3.3. Float-chamber level) or (plotted against air flow,
 - 3.2.1.3.4. Weight of float) (and settings required to
 - 3.2.1.3.5. Float needle) (keep to the curve ^{2/}
- 3.2.1.4. Manual/automatic choke^{2/} Closure setting^{3/}
- 3.2.1.5. Feed pump
 - Pressure^{3/} or characteristic diagram^{3/}
- 3.2.2. Injection system
 - 3.2.2.1. Make(s)
 - 3.2.2.2. Type(s)
 - 3.2.2.3. Description (General)
 - 3.2.2.4. Calibration bars ^{2/ 3/}
 - or characteristic diagram^{2/ 3/}
- 4. Valve timing or equivalent data
 - 4.1. Maximum lift of valves, angles of opening and closing, or timing details of alternative distribution systems, in relation to top dead centre
 - 4.2. Reference and/or setting ranges^{2/}
- 5. Ignition
 - 5.1. Ignition system type
 - 5.1.1. Make
 - 5.1.2. Type
 - 5.1.3. Ignition advance curve^{3/}
 - 5.1.4. Ignition timing^{3/}
 - 5.1.5. Contact-point gap^{2/ 3/} and dwell-angle^{2/}
- 6. Exhaust system
 - Description and diagrams

^{2/} Strike out what does not apply

^{3/} Specify the tolerance

- 7. Lubrication system
- 7.1. Description of system
- 7.1.1. Position of lubricant reservoir:
- 7.1.2. Feed system (by pump, injection into intake, mixing with fuel, etc.) ...
.....
- 7.2. Lubricating pump^{2/}
- 7.2.1. Make:
- 7.2.2. Type:
- 7.3. Mixture with fuel^{2/}
- 7.3.1. Percentage:
- 7.4. Oil cooler: with/without^{2/}
- 7.4.1. Drawing(s) or make(s) and type(s)
- 8. Electrical equipment
- Generator/alternator^{2/} Characteristics or make(s) and type(s)
-
- 9. Other auxiliaries fitted on the engine
(Enumeration and brief description if necessary)
- 10. Additional information on test conditions
- 10.1. Sparking plugs
- 10.1.1. Make
- 10.1.2. Type
- 10.1.3. Spark-gap setting
- 10.2. Ignition coil
- 10.2.1. Make
- 10.2.2. Type
- 10.3. Ignition condenser
- 10.3.1. Make
- 10.3.2. Type
- 10.4. Radio interference suppression equipment
- 10.4.1. Make
- 10.4.2. Type

^{2/} Strike out what does not apply.

Appendix 3

STATEMENT OF THE RESULTS OF TESTS FOR MEASURING NET ENGINE POWER

1. Trade name or mark of the engine
2. Type and identification number of engine
3. Manufacturer's name and address
4. Name and address of manufacturer's representative, if any
5. Test conditions
- 5.1. Pressures measured at maximum power
- 5.1.1. barometric mbars
- 5.1.2. exhaust mbars
- 5.1.3. Inlet depression: mbars at engine intake system
- 5.2. Temperatures measured at full load and with the engine speed at maximum power:
- 5.2.1. of the intake air °C
- 5.2.2. at the outlet of the engine intercooler °C
- 5.2.3. of the cooling fluid:
- 5.2.3.1. at the engine cooling fluid outlet °C^{*/}
- 5.2.3.2. at the reference point in the case of air cooling °C^{*/}
- 5.2.4. of the oil °C (indicate point of measurement)
- 5.2.5. of the fuel:
- 5.2.5.1. at the carburettor/injection pump intake^{*/} °C
- 5.2.5.2. in the fuel-consumption measuring device °C
- 5.2.6. of the exhaust measured at the point adjacent to the outlet flange(s) of the exhaust manifold(s) °C
- 5.3. Engine speed when idling r.p.m.
- 5.4. Characteristics of the dynamometer:
- 5.4.1. Make
- 5.4.2. Type
- 5.5. Characteristics of the opacimeter:
- 5.5.1. Make
- 5.5.2. Type

^{*/} Strike out what does not apply.

- 5.6. Fuel
- 5.6.1. For positive-ignition engines operating on liquid fuel
- 5.6.1.1. Make:
- 5.6.1.2. Specification
- 5.6.1.3. Anti-knock additive (lead, etc.)
- 5.6.1.3.1. Type:
- 5.6.1.3.2. Content mg/litre
- 5.6.1.4. Octane number
- 5.6.1.4.1. RON No.
- 5.6.1.4.2. MON No.
- 5.6.1.5. Relative density: at 15°/4°C ..
- 5.6.1.6. Calorific value: kJ/kg
- 5.6.2. For positive ignition engines operating on gaseous fuel
- 5.6.2.1. Make:
- 5.6.2.2. Specification
- 5.6.2.3. Storage pressure:
- 5.6.2.4. Utilization pressure:
- 5.6.3. For diesel engines operating on gaseous fuels
- 5.6.3.1. Feed system: gas
- 5.6.3.2. Specification of gas used
- 5.6.3.3. Fuel oil/gas proportion
- 5.6.4. For diesel engines operating on liquid fuel
- 5.6.4.1. Make:
- 5.6.4.2. Specification of fuel used
- 5.6.4.3. Cetane number
- 5.6.4.4. Relative density: at 15°/4°C
- 5.7. Lubricant
- 5.7.1. Make:
- 5.7.2. Specification
- 5.7.3. SAE viscosity:

6. Detailed results of measurements

6.1. Engine performance

Engine speed (r.p.m.)							
Engine test results	Specific fuel consumption g/kWh * Kj/KWh ✓						
	Torque Nm						
	Power kW						
Correction factor							
Corrected brake power kW							
Corrected fuel consumption ^{**/}							
Corrected torque Nm							
Power to be added for auxiliaries fitted in excess of table 1. (See appendix 1, paragraph 8, and appendix 2, paragraph 9) Power to be subtracted when fan not fitted (see table 1 note 5/)	No. 1						
	No. 2						
	No. 3						
Net power kW							
Net torque Nm							

* / Delete whichever does not apply.

** / Applicable to diesel engine only.

6.2. Exhaust smoke index (to be completed for diesel engines only):

Engine speed (r.p.m.)	Nominal flow G (litres/second)	Limit absorption values (m^{-1})	Measured absorption values (m^{-1})
1
2
3
4
5
6

- 6.3. Maximum net power: kW/ at r.p.m.^{*/}
- 6.4. Maximum 'net' torque: Nm
7. Engine submitted for testing on
8. Technical service conducting the tests
9. Date of test report issued by that service
10. Number of test report issued by that service
11. Place
12. Date
13. Signature
14. The following documents are annexed to this communication:

1 copy of appendix 1/2^{**/} duly completed, with the drawings and documents required for the different items.

^{*/} The maximum net power and the corresponding engine speed are determined, where applicable, by the horizontal tangent to the curve of the net power as a function of engine speed.

^{**/} Strike out what does not apply.

Appendix 4

STATEMENT OF THE RESULTS OF CALCULATION OF AVAILABLE POWER^{1/}

1. Auxiliaries fitted for vehicle application additional to those required for net power measurement.

Auxiliary ^{2/}		Make and type Reference number
No. 1		
2		
3		
4		

2. Calculation of available power.

Engine speed					
Corrected net power kW ⁺					
Corrected net torque Nm ⁺					
Power absorbed by additional auxiliaries kW ^{2/}	No. 1 2 3 4				
Available power (kW)					
Available torque (Nm)					

⁺/ Net power report details.

Technical service conducting the net power tests

Dates of test report issued by that service

Number of test report issued by that service

3. Maximum available power kW^{3/} at r.p.m.
4. Maximum available torque Nm^{3/} at r.p.m.
5. Technical service issuing the report
6. Date of test report issued by that service

