

No. 4789. 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 1958¹

REGULATION No. 15:² UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES EQUIPPED WITH A POSITIVE-IGNITION ENGINE WITH REGARD TO THE EMISSION OF GAZEOUS POLLUTIONS BY THE ENGINE

Authentic texts: English and French.

Registered ex officio on 1 August 1970.

1. SCOPE

This Regulation applies to the emission of gaseous pollutants from positive-ignition engines of power-driven vehicles other than two-wheeled or three-wheeled power-driven vehicles with a maximum weight of less than 400 kg and /or a maximum design speed of less than 50 km/h.

2. 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, items 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 120 kg. The weight of the vehicle in

¹ United Nations, *Treaty Series*, vol. 335, p. 211; for subsequent actions, see references in Cumulative Indexes Nos. 4 to 8, as well as annex A in volumes 601, 606, 607, 609, 630, 631, 652, 656, 659, 667, 669, 672, 673, 680, 683, 686, 696, 723 and 730

² Came into force on 1 August 1970 in respect of France and Spain, in accordance with article 1, paragraph 5, of the above-mentioned Agreement.

running order is its total unladen weight with all tanks except the fuel tank full, the fuel tank only half full, and a set of tools and the spare wheel on board;

- 2.4. "*Engine crank-case*" means the spaces in or external to an engine which are connected to the oil sump by internal or external ducts through which gases and vapours can escape;
- 2.5. "*Gaseous pollutants*" means carbon monoxide and hydrocarbons;
- 2.6. "*Maximum weight*" means the technically permissible maximum weight declared by the vehicle manufacturer (this weight may be greater than the maximum weight authorized by the national administration).

3. 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 undermentioned documents in triplicate and the following particulars:
 - 3.2.1. a description of the engine type comprising all the particulars referred to in annex 1;
 - 3.2.2. drawings of the combustion chamber and of the piston, including the piston rings;
 - 3.2.3. maximum lift of valves and angles of opening and closing in relation to dead centres;
 - 3.2.4. 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 conducting approval tests for the tests referred to in paragraph 5. of this Regulation.

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. The same Contracting Party may not assign the same 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 which apply this Regulations 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 × 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; *
 - 4.4.2. the number of this Regulation, followed by the letter "R", a dash and the approval number, below the circle.
- 4.5. The approval mark shall be clearly legible and be indelible.
- 4.6. Annex 3 to this Regulation gives an example of the arrangement of the approval mark.

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.

5.2. *Description of tests*

- 5.2.1. The vehicle shall be subjected, according to its category, to tests of three types, I, II and III, as specified below.
 - 5.2.1.1. *Type-I test* (verifying the average emission of pollutants in a congested urban area after a cold start).
 - 5.2.1.1.1. This test shall be carried out on all vehicles referred to in paragraph 1. whose maximum weight does not exceed 3.5 metric tons.
 - 5.2.1.1.2. The vehicle shall be placed on a dynamometer bench equipped with a brake and a fly-wheel. A test lasting a total of 13 minutes and comprising four cycles shall be carried out without interruption. Each cycle shall comprise 15 phases (idling, acceleration, steady speed, deceleration, etc.). During the test the exhaust gases shall be collected in one or more bags. The gases shall be analysed and their volume measured at the end of the filling period.

* 1 for the Federal Republic of 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, and 11 for the United Kingdom. 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.

- 5.2.1.1.3. The test shall be carried out by the procedure described in annex 4 to this Regulation. The methods used to collect and analyse the gases shall be those prescribed. Other methods may be approved if it is found that they yield equivalent results.
- 5.2.1.1.4. The mass of the carbon monoxide and the mass of the hydrocarbons obtained in the test shall be less, for a vehicle of given reference weight, than the amounts shown in the table below:

<i>Reference weight (rw) kilogrammes</i>	<i>Mass of carbon monoxide grammes per test</i>	<i>Mass of hydrocarbons grammes per test</i>
rw ≤ 750	100	8.0
750 < rw ≤ 850	109	8.4
850 < rw ≤ 1020	117	8.7
1020 < rw ≤ 1250	134	9.4
1250 < rw ≤ 1470	152	10.1
1470 < rw ≤ 1700	169	10.8
1700 < rw ≤ 1930	186	11.4
1930 < rw ≤ 2150	203	12.1
2150 < rw	220	12.8

5.2.1.2. *Type-II test* (carbon-monoxide emission test at idling speed).

- 5.2.1.2.1. This test shall be carried out on vehicles referred to in paragraph 1.
- 5.2.1.2.2. The carbon-monoxide content by volume of the exhaust gases emitted with the engine idling must not exceed 4.5 per cent.
- 5.2.1.2.3. Conformity with the last preceding requirement shall be checked by a test carried out by the procedure described in annex 5 to this Regulation.
- 5.2.1.3. *Type-III test* (verifying emissions of crank-case gases).
- 5.2.1.3.1. This test shall be carried out on all vehicles referred to in paragraph 1, except those having a two-stroke engine with compression in the crank-case.
- 5.2.1.3.2. The mass of the hydrocarbons contained in the crank-case gases not recycled by the engine must be less than 0.15 per cent of the mass of the fuel consumed by the engine.
- 5.2.1.3.3. Conformity with the last preceding requirement shall be checked by a test carried out by the procedure described in annex 6 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 conducting the tests.
- 6.2. Confirmation or refusal of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 4.2. above to the Parties to the Agreement which apply this Regulation.

7. CONFORMITY OF PRODUCTION

- 7.1. 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.
- 7.2. In order to verify conformity as prescribed in paragraph 7.1., a vehicle bearing the approval mark required by this Regulation shall be taken from the series.
- 7.3. As a general rule, conformity of the vehicle with the approved 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 all or some of the tests of types I, II and III referred to in paragraph 5.2. above.
 - 7.3.1. In a type-I test carried out on a vehicle taken from the series the measured mass of the carbon monoxide and the measured mass of the hydrocarbons shall not exceed the values L_1 and L_2 respectively given in the table below:

<i>Reference weight (rw) kilogrammes</i>	<i>Mass of carbon monoxide grammes per test L_1</i>	<i>Mass of hydrocarbons grammes per test L_2</i>
$rw \leq 750$	120	10.4
$750 < rw \leq 850$	131	10.9
$850 < rw \leq 1020$	140	11.3
$1020 < rw \leq 1250$	161	12.2
$1250 < rw \leq 1470$	182	13.1
$1470 < rw \leq 1700$	203	14.0
$1700 < rw \leq 1930$	223	14.8
$1930 < rw \leq 2150$	244	15.7
$2150 < rw$	264	16.6

7.3.1.1. If the mass of the carbon monoxide or the mass of the hydrocarbons produced by the vehicle taken from the series exceeds the limit L_1 or L_2 (as the case may be) 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 \bar{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: $\bar{x} + k \cdot S > L$, where:

L = the limit value laid down in paragraph 7.3.1. for each gaseous pollutant considered; and

k = a statistical factor dependent on n and given in the following table:

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

$$\text{If } n \geq 20 \quad k = \frac{0.860}{\sqrt{n}}$$

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

- 7.3.2. In a type-II or type-III test carried out on a vehicle taken from the series, the conditions laid down in paragraphs 5.2.1.2.2. and 5.2.1.3.2. shall be complied with.

8. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

- 8.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 7.1. are not complied with or if the vehicle or vehicles taken fail to pass the tests prescribed in paragraph 7.3. above.
- 8.2. If a Party to the Agreement which applies this Regulation withdraws an approval it has previously granted, it shall forthwith notify the other Contracting Parties applying this Regulation thereof by means of a copy of the approval form bearing at the end, in large letters, the signed and dated annotation "APPROVAL WITHDRAWN".

9. NAMES AND ADDRESSES OF TECHNICAL SERVICES CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENTS

The Parties to the Agreement which apply this Regulation shall communicate to the United Nations Secretariat the names and addresses of the technical services 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. *Description of engine*

- 1.1. Make
- 1.2. Type
- 1.3. Cycle: four-stroke /two-stroke **
- 1.4. Number of cylinders
- 1.5. Bore mm

* In the case of engines and systems differing from conventional engines and systems, particulars equivalent to those referred to here shall be supplied.

** Strike out what does not apply.

- 1.6. Stroke mm
- 1.7. Cylinder capacity cm³
- 1.8. Compression ratio *
- 1.9. System of cooling
- 1.10. Supercharger with/without ** description of the system
- 1.11. Device for recycling crank-case gases (description and diagrams)
- 1.12. 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.)
 - 3.2. Fuel feed
 - 3.2.1. by carburettor(s) ** number
 - 3.2.1.1. Make
 - 3.2.1.2. Type
 - 3.2.1.3. Adjustments **
 - 3.2.1.3.1. Jets } or { Curve of fuel
 - 3.2.1.3.2. Venturis } delivery plotted
 - 3.2.1.3.3. Float-chamber level } against air
 - 3.2.1.3.4. Weight of float } flow **
 - 3.2.1.3.5. Float needle }
 - 3.2.1.4. Manual/automatic choke ** Closure setting *
 - 3.2.1.5. Feed pump
 - Pressure * or characteristic diagram *
 - 3.2.2. by injector **
 - 3.2.2.1. Pump
 - 3.2.2.1.1. Make
 - 3.2.2.1.2. Type
 - 3.2.2.1.3. Delivery mm³ per stroke at pump speed of r.p.m., *, ** or characteristic diagram *, **
 - 3.2.2.2. Injector(s)
 - 3.2.2.2.1. Make
 - 3.2.2.2.2. Type
 - 3.2.2.2.3. Calibration bars *, ** or characteristic diagram *, **
 4. *Valve timing*
 - 4.1. Maximum lift of valves and angles of opening and closing in relation to

* Specify the tolerance.

** Strike out what does not apply.

- dead centres
- 4.2. Reference and/or setting ranges *
5. *Ignition*
- 5.1. Distributor(s)
- 5.1.1. Make
- 5.1.2. Type
- 5.1.3. Ignition advance curve **
- 5.1.4. Ignition timing **
- 5.1.5. Contact-point gap **
6. *Exhaust system*
- Description and diagrams
7. *Additional information on test conditions*
- 7.1. Lubricant used
- 7.1.1. Make
- 7.1.2. Type
- (State percentage of oil in mixture if lubricant and fuel mixed)
- 7.2. Sparking plugs
- 7.2.1. Make
- 7.2.2. Type
- 7.2.3. Spark-gap setting
- 7.3. Ignition coil
- 7.3.1. Make
- 7.3.2. Type
- 7.4. Ignition condenser
- 7.4.1. Make
- 7.4.2. Type
8. *Engine performances*
- 8.1. Idling speed r.p.m. **
- 8.2. Engine speed at maximum power r.p.m. **
- 8.3. Maximum power CV/HP * (ISO; BSI; CUNA; DIN; IGM; SAE; etc. *)

* Strike out what does not apply.

** Specify the tolerance.

ANNEX 2

(Maximum format: A 4 (210 × 297 mm))

NAME OF
ADMINISTRATION

Communication concerning the approval (or refusal or withdrawal of approval) of a vehicle type with regard to the emission of gaseous pollutants by the engine pursuant to Regulation No. 15

- Approval No.
1. Trade name or mark of the vehicle
 2. Vehicle type.....
 3. Manufacturer's name and address
 4. If applicable, name and address of manufacturer's representative
 5. Reference weight of vehicle
 6. Maximum weight of vehicle
 7. Gear-box
 - 7.1. Manual or automatic *
 - 7.2. Number of gear ratios
 - 7.3. Speed of vehicle for each gear ratio at engine speed of 1,000 r.p.m. **
 - (first)
 - (second)
 - (third)
 - 7.4. Check of performances referred to in annex 4, paragraph 3.1.6., of this Regulation
 8. Vehicle submitted for approval on
 9. Technical service conducting approval tests
 10. Date of report issued by that service
 11. Number of report issued by that service
 12. Approval granted/refused *
 13. Position of approval mark on the vehicle
 14. Place
 15. Date
 16. Signature

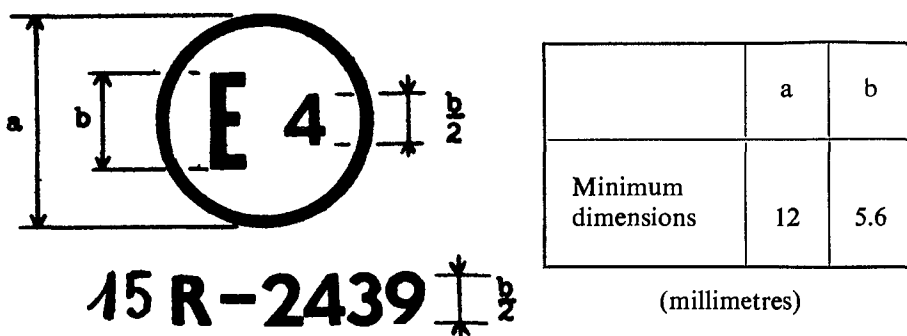
* Strike out what does not apply.

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

17. The following documents, bearing the approval number shown above, are annexed to this communication:
- 1 copy of annex 1 to this Regulation, duly completed and with the drawings and diagrams referred to attached;
 - 1 photograph of the engine and its compartment.

ANNEX 3

ARRANGEMENT OF THE APPROVAL MARK



The above approval mark affixed to a vehicle shows that, pursuant to Regulation No. 15, the vehicle type concerned has, with regard to the emission of gaseous pollutants by the engine, been approved in the Netherlands (E4) under approval number 2439.

ANNEX 4

TYPE-I TEST

(Verifying the average emission of pollutants in a congested urban aerea after a cold start)

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 on the dynamometer bench shall be that indicated in

OPERATING CYCLE ON THE DYNAMOMETER BENCH

No. of operation	Phase	Acceleration m/sec. ²	Speed km/h	Duration of each		Cumulative time sec.	Gear to be used in the case of a manual shift
				operation sec.	phase sec.		
1 Idling				11	11	11	6 sec. PM + 5 sec. K1 *
2 Acceleration	2	1.04	0-15	4	4	15	1
3 Steady speed	3		15	8	8	23	1
4 Deceleration	4	-0.69	15-10	2	2	25	1
5 Deceleration, clutch disengaged							
6 Idling	5	-0.92	10-0	3	3	28	K1
7 Acceleration	6	0.83	0-15	5	12	49	16 sec. PM + 5 sec. K1
8 Shifting of gears				2		54	1
9 Acceleration	7	0.94	15-32	5	24	56	2
10 Steady speed			32	24		61	2
11 Deceleration	8	-0.75	32-10	8	11	85	2
12 Deceleration, clutch disengaged						93	
13 Idling	9	-0.92	10-0	3		96	K2
14 Acceleration	10	0.83	0-15	21	26	117	16 sec. PM + 5 sec. K1
15 Shifting of gears				5		122	1
16 Acceleration	11	0.62	15-35	2	12	124	2
17 Shifting of gears				9		133	
18 Acceleration	12	0.52	35-50	2	13	135	3
19 Steady speed			50	8		143	3
20 Deceleration	13	-0.52	50-35	12	8	155	3
21 Steady speed			35	8		163	3
22 Shifting of gears	14			13	12	176	3
23 Deceleration		-0.86	32-10	2		178	2
24 Deceleration, clutch disengaged	15	-0.92	10-0	7	7	185	
25 Idling				3		188	K2
				7		195	7 sec. PM

* PM = Gears in neutral, clutch engaged.

K1, K2 = First or second gear engaged, clutch disengaged.

the above table and depicted in the graph in the appendix (page [406]). The breakdown by operations is also given in the table in the appendix (page [408]).

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 and brake controls so as to achieve a cycle approximating to the theoretical cycle within the prescribed limits.

2.3. Use of the gear-box

- 2.3.1. If the maximum speed which can be attained in first gear is below 15 km/h, the second, third and fourth gears shall be used.

- 2.3.2. Vehicles equipped with semi-automatic-shift gear-boxes shall be tested by using the gears normally employed for driving, and the gear shift shall be used in accordance with the manufacturer's instructions.
- 2.3.3. Vehicles equipped with automatic-shift gear-boxes shall be tested with the highest gear ("Drive") engaged. The accelerator shall be used in such a way as to obtain the steadiest acceleration possible, enabling the various gears to be engaged in the normal order. Furthermore, the gear-change points shown in the appendix (page [406]) shall not apply; acceleration shall continue throughout the period represented by the straight line connecting the end of each period of idling with the beginning of the next following period of steady speed. The tolerances given in paragraph 2.4. shall apply.
- 2.3.4. Vehicles equipped with an overdrive which the driver can actuate shall be tested with the overdrive out of action.

2.4. *Tolerances*

- 2.4.1. A tolerance of 1 km/h above or below the theoretical speed shall be allowed during acceleration, during steady speed, and during deceleration when the vehicle's brakes are used. If the vehicle decelerates more rapidly without the use of the brakes, only the provisions of paragraph 6.6.3. shall apply. 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 one occasion.
- 2.4.2. Time tolerances of ± 0.5 sec.
The above tolerances shall apply equally at the beginning and at the end of each gear-changing period.*
- 2.4.3. The speed and time tolerances shall be combined as indicated in the appendix (page [406]) 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 3,000 km before the test.
- 3.1.2. The exhaust device shall not exhibit any leak likely to reduce the quantity of gas collected, which quantity shall be that emerging from the engine.
- 3.1.3. The tightness of the admission 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.

* It should be noted that the time of 2 seconds allowed includes the time for changing the combination and, if necessary, a certain amount of latitude to catch up with the cycle.

- 3.1.5. A vacuum gauge shall be installed in the intake circuit near the carburettor, beyond the throttle.
- 3.1.6. The laboratory may verify that the vehicle conforms to the performances stated by the manufacturer, that it can be used for normal driving, and more particularly that it is capable of starting when cold and when hot.

3.2. *Motor fuel*

- 3.2.1. The fuel shall be the reference fuel whose specifications are given in annex 7. If the engine is lubricated by mixture, the oil added to the reference fuel shall comply as to grade and quantity with the manufacturer's recommendations.

4. TEST EQUIPMENT

4.1. *Dynamometer brake*

No particular model is prescribed. However, its adjustment shall not be affected by the lapse of time. It shall not produce any vibrations perceptible in the vehicle and likely to impair the latter's normal operation. It shall be equipped with an inertia adapter enabling the vehicle's operation on the road to be reproduced (equivalent inertias).

4.2. *Gas-collection equipment*

- 4.2.1. The connecting tubes shall be made of steel and shall, so far as possible, be provided with rigid connexions. However, a completely gas-tight flexible ring element shall be used to isolate the device from the vehicle's vibrations. Other materials may be used if they do not affect the composition of the gases.
- 4.2.2. If the vehicle being tested is equipped with an exhaust pipe comprising several branches, the branches shall be connected as near as possible to the vehicle.
- 4.2.3. The temperature of the gases in the collecting system shall be compatible with correct operation of the engine; with maintenance of the sampling bags in good condition; with the hydrocarbon absorption level prescribed in paragraph 5.5.1.; and with reduction to a minimum of condensation on the sides of the sampling bag or bags.
- 4.2.4. The various valves used to direct the exhaust gases either to the atmosphere or to the sampling device shall be of a quick-adjustment, quick-acting type.
- 4.2.5. The collecting device shall comprise one or more bags of adequate capacity. The bags shall be made of such materials as will not adversely affect either the accuracy of the measurements or the conservation of the gases.

4.3. *Analytical equipment*

- 4.3.1. The sampling probe may consist of the sampling tube leading into the

collecting device or of the bag-emptying tube. It may also be independent, but in no case shall its opening be at the bottom of the bag.

- 4.3.2. Analysers shall be of the non-dispersive type with absorption in the infra-red. The hydrocarbons analyser shall be sensitized for n-hexane.

4.4. *Volume-measuring equipment*

- 4.4.1. A volumetric gauge shall be used.
- 4.4.2. Pressure and temperature measurements enabling the volume to be referred to standard conditions shall be carried out at points selected in the light of the type of gauge used. The laboratory shall specify their positions.
- 4.4.3. The gas-bleeding device may consist of a pump or of any other system which keeps the pressure measured at the gauge constant.

4.5. *Accuracy of instruments*

- 4.5.1. As the brake is calibrated in a separate test, the accuracy of the dynamometer is not indicated. The total inertia of the rotating masses, including that of the rollers and the rotating part of the brake (see paragraph 5.2.), shall be given to within ± 20 kg.
- 4.5.2. The speed of the vehicle shall be measured by the speed of rotation of the rollers connected to the brake fly-wheel. It shall be measurable to within ± 2 km/h in the speed range from 0 to 10 km/h and to within ± 1 km/h at speeds above 10 km/h.
- 4.5.3. The temperatures considered in paragraphs 6.1.1. and 7.3.3. shall be measurable to within $\pm 2^{\circ}\text{C}$.
- 4.5.4. The atmospheric pressure shall be measurable to within ± 1 mm of mercury.
- 4.5.5. The vacuum in the vehicle's intake manifold shall be measured to within ± 5 mm (mercury gauge) and the other pressures (back-pressure in the sampling device; pressure for correction of volume; etc.) to within ± 5 mm (water gauge).
- 4.5.6. The size and accuracy of the meter shall be appropriate to the volume of gas to be measured, so that the measurement of volume is accurate to within ± 2 per cent.
- 4.5.7. The analysers shall have a measuring range compatible with the accuracy required to measure the content of the various constituents to within ± 3 per cent, disregarding the accuracy of the standard (calibration) gases. The over-all response time of the analysing circuit shall be less than one minute.
- 4.5.8. The content of the standard gases shall not differ by more than ± 2 per cent from the reference value of each gas. The diluent shall be nitrogen.

5. PREPARING THE TEST

5.1. *Setting of brake*

- 5.1.1. The brake shall be so adjusted as to reproduce the operation of the vehicle on the level at a steady speed of 50 km/h.
- 5.1.2. For this purpose the vacuum shall be measured at the engine intake during a road test carried out at 50 km/h in third gear, or by using the gears specified in paragraph 2.3., the vehicle being loaded to its reference weight and the tyre pressure being that indicated by the manufacturer. The vacuum shall be measured when a steady speed on the level has been maintained for at least 15 seconds. To take accounts of the influence of the wind, the average of the results of measurements made twice in each direction shall be taken.
- 5.1.3. The vehicle shall then be placed on the dynamometer bench and the brake so adjusted as to obtain the same vacuum at the intake as that recorded in the road test referred to in paragraph 5.1.2. above. This brake setting shall be maintained throughout the test.
- 5.1.4. This setting is appropriate for brakes of hydraulic type. For other types it may be necessary to make sure that the setting so obtained is appropriate for other intermediate states between idling and the maximum speed in the cycle. If necessary, an intermediate setting shall be adopted.
- 5.2. *Adjustment of equivalent inertias to the vehicle's translatory inertias.* A fly-wheel shall be used enabling a total inertia of the rotating masses to be obtained proportional to the reference weight within the following limits:

<i>Reference weight of vehicle</i> <i>rw, kg</i>	<i>Equivalent inertias</i> <i>kg</i>
$rw \leq 750$	680
$750 < rw \leq 850$	800
$850 < rw \leq 1020$	910
$1020 < rw \leq 1250$	1130
$1250 < rw \leq 1470$	1360
$1470 < rw \leq 1700$	1590
$1700 < rw \leq 1930$	1810
$1930 < rw \leq 2150$	2040
$2150 < rw$	2270

5.3. *Conditioning of vehicle*

- 5.3.1. Before the test the vehicle shall be kept at a temperature between 20° and 30°C for at least 6 hours. The cooling-water and engine-oil temperatures shall be measured before the test to make sure that they are between 20° and 30°C.

- 5.3.2. The tyre pressure shall be the same as that indicated by the manufacturer for the preliminary road test for brake adjustment. However, if the diameter of the rollers is less than 50 cm, the pressure in the tyres shall be increased by 30–50 per cent to prevent damage to them.

5.4. *Check of back-pressure*

During the preliminary tests a check shall be made to ensure that the back-pressure set up by the sampling device does not exceed 75 mm (water gauge), measurement being performed at the various steady speeds prescribed in the cycle.

5.5. *Conditioning of bags*

- 5.5.1. The bags shall be so conditioned, particularly with regard to hydrocarbons, that hydrocarbon losses over a period of 20 minutes do not exceed 2 per cent of the initial content. This conditioning shall be carried out during preliminary tests conducted at temperatures close to the extreme temperatures encountered during the various tests.

- 5.5.2. Losses shall be measured as follows. When the engine is running at a constant r.p.m. speed the hydrocarbons content of the gases entering the bag shall be measured continuously until the bag has been filled. The content when filling is completed shall be the average of the contents recorded during filling. The bag shall be emptied by the analyser pumps and the content recorded continuously or at fixed intervals. If after 20 minutes the content has varied by more than 2 per cent, the bag shall be emptied and then refilled for a second measurement. This cycle shall be repeated as many times as is necessary to saturate the walls.

5.6. *Calibration 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 discharge gauge and the pressure-reducing valve 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 attained in less than one

minute. If this value is not attained, the analysing circuit shall be inspected from end to end for leaks.

5.7. *Adjustment of volume-measuring device*

The bag shall be filled during the preliminary tests and a check made to ensure that the volume can be measured with the desired accuracy. If necessary, a suitable meter will be selected in each specific case.

6. PROCEDURE FOR BENCH TESTS

6.1. *Special conditions for carrying out the cycle*

- 6.1.1. The temperature in the room accommodating the roller bed shall be between 20° and 30°C throughout the test and approximate as closely as possible that of the room in which the vehicle was conditioned for the test.
- 6.1.2. The vehicle shall be approximately horizontal during the test so as to avoid any abnormal distribution of the fuel.
- 6.1.3. The test shall be carried out with the bonnet raised. An auxiliary ventilating device acting on the radiator (water-cooling) or on the air intake (air-cooling) may be used if necessary to keep the engine temperature normal.
- 6.1.4. When the cycle is carried out the speed considered shall be that of the rollers connected to the brake fly-wheel. During the test the speed shall be plotted against time so that the correctness of the cycles performed can be assessed.
- 6.1.5. Recording of the vacuum shall be optional; however, if it is recorded at the same time as the speed it will be possible to judge whether the accelerations have been made correctly.
- 6.1.6. The temperatures of the cooling water and of the crank-case oil may also be recorded if desired.

6.2. *Starting up the engine*

- 6.2.1. The engine shall be started up by means of the devices provided for this purpose, such as the choke, the starter valve, etc., according to the manufacturer's instructions.
- 6.2.2. The engine shall be kept idling on the choke for a period of 40 seconds. The first cycle shall begin when the valve of the effluent-recovery device is operated, which shall be done at the end of the aforesaid period of 40 seconds.

6.3. *Use of the manual choke*

The choke shall be cut out as soon as possible, and in principle before acceleration from zero to 50 km/h. If this principle cannot be abided by, the moment of effective cut-out shall be stated. The method used to adjust the choke shall be that indicated in the manufacturer's specifications.

6.4. *Idling*

6.4.1. Manual-shift gear-box.

- 6.4.1.1. During periods of idling the clutch shall be engaged and the gears in neutral.
- 6.4.1.2. To enable the accelerations to be performed according to the normal cycle the vehicle shall be placed in first gear, with the clutch disengaged, 5 seconds before the acceleration following the idling period considered.
- 6.4.1.3. The first idling period at the beginning of the cycle shall consist of 6 seconds of idling in neutral with the clutch engaged and 5 seconds in first gear with the clutch disengaged.
- 6.4.1.4. For the idling periods during each cycle the corresponding times shall be 16 seconds in neutral and 5 seconds in first gear with the clutch disengaged.
- 6.4.1.5. The idling period between two successive cycles shall comprise 13 seconds in neutral with the clutch engaged.

6.4.2. Semi-automatic-shift gear-boxes.

The manufacturer's instructions for driving in town, or in their absence the rules applicable to manual-shift gear-boxes, shall be followed.

6.4.3. Automatic-shift gear-boxes.

The selector shall not be operated at any time during the test unless the manufacturer specifies otherwise. In the latter case the procedure for manual-shift gear-boxes shall be applied.

6.5. *Accelerations*

- 6.5.1. Accelerations shall be so performed that the rate of acceleration is as constant as possible throughout the phase.
- 6.5.2. If acceleration cannot be carried out in the prescribed time, the extra time required shall be deducted from the time allowed for changing the combination, if possible, and in any case from the subsequent steady-speed period.

6.6. *Decelerations*

- 6.6.1. All decelerations shall be effected by removing the foot completely from the accelerator, the clutch remaining engaged. The clutch shall be disengaged, without use of the gear lever, at a speed of 10 km/h.
- 6.6.2. If the period of deceleration is longer than that prescribed for the corresponding phase, the vehicle's brakes shall be used to enable the timing of the cycle to be abided by.
- 6.6.3. If the period of deceleration is shorter than that prescribed for the corresponding phase, the timing of the theoretical cycle shall be restored by an idling period merging into the following idling operation.

- 6.6.4. At the end of the deceleration period (halt of the vehicle on the rollers) the gears shall be placed in neutral and the clutch engaged.

6.7. *Steady speeds*

- 6.7.1. "Pumping" or the closing of the throttle shall be avoided when passing from acceleration to the following steady speed.
- 6.7.2. Periods of constant speed shall be achieved by keeping the acceleration position fixed.

7. PROCEDURE FOR SAMPLING AND ANALYSIS

7.1. *Sampling*

- 7.1.1. Sampling shall begin as soon as the valve has been opened as indicated in paragraph 6.2.2.
- 7.1.2. If several bags are used the bag shall be changed at the beginning of the first idling period of a cycle.
- 7.1.3. The bag shall be hermetically closed as soon as it is full.
- 7.1.4. At the end of the last cycle the valve shall be operated to divert the gases produced by the engine to 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 bag considered began.
- 7.2.2. If the sampling probe is not left permanently in the bag, the entry of air into the latter during insertion of the probe and the escape of gases from the bag during extraction of the probe shall be avoided.
- 7.2.3. The analyser shall be in a stabilised condition within one minute after the operation of placing it in communication with the bag.
- 7.2.4. The figure adopted as the content of the gases in each of the effluents measured shall be that read off after stabilization of the measuring device.

7.3. *Measurement of volume*

- 7.3.1. To avoid wide temperature variations, the volume of the bag or bags shall be measured as soon as the temperature has reached room temperature.
- 7.3.2. The bags shall be emptied through the gas gauge.
- 7.3.3. The temperature (t_m) used for the calculations shall be the arithmetical mean of the temperatures at the beginning and at the end of emptying, the maximum permissible difference between these two temperatures being below 5°C.
- 7.3.4. The pressure (P_m) used for the calculations shall be the arithmetical mean of the absolute pressures recorded at the beginning and at the end of

emptying the maximum permissible difference between these two pressures being below 4 mm (mercury gauge).

- 7.3.5. The volume of gas drawn off for analysis shall be added to the volume measured by the meter if the first-mentioned volume is equivalent to more than 1 per cent of the said volume measured. The result obtained shall be designated by the symbol V_m .

8. DETERMINATION OF THE QUANTITY OF GASEOUS POLLUTANTS EMITTED

8.1. *Correction of the measured volumes of gas*

The volume of the gases contained in each bag shall be referred to normal temperature and pressure by means of the formula:

$$V = V_m \frac{273}{273 + t_m} \cdot \frac{P_m - P_H}{760},$$

where

V_m is the volume measured expressed in litres, as indicated in paragraph 7.3.5.;

t_m is the arithmetical mean of the extreme temperatures recorded as indicated in paragraph 7.3.3., expressed in degrees centigrade;

P_m is the arithmetical mean of the extreme absolute pressures recorded as indicated in paragraph 7.3.4., expressed in millimetres (mercury gauge) and

P_H is the saturated-water-vapour pressure, expressed in millimeters (mercury gauge), at the temperature.

8.2. *Mass of the gaseous pollutants contained in each bag*

The mass of the gaseous pollutants contained in each bag shall be determined by the product of dCV , where C is the content by volume and d the volume mass of the gaseous pollutant considered:

in the case of carbon monoxide, $d = 1.250$;

in the case of hydrocarbons, $d = 3.844$ (hexane).

8.3. *Total mass of gaseous pollutants emitted*

The mass M of each gaseous pollutant emitted by the vehicle during the test shall be determined by adding the masses of the gaseous pollutants contained in each bag and calculated as indicated in paragraph 8.2.

NOTE: Laboratories are recommended to check the analyses by also measuring the quantity of carbon dioxide produced.

BREAKDOWN OF THE OPERATING CYCLE
USED FOR THE TYPE-I TEST

	<i>Time</i>	<i>Percentage</i>	
(1) <i>Breakdown by phases</i>			
Idling	60 sec.	30.8	} 35.4
Idling, vehicle moving, clutch engaged on one combination .	9 sec.	4.6	
Gear-shift	8 sec.		4.1
Accelerations	36 sec.		18.5
Steady-speed periods	57 sec.		29.2
Decelerations	25 sec.		12.8
	195 sec.		100%
(2) <i>Breakdown by use of gears</i>			
Idling	60 sec.	30.8	} 35.4
Idling, vehicle moving, clutch engaged on one combination .	9 sec.	4.6	
Gear-shift	8 sec.		4.1
first gear	24 sec.		12.3
second gear	53 sec.		27.2
third gear	41 sec.		21
	195 sec.		100%

Average speed during test: 19 km/h Effective running time: 195 sec.

Theoretical distance covered per cycle: 1.013 km

Equivalent distance for the test (4 cycles): 4.052 km

ANNEX 5

TYPE-II TEST

(Carbon-monoxide emission test at idling speed)

1. INTRODUCTION

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

2. CONDITIONS OF MEASUREMENT

2.1. The fuel shall be the reference fuel whose specifications are given in annex 7.

- 2.2. The carbon-monoxide content by volume shall be measured immediately after the fourth cycle of the type-I test, with the engine at idling speed.
- 2.3. In the case of vehicles with manually-operated or semi-automatic-shift gear-boxes the test shall be carried out with the gear lever in the "neutral" position and with the clutch engaged.
- 2.4. In the case of vehicles with automatic-shift gear-boxes the test shall be carried out with the gear selector in either the "neutral" or the "parking" position.

3. SAMPLING OF GASES

- 3.1. The sampling probe shall be placed in the pipe connecting the exhaust with the sampling bag and as close as possible to the exhaust.
- 3.2. In order to take account of possible dilution of the exhaust gases with air, the content by volume of carbon monoxide (T_1) and of carbon dioxide (T_2) shall be measured, and the content by volume (T) to be compared with the prescribed limit shall be calculated by the formula:

$$T = T_1 \frac{0.15}{(T_1 + T_2)}$$

ANNEX 6

TYPE-III TEST

(Verifying emissions of crank-case gases)

1. INTRODUCTION

This annex describes the procedure for the type-III test defined in paragraph 5.2.1.3. of this Regulation.

2. GENERAL PROVISIONS

- 2.1. The type-III test shall be carried out on the vehicle subjected to the type-I and the type-II tests.
- 2.2. The engines tested shall include leak-proof engines other than those so designed that even a slight leak may cause unacceptable operating faults (such as flat-twin engines).

3. TEST CONDITIONS

- 3.1. Idling shall be regulated in conformity with the manufacturer's recommendations; in the absence of such recommendations it shall be so regulated as to achieve a maximum vacuum in the intake manifold.

- 3.2. The measurements shall be performed in the following three sets of conditions of engine operation:

No.	Vehicle speed (km/h)	Vacuum at intake (mm mercury)	Weighting factor
1	Idling		0.25
2	50 ± 2	400 ± 8	0.25
3	50 ± 2	250 ± 8	0.50

- 3.3. If the engine cannot operate under a vacuum of 400 mm (mercury gauge), the vacuum shall be so adjusted as to equal that recorded on a level road at a constant speed of 50 km/h.

The vacuum of condition 3 in the table above shall be that recorded as specified above multiplied by $250/400 = 0.625$.

- 3.4. The engine speed for measurements as referred to under 2 and 3 in paragraph 3.2. above shall be selected as the lowest engine speed at which, gear ratios being taken into account, the vehicle can travel at a speed of 50 km/h in normal operating conditions.

4. TEST METHOD

- 4.1. In each of the sets of conditions 1, 2 and 3 specified in paragraph 3.2. above the following shall be measured:

- 4.1.1. the volume Q_n not recycled by the device in the unit time;
4.1.2. the consumption by weight C_n of fuel in the same unit time.

- 4.2. The volumes Q_n , measured as specified in paragraph 5.6. in each of the sets of conditions of measurement, shall be referred to the standard conditions (760 mm mercury; 0°C) by the formula

$$Q'_n = Q_n \frac{H}{760} \times \frac{273}{T}$$

- 4.3. The content by volume of hydrocarbons, t , shall be measured as specified in paragraph 5.4. below. If the manufacturer so requests, the crank-case gases shall not be analysed, but shall be assumed to contain 15,000 p.p.m. of hydrocarbons.

- 4.4. The volume mass (weight per unit volume) of hydrocarbons shall be assumed to be 3.84 g/litre, and for each set of conditions of measurement the weight of hydrocarbons discharged to the atmosphere shall be determined by the formula:

$$P_n = Q'_n \times t \times 3.84,$$

Q'_n being the corrected volumes.

4.5. The mean weight of hydrocarbons \bar{P} and the consumption \bar{C} of fuel shall be calculated from the values obtained for each of the sets of conditions of measurement by applying the weighting factors specified in paragraph 3.2. above. They shall be expressed in the same units.

4.6. Interpretation of results:

The vehicle shall be deemed satisfactory if

$$\bar{P} \leq \frac{0.15}{100} \times \bar{C}$$

5. METHOD OF MEASUREMENT OF THE DELIVERY Q_n NOT RECYCLED BY THE DEVICE

5.1. Steps to be taken before the test.

Before the test, all apertures other than that required for the recovery of the gases shall be stopped up.

5.2. Principle of the method

5.2.1. A suitable take-off not introducing any additional loss of pressure shall be installed on the recycling circuit of the device directly at the engine-connexion aperture.

5.2.2. A flexible bag made of a material not absorbing hydrocarbons shall be so connected to the outlet from the take-off aforesaid as to collect the gases which are not recycled by the engine (appendix, page [418]). The bag shall be emptied at each measurement.

5.3. Method of measurement.

The bag shall be stopped up before each measurement. It shall be brought into communication with the take-off for a known period of time and then emptied through a suitable volumetric meter.

During emptying as aforesaid the pressure H , expressed in mm (mercury gauge), and the temperature N , expressed in degrees centigrade, shall be measured for the purposes of volume correction as referred to in paragraph 4.2.

5.4. Measurement of hydrocarbons content.

5.4.1. During emptying as aforesaid the hydrocarbons content shall, if appropriate, be measured by means of a non-dispersive n -hexane-sensitized infra-red analyser. The reading shall be multiplied by the coefficient 1.24 to allow for the absolute hydrocarbons concentration in the crank-case gases.

5.4.2. The analysers and the reference gases shall meet the conditions laid down in annex 4, paragraphs 4.5.7. and 4.5.8.

5.5. Measurement of fuel consumption

The weight of fuel consumed in each of the conditions of operation defined

in paragraph 3.2. shall be determined. This weight shall be referred to the unit time.

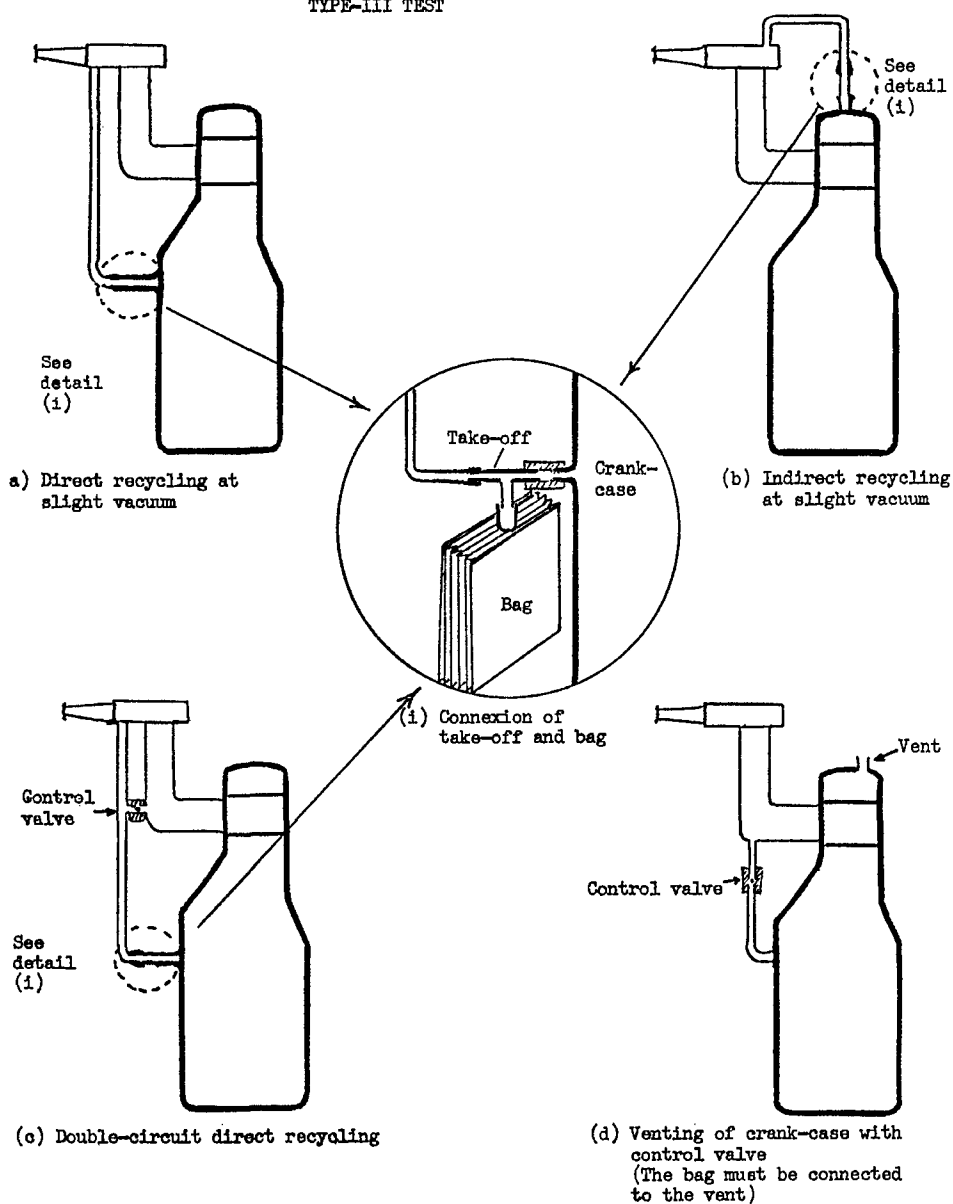
5.6. Expression of results of measurements.

The values Q'_n , in which n relates to each of the conditions referred to in paragraph 3.2., and the consumptions C_n shall be referred to the same unit time for the purpose of applying the weighting coefficients and the calculations for determining the weighted weight of hydrocarbons and the weighted consumption of fuel.

5.7. Accuracy of measurements.

- 5.7.1. The pressure in the bag during measurement of the volumes shall be measured to within ± 1 mm (mercury gauge).
- 5.7.2. The vacuum at intake shall be measured to within ± 8 mm (mercury gauge).
- 5.7.3. The vehicle speed shall be taken at the rollers and measured to within ± 2 km/h.
- 5.7.4. The quantity of gas discharged shall be measured to within ± 5 per cent.
- 5.7.5. The temperature of the gases during measurement of the volume shall be measured to within $\pm 2^\circ\text{C}$.
- 5.7.6. The hydrocarbons content shall be measured, if appropriate, to within ± 5 per cent, irrespective of the degree of accuracy of the reference gases.
- 5.7.7. The fuel consumption shall be measured to within ± 4 per cent.

TYPE-III TEST



ANNEX 7

SPECIFICATIONS OF REFERENCE FUEL *

	<i>Limits and units</i>	<i>Method</i>
Research octane number . . .	99 ± 1	ASTM ** D 908-67
Specific gravity 15/4°C . . .	0.742 ± 0.007	ASTM D 1298-67
Reid vapour pressure . . .	$\left\{ \begin{array}{l} 0.6 \pm 0.04 \text{ bars} \\ 8.82 \pm 0.59 \text{ psi} \end{array} \right.$	ASTM D 323-58
Distillation		
Initial boiling point		ASTM D 86-67
— 10% vol.	50 ± 5°C	
— 50% vol.	100 ± 10°C	
— 90% vol.	160 ± 10°C	
Final boiling point. . .	195 ± 10°C	
— residue (% vol.) . .	max. 2	
— loss (% vol.) . .	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
Existent gum	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
Lead content	$\left\{ \begin{array}{l} 0.57 \pm 0.03 \text{ g/l} \\ 2.587 \pm 0.136 \text{ g/IG} \end{array} \right.$	ASTM D 526-66
Nature of scavenger . .	motor mix	
Nature of lead alkyl . .	not specified	
Other additives	nil	

* In blending the reference fuel, only conventional European base materials should be used, unconventional components such as pyrolysis gasoline, thermally cracked material and motor benzole being excluded.

** Initials of the American Society for Testing and Materials, 1916 Race St., Philadelphia, Pennsylvania 19103, U.S.A. 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 will remain applicable unless all Parties to the 1958 Agreement which apply this Regulation agree to replace them by later standards.