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UNITED NATIONS

AGREEMENT

CONCERNING THE ADOPTION OF UNIFORM CONDITIONS OF APPROVAL AND RECIPROCAL RECOGNITION OF APPROVAL FOR MOTOR VEHICLE EQUIPMENT AND PARTS

done at Geneva on 20 March 1958

Addendum 46 : Regulation No. 47

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UNIFORM PROVISIONS CONCERNING THE APPROVAL OF MOPEDS EQUIPPED WITH A POSITIVE-IGNITION ENGINE WITH REGARD TO THE EMISSION OF GASEOUS POLLUTANTS BY THE ENGINE

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Regulation No. 47

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CONTENTS

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1. SCOPE

This Regulation applies to the emission of gaseous pollutants from positive-ignition engines of two-wheeled or three-wheeled vehicles with an unladen weight of less than 400 kg, a maximum design speed not exceeding 50 km/h and a cylinder capacity not exceeding 50 cm3.

1. DEFINITIONS

For the purposes of this Regulation,

2.1. "Approval of a vehicle" means the approval of a vehicle type with regard to the limitation of the emission of gaseous pollutants from the engine;

2.2. "Vehicle type" means a category of power-driven vehicles which do not differ in such essential respects as:

2.2.1. the equivalent inertia determined in relation to the reference weight as prescribed in annex 4, paragraph 5.2., to this Regulation, and

2.2.2. the engine and vehicle characteristics as defined in annex 1, paragraphs 1-6 and 8, and annex 2 to this Regulation;

2.3. "Reference weight" means the weight of the vehicle in running order, increased by a uniform figure of 75 kg. The weight of the vehicle in running order is its total unladen weight with all tanks filled to within 90 per cent of their maximum capacity;

2.4. "Gaseous pollutants" means carbon monoxide, hydrocarbons and nitrogen oxides, the last-named being expressed in nitrogen dioxide (NO_2) equivalent.

2. APPLICATION FOR APPROVAL

3.1. The application for approval of a vehicle type with regard to limitation of the emission of gaseous pollutants from its engine shall be submitted by the vehicle manufacturer or by his duly accredited representative.

3.2. It shall be accompanied by the under-mentioned documents in triplicate and the following particulars:

3.2.1. a description of the engine type comprising all the particulars shown in annex 2;

3.2.2. particulars concerning the vehicle as shown in annex 2.

3.3. A vehicle representative of the vehicle type to be approved shall be submitted to the technical service responsible for conducting approval tests, for the tests referred to in paragraph 5. of this Regulation.

3.3.1. The vehicle shall be fitted with an exhaust system suited to accept the gas-collecting device indicated in paragraph 4.2.1 of annex 4 to this Regulation. If this requires an extension of the standard exhaust system, this extension shall in no way modify the performance of emission characteristics of the engine.

4. APPROVAL

4.1. If the vehicle type submitted for approval pursuant to this Regulation meets the requirements of paragraphs 5. and 6. below, approval of that vehicle type shall be granted.

4.2. An approval number shall be assigned to each type approved. Its first two digits (at present OO for the Regulation in its original form) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign this number to another vehicle type.

4.3. Notice of approval or of refusal of approval of a vehicle type pursuant to this Regulation shall be communicated to the Parties to the Agreement applying this Regulation, by means of a form conforming to the model in annex 2 to this Regulation and of drawings and diagrams supplied by the applicant for approval, in a format not exceeding A 4 (210 x 297 mm) or folded to that format and on an appropriate scale.

4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this Regulation an international approval mark consisting of :

4.4.1. a circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval; 1/

4.4.2. the number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1.

4.5. If the vehicle conforms to a vehicle type approved, under one or more other Regulations annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 4.4.1. above need not be repeated; in such a case the Regulation and approval numbers and the additional symbols of all the Regulations under which approval has been granted in the country which has granted approval under this Regulation shall be placed in vertical columns to the right of the symbol prescribed in paragraph 4.4.1.

4.6. The approval mark shall be clearly legible and be indelible.

4.7. The approval mark shall be placed close to or on the vehicle data plate affixed by the manufacturer.

4.8. Annex 3 to this Regulation gives examples of arrangements of approval marks.

5. SPECIFICATIONS AND TESTS

5.1. General
The components liable to affect the emission of gaseous pollutants shall be so designed, constructed and assembled as to enable the vehicle in normal use, despite the vibration to which it may be subjected, to comply with the provisions of this Regulation.

1/ 1 for the Federal Republic Germany, 2 for France, 3 for Italy, 4 for the Netherlands, 5 for Sweden, 6 for Belgium, 7 for Hungary, 8 for Czechoslovakia , 9 for Spain, 10 for Yugoslavia, 11 for the United Kingdom, 12 for Austria, 13 for Luxembourg, 14 for Switzerland, 15 for the German Democratic Republic, 16 for Norway, 17 for Finland, 18 for Denmark, 19 for Romania, 20 for Poland and 21 for Portugal. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify the Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, or in which they accede to that Agreement, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement

5.2. Description of tests

5.2.1. The vehicle shall be subjected to tests of two types, I and II, as specified below.

5.2.1.1. Type-I test (verifying the average emission of gaseous pollutants in a congested urban area)

5.2.1.1.1. The vehicle shall be placed on a dynamometer bench equipped with a brake and a fly-wheel. A test lasting a total of 448 seconds and comprising four cycles shall be carried out without interruption. Each cycle shall comprise seven phases (idling, acceleration, steady speed, deceleration, etc.). During the test, the exhaust gases shall be diluted with air to obtain a constant volumetric flow of mixture. Throughout the test, from the mixture thus obtained:

Samples at a constant rate of flow shall be collected in a bag for successive determination of the concentration (average for the test) of carbon monoxide, unburnt hydrocarbons and nitrogen oxides. The total volume shall be determined.

At the end of the test, the distance actually travelled shall be measured by means of a cumulative revolution counter applied to the roller.

5.2.1.1.2. The test shall be carried out by the method described in annex 4. The gases shall be collected and analysed by the prescribed methods.

5.2.1.1.3. Subject to the provisions of paragraph 5.2.1.1.4. below, the test shall be repeated three times. In each test, the mass of the carbon monoxide and the mass of the hydrocarbons obtained shall be less than the amounts shown in the tables below. The measurement of the mass per km of nitrogen oxides is made for information only.

Two-wheeled vehicles

Mass of carbon monoxide gramme/km L_1	Mass of hydrocarbons gramme/km L_2
8	5

Three-wheeled vehicles other than those referred to in paragraph 7.4.

Mass of carbon monoxide gramme/km L_1	Mass of hydrocarbons gramme/km L_2
15	10

5.2.1.1.3.1. Nevertheless, for each of the pollutants referred to in the foregoing paragraph, one of the three results obtained may exceed by not more than 10 per cent the limit prescribed in that paragraph for the vehicle concerned, provided the arithmetical mean of the three results is below the prescribed limit. In cases where the prescribed limits are exceeded for more than one pollutant, it shall be immaterial whether this occurs in the same test or in different tests.

5.2.1.1.4. The number of tests prescribed in paragraph 5.2.1.1.3. above shall be reduced in the conditions hereinafter defined, where V_1 is the result of the first test and V_2 the result of the second test for each of the pollutants referred to in paragraph 5.2.1.1.3. of this Regulation.

5.2.1.1.4.1. Only one test need be made if, for all pollutants concerned $V_1 \leq 0.70\ L$.

5.2.1.1.4.2. Only two tests need be made if, for all pollutants concerned $V_1 \leq 0.85\ L$ but for at least one of the pollutants $V_1 > 0.70\ L$. In addition, for each of the pollutants concerned, V_2 must satisfy the requirements that $V_1 + V_2 < 1.70\ L$ and $V_2 < L$.

5.2.1.2. Type-II test (verifying the emission of carbon monoxide and unburnt hydrocarbons at idling speed)

5.2.1.2.1. The mass of carbon monoxide and the mass of unburnt hydrocarbons emitted with the engine idling during one minute shall be noted.

5.2.1.2.2. This test shall be carried out by the method described in annex 5 to this Regulation.

6. MODIFICATIONS OF THE VEHICLE TYPE

6.1. Every modification of the vehicle type shall be notified to the administrative department which approved the vehicle type. The department may then either:

6.1.1. consider that the modifications made are unlikely to have an appreciable adverse effect and that in any case the vehicle still complies with the requirements; or

6.1.2. require a further test report from the technical service responsible for conducting the tests.

6.2 Confirmation or refusal of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 4.3. above to the Parties to the Agreement applying this Regulation.

7. EXTENSION OF APPROVAL

7.1. Vehicle types of different reference weights
Approval of a vehicle type may be extended to vehicle types which differ from the type approved only in respect of their reference weight, provided that the reference weight of the vehicle type for which extension of the approval is requested requires merely the use of the next higher or next lower equivalent inertia.

7.2. Vehicle types with different over-all gear ratios

7.2.1. Approval granted to a vehicle type may under the following conditions be extended to vehicle types differing from the type approved only in respect of their over-all transmission ratios:

7.2.1.1.1. For each of the transmission ratios used in the type-I test, it shall be necessary to determine the proportion

$$E = \frac{V_2 - V_1}{V_1}$$

Where V_1 and V_2 are respectively the speed at 1,000 r.p.m. of the engine of the vehicle type approved and the speed of the vehicle type for which extension of the approval is requested.

7.2.2. If for each gear ratio $E \leq 8$ per cent, the extension shall be granted without repeating the type-I tests.

7.2.3. If for at least one gear ratio $E > 8$ per cent and if for each gear ratio $E \leq 13$ per cent, the type-I tests shall be repeated, but may be performed in a laboratory chosen by the manufacturer subject to the approval of the Administration granting approval. The report of the tests shall be sent to the recognized laboratory.

7.3. Vehicle types of different reference weights and different over-all transmission ratios
Approval granted to a vehicle type may be extended to vehicle types differing from the approved type only in respect of their reference weight and their over-all transmission ratios, provided that all the conditions prescribed in paragraphs 7.1 and 7.2 above are fulfilled.

7.4. Three-wheeled vehicles
Approval granted to a two-wheeled vehicle type may be extended to three-wheeled vehicles using the same engine and exhaust system and using a transmission that is either the same or differs only in respect of the over-all transmission ratios.

7.5. When a vehicle type has been approved in accordance with the provisions of paragraphs 7.1. to 7.4. above, such approval may not be extended to other vehicle types.

8. CONFORMITY OF PRODUCTION

8.1. Every vehicle bearing an approval mark as prescribed under this Regulation shall conform, with regard to components affecting the emission of gaseous pollutants by the engine, to the vehicle type approved.

8.2. In order to verify conformity as prescribed in paragraph 8.1., a vehicle bearing the approval mark required by this Regulation shall be taken from the series.

8.3. As a general rule, conformity of the vehicle with the approval type shall be verified on the basis of the description given in the approval form and its annexes, and if necessary a vehicle shall be subjected to one or both of the tests of types I and II referred to in paragraph 5.2. above.

8.3.1. For verifying the conformity of the vehicle in a type-I test, the following procedure is adopted:

8.3.1.1. A vehicle is taken from the series and subjected to the test described in paragraph 5.2.1.1.
However, the limit values shown in paragraph 5.2.1.1.3. are replaced by the following limit values:

Two-wheeled vehicles

Mass of carbon monoxide gramme/km L_1	Mass of hydrocarbons gramme/km L_2
9.6	6.5

Three-wheeled vehicles other than those referred to in paragraph 7.4.

Mass of carbon monoxide gramme/km L_1	Mass of hydrocarbons gramme/km L_2
18	13

8.3.2. If the vehicle taken from the series does not satisfy the requirements of paragraph 8.3.1.1. above the manufacturer may ask for measurements to be performed on a sample of vehicles taken from the series and including the vehicle originally taken. The manufacturer shall determine the size n of the sample. The arithmetical mean $\overline{X}$ of the results obtained with the sample and the standard deviation S of the sample shall then be determined for each gaseous pollutant. The production of the series shall then be deemed to conform if the following condition is met

$$\overline{X} + k \times S \leq L \text{ 1/}$$

where L is the limit value laid down in paragraph 8.3.1.1. for each gaseous pollutant considered ; and
k is a statistical factor depending on n and given in the following table:

1/ $S^2 = \sum \frac{(x - \bar{x})^2}{n-1}$,where x is any of the individual results obtained with the sample n.

n	2	3	4	5	6	7	8	9	10
k	0.973	0.613	0.489	0.421	0.376	0.342	0.317	0.296	0.279
n	11	12	13	14	15	16	17	18	19
k	0.265	0.253	0.242	0.233	0.224	0.216	0.210	0.203	0.198

if n ≥ 20 $k = \frac{0.860}{\sqrt{n}}$

9. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

9.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 8.1 are not complied with or if the vehicle or vehicles taken fail to pass the tests prescribed in paragraph 8.3. above.

9.2. If a Party to the Agreement applying this Regulation withdraws and approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a copy of the approval form bearing at the end, in large letters, the signed and dated annotation "APPROVAL WITHDRAWN".

10. PRODUCTION DEFINITELY DISCONTINUED
If the holder of the approval completely ceases to manufacture a type of vehicle approved under this Regulation, he shall inform thereof the authority which granted the approval. Upon receiving the relevant communication, that authority shall inform thereof the other Parties to the Agreement which apply this Regulation by means of a copy of the approval form bearing at the end, in large letters, the signed and dated annotation "PRODUCTION DISCONTINUED".

11. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENTS

11.1. The Parties to the Agreement applying this Regulation shall communicate to the secretariat of the United Nations the names and addresses of the technical services responsible for conducting approval tests and of the administrative departments which grant approval and to which forms certifying approval or refusal or withdrawal of approval, issued in other countries, are to be sent.

Annex 1

ESSENTIAL CHARACTERISTICS OF THE ENGINE AND INFORMATION CONCERNING THE CONDUCT OF TESTS 1/

1. Description of engine
1.1. Make .....
1.2. Type .....
1.3. Cycle: four-stroke/two-stroke 2/
1.4. Number and arrangement of cylinders .....
1.5. Bore ..... mm
1.6. Stroke ..... mm
1.7. Cylinder capacity ..... cm^3
1.8. Compression ratio 3/ 4/ .....
1.9. Combustion chamber:
Drawings of the combustion chamber and of the piston, including the piston rings;
1.10. System of cooling .....
1.11. System of lubrication (two-stroke engines - separate or by mixture) .....
1.12. Device for recycling crank-case gases (description and diagrams) if any .....
1.13. Air filter: drawings, or makes and types .....
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 air intakes and their accessories (dashpot, heating device, additional air intakes, etc.)
.....

1/ In the case of unconventional engines and systems, particulars equivalent to those mentioned here shall be appllied.

2/ Strike out what does not apply.

3/ Specify the tolerance.

4/ Compression ratio = $\frac{\text{Volume combustion chamber + cylinder capacity}}{\text{volume combustion chamber}}$

3.2. Fuel feed
3.2.1. by carburettor
3.2.1.1. Make .....
3.2.1.2. Type .....
3.2.1.3. Settings[3/]
3.2.1.3.1. Dimension (s) mixture duct .....) (
3.2.1.3.2. Venturi throat diameter .....) (
3.2.1.3.3. Dimension (s) throttle slide .....) (
3.1.3.4. Needle, type or number .....) (Curve of fuel delivery
3.2.1.3.5. Needle position .....) or (plotted against air
3.2.1.3.6. Jets .....) (flow 2/ 3/
3.2.1.3.7. Float-chamber level .....) (
3.2.1.3.8. Weight of float .....) (
3.2.1.3.9. Float needle .....) (
3.2.1.4. Manual/automatic choke[2/] Closure setting[2]/....
3.2.2.1. Make .....
3.2.2.2. Type .....
3.2.2.3. General description .....
4. Valve timing
4.1. Timing for mechanically operated valves
4.1.1. Maximum lift of valves and angles of opening and closing in relation to dead centres .....
4.1.2. Reference and/or setting clearance[2/].....
4.2. Distribution by ports
4.2.1. Volume of crank-case cavity with piston at tdc
4.2.2. Description of reed valves, if any (with dimensioned drawing)
4.2.3. Description (with dimensioned drawings) of inlet ports, scavenging and exhaust, with corresponding timing diagram.
The drawings should include one representing the inner surface of the cylinder.
5. Ignition
5.1. Ignition system type .....
5.1.1. Make .....
5.1.2. Type .....

2/ Strike out what does not apply.
3/ Specify the tolerance.

5.1.3. Ignition advance curve [3/] .....
5.1.4. Ignition timing[3]/.....
5.1.5. Contact-point gap[3/] dwell angle[3/] [2/].....
6. Exhaust system
Description and drawings .....
7. Additional information on test conditions
7.1. Fuel used .....
7.2. Lubricant used

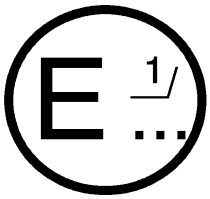
7.2.1. Make .....
7.2.2. Type .....
(State percentage of oil in mixture if lubricant and fuel mixed)
7.3. Sparking plug(s)
7.3.1. Make .....
7.3.2. Type .....
7.3.3. Spark-gap setting .....
7.3. Ignition coil
7.4.
7.4.1. Make .....
7.4.2. Type .....
7.5. Ignition condenser
7.5.1. Make .....
7.5.2. Type .....
7.6. Idling system. Description of setting and relevant requirements in accordance with paragraph 3.1.4. of annex 4.
7.7. Carbon monoxide content in the exhaust gas, with the engine idling ..... g/min. (Manufacturer=s standard)
8. Engine performance
8.1. Idling speed ..... r.p.m.[3/]
8.2. Engine speed at maximum power ..... r.p.m.[3/]
8.3. Maximum power .....kW (ECE)

2/ Strike out what does not apply.
3/ Specify the tolerance.

Annex 2

Maximum format: A4 (210 x 297 mm)

Name of administration



Communication concerning the approval (or refusal or withdrawal of approval or production definitely discontinued) of a vehicle type (moped) with regard to the emission of gaseous pollutants by the engine, pursuant to Regulation No. 47

Approval No.

1. Trade name or mark of vehicle [1/].....
2. Type of vehicle [1/].....
3. Manufacturer=s name and address [1/].....
4. If applicable; name and address of manufacturer=s
5. representative [1/].....
6. Reference weight of vehicle .....
7. Maximum weight of vehicle .....
8. Gear-box .....
7.1. Manual or automatic [2/] [3/]
7.2. Number of gear ratios .....
7.3. Gear ratio: [2/] First gear.....
Second gear .....
Third gear .....
Final drive ratio .....
Tyres: dimensions .....
dynamic rolling circumference .....
Maximum design speed specified by the manufacturer .....km/h
7.4. Check of performance referred to in annex 4, paragraph 3.1.5., to this Regulation .....
8. Vehicle submitted for approval on.....

1/ When the engine is not manufactured by the manufacturer of the vehicle, give the equivalent data for the engine as well.

2/ Strike out what does not apply.

3/ In the case of power-driven vehicles equipped with automatic-shift gear-boxes, give all pertinent technical data.

9. Technical service responsible for conducting approval tests ...
10. Date of report issued by that service .....
11. Number of report issued by that service .....
12. Values measured during the Type-I test - CO ... g/km
HC ... g/km
No_x... g/km
13. Values measured during the Type-II test - CO.... g/min.
HC.. ..g/min.

14. Approval granted/refused[1/]
15. Position of approval mark on the vehicle .....
16. Place .....
17. Date .....
18. Signature .....
19. The following documents, bearing the approval number shown above, are annexed to this communication:

one copy of annex 1, duly completed and accompanied by the drawings and diagrams referred to;

one photograph of the engine;

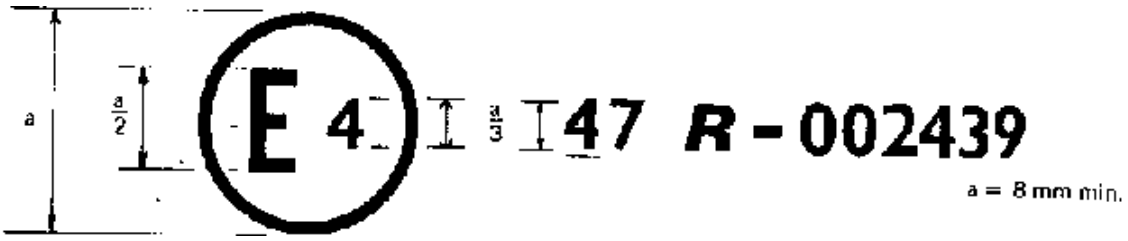
one copy of the test report.

1/ Strike out what does not apply.

Annex 3

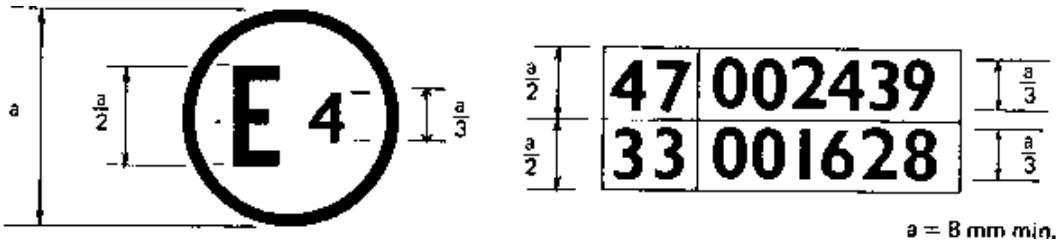
ARRANGEMENTS OF THE APPROVAL MARK

Model A
(See paragraph 4.4. of this Regulation)



The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to the emission of gaseous pollutants by the engine, been approved in the Netherlands (E4), pursuant to Regulation No. 47. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No. 47 in its original form.

Model B
(See paragraph 4.5. of this Regulation)



The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E4) pursuant to Regulation No. 47 and Regulation No. 33.[1/] The approval numbers indicate that, at the dates when the respective approvals were given, Regulations Nos. 47 and 33 were still in their original form.

1/ The second number is given merely as an example.

Annex 4

TYPE-I TEST

(Verifying the average emission of gaseous pollutants in a congested urban area)

1. INTRODUCTION
This annex describes the procedure for the type-I test defined in paragraph 5.2.1.1. of this Regulation.

2. OPERATING CYCLE ON THE DYNAMOMETER BENCH

2.1. Description of the cycle
The operating cycle to be used on the dynamometer bench shall be that indicated in the following table and depicted in the graph shown in appendix 1 to this annex.

Operating Cycle on the Dynamometer Bench

No. Of operation	Operation	Acceleration	Speed	Duration of operation	Total time
		(m/s^2)	(km/h)	(s)	(s)
1	Idling	-	-	8	8
2	Acceleration)	full throttle	0-max)		-
3	Constant speed)	full throttle	max)	57	-
4	Deceleration)	-0.56	max-20)		65
5	Constant speed	-	20	36	101
6	Deceleration	-0.93	20-0	6	107
7	Idling	-	-	5	112

2.2. General conditions under which the cycle is carried out
Preliminary testing cycles should be carried out if necessary to determine how best to actuate the accelerator control and, where necessary, the gear-box and the brake control.

2.3. Use of the gear-box
The use of the gear-box shall be, if necessary, as specified by the manufacturer; however, in the absence of such instructions, the following points shall be taken into account:

2.3.1 Manual change gear-box

At the constant speed of 20 km/h, the rotating speed on the engine shall be, if possible, within 50 and 90 per cent of the speed corresponding to the maximum power of the engine. When this speed can be reached in two or more gears, the vehicle shall be tested with the higher gear engaged. During acceleration, the vehicle shall be tested with the gear which gives maximum acceleration. A higher gear shall be engaged at the latest when the rotating speed is equal to 110 per cent of the speed corresponding to the maximum power of the engine. During deceleration, a lower gear shall be engaged before the engine starts to idle roughly, at the latest when the engine revolutions are equal to 30 per cent of the speed corresponding to the maximum power of the engine. No change down to first gear shall be affected during deceleration.

2.3.2. Automatic gear-box and torque converter

The position "road" shall be used.

2.4. Tolerances

2.4.1. A tolerance of ± 1 km/h on the theoretical speed shall be allowed during all phases.
Speed tolerances greater than those prescribed shall be accepted during phase changes, provided that the tolerances are never exceeded for more than 0.5 second on any occasion.
If the vehicle decelerates more rapidly without the use of the brakes the specifications of paragraph 6.2.6.3. of this annex shall apply.

2.4.2. A tolerance of ± 0.5 s on the theoretical time shall be allowed.

2.4.3. The speed and time tolerances shall be combined as indicated in appendix 1 to this annex.

3. VEHICLE AND FUEL

3.1. Test vehicle

3.1.1. The vehicle shall be presented in good mechanical condition. It shall have been run in and have been driven at least 250 km before the test.

3.1.2. The exhaust device shall not exhibit any leak likely to reduce the quantity of gas collected, which shall be the quantity emerging from the engine.

3.1.3. The leakproofness of the intake system may be checked to ensure that carburation is not affected by an accidental intake of air.

3.1.4. The settings of the engine and of the vehicle's controls shall be those prescribed by the manufacturer. This requirement also applies, in particular, to the settings for idling (rotation speed and carbon monoxide content of the exhaust gases), for automatic choke and for the exhaust gas cleaning system.

3.1.5. The laboratory may verify that the vehicle conforms to the performances stated by the manufacturer, that it can be used for normal driving, and in particular that it is capable of starting when cold and when hot and that the engine will not stall during idling.

3.2. Fuel

Either of the reference fuels, particulars of which are given in annex 6 of this Regulation, may be used for the test. If the engine is lubricated by mixture, the oil added to the reference fuel shall comply as to grade quantity with the manufacturer=s recommendations.

4. TEST EQUIPMENT

4.1. Dynamometer bench

The main characteristics of the bench are as follows:

Equation of the power absorption curve: the test bench shall allow reproduction, within ± 15 per cent, from the initial speed of 12 km/h, of the road power developed by the engine, the vehicle being driven on a horizontal road, with a wind speed as near to zero as possible. If not, the power absorbed by the brakes and the internal friction of the test bench (P_A) shall be:

for a speed of $0 < V \leq 12$ km/h:

$0 \leq P_A \leq kV^3_{12} + 5\%\ kV^3_{12} + 5\%\ P_{V50}$ 1/

for a speed of $V > 12$ km/h:

$P_A = kV^3 \pm 5\%\ kV^3 \pm 5\%\ P_{V50}$ 1/

without being negative (the method of verification to be in accordance with appendix 4 to this annex).

1/ For single roller of diameter = 400 mm.

Basic inertia: 100 kg
Additional inertias 2/: from 10 kg to 10 kg
The roller shall be fitted with a revolution counter with reset to measure the distance actually covered.

4.2. Gas-collection equipment
The gas-collection device is described below (see appendices 2 and 3 to this annex).

4.2.1. A device to collect all the exhaust gases produced during the test maintaining the atmospheric pressure at the vehicle exhaust outlet(s).

4.2.2. A connecting tube between the device for collecting the exhaust gases and the exhaust gas sampling system.
This tube, and the collecting device shall be made of stainless steel, or some other material which does not affect the composition of the gases collected and which withstands the temperature of these gases.

4.2.3. An extractor device for the dilute exhaust mixture. The capacity of this advice shall be constant and large enough to ensure the extraction of all the exhaust gases.

4.2.4. A sample probe, located near to, but outside the gas collecting device, to collect, through a pump, a filter and a flowmeter, samples of the dilution air stream, at constant flow rates, throughout the test.

4.2.5. A sample probe, pointed upstream into the dilute exhaust mixture flow, to collect, if necessary through a filter, a flowmeter and a pump, samples from the dilute exhaust mixture at constant flow rates, throughout the test. The minimum sample flow rate in these two sampling devices shall be 150 1/h.

4.2.6. Three way valves on the above sampling system to direct sample streams either to their respective bags or to the outside throughout the test.

4.2.7. Gas tight sample collection bags for dilution air and dilute exhaust mixture, of sufficient capacity so as not to impede sample flow and which will not change the nature of the gas pollutants concerned.
The bags shall have an automatic self-locking device and shall be easily and tightly fastened either to the sampling system or to the analysing system at the end of the test.

2/ This item concerns additional masses that could possibly be replaced by an electronic device, provided that it is demonstrated that the results are equivalent.

4.2.8. A method of determining the total volume of the dilute gases going through the sampling system during the test shall be provided.

4.3. Analytical equipment

4.3.1. The sample probe may consist of a sampling tube leading into the collecting bags or of a bag-emptying tube. This sample probe shall be made of stainless steel or of material such as will not adversely affect the gas composition. The sample probe and the connecting tube to the analyser shall be at ambient temperature.

4.3.2. Analysers shall be of the following types:
non-dispersive type with absorption in the infra-red for carbon monoxide;
flame ionization type for hydrocarbons;
chemiluminescence type for nitrogen oxides.

4.4. Accuracy of instruments and measurements

4.4.1. As the brake is calibrated in a separate test (paragraph 5.1. of this annex), an indication of the accuracy of the chassis dynamometer is not required. The total inertia of the rotating masses, including that of the roller and the rotating part of the brake (see paragraph 4.1) shall be measured to within ± 5 kg.

4.4.2. The distance covered by the vehicle shall be measured by the rotation of the roller; it shall be measured to within ± 10 m.

4.4.3. The speed of the vehicle shall be measured by the speed of rotation of the roller; it shall be measured to within ± 1 km/h in the speed range above 10 km/h.

4.4.4. The ambient temperature shall be measured to within ± 2C°.

4.4.5. The atmospheric pressure shall be measured to within ± 2 mbar.

4.4.6. The relative humidity of the air shall be measured to within ± 5 per cent.

4.4.7. The accuracy required to measure the content of the various pollutants disregarding the accuracy of the calibration gases shall be within ± 3 per cent. The over-all response time of the analysing circuit shall be less than one minute.

4.4.8. The content of the calibration gases shall not differ by more than ± 2 per cent from the reference value of each gas. The diluent shall be nitrogen for carbon monoxide and nitrogen oxides, and it shall be air for hydrocarbons (propane).

4.4.9. The accuracy of the measurement of cooling air speed shall be measured to within ± 5 km/h.

4.4.10. The duration of cycles and gas collection shall be conducted to within ± 1 s. These times shall be measured with an accuracy of 0.1 s.

4.4.11. The total volume of the dilute gases shall be measured with an accuracy of ± 3 per cent.

4.4.12. The total flow rate and the sampling flow rates shall be steady within ± 5 per cent.

5. PREPARING THE TEST

5.1. Setting of brake
The brake shall be so adjusted as to ensure that the vehicle bench speed, with the throttle fully open, shall be equal to the maximum attainable speed on the road within ± 1 km/h. This maximum attainable speed on the road shall not differ from the maximum design speed specified by the manufacturer by more than ± 2 km/h. In the case where the vehicle is fitted with a device to regulate its maximum road speed, the effect of the regulator will be taken into account.

5.2. Adjustment of equivalent inertias to the vehicle's translatory inertias
The fly wheel(s) shall be adjusted to obtain a total inertia of the rotating masses representing the vehicle reference weight, in accordance with the limits given in the table below:

Vehicle reference weight P (kg)	Equivalent inertias (kg)
P ≤ 105	100
105 < P ≤ 115	110
115 < P ≤ 125	120
125 < P ≤ 135	130
135 < P ≤ 145	140
145 < P ≤ 165	150
165 < P ≤ 185	170
185 < P ≤ 205	190
205 < P ≤ 225	210
225 < P ≤ 245	230
245 < P ≤ 270	260
270 < P ≤ 300	280
300 < P ≤ 330	310
330 < P ≤ 360	340
360 < P ≤ 395	380
395 < P ≤ 435	410
435 < P ≤ 475	-

5.3. Cooling of the vehicle

5.3.1. Throughout the test, an auxiliary cooling blower shall be positioned in front of the vehicle, so as to direct cooling air to the engine. The blower speed shall be 25 ± 5 km/h. The blower outlet shall have a cross sectional area of at least 0.20 m^2 and shall be perpendicular to the longitudinal axis of the vehicle between 30 to 45 cm in front of its front wheel. The device used to measure the linear velocity of the air shall be located in the middle of the stream at 20 cm away from the air outlet. This velocity shall be as nearly constant as possible across the whole of the blower outlet surface.

5.3.2. As an alternative, the vehicle may also be cooled in the following manner. A current of air of variable speed shall be blown over the vehicle. The blower speed shall be such that, within the operating range of 10 km/h to 50 km/h, the linear velocity of the air at the blower outlet is within ± 5 km/h of the corresponding roller speed. At roller speeds of less than 10 km/h, air velocity may be zero. The blower outlet shall have a cross section area of at least 0.20 m^2 and the bottom of the blower outlet shall be between 15 and 20 cm above floor level. The blower outlet shall be perpendicular to the longitudinal axis of the vehicle between 30 and 45 cm in front of its front wheel.

5.4. Conditioning of the vehicle

5.4.1. Directly before starting with the first test cycle the vehicle shall be run for four consecutive cycles of 112 sec. each, in order to warm the engine.

5.4.2. The tyre pressure shall be that recommended by the manufacturer for normal road use conditions. However, if the diameter of the roller is less than 500 mm, the tyre pressure may be increased by 30-50 per cent.

5.4.3. Load on the driving wheel: the load on the driving wheel shall be within ± 3 kg that of a vehicle in normal road use with a rider of 75 kg ± 5 kg and in the upright position.

5.5. Check of back-pressure

5.5.1. During the preliminary tests, a check shall be made to ensure that the back-pressure set up by the sampling device is equal to the atmospheric pressure to within ± 7.5 mbar.

5.6. Adjustment of analytical apparatus

5.6.1. Calibration of analysers
The quantity of gas at the indicated pressure compatible with the correct functioning of the equipment shall be injected into the analyser by means of the flowmeter and the discharge gauge mounted on each gas cylinder. The apparatus shall be adjusted to indicate, as a stabilized value, the value shown on the standard-gas cylinder.
Starting from the setting obtained, with the maximum content cylinder, the curve of the analyser's deviations shall be drawn as a function of the content of the various standard-gas cylinders used.

5.6.2. Over-all response time of the apparatus
The gas from the maximum content cylinder shall be injected into the end of the sampling probe. A check shall be made to ensure that the indicated value corresponding to the maximum deviation, is reached in less than one minute. If this value is not reached, the analysing circuit shall be inspected from end to end for leaks.

6. PROCEDURE FOR BENCH TESTS

6.1. Special conditions for carrying out the cycle

6.1.1. The temperature in the room housing the roller bench shall be between 20°C and 30°C throughout the test.

6.1.2. The vehicle shall be as nearly level as possible when tested, in order to prevent any abnormal fuel or engine oil distribution.

6.1.3. During the test the speed shall be plotted against time, so that the correctness of the cycles performed can be assessed.

6.2. Starting up the engine

6.2.1. After the preliminary operations on the equipment for collecting, diluting, analysing and measuring the gases (see paragraph 7.1. below) have been carried out, the engine shall be started up by means of the devices provided for the purpose - the choke, the starter valve, etc. - in accordance with the manufacturer=s instructions.

6.2.2. The first test cycle shall start at the same time as the collection of samples and the measurement of the flow through the aspirator.

6.2.3. Idling

6.2.3.1. Manual change gear-box
To enable the accelerations to be performed correctly the vehicle shall be place in first gear, with the clutch disengaged within 5 seconds before the acceleration following
the idling period considered.

6.2.3.2. Automatic gear-box and torque converter
The gear selector shall be locked at the start of the test. When two positions "town" and "road" are possible, the "road" position shall be used.

6.2.4. Accelerations
At the end of each period of idling the acceleration phase shall be effected by fully opening the throttle and, if necessary, using the gear-box to attain maximum speed as quickly as possible.

6.2.5. Constant speedThe constant maximum speed phase shall be effected by holding the throttle fully open, until the deceleration phase commences. During the constant speed phase at 20 km/h, the throttle position shall, as far as possible, be kept fixed.

6.2.6. Decelerations

6.2.6.1. All deceleration shall be effected by closing the throttle completely, the clutch remaining engaged. The manual clutch shall be disengaged independently of gear selection, at a speed of 10 km/h.

6.2.6.2. If the rate of deceleration is slower than that prescribed for the corresponding phase, the vehicle=s brake shall be used to enable the cycle to be followed.

6.2.6.3. If the rate of deceleration is faster than that prescribed for the corresponding phase, the timing of the theoretical cycle shall be restored by a constant speed or idling period merging into the succeeding constant speed or idling operation. In that case, paragraph 2.4.3. to this annex is not applicable.

6.2.6.4. At the end of the second deceleration period (the vehicle being stationary on the roller) the gears shall be in neutral and the clutch engaged.

7. PROCEDURE FOR SAMPLING AND ANALYSIS

7.1. Sampling

7.1.1. Sampling shall start at the beginning of the test as indicated in paragraph 6.2.2.

7.1.2. The bags shall be hermetically closed as soon as filling is completed.

7.1.3. At the end of the last cycle, the system of collection of dilute exhaust mixture and dilution air shall be closed and the gases produced by the engine shall be released into the atmosphere.

7.2. Analysis

7.2.1. The gases contained in each bag shall be analysed as soon as possible and in any event not later than 20 minutes after filling of the bags began.

7.2.2. If the sampling probe is not left permanently in the bags, entry of air into the latter during insertion of the probe and escape of gas from the bag during extraction of the probes must be avoided

7.2.3 The analyser shall be in a stabilized condition within one minute after connecting it to the bag.

7.2.3.

7.2.4. The concentrations in HC, CO and NO_X in the dilute exhaust mixture samples and in the dilution air collecting bags shall be determined from the measuring instrument readings or recordings by use of appropriate calibration curves.

7.2.5. The figure recorded as the content of the gases in each of the effluents measured shall be that read off after stabilization of the measuring device.

8. DETERMINATION OF THE QUANTITY OF GASEOUS POLLUTANTS EMITTED

$$CO_M = \frac{1}{S} \cdot V \cdot d_{co} \cdot \frac{CO_c}{10^6}$$

8.1. The mass of carbon gases shall be determined by means of the following formula:

where:

8.1.1. CO_M is the mass of carbon monoxide emitted during the test in g/km;

8.1.2. S is the distance actually; shall be arrived at by multiplying the number of revolutions read from the cumulative counter by the circumference of the roller. This distance shall be measured in km;

8.1.3. d_{co} is the density of the carbon monoxide at a temperature of 0□C and a pressure of 1013.3 mbar : 1.250kg/m^3;

8.1.4 Co_c is the volumetric concentration, expressed in parts per million, of carbon monoxide in the diluted gases, corrected to take account of pollution in the diluent air.

$$CO_c = CO_e - CO_d \left(1 - \frac{1}{DF}\right)$$

where:

8.1.4.1. Co_e is the concentration of carbon monoxide, measured in parts per million, in the sample of diluted gases collected in bag SA;

8.1.4.2. Co_d is the concentration of carbon monoxide, measured in parts per million, in the sample of diluent air collected in bag SB;

8.1.4.3. Df is the coefficient defined in paragraph 8.4. below;

8.1.5. V is the total volume of diluted gas, expressed in m^3 test, adjusted to the reference conditions of 0ºC (273ºK) and 1013.3 mbar:

$$V = V_o \cdot N \cdot \frac{(P_a - P_i) \cdot 273}{1013.3 \cdot (T_p + 273)}$$

where :

8.1.5.1. V_o is the volume of gas displaced by pump P_1 during one revolution, expressed in m^3/revolution. This volume is a function of the differences between the intake and output sections of the pump:

8.1.5.2. N is the number of revolutions made by pump P_1 during the four cycles of the test;

8.1.5.3. Pa is the ambient pressure in mbar;

8.1.5.4. Pi is the average under-pressure during the four test cycles in the intake section of pum P_1, expressed in mbar:

8.1.5.5. T_p is the temperature of the diluted gases during the four test cycles, measured in the intake section of pump P_1.

8.2. The mass of unburnt hydrocarbons emitted by the vehicle=s exhaust during the test shall be calculated by means of the following formula:

$$HC_M = \frac{1}{S} \cdot V \cdot d_{HC} \cdot \frac{HC_c}{10^6}$$

where:

8.2.1. HC_M is the mass of hydrocarbons emitted during the test, in g/km;

8.2.2. S is the distance defined in paragraph 8.1.2. above;

8.2.3. d_{HC} is the density of the hydrocarbons at a temperature of 0□C and a pressure of 1013.3 mbar: 0.619 kg/m^3 (where the average carbon/hydrogen ratio is 1 : 1.85);

8.2.4. Hc_c is the concentration of diluted gases, expressed in parts per million of carbon equivalent (e.g. the concentration in propane multiplied by 3), corrected to take account of the diluent air.

$$HC_c = HC_e - HC_d\left(1 - \frac{1}{DF}\right)$$

where:

8.2.4.1. Hc_e is the concentration of hydrocarbons, expressed in parts per million of carbon equivalent, in the sample of diluted gases collected in bag SA;

8.2.4.2. Hc_d is the contration of hydrocarbons expressed in parts per million of carbon equivalent, in the sample of diluent air collected in bag SB;

8.2.4.3. DF is the oefficient defined in paragraph 8.4. below;

8.2.5. V is the total volume(see paragraph 8.1.5.)

8.3. The mass of nitrogen oxides emitted by the vehicle=s exhaust during the test shall be calculated by means of the following formula:

$$NO_{XM} = \frac{1}{S} \cdot V \cdot d_{NO_2} \cdot \frac{NO_{xc} \cdot K_h}{10^6}$$

where:

8.3.1. NO_{XM} is the mass of nitrogen oxides emitted during the test, expressed in g/km;

8.3.2. S is the distance defined in paragraph 8.1.2. above;

8.3.3. d_{NO2} is the density of nitrogen oxides in the exhaust gases, assuming that they will be in the form of nitric oxide at a temperature of 0□C and a pressure of 1013.3 mbar: 2.05 kg/m^3;

8.3.4. NO_{XC} is the nitrogen oxide concentration of the diluted gases, expressed in parts per million, corrected to take account of the diluent air.

$$NO_{xc} = NO_{xe} - NO_{xd}\left(1 - \frac{1}{DF}\right)$$

Where:

8.3.4.1. NO_{Xe} is the concentration of nitrogen oxides, expressed in parts per million. In the sample of diluted gases collected in bag SA;

8.3.4.2. NO_{Xd} is the concentration of nitrogen oxides, expressed in parts per million, in the sample of diluent air collected in bag SB;

8.3.4.3. DF is the coefficient defined in paragraph 8.4. below;

8.3.5. K_h is the humidity correction factor.

$$K_h = \frac{1}{1 - 0.0329\,(H - 10.7)}$$

Where :

8.3.5.1. H is the absolute humidity in grammes of water per kg of dry air.

$$H = \frac{6.2111 \cdot U \cdot P_d}{P_a - P_d \ \frac{U}{100}} \quad [g/K]$$

Where

8.3.5.1.1. U is the percentage humidity;

8.3.5.1.2. P_d is the saturated pressure of water at the test temperature, in mbar;

8.3.5.1.3. P_a is atmospheric pressure in mbar.

8.4. DF is a coefficient expressed by the formula;

$$DF = \frac{14.5}{CO_2 + 0.5CO + HC}$$

8.4.1. "CO, CO_2 and HC" are the concentrations of carbon monoxide, carbon dioxide and hydrocarbons, expressed in per cent, in the sample of diluted gases contained in bag SA.

9. PRESENTATION OF RESULTS

The results will be expressed in grammes per kilometre:

HC in g/km = HC mass/S
CO in g/km = CO mass/S
NO_X in g/km = NO_X mass/S

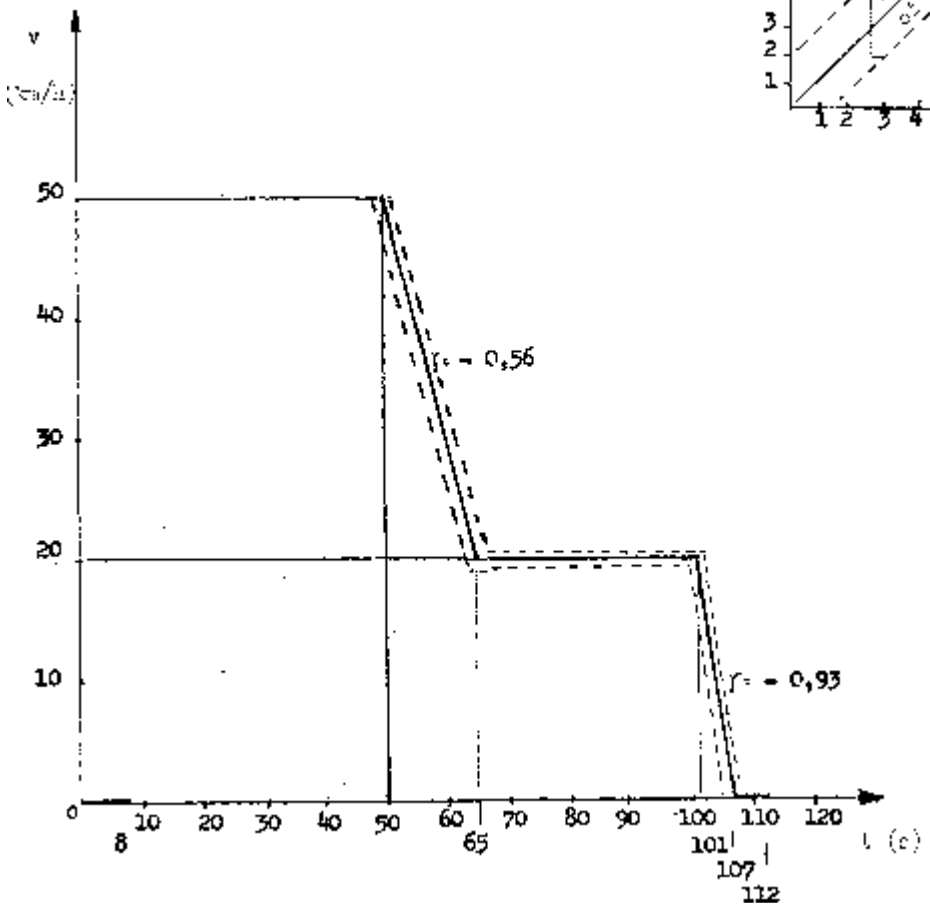
where:

HC mass is as defined in paragraph 8.2.
CO mass is as defined in paragraph 8.1.
NO_X mass is as defined in paragraph 8.3.
S is the distance effectively covered by the vehicle during the test.

Annex 4 - Appendix 1

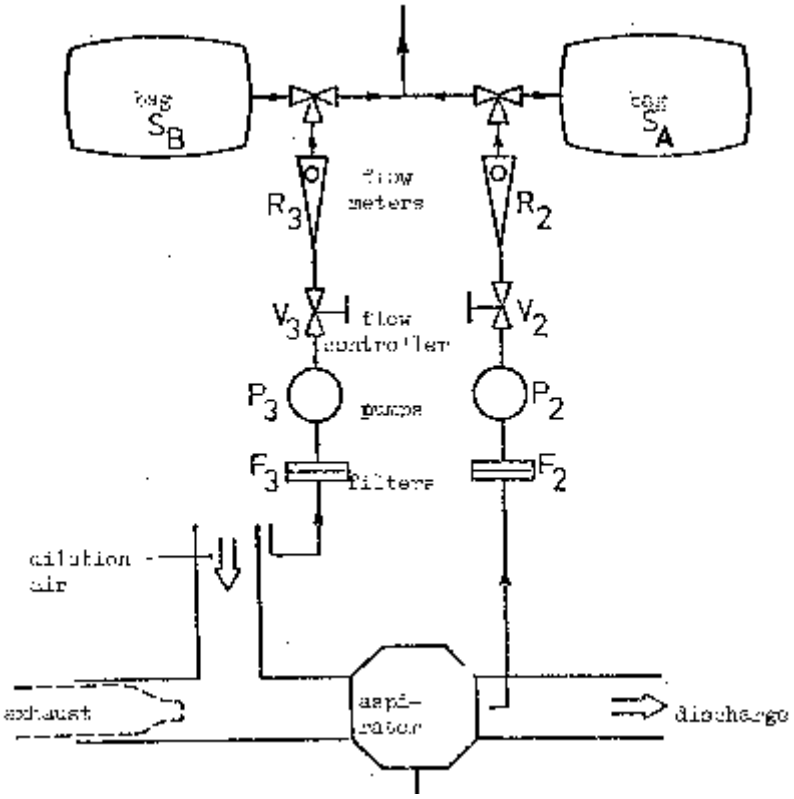
OPERATING CYCLE FOR THE TYPE-I TEST

Speed (±1 km/h) and time (±0.5 sec) tolerances are combined geometrically for each point, as shown in the inset.



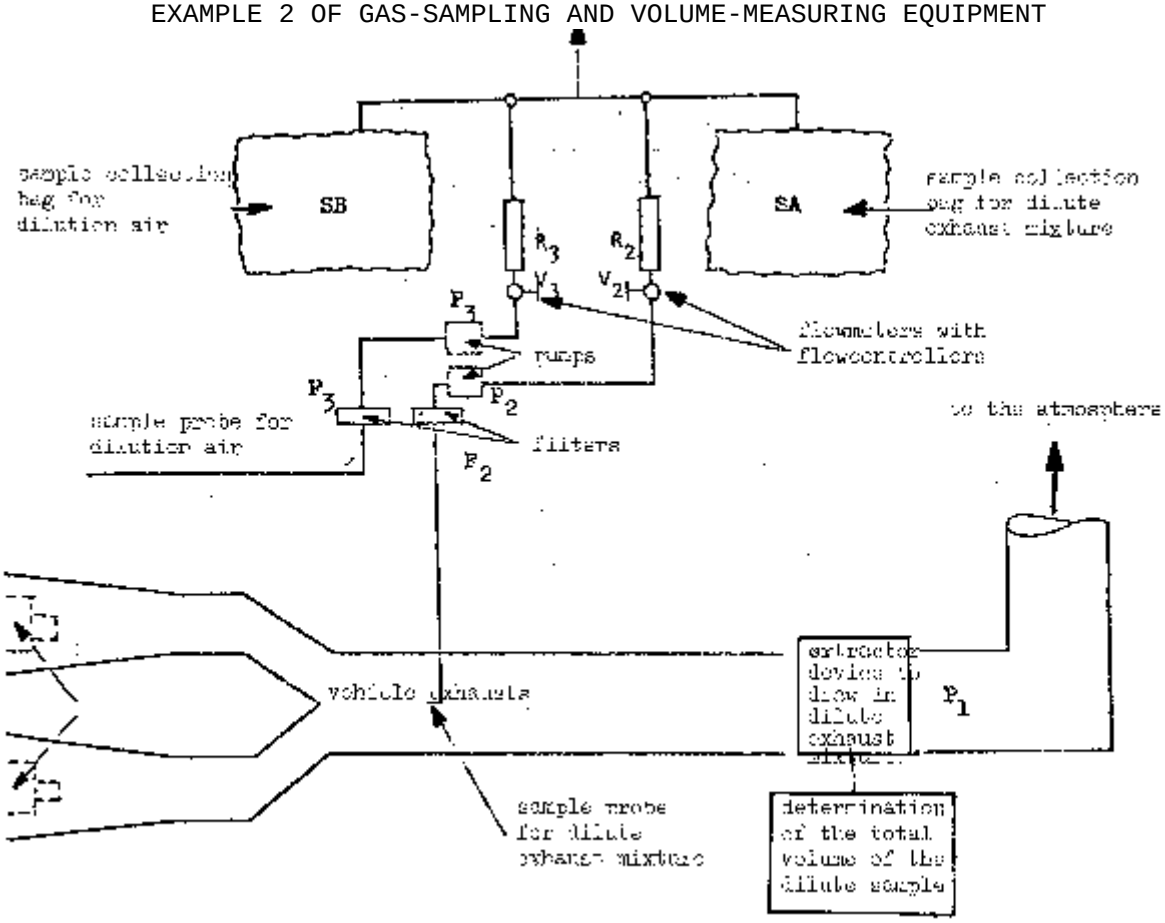
Annex 4 - Appendix 2

EXAMPLE 1 OF GAS-SAMPLING AND VOLUME-MEASURING EQUIPMENT



Annex 4 - Appendix 3

EXAMPLE 2 OF GAS-SAMPLING AND VOLUME-MEASURING EQUIPMENT



Annex 4 - Appendix 4

METHOD FOR CALIBRATION OF THE DYNAMOMETER BENCH

1 Scope

This appendix describes the method to be used for verifying that the curve for the power absorbed by the dynamometer bench conforms with the absorption curve required in paragraph 4.1. of annex 4. The absorption of power which is measured includes that absorbed by friction as well as the power absorbed by the brake excluding the power lost by the friction between the type and roller.

2 Principal of the method

this method permits the calculation of the power absorbed by using the measurement of the deceleration time of the roller. The kinetic energy of the system is dissipated by the brake and by friction within the dynamometer bench. The method ignores the variations of the internal bearing friction in the roller due to the weight of the vehicle.

3. Procedure

3.1. Engage the inertia simulation system corresponding to the mass of the vehicle which is to be tested.

3.2. Set the brake according to the method defined in paragraph 5.1. of annex 4.

3.3. Run the roller up to a speed of v + 10 km/h.

3.4. Disengage the driving device and allow the roller to decelerate freely.

3.5 Record the time taken by the roller to decelerate from v + 0.1 v to - 0.1 v.

3.6. Calculate the power absorbed from the following formula:

$$P_A = 0.2\ x\ \frac{Mv^2\ x\ 10^{-3}}{t}$$

where:

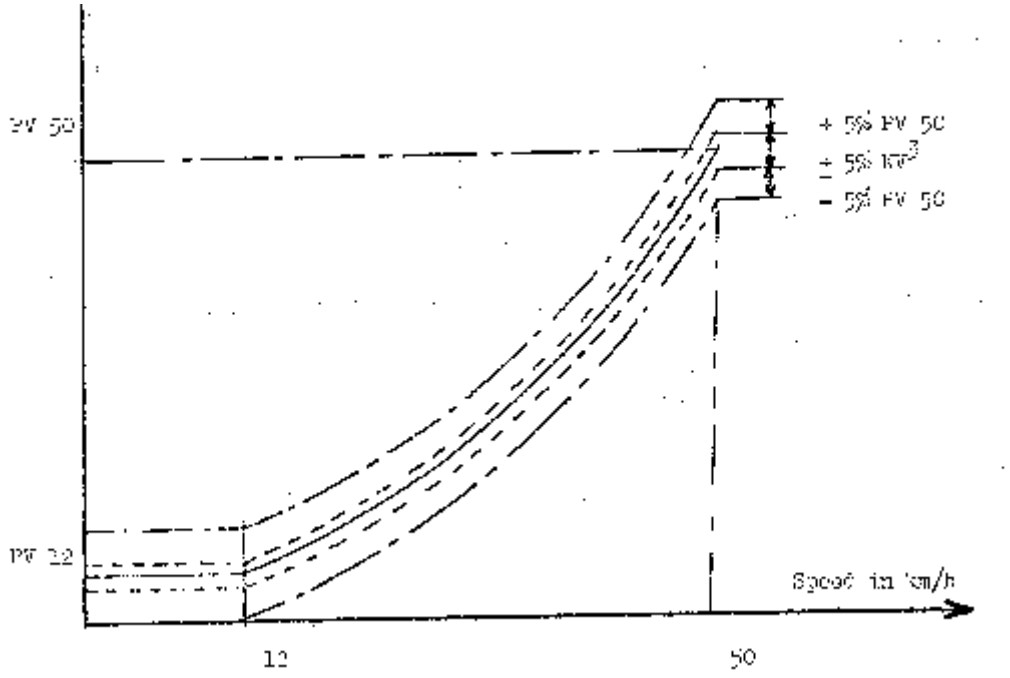
P_A is the power absorbed by the dynamometer bench expressed in kW
M is the equivalent inertia expressed in kg
v is the velocity expressed in m/s of the test speed used in paragraph 3.3. above.
t is the elapsed time expressed in seconds for the roller to decelerate from v + 0.1 v to v - 0.1 v.

3.7. Repeat the procedure described in paragraph 3.3. to 3.6. above to cover the range of speeds from 10 to 50 km/h by 10 km/h stages.

3.8. Trace the curve which represents the power absorbed as a function of the speed.

3.9. Verify that this curve is within the tolerance given in paragraph 4.1. of annex 4.

Absorbed power P_A in (kW)



Annex 5

TYPE-II TEST

(Measurement of the emission of carbon monoxide and hydrocarbons at idle)

1. Introduction

This annex describes the procedure for the type-II test defined in paragraph 5.2.1.2. of this Regulation.

2. Measurement conditions

2.1. The fuel to be used shall be one or the other of the fuels mentioned in paragraph 3.2. of annex 4 of this Regulation.

2.2. For the oil to be used see also paragraph 3.2. of annex 4.

2.3. The mass emission of carbon monoxide and hydrocarbons will be measured immediately after the type-I test described in paragraph 2.1. of annex 4 of this Regulation, as soon as they are stabilized, the engine running at idling speed.

2.4. For vehicles equipped with a manual change gear-box, the test shall be carried out in neutral with the clutch engaged.

2.5. For vehicles equipped with an automatic gear-box, the test shall be carried out with the clutch engaged, but with the driving wheel kept stationary.

2.6. The idling speed of the engine during the idling period shall be adjusted in accordance with the manufacture=s specifications.

3. Sampling and analysis of exhaust gases

3.1. The switch valves shall be set for direct analysis of the dilute exhaust mixture and the dilution air.

3.2. The analyser shall be in a stabilized condition within one minute after connecting it to the probe.

3.3. The concentrations in HC and CO in the dilute exhaust mixture sample and in the dilution air shall be determined from the measuring instrument readings or recordings by use of appropriate calibration curves.

3.4. The figure recorded as the content of the gages in each of the effluents measured shall be that read off after stabilization of the measuring device.

Determination of the quantity of gaseous pollutants emitted

4.1. The means of carbon gases shall be determined by means of the following formula:

$$CO_M = v \cdot d_{co} \cdot \frac{CO_c}{10^6}$$

where:

4.1.1. CO_M is the mass of carbon monoxide emitted during the test in g/min;

4.1.2. d_{co} is the density of the carbon monoxide at a temperature of 0°C and a pressure of 1013.3 mbar : 1.250 kg/m^3;

4.1.3. Co_c is the volumetric concentration, expressed in parts per million, of carbon monoxide in the diluted gases, corrected to take account of pollution in the diluent air.

$$CO_c = CO_e - CO_d \left(1 - \frac{1}{DF}\right)$$

where :

4.1.3.1. Co_e is the concentration of carbon monoxide, measured in parts per million, in the sample of diluted gases;

4.1.3.2. Co_d is the concentration of carbon monoxide; measured in parts per million, in the sample of diluent air;

4.1.3.3. DF is the coefficient defined in paragraph 4.3. below;

4.1.4. V is the total volume of diluted gas, expressed in m^3/min, adjusted to the reference conditions of 0°C (273°K) and 1013.3 mbar;

$$v = v_o \cdot N \frac{(P_a - P_i) \cdot 273}{1013.3 \cdot (T_p + 273)}$$

where:

4.1.4.1. V_0 is the volume of gas displaced by pump P_1 during one revolution, expressed in m^3/revolution. This volume is a function of the differences between the intake and output sections of the pump;

4.1.4.2. N is the number of revolutions made by pump P_1 during the idling test divided by time in min.;

4.1.4.3. Pa is the ambient pressure in mbar;

4.1.4.4. Pi is the average under-pressure during the test in the intake section of pump P_1, expressed in mbar;

4.1.4.5. T_p is the temperature of the diluted gases during the test, measured in the intake section of pump P_1.

.2. The mass of unburnt hydrocarbons emitted by the vehicle=s exhaust during the test shall be calculated by means of the following formula:

$$HC_M = v \cdot d_{HC} \cdot \frac{HC_c}{10^6}$$

where:

4.2.1. HC_M is the mass of hydrocarbons emitted during the test, in g/min.;

4.2.2. d_{HC} is the density of the hydrocarbons at a temperature of 0□C and a pressure of 1013.3 mbar: 0.619 kg/m^3 (where the average carbon/hydrogen ratio is 1: 1.85);

4.2.3. Hc_c is the concentration of diluted gases, expressed in parts per million of carbon equivalent (e.g. the concentration in propane multiplied by 3), corrected to take account of the diluent air.

$$HC_c = HC_e - HC_d \left(1 - \frac{1}{DF}\right)$$

where :

4.2.1. HC_e is the concentration of hydrocarbon, expressed in parts per million of carbon equivalent, in the sample of diluted gases;

4.2.3.2. HC_d is the concentration of hydrocarbons expressed in parts per million of carbon equivalent, in the sample of diluent air;

4.2.3.3. DF is the coefficient defined in paragraph 4.3. below;

4.2.4. V is the total volume (see paragraph 4.1.4.).

4.3. DF is a coefficient expressed by the formula:

$$DF = \frac{14.5}{CO_2 + 0.500 + HC}$$

4.3.1. ACO, CO_2 and HC@ are the concentrations of carbon monoxide, carbon dioxide and hydrocarbons, expressed in per cent, in the sample of diluted gases.

Anex 6

SPECIFICATIONS OF REFERENCE FUELS [1/]

REFERENCE FUEL No. 1 (identical with Regulation No. 15 (E/ECE/TRANS/505/Rev.1/Add.14/Rev.2, annex 7))

	Limits and units	Method
Research octane number	99 + I	ASTM[2/] D 908-67
Specific gravity 15/4□C	0.742 + 0.007	ASTM[2/] D 1298-67
Reid vapour pressure	(0.6 + 0.04 bars (8.82 + 0.59 psi	ASTM[2/] D 323-58
Distillation		ASTM D 86-6
Initial boiling point		
10% vol.	50 + 5°C	
50% vol.	100 + 10°C	
90% vol.	160 + 10°C	
Final boiling popint	195 + 10°C	
residue (% vol.)	max. 2	
loss	max. 1	
Hydrocarbon analysis		ASTM D 1319-66 T
olefins	18 + 4% by volume	
aromatics	35 + 5% by volume	
saturates	balance	
Oxidation stability	min. 480 minutes	ASTM D 525-55
Gum (residues)	max. 4 mg/100 ml.	ASTM D 381-64
Antioxidant	min. 50 ppm	
Sulphur content	0.03 + 0.015% by weight	ASTM D 1266-64 T
Lead content	(0.57 + 0.03 g/l (2.587 + 0.136 g/IG	ASTM D 526-66
Nature of scavenger	motor mix	
Nature of lead alkyl	not specified	
Other additives	nil	

1/ In blending the reference fuel, only convectional European base materials should be used, unconventional components such as pyrolysis gasoline, thermally cracked material and motor benzol being excluded.

2/ Initials of the American Society for Testing and Materials, 1916 Race St., Philadelphia, Pennsylvania 19103, United States of America. The figures after the dash denote the year when a standard was adopted or revised.

Should any ASTM standards be amended, the standards adopted in the years quoted above shall remain applicable unless all Parties to the 1958 Agreement applying this Regulation agree to replace them by later standards.

REFERENCE FUEL No. 2 (CEC-RF-05-T-76)

Application: Regular gasoline, unleaded, for United States of America exhaust and evaporative emission test

	Limits and units		ASTM method [1/]
Research octane number	min. 91.0		D 2699
Reid vapour pressure [2/]	min. 0.58	bar	323
Distillation [3/]			86
Initial boiling point	min. 24	ºC	
	max. 40		
10 vol.-per cent-point	min. 49		
	max. 57		
50 vol.-per cent-point	min. 93		
	max. 110		
90 vol.-per cent-point	min. 149		
	max. 163		
Final boiling point	max. 213		
Hydrocarbon analysis			1319
Olefins	max. 10	per cent vol.	
Aromatics	max. 55		
Saturates	balance		
Oxidation stability	min. 480	minutes	525
Sulphur content	max. 0.10	per cent-wt	526 or 1266
Lead content	max. 0.005	g/1	5237
Phosphorus content	max. 0.001	g/l	3231

1/ Equivalent ISO methods will be adopted when issued for all specifications listed above.
2/ For tests unrelated to evaporative losses, RVP can be min. 0.55
max. 0.66 bar
3/ The figures quoted show the total evaporated quantities (per cent evaporated + per cent loss).

Note: In reaching a decision on acceptability of a fuel with relation to these specifications, reference is to be made to "Recommended procedures for applying precision data to specifications for petroleum products".