Regulation No 101 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of passenger cars equipped with an internal combustion engine with regard to the measurement of the emission of carbon dioxide and fuel consumption and of categories M_1 and N_1 vehicles equipped with an electric power train with regard to the measurement of electric energy consumption and range (*)

1. SCOPE

This Regulation applies to the measurement of the emission of carbon dioxide (CO_2) and fuel consumption from all motor vehicles of M_1 category vehicles, or to the measurement of electric energy consumption and range of categories M_1 and N_1 vehicles (1).

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 measurement of energy consumption (fuel or electric energy).

2.2. 'Vehicle type' means a category of power driven vehicles which do not differ in such essential respects as body, drive train, transmission, traction battery (if applicable), tyres and unladen mass.

2.3. 'Unladen mass' means the mass of the vehicle in running order without crew, passengers or load, but with the fuel tank full (if any), cooling liquid, service and traction batteries, oils, onboard charger, portable charger, tools and spare wheel, whatever is appropriate for the vehicle considered and if provided by the manufacturer of the vehicle.

2.4. 'Reference mass' means the unladen mass of the vehicle increased by a uniform figure of 100 kg.

2.5. 'Maximum mass' means the technically permissible maximum mass declared by the manufacturer (this mass may be greater than the maximum mass authorized by the national administration).

2.6. 'Test mass' for the pure electric vehicles means the 'reference mass' for the category M_1 vehicles and the unladen mass plus half the full load for the category N_1 vehicles.

2.7. 'Cold start device' means a device, which enriches the air/fuel mixture of the engine temporarily, to assist starting.

2.8. 'Starting aid' means a device which assists engine starting without enrichment of the air/fuel mixture, e.g. glow plug, changed injection timing, etc.

2.9. 'Drive train' means the combination of an electric motor and a power controller.

2.10. 'Power train' means the combination of a drive train and a traction battery.

2.11. 'Periodically regenerating system' means an anti-pollution device (e.g. catalytic converter, particulate trap) that requires a periodical regeneration process in less than 4 000 km of normal vehicle operation. If a regeneration of an anti-pollution device occurs at least once per Type I test and has already regenerated at least once during the vehicle preparation cycle, it will be considered as a continuously regenerating system, which does not require a special test procedure. Annex 8 does not apply to continuously regenerating systems.

(*) Publication in accordance with article 4(5) of Council Decision 97/836/EC of 27 November 1997 (OJ L 346 of 17.12.1997, p. 78).

(1) As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3) (document TRANS/WP.29/78/Rev. 1/Amend. 2).

At the request of the manufacturer, the test procedure specific to periodically regenerating systems will not apply to a regenerative device if the manufacturer provides data to the type approval authority that, during cycles where regeneration occurs, emission of CO_2 does not exceed the declared value by more than 4 per cent after agreement of the technical service.

3. APPLICATION FOR APPROVAL

3.1. The application for approval of a vehicle type with regard to the measurement of the emission of carbon dioxide and fuel consumption or to the measurement of electric energy consumption 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 internal combustion engine type or the electric power train type comprising all the particulars referred to in annex 1 or annex 2. At the request of the technical service in charge of the tests or the manufacturer, complementary technical information could be considered for specific vehicles, which are particularly fuel efficient.

3.2.2. Description of the basic features of the vehicle, including those used in drafting annex 3.

3.3. A vehicle, representative of the vehicle type to be approved, shall be submitted to the technical services responsible for conducting approval tests. During the test, the technical service will check that this vehicle, if equipped with an internal combustion engine, conforms to the limit values applicable to that type, as described in Regulation No 83.

3.4. The competent authority shall verify the existence of satisfactory provisions to ensure an effective check of conformity of production before approval of the vehicle type is granted.

4. APPROVAL

4.1. If the emissions of CO_2 and fuel consumption of internal combustion engine or the electric energy consumption of the vehicle type submitted for approval pursuant to this Regulation have been measured according to the conditions specified in paragraph 5 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 00 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 the same number to another vehicle type.

4.3. Notice of approval or of extension or refusal of approval of a vehicle type pursuant to this Regulation shall be communicated to the Parties to the 1958 Agreement applying this Regulation by means of a form conforming to the model in annex 3 to this Regulation.

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 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.

4.8. Annex 4 to this Regulation gives examples of arrangements of the approval mark.

5. SPECIFICATIONS AND TESTS

5.1. *General*

The components liable to affect the emissions of CO_2 and fuel consumption or the electric energy consumption shall be so designed, constructed and assembled as to enable the vehicle, in normal use, despite the vibrations to which it may be subjected, to comply with the provisions of this Regulation.

5.2. *Description of tests for internal combustion engines*

5.2.1. The emissions of CO_2 shall be measured during the test cycle simulating the urban and extra-urban driving patterns as described in appendix 1 of annex 4 to Regulation No. 83, in force at the time of the approval of the vehicle.

5.2.2. The results of the test must be expressed as CO_2 emissions in grams per kilometre (g/km) rounded to the nearest whole number.

5.2.3. Fuel consumptions are calculated according to paragraph 1.5 of annex 4 by the carbon balance method using the measured emissions of CO_2 and the other carbon related emissions (CO and HC). The results will be rounded to the first decimal place.

5.2.4. The appropriate reference fuels as defined in annex 10 to Regulation No 83 must be used for testing.

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[1] 1 for Germany, 2 for France, 3 for Italy, 4 for the Netherlands, 5 for Sweden, 6 for Belgium, 7 for Hungary, 8 for the Czech Republic, 9 for Spain, 10 for Serbia and Montenegro, 11 for the United Kingdom, 12 for Austria, 13 for Luxembourg, 14 for Switzerland, 15 (vacant), 16 for Norway, 17 for Finland, 18 for Denmark, 19 for Romania, 20 for Poland, 21 for Portugal, 22 for the Russian Federation, 23 for Greece, 24 for Ireland, 25 for Croatia, 26 for Slovenia, 27 for Slovakia, 28 for Belarus, 29 for Estonia, 30 (vacant), 31 for Bosnia-Herzegovina, 32 for Latvia, 33 (vacant), 34 for Bulgaria, 35 and 36 (vacant), 37 for Turkey, 38 (vacant), 39 for Azerbaijan, 40 for The former Yugoslav Republic of Macedonia, 41 (vacant), 42 for the European Community (Approvals are granted by its Member States using their respective ECE symbol), 43 for Japan, 44 (vacant), 45 for Australia, 46 for Ukraine, 47 for South Africa and 48 for New Zealand. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the Agreement Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

For LPG and natural gas (NG) that reference fuel must be used which is chosen by the manufacturer for the measurement of the net power in accordance with Regulation No 85. The chosen fuel must be specified in the communication document as defined in annex 3 to this Regulation.

For the purpose of calculation mentioned in paragraph 5.2.3, the fuel consumption shall be expressed in appropriate units and the following fuel characteristics shall be used:

(a) density: measured on the test fuel according to ISO 3675 or an equivalent method.

For petrol and diesel fuel the density measured at 15 °C will be used; for LPG and natural gas a reference density will be used, as follows:

0,538 kg/litre for LPG

0,654 kg/m^3 for NG [1]

(b) hydrogen-carbon ratio: fixed values will be used which are:

1,85 for petrol

1,86 for diesel fuel

2,525 for LPG

4,00 for NG

5.3. *Description of tests for pure electric vehicles*

5.3.1. The technical service in charge of the tests conducts the measurement of the electric energy consumption according to the method and test cycle described in annex 6 to this Regulation.

5.3.2. The technical service in charge of the tests conducts the measurement of the range of the vehicle according to the method described in annex 7.

The range measured by this method is the only one which may be included in sales promotional material.

5.3.3. The result of the electric energy consumption must be expressed in Watt hours per kilometer (Wh/km) and the range in km, both rounded to the nearest whole number.

5.4. *Interpretation of results*

5.4.1. The CO_2 value or the value of electric energy consumption adopted as the type approval value shall be the value declared by the manufacturer if the value measured by the technical service does not exceed the declared value by more than 4 per cent. The measured value can be lower without any limitations.

In the case of periodically regenerating systems as defined in paragraph 2.11, the results are multiplied by the factor K_i obtained from annex 8 before being compared to the declared value.

5.4.2. If the measured value of CO_2 or electric energy consumption exceeds the manufacturer's declared CO_2 or electric energy consumption value by more than 4 per cent, then another test is run on the same vehicle.

When the average of the two test results does not exceed the manufacturer's declared value by more than 4 per cent, then the value declared by the manufacturer is taken as the type approval value.

[1] Mean value of G 20 and G 23 reference fuels at 15 °C.

5.4.3. If the average still exceeds the declared value by more than 4 per cent, a final test is run on the same vehicle. The average of the three test results is taken as the type approval value.

6. MODIFICATION AND EXTENSION OF APPROVAL OF THE APPROVED TYPE

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

6.1.1. Consider that the modifications made are unlikely to have an appreciable adverse effect on the values of CO_2 and fuel consumption or electric energy consumption and that, in this case, the original approval will be valid for the modified vehicle type; or

6.1.2. require a further test report from the technical service responsible for conducting the tests according to conditions in paragraph 7 of this Regulation.

6.2. Confirmation or extension of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 4.3 to the Parties to the 1958 Agreement applying this Regulation.

6.3. The competent authority which grants the extension of the approval shall assign a series number for such an extension and inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in annex 3 to this Regulation.

7. CONDITIONS OF EXTENSION OF THE TYPE APPROVAL FOR VEHICLE TYPE

7.1. *Vehicles powered by an internal combustion engine, except vehicles equipped with a periodically regenerating emission control system*

The type approval can be extended to vehicles from the same type or from a different type differing with regard to the following characteristics of annex 2 if the CO_2 emissions measured by the technical service do not exceed by more than 4 per cent the type approved value:

7.1.1. Mass

7.1.2. Maximum authorized mass

7.1.3. Type of bodywork: saloon, estate, coupé

7.1.4. Overall gear ratios

7.1.5. Engine equipment and accessories

7.2. *Vehicles powered by an internal combustion engine and equipped with a periodically regenerating emission control system*

The type approval can be extended to vehicles from the same type or from a different type, differing with regard to the characteristics of annex 3, given in paragraphs 7.1.1 to 7.1.5 above, but not exceeding the family characteristics of annex 8, if the CO_2 emissions measured by the technical service do not exceed by more than 4 per cent the type approved value, and where the same K_i factor is applicable.

The type approval can be extended also to vehicles from the same type, but with a different K_i factor, if the corrected CO_2 value measured by the technical service does not exceed by more than 4 per cent the type approved value.

7.3. *Vehicles powered by an electric power train*

Extensions may be granted after agreement with the technical service responsible for conducting the tests.

8. SPECIAL PROVISIONS

In the future, vehicles with special energy efficient technologies may be offered which could be submitted to complementary testing programmes. These would be specified at a later stage, which can be claimed by the manufacturer in order to demonstrate the advantages of the solution.

9. CONFORMITY OF PRODUCTION

9.1. Vehicles approved to this Regulation shall be so manufactured as to conform to the type approved vehicle.

9.2. So as to verify that the conditions set out in paragraph 9.1 are complied with, appropriate production checks shall be carried out.

9.3. *Vehicles powered by an internal combustion engine:*

9.3.1. As a general rule, measures to ensure the conformity of production with regard to CO_2 emissions from vehicles is checked on the basis of the description in the type approval certificate conforming to the model in annex 3 of this Regulation.

The control of production conformity is based on an assessment made by the competent authority of the manufacturer's auditing procedure in order to ensure conformity of the vehicle type with respect to the emission of pollutants.

If the authority is not satisfied with the standard of the manufacturer's auditing procedure, they may require that verification tests be carried out on vehicles in production.

9.3.1.1. If a measurement of the emissions of CO_2 must be carried out on a vehicle type that has had one or several extensions, the tests will be carried out on the vehicle(s) available at the time of the test (vehicle(s) described in the first document or in subsequent extensions).

9.3.1.1.1. Conformity of the vehicle for the CO_2 test.

9.3.1.1.1.1. Three vehicles are randomly taken in the series and are tested as described in paragraph 1.4 of annex 5.

9.3.1.1.1.2. If the authority is satisfied with the production standard deviation given by the manufacturer, the tests are carried out according to paragraph 9.2.

If the authority is not satisfied with the production standard deviation given by the manufacturer, the tests are carried out according to paragraph 9.3.

9.3.1.1.1.3. The production of a series is regarded as conforming or non-conforming, on the basis of tests on the three sampled vehicles, once a pass or fail decision is reached for CO_2, according to the test criteria applied in the appropriate table.

If no pass or fail decision is reached for CO_2, a test is carried out on an additional vehicle (see Figure 1).

9.3.1.1.1.4. In the case of periodically regenerating systems as defined in paragraph 2.11., the results shall be multiplied by the factor K_i obtained by the procedure specified in annex 8 at the time when type approval was granted.

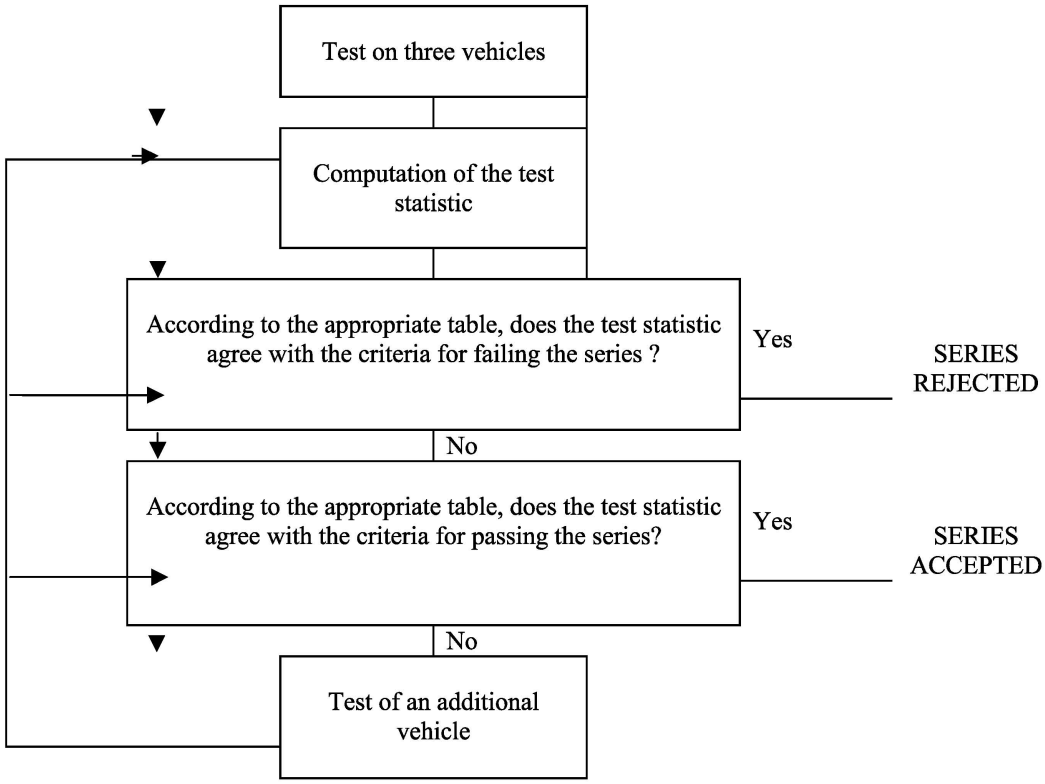
At the request of the manufacturer, testing may be carried out immediately after a regeneration has been completed.

9.3.1.1.2. Notwithstanding the requirements of paragraph 1.1.1 of annex 5, the tests will be carried out on vehicles which have not travelled any distance.

9.3.1.1.2.1. However, at the request of the manufacturer, the tests will be carried out on vehicles which have been run-in a maximum of 15 000 km.

In this case, the running-in procedure will be conducted by the manufacturer who shall undertake not to make any adjustments to those vehicles.

Figure 1



9.3.1.1.2.2. If the manufacturer asks to conduct a running-in procedure ('x' km, where ≤ 15 000 km), it may be carried out as follows:

— the emissions of CO_2 will be measured at zero and at 'x' km on the first tested vehicle (which can be the type approval vehicle);

— the evolution coefficient (EC) of the emissions between zero and 'x' km will be calculated as follows:

$$EC = \frac{\text{Emmissions at x km}}{\text{Emissions at zero km}}$$

It may be less than 1.

— The following vehicles will not be subjected to the running-in procedure, but their zero km emissions will be modified by the evolution coefficient, EC.

In this case, the values to be taken will be:

— the value at 'x' km for the first vehicle;

— the values at zero km multiplied by the evolution coefficient for the following vehicles.

9.3.1.1.2.3. As an alternative to this procedure, the car manufacturer can use a fixed evolution coefficient, EC, of 0,92 and multiply all values of CO_2 measured at zero km by this factor.

9.3.1.1.2.4. The reference fuels described in annex 9 of Regulation No 83 shall be used for this test.

9.3.2. Conformity of production when manufacturer's statistical data is available.

9.3.2.1. The following sections describe the procedure to be used to verify the CO_2 conformity of production requirements when the manufacturer's production standard deviation is satisfactory.

9.3.2.2. With a minimum sample size of three, the sampling procedure is set so that the probability of a lot passing a test with 40 per cent of the production defective is 0,95 (producer's risk = 5 per cent) while the probability of a lot being accepted with 65 per cent of the production defective is 0,1 (consumer's risk = 10 per cent).

9.3.2.3. The following procedure is used (see Figure 1).

Let L be the natural logarithm of the CO_2 type approval value:

x_i = the natural logarithm of the measurement for the i-th vehicle of the sample;

s = an estimate of the production standard deviation (after taking the natural logarithm of the measurements);

n = the current sample number.

9.3.2.4. Compute for the sample, the test statistic quantifying the sum of the standardized deviations to the limit and defined as:

$$\frac{1}{s}\sum_{i=1}^{n}(L - x_i)$$

9.3.2.5. Then:

9.3.2.5.1. if the test statistic is greater than the pass decision number for the sample given in Table 1, a pass decision is reached;

9.3.2.5.2. if the test statistic is less than the fail decision number for the sample size given in Table 1, a fail decision is reached;

9.3.2.5.3. otherwise, an additional vehicle is tested according to paragraph 1.4 of annex 5 and the procedure is applied to the sample with one unit more.

Table 1

Sample Size (cumulative number of vehicles tested)	Pass Decision No	Fail Decision No
(a)	(b)	(c)
3	3,327	– 4,724
4	3,261	– 4,790
5	3,195	– 4,856
6	3,129	– 4,922
7	3,063	– 4,988
8	2,997	– 5,054
9	2,931	– 5,120
10	2,865	– 5,185
11	2,799	– 5,251
12	2,733	– 5,317
13	2,667	– 5,383
14	2,601	– 5,449
15	2,535	– 5,515
16	2,469	– 5,581
17	2,403	– 5,647
18	2,337	– 5,713
19	2,271	– 5,779
20	2,205	– 5,845
21	2,139	– 5,911
22	2,073	– 5,977
23	2,007	– 6,043
24	1,941	– 6,109
25	1,875	– 6,175
26	1,809	– 6,241
27	1,743	– 6,307
28	1,677	– 6,373
29	1,611	– 6,439
30	1,545	– 6,505
31	1,479	– 6,571
32	– 2,112	– 2,112

9.3.3. Conformity of production when manufacturer's statistical data is unsatisfactory or unavailable.

9.3.3.1. The following sections describe the procedure to be used to verify the CO_2 conformity of production requirements when the manufacturer's evidence of production standard deviation is either unsatisfactory or unavailable.

9.3.3.2. With a minimum sample size of three the sampling procedure is set so that the probability of a lot passing a test with 40 per cent of the production defective is 0,95 (producer's risk = 5 per cent) while the probability of a lot being accepted with 65 per cent of the production defective is 0,1 (consumer's risk = 10 per cent).

9.3.3.3. The measurement of CO_2 is considered to be log-normally distributed and should first be transformed by taking the natural logarithms. Let m_o and m denote the minimum and maximum sample sizes respectively ($m_o = 3$ and $m = 32$) and let n denote the current sample number.

9.3.3.4. If the natural logarithms of the measurements in the series are x_1, x_2, . . ., x_j and L is the natural logarithm of the CO_2 type approval value, then define:

$$d_j = x_j - L$$

$$\overline{d}_n = \frac{1}{n}\sum_{j=1}^{n} d_j$$

$$v_n^2 = \frac{1}{n}\sum_{j=1}^{n}(d_j - \overline{d}_n)^2$$

9.3.3.5. Table 2 shows values of the pass (A_n) and fail (B_n) decision numbers against current sample number. The test statistic is the ratio $\overline{d}_n/v_n$ and shall be used to determine whether the series has passed or failed as follows:

for $m_o \leq n \leq m$:

9.3.3.5.1. pass the series if $\overline{d}_n/v_n \leq A_n$;

9.3.3.5.2. fail the series if $\overline{d}_n/v_n \geq B_n$;

9.3.3.5.3. take another measurement if $A_n < \overline{d}_n/v_n < B_n$.

9.3.3.6. Remarks

The following recursive formulae are useful for computing successive values of the test statistic:

$$\overline{d}_n = \left(1 - \frac{1}{n}\right)\overline{d}_n - 1 + \frac{1}{n}d_n$$

$$v_n^2 = \left(1 - \frac{1}{n}\right)v_n^2 - 1 + \frac{(\overline{d}_n - d_n)^2}{n-1}$$

$$(n = 2, 3. . .;\ \overline{d}_n = d_1;\ v_1 = 0)$$

9.4. *Vehicles powered by an electric power train:*

As a general rule, measures to ensure the conformity of production with regard to electric energy consumption is checked on the basis of the description in the type approval certificate set out in annex 3 to this Regulation.

9.4.1. The holder of the approval shall, in particular:

9.4.1.1. Ensure the existence of procedures for the effective control of product quality;

9.4.1.2. Have access to the equipment necessary for checking conformity with each approved type;

9.4.1.3. Ensure that the data concerning the test results are recorded and that the annexed documents are available during a period to be agreed with the administrative service;

9.4.1.4. Analyze the results of each type of test so as to monitor and ensure the consistency of the characteristics of the product, taking into account the variations admissible in industrial manufacture;

9.4.1.5. Make sure that for each type of vehicle tests prescribed in annex 6 to this Regulation are carried out; notwithstanding the requirements of paragraph 2.3.1.6 of annex 6, at the request of the manufacturer, the tests will be carried out on vehicles which have not travelled any distance;

9.4.1.6. Make sure that any collections of samples or test pieces demonstrating non-conformity with the type of test under consideration is followed by a subsequent sampling and a further test. All necessary steps shall be taken to re-establish the conformity of production.

9.4.2. The competent authorities issuing the approval may verify at any time the methods applied in each production unit.

9.4.2.1. In every inspection, the records of tests and production monitoring shall be communicated to the visiting inspector.

9.4.2.2. The inspector may select at random the samples to be tested in the manufacturer's laboratory. The minimum number of samples may be determined on the basis of the results of the manufacturer's own checks.

9.4.2.3. When the quality standard does not seem satisfactory or when it seems necessary to verify the validity of the tests conducted under paragraph 9.4.2.2, the inspector shall collect samples to be sent to the technical service which carried out the approval tests.

9.4.2.4. The competent authorities may carry out all the tests prescribed in this Regulation.

9.4.2.5. If, during inspections, negative results are observed, the competent authority shall ensure that all necessary steps are taken to re-establish conformity of production as soon as possible.

Table 2

Sample Size (cumulative number of vehicles tested) n	Pass Decision No A_n	Fail Decision No B_n
(a)	(b)	(c)
3	– 0,80381	16,64743
4	– 0,76339	7,68627
5	– 0,72982	4,67136
6	– 0,69962	3,25573
7	– 0,67129	2,45431
8	– 0,64406	1,94369
9	– 0,61750	1,59105
10	– 0,59135	1,33295
11	– 0,56542	1,13566
12	– 0,53960	0,97970
13	– 0,51379	0,85307
14	– 0,48791	0,74801
15	– 0,46191	0,65928
16	– 0,43573	0,58321
17	– 0,40933	0,51718
18	– 0,38266	0,45922
19	– 0,35570	0,40788
20	– 0,32840	0,36203
21	– 0,30072	0,32078
22	– 0,27263	0,28343
23	– 0,24410	0,24943
24	– 0,21509	0,21831
25	– 0,18557	0,18970
26	– 0,15550	0,16328
27	– 0,12483	0,13880
28	– 0,09354	0,11603
29	– 0,06159	0,09480
30	– 0,02892	0,07493
31	0,00449	0,05629
32	0,03876	0,03876

10. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

10.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 9.1 are not complied with.

10.2. If a Party to the 1958 Agreement which applies this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a communication form conforming to the model in annex 3 of this Regulation.

11. PRODUCTION DEFINITELY DISCONTINUED

If the holder of the approval completely ceases to manufacture a type of vehicle approved in accordance with this Regulation, he shall so inform the authority which granted the approval. Upon receiving the relevant communication, that authority shall inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in annex 3 to this Regulation.

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

The Parties to the 1958 Agreement which apply this Regulation shall communicate to the United Nations Secretariat the names and addresses of the technical services responsible for conducting approval tests and the administrative departments which grant approval and to which forms, certifying approval or refusal or extension or withdrawal of approval, issued in other countries, are to be sent.

ANNEX 1

ESSENTIAL CHARACTERISTICS OF THE INTERNAL COMBUSTION ENGINE AND INFORMATION CONCERNING THE CONDUCT OF TESTS

The following information, when applicable, shall be supplied in triplicate and shall include a summary.

If there are drawings, they shall be to an appropriate scale and show sufficient detail. They shall be presented in A4 format or folded to that format. In the case of microprocessor controlled functions, appropriate operating information shall be supplied.

1. **Description of Engine**

1.1. Manufacturer: .....

1.1.1. Manufacturer's engine code (as marked on the engine or other means of identification): .....

1.2. Internal combustion engine:

1.2.1. Specific engine information: .....

1.2.1.1. Working principle: positive-ignition/compression-ignition, four stroke/two stroke (1)

1.2.1.2. Number, arrangement and firing order of cylinders:

1.2.1.2.1. Bore: (2) ..... mm

1.2.1.2.2. Stroke: (2) ..... mm

1.2.1.3. Engine capacity: (3) ..... cm^3

1.2.1.4. Volumetric compression ratio: (4) .....

1.2.1.5. Drawing(s) of combustion chamber and piston crown: .....

1.2.1.6. Idle speed: (4) .....

1.2.1.7. Carbon monoxide content by volume in the exhaust gas with the engine idling:

..... per cent (according to the manufacturer's specifications) (4)

1.2.1.8. Maximum net power: ..... kW at: ..... min^{-1}

1.2.2. Fuel: leaded petrol/unleaded petrol/diesel oil/LPG/NG (1)

1.2.3. RON unleaded petrol: .....

1.2.4. Fuel feed: .....

1.2.4.1. By carburettor(s): yes/no (1)

1.2.4.1.1. Make(s): .....

1.2.4.1.2. Type(s): .....

1.2.4.1.3. Number fitted: .....

1.2.4.1.4. Adjustments: (4) .....

1.2.4.1.4.1. Jets: .....

1.2.4.1.4.2. Venturis: .....

1.2.4.1.4.3. Float-chamber level: .....

1.2.4.1.4.4. Mass of float: .....

1.2.4.1.4.5. Float needle: .....

1.2.4.1.5. Cold start system: manual/automatic (1)

1.2.4.1.5.1. Operating principle: .....

1.2.4.1.5.2. Operating limits/settings: (1) (4) .....

1.2.4.2. By fuel injection (compression-ignition only): yes/no (1)

1.2.4.2.1. System description: .....

1.2.4.2.2. Working principle: direct injection/pre-chamber/swirl chamber (1)

1.2.4.2.3. Injection pump

1.2.4.2.3.1. Make(s): .....

1.2.4.2.3.2. Type(s): .....

1.2.4.2.3.3. Maximum fuel delivery: (1) (4) ..... mm^3/stroke or cycle at a pump speed of ..... min^{-1}: (1) (4) or characteristic diagram: .....

1.2.4.2.3.4. Injection timing: (4)

1.2.4.2.3.5. Injection advance curve: (4)

1.2.4.2.3.6. Calibration procedure: test bench/engine (1) .....

1.2.4.2.4. Governor:

1.2.4.2.4.1. Type: .....

1.2.4.2.4.2. Cut-off point: .....

1.2.4.2.4.3. Cut-off point under load: ..... min^{-1}

1.2.4.2.4.4. Cut-off point without load: ..... min^{-1}

1.2.4.2.4.5. Idling speed: ..... min^{-1}

1.2.4.2.5. Injector(s): .....

1.2.4.2.5.1. Make(s): .....

1.2.4.2.5.2. Type(s): .....

1.2.4.2.5.3. Opening pressure: (4) ..... kPa or characteristic diagram: .....

1.2.4.2.6. Cold start system:

1.2.4.2.6.1. Make(s): .....

1.2.4.2.6.2. Type(s): .....

1.2.4.2.6.3. Description: .....

1.2.4.2.7. Auxiliary starting aid:

1.2.4.2.7.1. Makes(s): .....

1.2.4.2.7.2. Type(s): .....

1.2.4.2.7.3. Description: .....

1.2.4.3. By fuel, injection (positive-ignition only): yes/no (1)

1.2.4.3.1. System description: .....

1.2.4.3.2. Working principle (1): intake manifold (single/multi-point)/direct injection/other — specify)

Control unit — type or No
Fuel regulator — type
Air flow sensor — type
Fuel distributor — type
Pressure regulator — type
Microswitch — type
Idle adjusting screw — type
Throttle housing — type
Water temperature sensor — type
Air temperature sensor — type
Air temperature switch — type

} Information to be given in the case of continuous injection; in the case of other systems, equivalent details

Electromagnetic interference protection.

Description and/or drawing: .....

1.2.4.3.3. Makes(s): .....

1.2.4.3.4. Type(s): .....

1.2.4.3.5. Injector(s): Opening pressure: (4) ..... kPa or characteristic diagram: (4)

1.2.4.3.6. Injection timing: .....

1.2.4.3.7. Cold start system: .....

1.2.4.3.7.1. Operating principle(s): .....

1.2.4.3.7.2. Operating limits/settings: (1) (4) .....

1.2.4.4. Feed pump

1.2.4.4.1. Pressure: (1) ..... kPa or characteristic diagram: .....

1.2.4.5. By LPG fuelling system: yes/no (1)

1.2.4.5.1. Approval number according to Regulation No 67 and documentation: .....

1.2.4.5.2. Electronic Engine Management Control Unit for LPG-fuelling:

1.2.4.5.2.1. Make(s): .....

1.2.4.5.2.2. Type: .....

1.2.4.5.2.3. Emission related adjustment possibilities: .....

1.2.4.5.3. Further documentation:

1.2.4.5.3.1. Description of the safeguarding of the catalyst at switch-over from petrol to LPG or back: .....

.....

1.2.4.5.3.2. System lay-out (electrical connections, vacuum connections, compensation hoses, etc): .....

1.2.4.5.3.3. Drawing of the symbol: .....

1.2.4.6. By NG fuelling system: yes/no (1)

1.2.4.6.1. Approval number according to Regulation No 67: .....

1.2.4.6.2. Electronic Engine Management Control Unit for NG-fuelling:

1.2.4.6.2.1. Make(s): .....

1.2.4.6.2.2. Type: .....

1.2.4.6.2.3. Emission related adjustment possibilities: .....

1.2.4.6.3. Further documentation:

1.2.4.6.3.1. Description of the safeguarding of the catalyst at switch-over from petrol to NG or back: .....

1.2.4.6.3.2. System lay-out (electrical connections, vacuum connections, compensation hoses, etc.): .....

1.2.4.6.3.3. Drawing of the symbol: .....

1.2.5. Ignition

1.2.5.1. Make(s): .....

1.2.5.2. Type(s): .....

1.2.5.3. Working principle: .....

1.2.5.4. Ignition advance curve: ([4]) .....

1.2.5.5. Static ignition timing: ([4]) ..... degrees before TDC

1.2.5.6. Contact point gap: ([4]) .....

1.2.5.7. Dwell angle: ([4]) .....

1.2.5.8. Spark plugs: .....

1.2.5.8.1. Make: .....

1.2.5.8.2. Type: .....

1.2.5.8.3. Spark plug gap setting: ..... mm

1.2.5.9. Ignition coil:

1.2.5.9.1. Make: .....

1.2.5.9.2. Type: .....

1.2.5.10. Ignition condenser:

1.2.5.10.1. Make: .....

1.2.5.10.2. Type: .....

1.2.6. Cooling system: liquid/air ([1])

1.2.7. Intake system: .....

1.2.7.1. Pressure charger: yes/no ([1])

1.2.7.1.1. Make(s): .....

1.2.7.1.2. Type(s): .....

1.2.7.1.3. Description of the system (maximum charge pressure: ..... kPa, wastegate)

1.2.7.2. Intercooler: yes/no (1)

1.2.7.3. Description and/or drawings of inlet pipes and their accessories (plenum chamber, heating device, additional air intakes etc.): .....

1.2.7.3.1. Intake manifold description (include drawings and/or photographs): .....

1.2.7.3.2. Air filter, drawings, or

1.2.7.3.2.1. Make(s): .....

1.2.7.3.2.2. Type(s): .....

1.2.7.3.3. Intake silencer, drawings, or

1.2.7.3.3.1. Make(s): .....

1.2.7.3.3.2. Type(s): .....

1.2.8. Exhaust system:

1.2.8.1. Description and drawings of the exhaust system: .....

1.2.9. Valve timing or equivalent data

1.2.9.1. Maximum lift of valves, angles of operating and closing or timing details of alternative distribution systems, in relation to dead centres: .....

1.2.9.2. Reference and/or setting ranges: (1) .....

1.2.10. Lubricant used:

1.2.10.1. Make: .....

1.2.10.2. Type: .....

1.2.11. Measures taken against air pollution

1.2.11.1. Device for recycling crankcase gases (description and/or drawings): .....

1.2.11.2. Additional pollution control devices (if any, and if not covered by another heading):

1.2.11.2.1. Catalytic converter: yes/no (1)

1.2.11.2.1.1. Number of catalytic converters and elements: .....

1.2.11.2.1.2. Dimensions and shape of the catalytic converter(s) (volume, . . .): .....

1.2.11.2.1.3. Type of catalytic action: .....

1.2.11.2.1.4. Total charge of precious metal: .....

1.2.11.2.1.5. Relative concentration: .....

1.2.11.2.1.6. Substrate (structure and material): .....

1.2.11.2.1.7. Cell density: .....

1.2.11.2.1.8. Type of casing for catalytic converter(s): .....

1.2.11.2.1.9. Positioning of the catalytic converter(s) (Place and reference distances in the exhaust system): .....

1.2.11.2.1.10.	Regeneration systems/method of exhaust after-treatment systems, description: .....
1.2.11.2.1.10.1.	The number of Type I operating cycles, or equivalent engine test bench cycles, between two cycles where regenerative phases occur under the conditions equivalent to Type I test (Distance 'D' in figure 1 in annex 8): .....
1.2.11.2.1.10.2.	Description of method employed to determine the number of cycles between two cycles where regenerative phases occur: .....
1.2.11.2.1.10.3.	Parameters to determine the level of loading required before regeneration occurs (i.e. temperature, pressure etc.): .....
1.2.11.2.1.10.4.	Description of method used to load system in the test procedure described in paragraph 3.1, annex 8: .....
1.2.11.2.1.11.	Oxygen sensor: type: .....
1.2.11.2.1.11.1.	Location of oxygen sensor: .....
1.2.11.2.1.11.2.	Control range of oxygen sensor: .....
1.2.11.2.2.	Air injection: yes/no [1]
1.2.11.2.2.1.	Type (pulse air, air pump, . . .): .....
1.2.11.2.3.	EGR: yes/no [1]
1.2.11.2.3.1.	Characteristics (flow, . . .): .....
1.2.11.2.4.	Evaporative emission control system:
	Complete detailed description of the devices and their state of tune: .....
	Drawing of the evaporative control system: .....
	Drawing of the carbon canister: .....
	Drawing of the fuel tank with indication of capacity and material: .....
1.2.11.2.5.	Particulate trap: yes/no [1]
1.2.11.2.5.1.	Dimensions and shape of the particulate trap (capacity): .....
1.2.11.2.5.2.	Type of particulate trap and design: .....
1.2.11.2.5.3.	Location of the particulate trap (reference distances in the exhaust system): .....
1.2.11.2.5.4.	Regeneration system/method. Description and drawing: .....
1.2.11.2.5.4.1.	The number of Type I operating cycles, or equivalent engine test bench cycle, between two cycles where regeneration phases occur under the conditions equivalent to Type I test (Distance 'D in figure 1 in annex 8): .....
1.2.11.2.5.4.2.	Description of method employed to determine the number of cycles between two cycles where regenerative phases occur: .....
1.2.11.2.5.4.3.	Parameters to determine the level of loading required before regeneration occurs (i.e. temperature, pressure, etc.): .....
1.2.11.2.5.4.4.	Description of method used to load system in the test procedure described in paragraph 3.1, annex 8: .....
1.2.11.2.6.	Other systems (description and working principles): .....

---

(1) Strike out what does not apply.

(2) This value must be rounded to the nearest tenth of a millimetre.

(3) This value must be calculated with $\pi = 3{,}1416$ and rounded to the nearest cm^3.

(4) Specify the tolerance.

ANNEX 2

ESSENTIAL CHARACTERISTICS OF THE ELECTRIC POWER TRAIN AND INFORMATION CONCERNING THE CONDUCT OF TESTS (1)

1. **Description of the traction battery**

1.1. Trade name and mark of the battery: .....

1.2. Kind of electro-chemical couple: .....

1.3. Nominal voltage: V

1.4. Battery maximum thirty minutes power (constant power discharge): ..... kW

1.5. Battery performance in 2 h discharge (constant power or constant current): (3)

1.5.1. Battery energy: ..... kWh

1.5.2. Battery capacity: ..... Ah in 2 h

1.5.3. End of discharge voltage value: V

1.6. Indication of the end of the discharge that leads to a compulsory stop of the vehicle: (4) .....

1.7. Battery mass: ..... kg

2. **Description of the drive train**

2.1. General

2.1.1. Make: .....

2.1.2. Type: .....

2.1.3. Use: (3) Monomotor/multimotors (number): .....

2.1.4. Transmission arrangement: parallel/transaxial/others, to precise: .....

2.1.5. Test voltage: V

2.1.6. Motor nominal speed: ..... min^{-1}

2.1.7. Motor maximum speed: ..... min^{-1}

or by default:

reducer outlet shaft/gear box speed (specify gear engaged): ..... min^{-1}

2.1.8. Maximum power speed: (2) ..... min^{-1}

2.1.9. Maximum power: ..... kW

2.1.10. Maximum thirty minutes power: ..... kW

2.1.11. Flexible range (where P ≥ 90 % of max. power):

speed at the beginning of range: ..... min^{-1}

speed at the end of range: ..... min^{-1}

2.2. Motor

2.2.1. Working principle:

2.2.1.1. direct current/alternating current 3/number of phases: .....

2.2.1.2. separate excitation/series/compound (3)

2.2.1.3. synchron/asynchron (3)

2.2.1.4. coiled rotor/with permanent magnets/with housing (3)

2.2.1.5. number of poles of the motor: .....

2.2.2. Inertia mass: .....

2.3. Power controller

2.3.1. Make

2.3.2. Type

2.3.3. Control principle: vectorial/open loop/closed/other (to be specified): (3) .....

2.3.4. Maximum effective current supplied to the motor: (2) ..... A during ..... seconds

2.3.5. Voltage range use: ..... V to V

2.4. Cooling system:

motor: liquid/air (3)

controller: liquid/air (3)

2.4.1. Liquid-cooling equipment characteristics:

2.4.1.1. Nature of the liquid ..... circulating pumps: yes/no (3)

2.4.1.2. Characteristics or make(s) and type(s) of the pump: .....

2.4.1.3. Thermostat: setting: .....

2.4.1.4. Radiator: drawing(s) or make(s) and type(s): .....

2.4.1.5. Relief valve: pressure setting: .....

2.4.1.6. Fan: characteristics or make(s) and type(s): .....

2.4.1.7. Fan duct: .....

2.4.2. Air-cooling equipment characteristics

2.4.2.1. Blower: characteristics or make(s) and type(s): .....

2.4.2.2. Standard air ducting: .....

2.4.2.3. Temperature regulating system: yes/no (3)

2.4.2.4. Brief description: .....

2.4.2.5. Air filter: ..... make(s): ..... type(s): .....

2.4.3. Temperatures admitted by the manufacturer

		maximum temperature
2.4.3.1.	Motor outlet:	. . .°C
2.4.3.2.	controller inlet:	. . .°C
2.4.3.3.	at motor reference point(s):	. . .°C
2.4.3.4.	at controller reference point(s):	. . .°C

2.5. Insulating category: .....

2.6. International protection (IP)-code: .....

2.7. Lubrication system principle: (3)

Bearings:	friction/ball
Lubricant:	grease/oil
Seal:	yes/no
Circulation:	with/without

3. **Description of the transmission**

3.1. Drive wheels: front/rear/4 × 4 (3)

3.2. Type of transmission: manual/automatic (3)

3.3. Number of gear ratios: .....

3.3.1.

Gear	Wheel speed	Gear ratio	Motor speed
1			
2			
3			
4			
5			
Reverse			

min. CVT (Continuous Variable Transmission): .....

max. CVT: .....

3.4. Recommendations for changing the gears

1 → 2:	2 → 1: .....
2 → 3:	3 → 2: .....
3 → 4:	4 → 3: .....
4 → 5:	5 → 4: .....
overdrive in:	overdrive out: .....

3.5. Tyres:

Dimensions: .....

Rolling circumference under load: .....

Recommended pressure: .....

3.6. Inertia mass:

3.6.1. Equivalent inertia mass of complete front axle: .....

3.6.2. Equivalent inertia mass of complete rear axle: .....

4. **Charge**

4.1. Charger: on board/external (3)

In case of an external unit, define the charger (trademark, model): .....

4.2. Description of the normal profile of charge: .....

4.3. Specification of mains:

4.3.1. Type of mains: single phase/three phase (3)

4.3.2. Voltage: .....

4.4. Rest period recommended between the end of the discharge and the start of the charge: .....

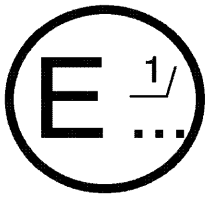
4.5. Theoretical duration of a complete charge: .....

(1) For non-conventional motors or systems, the manufacturer will supply data equivalent to those requested hereafter.
(2) Specify tolerances.
(3) Strike out what does not apply.
(4) If applicable.

ANNEX 3

COMMUNICATION

(Maximum format: A4 (210 × 297 mm))



issued by: Name of administration (1)

.....

.....

.....

concerning (2) APPROVAL GRANTED

APPROVAL EXTENDED

APPROVAL REFUSED

APPROVAL WITHDRAWN

PRODUCTION DEFINITELY DISCONTINUED

of a vehicle type pursuant to Regulation No 101

Approval No: ..... Extension No: .....

1. Trade name or mark of the vehicle: .....
2. Vehicle type: .....
3. Vehicle category: .....
4. Manufacturer's name and address: .....
5. If applicable, name and address of manufacturer's representative: .....
6. Description of the vehicle: .....
6.1. Mass of the vehicle in running order: .....
6.2. Maximum permitted mass: .....
6.3. Type of body: saloon/estate/coupé (2)
6.4. Drive: front-wheel/rear-wheel/four-wheel (2)
6.5. Internal combustion engine (2)
6.5.1. Cylinder capacity: .....
6.5.2. Fuel feed: carburettor/injection (2)
6.5.3. Fuel recommended by the manufacturer: .....
6.5.4. In the case of LPG/NG (1) the reference fuel used for the test (e. g. G20, G25): .....
6.5.5. Maximum engine power: ..... kW at: ..... min^{-1}
6.5.6. Super-charger: yes/no (2)
6.5.7. Ignition: compression ignition/positive ignition (mechanical or electronic) (2)

6.6. Electric power train (1)

6.6.1. Drive train:

6.6.1.1. Maximum net power: ..... kW, at ..... to ..... min^{-1}

6.6.1.2. Maximum thirty minutes power: ..... kW

6.6.1.3. Working principle: .....

6.6.2. Traction battery:

6.6.2.1. Nominal voltage:..... V

6.6.2.2. Capacity (2 h rate): ..... Ah

6.6.2.3. Battery maximum thirty minutes power: ..... kW

6.6.2.4. Charger: on board/external (2)

6.7. Transmission

6.7.1. Type of gearbox: manual/automatic/variable transmission (2)

6.7.2. Number of gears: .....

6.7.3. Overall gear ratios (including tyre tread circumference under load): road speeds (km/h) per 1 000 engine speed (min^{-1}):

First gear: .....

Second gear: .....

Third gear: .....

Fourth gear: .....

Fifth gear: .....

Overdrive: .....

6.7.4. Final drive ratio: .....

6.7.5. Tyres

Type: .....

Dimensions: .....

Rolling circumference under load: .....

7. Test results

7.1. Internal combustion engine (2)

7.1.1. CO_2 mass emissions: ..... g/km

7.1.1.1. Urban conditions: ..... g/km

7.1.1.2. Extra-urban conditions: ..... g/km

7.1.1.3. Combined: ..... g/km

7.1.2. Fuel consumption (3) (4)

7.1.2.1. Fuel consumption (urban conditions): ..... l/100 km

7.1.2.2. Fuel consumption (extra-urban conditions): ..... l/100 km

7.1.2.3. Fuel consumption (combined): ..... l/100 km

7.1.3. For vehicles equipped with periodically regenerating systems as defined in paragraph 2.11 of this Regulation, the test results must be multiplied by the factor K_i obtained from annex 8

7.2. Pure electric vehicles (2)

7.2.1. Measurement of electric energy consumption

7.2.1.1. Electric energy consumption: ..... Wh/km

7.2.1.2. Total time out of tolerance for the conduct of the cycle: ..... sec

7.2.2. Measurement of range:

7.2.2.1. Range: ..... km

7.2.2.2. Total time out of tolerance for the conduct of the cycle: ..... sec

8. Vehicle submitted for approval on: .....

9. Technical service responsible for conducting approval tests: .....

10. Number of report issued by that service: .....

11. Date of report issued by that service: .....

12. Approval granted/extended/refused/withdrawn (2)

13. Reasons for extension (if applicable): .....

14. Remarks: .....

15. Positioning of approval mark on the vehicle: .....

16. Place: .....

17. Date: .....

18. Signature: .....

---

(1) Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

(2) Strike out what does not apply.

(3) Repeat for petrol and gaseous fuel in the case of a vehicle that can run either on petrol or on a gaseous fuel.

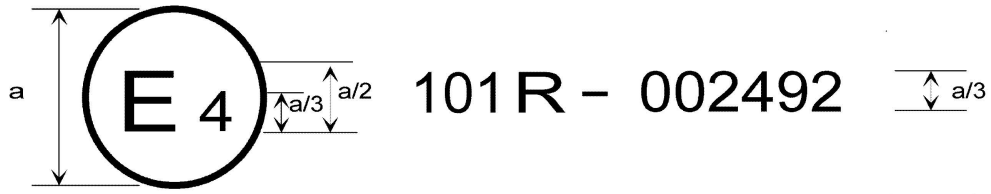
(4) For vehicles fuelled with NG the unit 1/100 km is replaced by m^3/km.

ANNEX 4

ARRANGEMENTS OF APPROVAL MARKS

Model A

(see paragraph 4.4 of this Regulation)

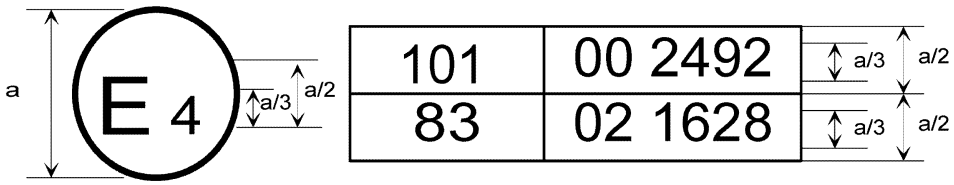


a ≥ 8 mm min

The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E 4) with regard to the measurement of emissions of CO_2 and fuel consumption or to the measurement of electric energy consumption and range pursuant to Regulation No 101 and under approval number 002492. The first two digits of the approval number indicate that the approval was granted according to the requirements of Regulation No 101 in its original form.

Model B

(see paragraph 4.5 of this Regulation)



a ≥ 8 mm min

The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E 4) pursuant to Regulations Nos 101 and 83 [1]. The first two digits of the approval numbers indicate that, at the dates when the respective approvals were given, Regulation No 101 had not been modified and Regulation No 83 already included the 02 series of amendments.

[1] The second number is given merely as an example.

ANNEX 5

METHOD OF MEASURING EMISSIONS OF CARBON DIOXIDE AND FUEL CONSUMPTION OF INTERNAL COMBUSION ENGINES

1. TEST CONDITIONS

1.1. *General condition of the vehicle*

1.1.1. The vehicle shall have been run-in and shall have been driven for at least 3 000 km but less than 15 000 km before the test.

1.1.2. 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 idle settings (rotation speed and carbon monoxide (CO) content of the exhaust gases), to the cold start device and to the exhaust gas pollutant emission control system.

1.1.3. The laboratory may check the tightness of the inlet system to ensure that carburation is not affected by accidental intake of air.

1.1.4. The laboratory may check that vehicle performance is as specified by the manufacturer and that it is possible to use it in normal driving conditions, particularly cold and hot starts.

1.1.5. Before the test, the vehicle shall be stored in a room where the temperature remains relatively constant between 20 and 30 °C. This conditioning shall be carried out for at least six hours and shall continue until the engine oil temperature and coolant, if any, have reached the temperature of the room to within 2 °C. At the request of the manufacturer, the test shall be carried out not later than 30 hours after the vehicle has been run at its normal temperature.

At the request of the manufacturer, vehicles with positive-ignition engines may be preconditioned according to the procedure prescribed in paragraph 5.2.1 of annex 7 to Regulation No 83 in force at the time of the approval of the vehicle.

1.1.6. Only the equipment necessary for the operation of the vehicle during the test shall be in use. If there is a manually controlled device for the engine intake air temperature, it shall be in the position prescribed by the manufacturer for the ambient temperature at which the test is performed. In general, the auxiliary devices required for the normal operation of the vehicle shall be in use.

1.1.7. If the radiator fan is temperature controlled, it shall be in the condition of normal operation on the vehicle. The passenger compartment heating system shall be switched off, as shall any air conditioning system, but such systems compressor shall be functioning normally.

1.1.8. If a super-charger is fitted, it shall be in the normal operating condition for the test conditions.

1.2. *Lubricants*

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

1.3. *Tyres*

The tyres shall be of a type specified as original equipment by the vehicle manufacturer inflated to the pressure recommended for the test load and speeds. The pressures shall be indicated in the test report.

1.4. *Measurement of CO_2 and carbon-related emissions*

1.4.1. The test cycle is described in appendix 1 of annex 4 to Regulation No 83 in force at the time of the approval of the vehicle.

1.4.2. Calculation of emissions:

1.4.2.1. The emissions of gaseous pollutants are calculated by means of the following equation:

$$M_i = \frac{V_{mix} \cdot Q_i \cdot C_i \cdot 10^{-6}}{d} \quad (1)$$

where:

M_i = mass emission of the pollutant i in grams per kilometre;

V_{mix} = volume of the diluted exhaust gas expressed in litres per test and corrected to standard conditions (273,2 K and 101,33 kPa);

Q_i = density of the pollutant i in grams per litre at normal temperature and pressure (273,2 K and 101,33 kPa);

C_i = concentration of the pollutant i in the diluted exhaust gas expressed in ppm and corrected by the amount of the pollutant i contained in the dilution air. If C_i is expressed in per cent volume, 10^{-6} factor is replaced by 10^{-2};

d = driven distance during the operating cycle in kilometres.

1.4.2.2. Volume determination:

1.4.2.2.1. Calculation of the volume when a variable dilution device with constant flow control by orifice or venturi is used. Record continuously the parameters showing the volumetric flow and calculate the total volume for the duration of the test.

1.4.2.2.2. Calculation of volume when a positive displacement pump is used. The volume of diluted exhaust gas in systems comprising a positive displacement pump is calculated with the following formula:

$$V = V_o \cdot N$$

where:

V = volume of the diluted exhaust gas expressed in litres per test (prior to correction);

V_o = volume of gas delivered by the positive displacement pump on testing conditions in litres per revolution;

N = number of revolutions per test.

1.4.2.2.3. Correction of the diluted exhaust gas volume to standard conditions. The diluted exhaust gas volume is corrected by means of the following formula:

$$V_{mix} V \cdot K_1 \cdot \frac{P_P}{T_P} \quad (2)$$

in which:

$$K_1 = \frac{273,2}{101,33} 2,6961 (K \cdot kPa^{-1}) \quad (2)$$

where:

P_p = absolute pressure at the inlet to the positive displacement pump in kPa;

T_p = average temperature of the diluted exhaust gas entering the positive displacement pump during the test (K).

1.4.2.3. Calculation of the corrected concentration of pollutants in the sampling bag:

$$C_i = C_e - C_d \left(1 - \frac{1}{DF}\right) \quad (3)$$

where:

C_i = concentration of the pollutant i in the diluted exhaust gas, expressed in ppm or per cent volume and corrected by the amount of i contained in the dilution air;

C_e = measured concentration of pollutant i in the diluted exhaust gas, expressed in ppm or per cent volume;

C_d = measured concentration of pollutant i in the air used for dilution, expressed in ppm or per cent volume;

DF = dilution factor.

where:

The dilution factor is calculated as follows:

For petrol and diesel: $$DF = \frac{13{,}4}{C_{CO_2} + (C_{HC} + C_{CO})\ 10^{-4}} \quad (5a)$$

For LPG: $$DF = \frac{11{,}9}{C_{CO_2} + (C_{HC} + C_{CO})\ 10^{-4}} \quad (5b)$$

For natural gas: $$DF = \frac{9{,}5}{C_{CO_2} + (C_{HC} + C_{CO})\ 10^{-4}} \quad (5c)$$

where:

C_{CO_2} = concentration of CO_2 in the diluted exhaust gas contained in the sampling bag, expressed in per cent volume;

C_{HC} = concentration of HC in the diluted exhaust gas contained in the sampling bag, expressed in ppm carbon equivalent;

C_{CO} = concentration of CO in the diluted exhaust gas contained in the sampling bag, expressed in ppm.

1.4.2.4. Example:

1.4.2.4.1. Data

1.4.2.4.1.1. Ambient conditions:

Ambient temperature: 23 °C = 296,2 K,

Barometric pressure: P_B = 101,33 kPa.

1.4.2.4.1.2. Volume measured and reduced to standard conditions:

V = 51,961 litres

1.4.2.4.1.3. Analyser readings:

	Diluted exhaust	Dilution air
HC (*)	92 ppm	3,0 ppm
CO	470 ppm	0 ppm
CO_2	1,6 volume	0,03 volume

(*) in ppm carbon equivalent.

1.4.2.4.2. Calculation

1.4.2.4.2.1. Dilution factor (DF) (see formula 5):

$$DF = \frac{13{,}4}{C_{CO_2} + (C_{HC} + C_{CO}) \cdot 10^{-4}}$$

$$DF = \frac{13{,}4}{1{,}6 + (92 + 470) \cdot 10^{-4}}$$

$$DF = 8{,}091$$

1.4.2.4.2.2. Calculation of the corrected concentration of pollutants in the sampling bag:

HC Mass emissions (see formulas 4 and 1):

$$C_i = C_e - C_d \left(1 - \frac{1}{DF}\right) \quad (4)$$

$$C_{HC} = 92 - 3 \cdot \left(1 - \frac{1}{8{,}091}\right)$$

$$C_{HC} = 89{,}371 \text{ ppm}$$

$$M_{HC} = C_{HC} \cdot V_{mix} \cdot Q_{HC} \cdot \frac{1}{d} \cdot 10^{-6} \quad (1)$$

where:

$$Q_{HC} = 0{,}619$$

$$M_{HC} = 89{,}371 \cdot 51{,}961 \cdot 0{,}619 \cdot 10^{-6} \cdot \frac{1}{d}$$

$$M_{HC} = \frac{2{,}88}{d} \text{ g/km}$$

CO_2 mass emissions (see formula 1):

$$M_{CO} = C_{CO} \cdot V_{mix} \cdot Q_{CO} \cdot \frac{1}{d} \cdot 10^{-6} \quad (1)$$

where:

$$Q_{CO} = 1{,}25$$

$$M_{CO} = 470 \cdot 51{,}961 \cdot 1{,}25 \cdot 10^{-6} \cdot \frac{1}{d}$$

$$M_{CO} = \frac{30{,}5}{d} \text{ g/km}$$

CO_2 mass emissions (see formula 1):

$$C_i = C_e - C_d \left(1 - \frac{1}{DF}\right) \quad (4)$$

$$C_{CO_2} = 1{,}6 - 0{,}03 \cdot \left(1 - \frac{1}{8{,}091}\right)$$

$$C_{CO_2} = 1{,}573 \text{ volume \%}$$

and:

$$Q_{CO_2} = 1{,}964$$

$$M_{CO_2} = C_{CO_2} \cdot V_{mix} \cdot Q_{CO_2} \cdot 10^{-2} \cdot \frac{1}{d} \quad (1)$$

$$M_{CO_2} = 1{,}573 \cdot 51{,}961 \cdot 1{,}964 \cdot 10^{-2} \cdot \frac{1}{d}$$

$$M_{CO_2} = \frac{1\,605{,}27}{d} \text{ g/km}$$

1.4.2.5. Special provisions relating to vehicles equipped with compression-ignition engines.

HC measurements for compression-ignition engines.

The average HC concentration used in determining the HC mass emissions from compression-ignition engines is calculated with the aid of the following formula:

$$C_e = \frac{\int_{t_1}^{t_2} C_{HC} \cdot dt}{t_2 - t_1} \quad (7)$$

where:

$\int_{t_1}^{t_2} C_{HC} \cdot dt$ = integral of the recording of the heated FID on the test duration (t_2 - t_1)

C_e = HC concentration of the diluted exhaust gas sample as calculated from the integrated HC trace, in ppm carbon equivalent.

1.5. *Calculation of fuel consumptions*

1.5.1. The fuel consumptions are calculated from the emissions of hydrocarbons, carbon monoxide and carbon dioxide in accordance with paragraph 1.4 of this annex.

1.5.2. The fuel consumption, expressed in litres per 100 km (in the case of petrol, LPG or diesel) or in m^3 per 100 km (in the case of NG) is calculated by means of the following formulas:

(a) for vehicles with a positive ignition engine fuelled with petrol:

$$FC = (0{,}1154/D) \cdot [(0{,}866 \cdot HC) + (0{,}429 \cdot CO) + (0{,}273 \cdot CO_2)]$$

(b) for vehicles with a positive ignition engine fuelled with LPG:

$$Fc_{norm} = (0{,}1212/0{,}538) \cdot [(0{,}825 \cdot HC) + (0{,}429 \cdot CO) + (0{,}273 \cdot CO_2)]$$

If the composition of the fuel used for the test differs from the composition that is assumed for the calculation of the normalised consumption, on the manufacturer's request a correction factor cf may be applied, as follows:

$$Fc_{norm} = (0{,}1212/0{,}538) \cdot (cf) \cdot [(0{,}825 \cdot HC) + (0{,}429 \cdot CO) + (0{,}273 \cdot CO_2)]$$

The correction factor cf, which may be applied, is determined as follows:

$$cf = 0{,}825 + 0{,}0693 \cdot n_{actual}$$

where:

n_{actual} = the actual H/C ratio of the fuel used

(c) for vehicles with a positive ignition engine fuelled with NG:

$$Fc_{norm} = (0{,}1336/0{,}654) \cdot [(0{,}749 \cdot HC) + (0{,}429 \cdot CO) + (0{,}273 \cdot CO_2)]$$

(d) or vehicles with a compression ignition engine:

$$FC = (0{,}1155/D) \cdot [(0{,}866 \cdot HC) + (0{,}429 \cdot CO) + (0{,}273 \cdot CO_2)]$$

In these formulas:

FC = the fuel consumption in litre per 100 km (in the case of petrol, LPG or diesel) or in m^3 per 100 km (in the case of natural gas)

HC = the measured emission of hydrocarbons in g/km

CO = the measured emission of carbon monoxide in g/km

CO_2 = the measured emission of carbon dioxide in g/km

D = the density of the test fuel. In the case of gaseous fuels this is the density at 15 °C.

ANNEX 6

METHOD OF MEASURING THE ELECTRIC ENERGY CONSUMPTION

1. TEST SEQUENCE

1.1. *Composition*

The test sequence is composed of two parts (see figure 1):

(a) an urban cycle made of four elementary urban cycles;

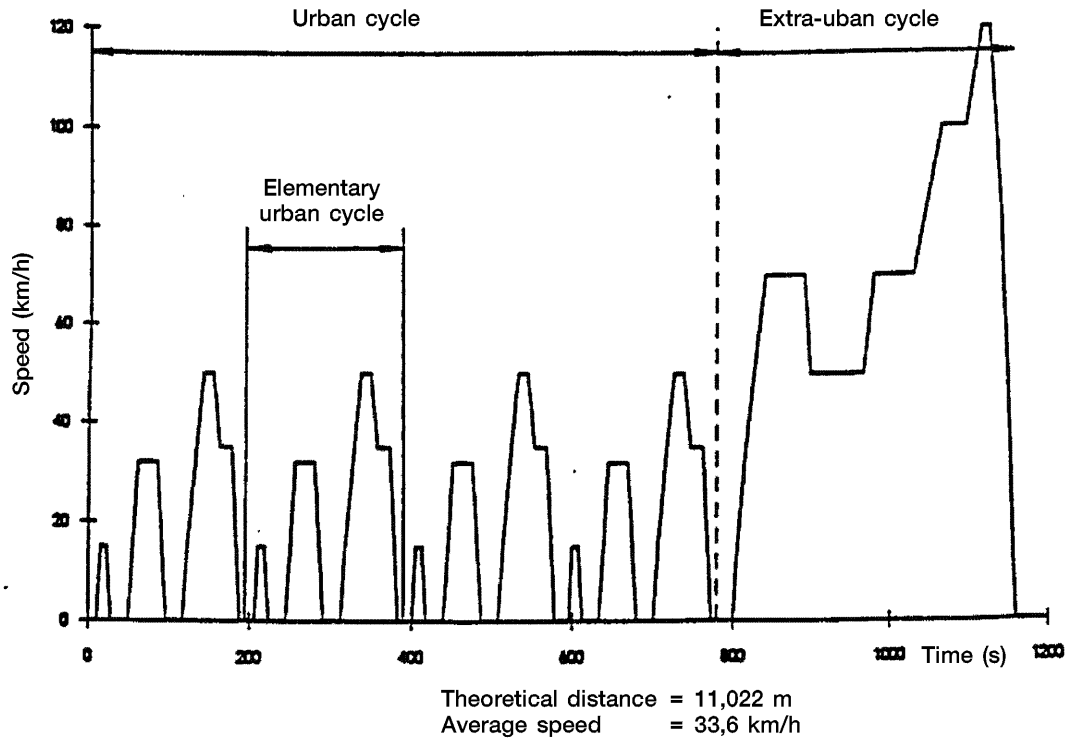
(b) an extra-urban cycle.

In case of a manual gear box with several gears, the operator changes the gear according to the manufacturer's specifications.

If the vehicle has several driving modes, which may be selected by the driver, the operator shall select the one to best match the target curve.

Figure 1

Test sequence — M_1 and N_1 categories of vehicles



1.2. *Urban cycle*

The urban cycle is composed of four elementary cycles of 195 seconds each and lasts 780 seconds in total.

Description of the elementary urban cycle is given in figure 2 and table 1.

Figure 2

Elementary urban cycle (195 seconds)

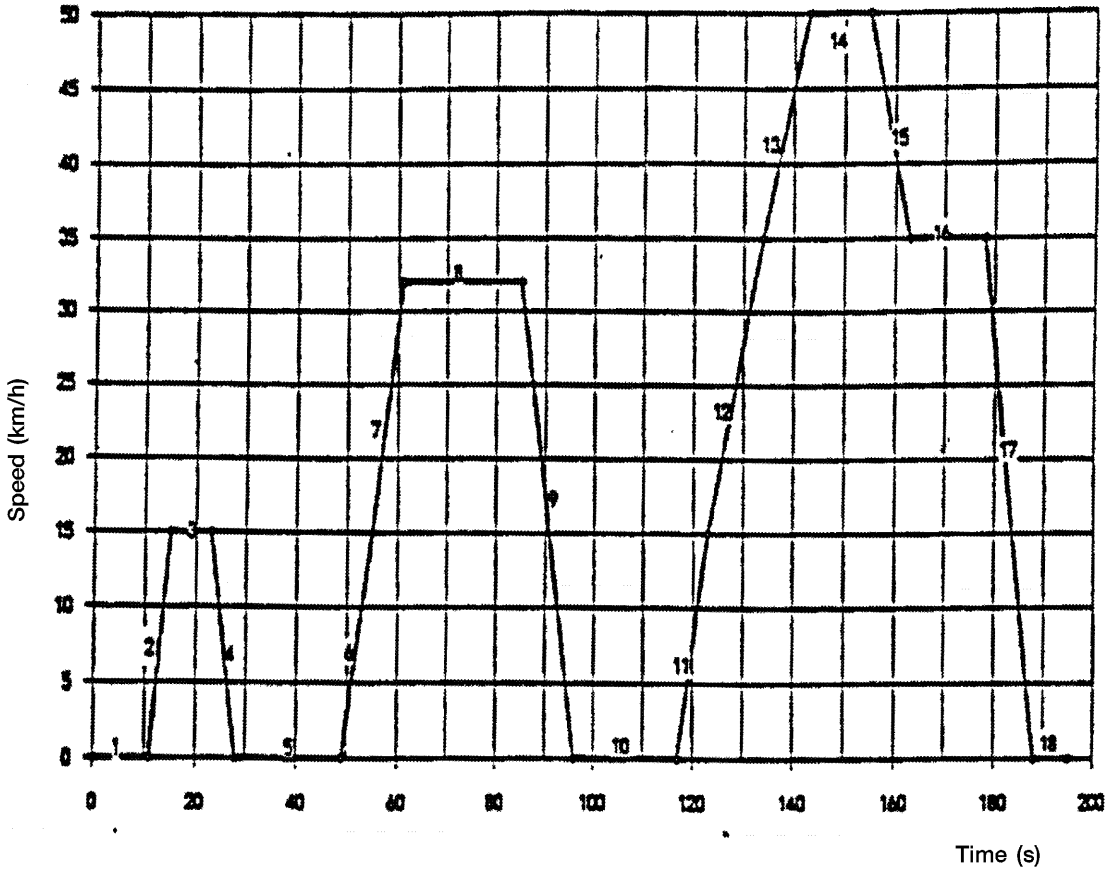


Table 1

Elementary urban cycle

Operation No	Operation type	Mode No	Acceleration (m/s^2)	Speed (km/h)	Operation duration (s)	Mode duration (s)	Total time (s)
1	Stop	1	0,00	0	11	11	11
2	Acceleration	2	1,04	0-15	4	4	15
3	Constant speed	3	0,00	15	8	8	23
4	Deceleration	4	– 0,83	15-0	5	5	28
5	Stop	5	0,00	0	21	21	49
6	Acceleration	6	0,69	0-15	6	12	55
7	Acceleration		0,79	15-32	6		61
8	Constant speed	7	0,00	32	24	24	85
9	Deceleration	8	– 0,81	32-0	11	11	96
10	Stop	9	0,00	0	21	21	117
11	Acceleration	10	0,69	0-15	6	26	123
12	Acceleration		0,51	15-35	11		134
13	Acceleration		0,46	35-50	9		143
14	Constant speed	11	0,00	50	12	12	155
15	Deceleration	12	– 0,52	50-35	8	8	163
16	Constant speed	13	0,00	35	15	15	178
17	Deceleration	14	– 0,97	35-0	10	10	188
18	Stop	15	0,00	0	7	7	195

Generalities	in time (s)	in percentage
Stop	60	30,77
Acceleration	42	21,54
Constant speed	59	30,26
Deceleration	34	17,44
Total	195	100,00

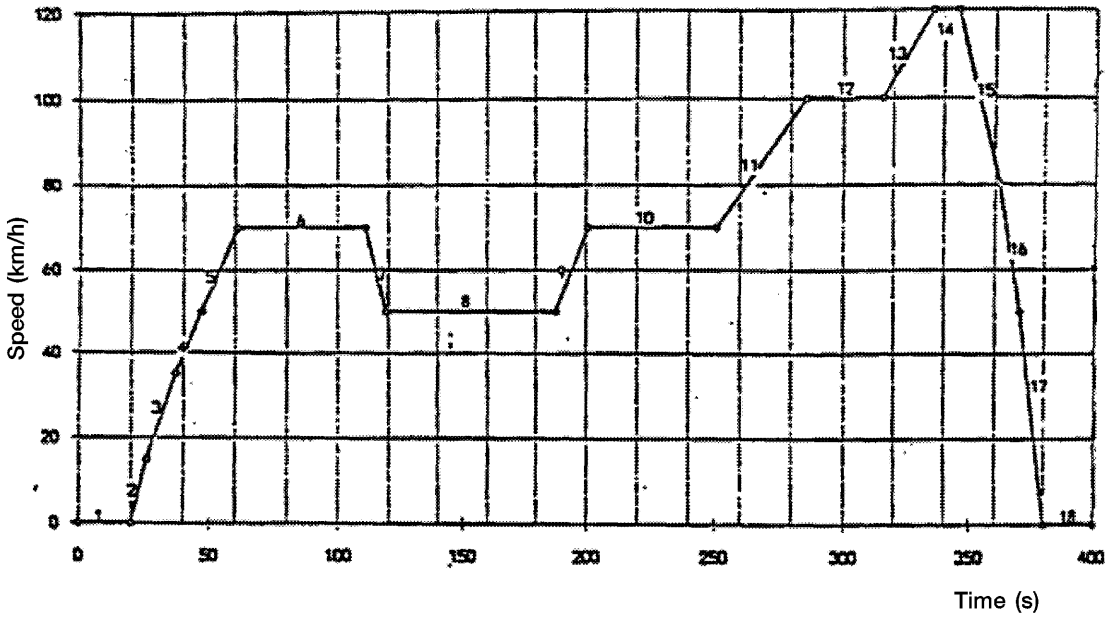
Average speed (km/h)	18,77
Working time (s)	195
Theoretical distance by elementary urban cycle (m)	1 017
Theoretical distance for four elementary urban cycles (m)	4 067

1.3. *Extra-urban cycle*

The description of the extra-urban cycle is given in figure 3 and table 2.

Figure 3

Extra-urban cycle (400 seconds)



Note: The procedure to be adopted when the vehicle failed to meet the speed requirements of this curve is detailed in item 1.4.

Table 2

Extra-urban cycle

Operation No	Operation type	Mode No	Acceleration (m/s^2)	Speed (km/h)	Operation duration (s)	Mode duration (s)	Total time (s)
1	Stop	1	0,00	0	20	20	20
2	Acceleration	2	0,69	0-15	6	41	26
3	Acceleration		0,51	15-35	11		37
4	Acceleration		0,42	35-50	10		47
5	Acceleration		0,40	50-70	14		61
6	Constant speed	3	0,00	70	50	50	111
7	Deceleration	4	– 0,69	70-50	8	8	119
8	Constant speed	5	0,00	50	69	69	188
9	Acceleration	6	0,43	50-70	13	13	201
10	Constant speed	7	0,00	70	50	50	251
11	Acceleration	8	0,24	70-100	35	35	286
12	Constant speed	9	0,00	100	30	30	316
13	Acceleration	10	0,28	100-120	20	20	336
14	Constant speed	11	0,00	120	10	10	346
15	Deceleration	12	– 0,69	120-80	16	34	362
16	Deceleration		– 1,04	80-50	8		370
17	Deceleration		– 1,39	50-0	10		380
18	Stop	13	0,00	0	20	20	400

Generalities	in time (s)	in percentage
Stop	40	10,00
Acceleration	109	27,25
Constant speed	209	52,25
Deceleration	42	10,50
Total	400	100,00

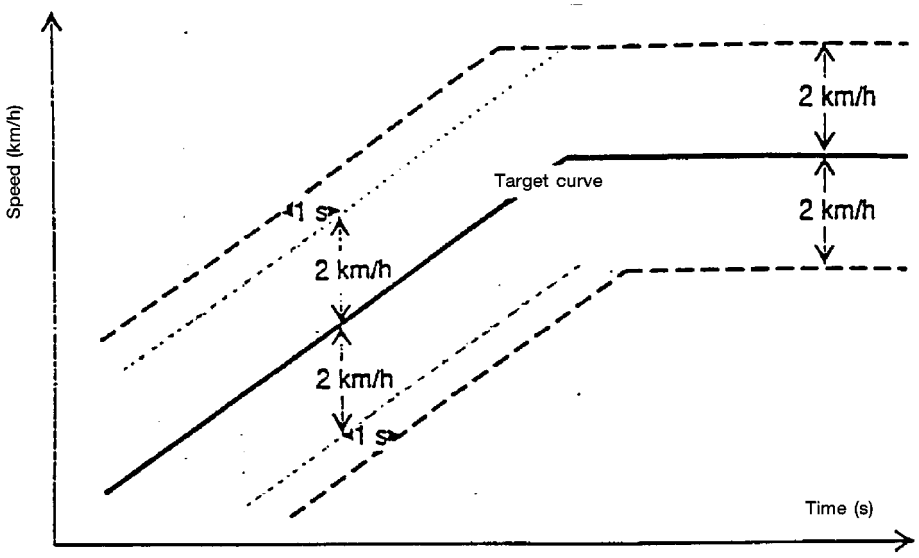
Average speed (km/h)	62,60
Working time (s)	400
Theoretical distance (m)	6 956

1.4. *Tolerance*

Tolerances are given in figure 4

Figure 4

Speed tolerance



Tolerances on speed (± 2 km/h) and on time (± 1 s) are geometrically combined at each point as represented in figure 4.

Below 50 km/h, deviations beyond this tolerance are permitted as follows:

(a) at gear changes for a duration less than 5 seconds,

(b) and up to five times per hour at other times, for a duration less than 5 seconds each.

The total time out of tolerance has to be mentioned in the test report.

Over 50 km/h, it is accepted to go beyond tolerances provided the accelerator pedal is fully depressed.

2. TEST METHOD

2.1. *Principle*

The test method described hereafter permits to measure the electric energy consumption expressed in Wh/km:

2.2. *Parameters, units and accuracy of measurements*

Parameter	Units	Accuracy	Resolution
Time	s	± 0,1 s	0,1 s
Distance	m	± 0,1 %	1 m
Temperature	°C	± 1 °C	1 °C
Speed	km/h	± 1 %	0,2 km/h
Mass	kg	± 0,5 %	1 kg
Energy	Wh	± 0,2 %	Class 0,2 s according to IEC 687

IEC = International Electrotechnical Commission.

2.3. *Vehicle*

2.3.1. Condition of the vehicle

2.3.1.1. The vehicle tyres shall be inflated to the pressure specified by the vehicle manufacturer when the tyres are at the ambient temperature.

2.3.1.2. The viscosity of the oils for the mechanical moving parts shall conform to the specification of the vehicle manufacturer.

2.3.1.3. The lighting and light-signaling and auxiliary devices shall be off, except those required for testing and usual day-time operation of the vehicle.

2.3.1.4. All energy storage systems available for other than traction purposes (electric, hydraulic, pneumatic, etc.) shall be charged up to their maximum level specified by the manufacturer.

2.3.1.5. If the batteries are operated above the ambient temperature, the operator shall follow the procedure recommended by the car manufacturer in order to keep the temperature of the battery in the normal operating range.

The manufacturer's agent shall be in a position to attest that the thermal management system of the battery is neither disabled nor reduced.

2.3.1.6. The vehicle must have undergone at least 300 km during the seven days before the test with those batteries that are installed in the test vehicle.

2.4. *Operation mode*

All the tests are conducted at a temperature of between 20 °C and 30 °C.

The test method includes the four following steps:

(a) Initial charge of the battery;

(b) Application twice of the cycle made of four elementary urban cycles and an extra-urban cycle;

(c) Charging the battery;

(d) Calculation of the electric energy consumption.

Between the steps, if the vehicle shall move, it is pushed to the following test area (without regenerative recharging).

2.4.1. Initial charge of the battery

Charging the battery consists of the following procedures:

2.4.1.1. Discharge of the battery

The procedure starts with the discharge of the battery of the vehicle while driving (on the test track, on a chassis dynamometer, etc.) at a steady speed of 70 % ± 5 % from the maximum thirty minutes speed of the vehicle.

Stopping the discharge occurs:

(a) when the vehicle is not able to run at 65 % of the maximum thirty minutes speed;

(b) or when an indication to stop the vehicle is given to the driver by the standard on-board instrumentation, or

(c) after covering the distance of 100 km.

2.4.1.2. Application of a normal overnight charge

The battery shall be charged according to the following procedure.

2.4.1.2.1. Normal overnight charge procedure

The charge is carried out:

(a) with the on-board charger if fitted,

(b) with an external charger recommended by the manufacturer, the connection being made with the domestic plug whose pattern has been recommended by the manufacturer,

(c) in an ambient temperature comprised between 20 °C and 30 °C.

The procedure excludes all types of special charges that could be automatically or manually initiated like, for instance, the equalization charges or the servicing charges.

The car manufacturer shall be in a position to attest that during the test, a special charge procedure has not occurred.

2.4.1.2.2. End of charge criteria

The end of charge criteria corresponds to a charging time of 12 hours except if a clear indication is given to the driver by the standard instrumentation that the battery is not yet fully charged.

In this case,

$$\text{the maximum time is } \frac{3 \cdot \text{claimed battery capacity (Wh)}}{\text{mains power supply (W)}}$$

2.4.1.2.3. Fully charged battery

Battery having been charged according to overnight charge procedure until the end of charge criteria.

2.4.2. Application of the cycle and measurement of the distance

The end of charging time t_0 (plug off) is reported.

The chassis dynamometer shall be set with the method described in appendix 1 to this annex.

Starting within 4 hours from t_0, the cycle made of four elementary urban cycles and an extra-urban cycle is run twice on a chassis dynamometer (test distance: 22 km, test duration: 40 minutes).

At the end, the measure D of the covered distance in km is recorded.

2.4.3. Charge of the battery

The vehicle shall be connected to the mains within the 30 minutes after the conclusion of the cycle made of four elementary urban cycles and an extra-urban cycle, carried out twice.

The vehicle is being charged according to normal overnight charge procedure (see paragraph 2.4.1.2 above).

The energy measurement equipment, placed between the mains socket and the vehicle charger, measures the charge energy E delivered from the mains, as well as its duration.

Charging is stopped after 24 hours from the previous end of charging time (t_0).

Note: In case of a mains power cut, the 24 hours period will be extended accordingly to the cut duration. Validity of the charge will be discussed between the technical services of the approval laboratory and the vehicle's manufacturer.

2.4.4. Electric energy consumption calculation

Energy E in Wh and charging time measurements are recorded in the test report.

The electric energy consumption c is defined by the formula:

$c = \frac{E}{D}$ (expressed in Wh/km and rounded to the nearest whole number)

where D = range (km).

Appendix 1

Determination of the total road load power of a vehicle and calibration of the dynamometer

1. INTRODUCTION

The purpose of this appendix is to define the method of measuring the total road load power of a vehicle with a statistical accuracy of ± 4 % at a constant speed and to reproduce this measured road load power on a dynamometer with an accuracy of ± 5 %.

2. CHARACTERISTICS OF THE TRACK

The test road layout shall be level, straight and free of obstacles or wind barriers which adversely affect the variability of road load measurement.

The test road longitudinal slope shall not exceed ± 2 %. This slope is defined as the ratio of the difference in elevation between both ends of the test road and its overall length. In addition, the local inclination between any two points 3 m apart shall not deviate by more than ± 0,5 % from this longitudinal slope.

The maximum cross-sectional camber of the test road shall be 1,5 % or less.

3. ATMOSPHERIC CONDITIONS

3.1. *Wind*

Testing shall be performed at wind speeds averaging less than 3 m/s with peak speeds less than 5 m/s. In addition, the vector component of the wind speed across the test track must be less than 2 m/s. Wind velocity shall be measured at 0,7 m above the track surface.

3.2. *Humidity*

The track shall be dry.

3.3. *Reference conditions*

Barometric pressure: $H_0 = 100$ kPa

Temperature: $T_0 = 293$ K (20 °C)

Air density: $d_0 = 1{,}189$ kg/m^3

3.3.1. Air density

3.3.1.1. The air density during the test, calculated as described in paragraph 3.3.1.2 below, shall not differ by more than 7,5 % from the air density under the reference conditions.

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

$$d_T = d_o \cdot \frac{H_T}{H_O} \cdot \frac{T_O}{T_T}$$

where:

d_T = is the air density during the test (kg/m^3)

d_0 = is the air density at reference conditions (kg/m^3)

H_T = is the total barometric pressure during the test (kPa)

T_T = is absolute temperature during the test (K).

3.3.2. Ambient conditions

3.3.2.1. The ambient temperature shall be between 5 °C (278 K) and 35 °C (308 K) and the barometric pressure between 91 kPa and 104 kPa. The relative humidity shall be less than 95 %.

3.3.2.2. However, with the manufacturer's agreement, the tests may be made at lower ambient temperatures down to 1 °C. In this case the correction factor calculated for 5 °C should be used.

4. PREPARATION OF THE VEHICLE

4.1. *Running-in*

The vehicle shall be in normal running order and adjustment after having been run in for at least 300 km. The tyres shall be run in at the same time as the vehicle or shall have a tread depth within 90 and 50 % of the initial tread depth.

4.2. *Checks*

The following checks shall be made in accordance with the manufacturer's specifications for the use considered: wheels, wheel rims, tyres (make, type, pressure), front axle geometry, brake adjustment (elimination of parasitic drag), lubrication of front and rear axles, adjustment of the suspension and vehicle ground clearance, etc. Check that during freewheeling, there is no electrical braking.

4.3. *Preparation for the test*

4.3.1. The vehicle shall be loaded to its test mass including driver and measurement equipments, spread in a uniform way in the loading areas.

4.3.2. The windows of the vehicle shall be closed. Any covers for air conditioning systems, headlamps, etc. shall be closed.

4.3.3. The vehicle shall be clean.

4.3.4. Immediately before the test, the vehicle shall be brought to the normal running temperature in an appropriate manner.

5. SPECIFIED SPEED V

The specified speed is required for determining the running resistance at the reference speed from the running resistance curve. To determine the running resistance as a function of vehicle speed in the vicinity of the reference speed V_o, running resistances shall be measured at the specified speed V. At least four to five points indicating the specified speeds, along with the reference speeds, are desired to be measured.

Table 1 shows the specified speeds in accordance with the category of the vehicle. The asterisk (*) indicates the reference speed in the table.

Table 1

Category $V_{max.}$	Specified speeds (km/h)					
> 130	120 (**)	100	80 (*)	60	40	20
130-100	90	80 (*)	60	40	20	—
100-70	60	50 (*)	40	30	20	—
< 70	50 (**)	40 (*)	30	20	—	—

(**) If it could be reached by the vehicle.

6. ENERGY VARIATION DURING COAST-DOWN

6.1. *Total road load power determination*

6.1.1. Measurement equipment and accuracy

The margin of measurement error shall be less than 0,1 second for time and less than ± 0,5 km/h for speed.

6.1.2. Test procedure

6.1.2.1. Accelerate the vehicle to a speed of 5 km/h greater than the speed at which test measurement begins.

6.1.2.2. Put the gearbox to neutral, or disconnect the power supply.

6.1.2.3. Measure the time t_1 taken by the vehicle to decelerate from: V2 = V + Δ Vkm/h to V1 = V – Δ Vkm/h

where:

Δ V ≤ 5 km/h for nominal speed ≤ 50 km/h

Δ V ≤ 10 km/h for nominal speed > 50 km/h

6.1.2.4. Carry out the same test in the opposite direction, measuring time t_2.

6.1.2.5. Take the average T1 of the two times t_1 and t_2.

6.1.2.6. Repeat these tests until the statistical accuracy (p) of the average

$$T = \frac{1}{n}\sum_{i=1}^{n} T_i$$

is equal to or less than 4 % (p ≤ 4 %).

The statistical accuracy (p) is defined by:

$$p = \frac{t \cdot s}{\sqrt{n}} \cdot \frac{100}{T}$$

where:

T = is the coefficient given by the table below;

s = is the standard deviation

$$s = \sqrt{\sum_{i=1}^{n} \frac{(T_i - T)^2}{n-1}}$$

n = is the number of tests

n	4	5	6	7	8	9	10
t	3,2	2,8	2,6	2,5	2,4	2,3	2,3
$t/\sqrt{n}$	1,6	1,25	1,06	0,94	0,85	0,77	0,73

6.1.2.7. Calculation of the running resistance force

The running resistance force F at the specified speed V is calculated as follows:

$$F = (M_{HP} + M_r)\,\frac{2 \cdot \triangle V}{\triangle T} \cdot \frac{1}{3{,}6}$$

Where:

M_{HP} = is the test mass.

M_r = is the equivalent inertia mass of all the wheels and vehicle portions rotating with the wheels during coast down on the road. M_r should be measured or calculated by an appropriate manner.

6.1.2.8. The running resistance determined on the track shall be corrected to the reference ambient conditions as follows:

$$F_{corrected} = k \times F_{measured}$$

$$k = \frac{R_R}{R_T} \cdot [1 + K_R(t - t_o)] + \frac{R_{AERO}}{R_T} \cdot \frac{d_0}{d_t}$$

where:

R_R = is the rolling resistance at speed V

R_{AERO} = is the aerodynamic drag at speed V

R_T = is the total road load = R_R + R_{AERO}

K_R = is the temperature correction factor of rolling resistance, taken to be equal to: $3{,}6 \times 10^{-3}$/°C

t = is the road test ambient temperature in °C

t_0 = is the reference ambient temperature = 20 °C

d_t = is the air density at the test conditions

d_0 = is the air density at the reference conditions (20 °C, 100 kPa) = 1,189 kg/m^3.

The ratios R_R/R_T and R_{AERO}/R_T shall be specified by the vehicle manufacturer on the basis of the data normally available to the company.

If these values are not available, subject to the agreement of the manufacturer and the technical service concerned, the figures for the rolling/total resistance ratio given by the following formula may be used:

$$\frac{R_R}{R_T} = a \cdot M_{HP} + b$$

where:

M_{HP} = is the test mass in kg

and for each speed the coefficients a and b are as shown in the following table:

V (km/h)	a	b
20	$7{,}24 \cdot 10^{-5}$	0,82
30	$1{,}25 \cdot 10^{-4}$	0,67
40	$1{,}59 \cdot 10^{-4}$	0,54
50	$1{,}86 \cdot 10^{-4}$	0,42
90	$1{,}71 \cdot 10^{-4}$	0,21
120	$1{,}57 \cdot 10^{-4}$	0,14

6.2. *Setting of the dynamometer*

The purpose of this procedure is to simulate on the dynamometer the total road load power at a given speed.

6.2.1. Measurement equipment and accuracy

The measuring equipment shall be similar to that used on the track.

6.2.2. Test procedure

6.2.2.1. Install the vehicle on the dynamometer.

6.2.2.2. Adjust the tyre pressure (cold) of the driving wheels as required for the chassis dynamometer.

6.2.2.3. Adjust the equivalent inertia mass of the chassis dynamometer, according to table 2.

Table 2

Test mass M_{HP} (kg)	Equivalent inertia I (kg)
$M_{HP} \leq 480$	455
$480 < M_{HP} \leq 540$	510
$540 < M_{HP} \leq 595$	570
$595 < M_{HP} \leq 650$	625
$650 < M_{HP} \leq 710$	680
$710 < M_{HP} \leq 765$	740
$765 < M_{HP} \leq 850$	800
$850 < M_{HP} \leq 965$	910
$965 < M_{HP} \leq 1\,080$	1 020
$1\,080 < M_{HP} \leq 1\,190$	1 130
$1\,190 < M_{HP} \leq 1\,305$	1 250
$1\,305 < M_{HP} \leq 1\,420$	1 360
$1\,420 < M_{HP} \leq 1\,530$	1 470
$1\,530 < M_{HP} \leq 1\,640$	1 590
$1\,640 < M_{HP} \leq 1\,760$	1 700
$1\,760 < M_{HP} \leq 1\,870$	1 810
$1\,870 < M_{HP} \leq 1\,980$	1 930
$1\,980 < M_{HP} \leq 2\,100$	2 040
$2\,100 < M_{HP} \leq 2\,210$	2 150
$2\,210 < M_{HP} \leq 2\,380$	2 270
$2\,380 < M_{HP} \leq 2\,610$	2 270
$2\,610 < M_{HP}$	2 270

6.2.2.4. Bring the vehicle and the chassis dynamometer to the stabilized operating temperature, in order to approximate the road conditions.

6.2.2.5. Carry out the operations specified in paragraph 6.1.2 with the exception of paragraphs 6.1.2.4 and 6.1.2.5, replacing M_{HP} by I and M_r by M_{rm} in the formula given in paragraph 6.1.2.7.

6.2.2.6. Adjust the brake to reproduce the corrected running resistance half payload (paragraph 6.1.2.8) and to take into account the difference between the vehicle mass on the track and the equivalent inertia test mass (I) to be used. This may be done by calculating the mean corrected road coast down time from V_2 to V_1 and reproducing the same time on the dynamometer by the following relationship:

$$T_{corrected} = (I + M_{rm}) \cdot \frac{2 \cdot \triangle V}{F_{corrected}} \cdot \frac{1}{3{,}6}$$

where:

I = is the flywheel equivalent inertia mass of chassis dynamometer.

M_{rm} = is the equivalent inertia mass of the powered wheels and vehicle portions rotating with the wheels during coast down. M_{rm} shall be measured or calculated by an appropriate manner.

6.2.2.7. The power P_a to be absorbed by the bench should be determined in order to enable the same total road load power to be reproduced for the same vehicle on different days or on different chassis dynamometers of the same type.

ANNEX 7

METHOD OF MEASURING THE RANGE OF VEHICLES POWERED BY AN ELECTRIC POWER TRAIN

1. MEASUREMENT OF THE RANGE

The test method described hereafter permits to measure the range of vehicles powered by an electric power train, expressed in km.

2. PARAMETERS, UNITS AND ACCURACY OF MEASUREMENTS

Parameters, units and accuracy of measurements shall be as follows:

Parameter	Unit	Accuracy	Resolution
Time	s	± 0,1 s	0,1 s
Distance	m	± 1 %	1 m
Temperature	°C	± 1 °C	1 °C
Speed	km/h	± 1 %	0,2 km/h
Mass	kg	± 0,5 %	1 kg

3. TEST CONDITIONS

3.1. *Condition of the vehicle*

3.1.1. The vehicle tyres shall be inflated to the pressure specified by the vehicle manufacturer when the tyres are at the ambient temperature.

3.1.2. The viscosity of the oils for the mechanical moving parts shall conform to the specifications of the vehicle manufacturer.

3.1.3. The lighting and light-signalling and auxiliary devices shall be off, except those required for testing and usual daytime operation of the vehicle.

3.1.4. All energy storage systems available for other than traction purposes (electric, hydraulic, pneumatic, etc.) shall be charged up to their maximum level specified by the manufacturer.

3.1.5. If the batteries are operated above the ambient temperature, the operator shall follow the procedure recommended by the vehicle manufacturer in order to keep the temperature of the battery in the normal operating range.

The manufacturer's agent shall be in a position to attest that the thermal management system of the battery is neither disabled nor reduced.

3.1.6. The vehicle must have undergone at least 300 km during the seven days before the test with those batteries that are installed in the test vehicle.

3.2. *Climatic conditions*

For testing performed outdoors, the ambient temperature shall be between 5 °C and 32 °C.

The indoors testing shall be performed at a temperature between 20 °C and 30 °C.

4. OPERATION MODES

The test method includes the following steps:

(a) Initial charge of the battery.

(b) Application of the cycle and measurement of the range.

Between the steps, if the vehicle shall move, it is pushed to the following test area (without regenerative recharging).

4.1. *Initial charge of the battery*

Charging the battery consists of the following procedures:

Note: 'Initial charge of the battery' applies to the first charge of the battery, at the reception of the vehicle. In case of several combined tests or measurements, carried out consecutively, the first charge carried out shall be an 'initial charge of the battery' and the following may be done in accordance with the 'normal overnight charge' procedure.

4.1.1. Discharge of the battery

The procedure starts with the discharge of the battery of the vehicle while driving (on the test track, on a chassis dynamometer, etc.) at a steady speed of 70 % ± 5 % from the maximum thirty minutes speed of the vehicle.

Stopping the discharge occurs:

(a) when the vehicle is not able to run at 65 % of the maximum thirty minutes speed;

(b) or when an indication to stop the vehicle is given to the driver by the standard on-board instrumentation, or;

(c) after covering the distance of 100 km.

4.1.2. Application of a normal overnight charge

The battery shall be charged according to normal overnight charge procedure for a period not exceeding 12 hours (see paragraph 2.4.1.2.1 of annex 6).

4.2. *Application of the cycle and measurement of the range*

The test sequence as defined in paragraph 1.1 of annex 6 is applied on a chassis dynamometer adjusted as described in appendix 1 of annex 6, until the end of the test criteria is reached.

The end of the test criteria is when the vehicle is not able to meet the target curve up to 50 km/h, or when an indication from the standard on-board instrumentation is given to the driver to stop the vehicle.

Then the vehicle shall be slowed down to 5 km/h by releasing the accelerator pedal, without touching the brake pedal and then stopped by braking.

At a speed over 50 km/h, when the vehicle does not reach the required acceleration or speed of the test cycle, the accelerator pedal shall remain fully depressed until the reference curve has been reached again.

To respect human needs, up to three interruptions are permitted between test sequences, of no more than 15 minutes in total.

At the end, the measure D of the covered distance in km is the range of the electric vehicle. It shall be expressed to the nearest whole number.

ANNEX 8

EMISSIONS TEST PROCEDURE FOR A VEHICLE EQUIPPED WITH A PERIODICALLY REGENERATING SYSTEM

1. INTRODUCTION

1.1. This annex defines the specific provisions regarding type-approval of a vehicle equipped with a periodically regenerating system as defined in paragraph 2.11 of this Regulation.

2. SCOPE AND EXTENTION OF THE TYPE APPROVAL

2.1. *Vehicle family groups equipped with periodically regenerating system*

The procedure applies to vehicles equipped with a periodically regenerating system as defined in paragraph 2.11 of this Regulation. For the purpose of this annex vehicle family groups may be established. Accordingly, those vehicle types with regenerative systems, whose parameters described below are identical, or within the stated tolerances, shall be considered to belong to the same family with respect to measurements specific to the defined periodically regenerating systems.

2.1.1. Identical parameters are:

Engine:

(a) number of cylinders,

(b) engine capacity (± 15 per cent),

(c) number of valves,

(d) fuel system,

(e) combustion process (2 stroke, 4 stroke, rotary).

Periodically regenerating system (i.e. catalyst, particulate trap):

(a) Construction (i.e. type of enclosure, type of precious metal, type of substrate, cell density),

(b) Type and working principle,

(c) Dosage and additive system,

(d) Volume (± 10 per cent)

(e) Location (temperature ± 50 °C at 120 km/h or 5 per cent difference of maximum temperature/pressure).

2.2. *Vehicle types of different reference masses*

The K_i factor developed by the procedures in this annex for type approval of a vehicle type with a periodically regenerating system as defined in paragraph 2.11 of this Regulation, may be extended to other vehicles in the family group with a reference mass within the next two higher equivalent inertia classes or any lower equivalent inertia.

2.3. Instead of carrying out the test procedures defined in the following section, a fixed K_i value of 1,05 may be used, if the technical service sees no reason that this value could be exceeded.

3. TEST PROCEDURE

The vehicle may be equipped with a switch capable of preventing or permitting the regeneration process provided that this operation has no effect on original engine calibration. This switch shall be permitted only for the purpose of preventing regeneration during loading of the regeneration system and during the pre-conditioning cycles. However, it shall not be used during the measurement of emissions during the regeneration phase; rather the emission test shall be carried out with the unchanged Original Equipment Manufacturer's (OEM) control unit.

3.1. *Measurement of carbon dioxide emission and fuel consumption between two cycles where regenerative phases occur*

3.1.1. Average of carbon dioxide emission and fuel consumption between regeneration phases and during loading of the regenerative device shall be determined from the arithmetic mean of several approximately equidistant (if more than 2) Type I operating cycles or equivalent engine test bench cycles. As an alternative, the manufacturer may provide data to show that the carbon dioxide emission and fuel consumption remain constant ± 4 per cent between regeneration phases. In this case, the carbon dioxide emission and fuel consumption measured during the regular Type I test may be used. In any other case emissions measurement for at least two Type I operating cycles or equivalent engine test bench cycles must be completed: one immediately after regeneration (before new loading) and one as close as possible prior to a regeneration phase. All emissions measurements and calculations shall be carried out according to annex 5, paragraphs 1.4.3 and 1.5.

3.1.2. The loading process and K_i determination shall be made during the Type I operating cycle, on a chassis dynamometer or on an engine test bench using an equivalent test cycle. These cycles may be run continuously (i.e. without the need to switch the engine off between cycles). After any number of completed cycles, the vehicle may be removed from the chassis dynamometer, and the test continued at a later time.

3.1.3. The number of cycles (D) between two cycles where regeneration phases occur, the number of cycles over which emissions measurements are made (n), and each emissions measurement (M'_{sij}) shall be reported in annex 1, items 1.2.11.2.1.10.1 or 1.2.11.2.1.10.4 to 1.2.11.2.5.4.1 to 1.2.11.2.5.4.4 as applicable.

3.2. *Measurement of carbon dioxide emission and fuel consumption during regeneration*

3.2.1. Preparation of the vehicle, if required, for the emissions test during a regeneration phase, may be completed using the preparation cycles in paragraph 5.3 of annex 4 of Regulation No 83 or equivalent engine test bench cycles, depending on the loading procedure chosen in paragraph 3.1.2 above.

3.2.2. The test and vehicle conditions for the test described in annex 5 apply before the first valid emission test is carried out.

3.2.3. Regeneration must not occur during the preparation of the vehicle. This may be ensured by one of the following methods:

3.2.3.1. A 'dummy' regenerating system or partial system may be fitted for the pre-conditioning cycles.

3.2.3.2. Any other method agreed between the manufacturer and the type approval authority.

3.2.4. A cold-start exhaust emission test including a regeneration process shall be performed according to the Type I operating cycle, or equivalent engine test bench cycle. If the emissions tests between two cycles where regeneration phases occur are carried out on an engine test bench, the emissions test including a regeneration phase shall also be carried out on an engine test bench.

3.2.5. If the regeneration process requires more than one operating cycle, subsequent test cycle(s) shall be driven immediately, without switching the engine off, until complete regeneration has been achieved (each cycle shall be completed). The time necessary to set up a new test should be as short as possible (e.g. particular matter filter change). The engine must be switched off during this period.

3.2.6. The carbon dioxide emission and fuel consumption values during regeneration (M_{ri}) shall be calculated according to annex 5, paragraph 1.4.3 and 1.5. The number of operating cycles (d) measured for complete regeneration shall be recorded.

3.3. *Calculation of the combined carbon dioxide emission and fuel consumption*

$$M_{si} = \frac{\sum_{j=1}^{n} M'_{sij}}{n} \qquad n \geq 2; \qquad M_{ri} = \frac{\sum_{j=1}^{d} M'_{rij}}{d}$$

$$M_{pi} = \left\{ \frac{M_{si} \cdot D + M_{ri} \cdot d}{D+d} \right\}$$

where for each carbon dioxide emission and fuel consumption considered:

M'_{sij} = mass emissions of CO_2 in g/km and fuel consumption in l/100 km over one part (i) of the operating cycle (or equivalent engine test bench cycle) without regeneration

M'_{rij} = mass emissions of CO_2 in g/km and fuel consumption in l/100 km over one part (i) of the operating cycle (or equivalent engine test bench cycle) during regeneration (when n > 1, the first Type I test is run cold, and subsequent cycles are hot)

M_{si} = mean mass emissions of CO_2 in g/km and fuel consumption in l/100 km over one part (i) of the operating cycle without regeneration

M_{ri} = mean mass emissions of CO_2 in g/km and fuel consumption in l/100 km over one part (i) of the operating cycle during regeneration

M_{pi} = mean mass emission of CO_2 in g/km and fuel consumption in l/100 km

N = number of test points at which emissions measurements (Type I operating cycles or equivalent engine test bench cycles) are made between two cycles where regenerative phases occur, ≥ 2

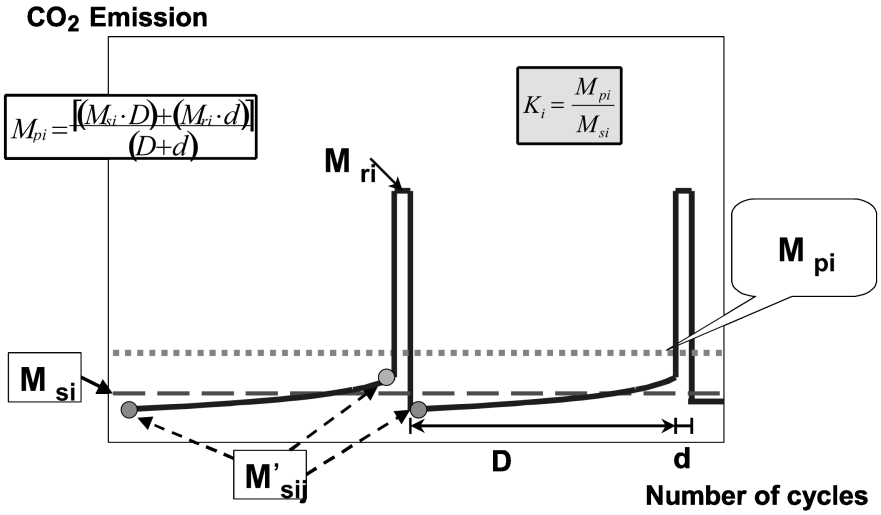
d = number of operating cycles required for regeneration

D = number of operating cycles between two cycles where regenerative phases occur

For exemplary illustration of measurement parameters see figure 1.

Figure 1

Parameters measured during carbon dioxide emission and fuel consumption test during and between cycles where regeneration occurs (schematic example, the emissions during 'D' may increase or decrease)



3.4. *Calculation of the regeneration factor K for each carbon dioxide emission and fuel consumption (i) considered*

$$K_i = M_{pi}/M_{si}$$

M_{si}, M_{pi} and K_i results shall be recorded in the test report delivered by the technical service.

K_i may be determined following the completion of a single sequence.