GHANA STANDARD

DGS 4083:2019
ECE 83R02:2011

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES WITH REGARD TO THE EMISSION OF POLLUTANTS ACCORDING TO ENGINE FUEL REQUIREMENTS

(UNECE 83R01 Rev. 1 – 1 July 1993, IDT)
(UNECE 83R01 Rev. 1 Corr. 1 – 24 August 1993, IDT)
(UNECE 83R01 Rev. 1 Corr. 2 – 24 March 1995, IDT)
(UNECE 83R02 Rev. 1 Amend. 1– 19 July 1995, IDT)

This document is a Draft Ghana Standard. This document shall not be used or referred to as a Ghana Standard.

ICS **Ref. No. DGS 4083:2019**

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National Foreword

The Ghana Standards Authority is the National Statutory Body responsible for the development and promulgation of Ghana Standards.

The Ghana Standards Authority is a member of the African Organization for Standardization (ARSO), the International Organization for Standardization (ISO) and an affiliate member of the International Electrotechnical Commission (IEC).

This Ghana Standard is an identical adoption of the *UNECE 83R05 Rev. 4 – 26 April 2011 - Uniform provisions concerning the approval of vehicles with regard to the emission of pollutants according to engine fuel requirements* and lays down the essential requirements to which such vehicles and their emission of pollutants according to engine fuel requirements must conform.

Throughout the text of this standard, read "…this UNECE Regulation…" to mean "…this Ghana Standard…"

The National Committee responsible for this standard (DGS 4083:2019) is the Technical Committee on Automobile Standards (GSA/TC 05).

This is the 1st edition.

Users of this standard should note that the standard undergoes revision from time to time and any references to it statutorily imply its latest edition.

E/ECE/324
E/ECE/TRANS/505 } Rev.1/Add.82/Rev.1/Amend.1
19 July 1995

AGREEMENT

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

done at Geneva on 20 March 1958

Addendum 82: *Regulation No. 83*

Revision 1 – Amendment 1

02 series of amendments – Date of entry into force: 2 July 1995

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES WITH REGARD TO THE EMISSIONS OF POLLUTANTS ACCORDING TO ENGINE FUEL REQUIREMENTS

UNITED NATIONS

Paragraph 4.4.1., footnote 1/, pertinent to this paragraph, amend to read:

> 1/ ... 23 for Greece, 24 (vacant), 25 for Croatia, 26 for Slovenia, 27 for Slovakia, 28 for Belarus and 29 for Estonia. Subsequent ..."

Paragraph 5.2.1., amend to read:

"5.2.1. Positive ignition engine powered vehicles must be subject to the following tests, as shown in Table 1:

- Type I: (Simulating the average tailpipe emissions after a cold start)
- Type II: (Carbon monoxide emission at idling speed)
- Type III: (Emission of crankcase gases)
- Type IV: (Evaporation emissions)
- Type V: (Durability of anti-pollution devices)."

Paragraph 5.2.2. should be deleted.

Paragraph 5.2.3., amend to read:

"5.2.3. Compression-ignition engine powered vehicles must be subject to the following tests, as shown in Table 1:

- Type I: (Simulating the average tailpipe emissions after a cold start)
- Type V: (Durability of anti-pollution devices)."

Paragraph 5.2.4. should be deleted.

Table 1: Approval system, replace by the following table (footnotes 5/ and 6/ being deleted):

"Table 1: Approval system

Type-Approval Test	Vehicles fuelled with leaded petrol Approval A	Vehicles fuelled with unleaded petrol Approval B	Vehicles fuelled with diesel fuel Approval C
	(identical to Regulation No. 15.04) M1, N1	M1 vehicles 3/ N1 vehicles 4/	M1 vehicles N1 vehicles
Type I:	YES (mass $\leq$ 3.5 tonnes) PART 1	YES (mass $\leq$ 3.5 tonnes) PART 1 AND PART 2	YES (mass $\leq$ 3.5 tonnes) PART 1 AND PART 2
Type II:	YES	YES (mass > 3.5 tonnes)	---
Type III:	YES	YES	---
Type IV:	---	YES (mass $\leq$ 3.5 tonnes)	---
Type V:	---	YES (mass $\leq$ 3.5 tonnes)	YES (mass $\leq$ 3.5 tonnes)
Extension:	paragraph 7	paragraph 7	paragraph 7; M2 and N2 vehicles with reference mass not more than 2,840 kg;

3/, 4/ In application of paragraphs 5.1.2.1. (restricted filler orifice) and 5.1.2.2. (marking)."

Paragraph 5.3.1.2.1., amend to read:

"5.3.1.2.1. With the exception of the vehicles referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A), a test lasting a total of 19 minutes ...."

Paragraph 5.3.1.2.4., amend to read:

"5.3.1.2.4. For the ....
.... 13 minutes ...."

Paragraph 5.3.1.4., amend to read:

"5.3.1.4. Subject to the requirements of paragraphs 5.3.1.4.5. and 5.3.1.5., the test shall be repeated three times. Except for the vehicles referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A), for each test the results shall be multiplied by ...."

Paragraph 5.3.1.4.2.1., amend to read:

"5.3.1.4.2.1. For vehicles equipped with a positive-ignition engine fuelled with unleaded petrol, the limits shall be:

Category of vehicle		Reference mass	Limit values	
			Mass of carbon monoxide	Combined mass of hydrocarbons and oxides of nitrogen
		Rm (kg)	L1 (g/km)	L2 (g/km)
M 5/		All	2.72	0.97
N1 6/	Category I	Rm ≤ 1,250	2.72	0.97
	Category II	1,250 < Rm ≤ 1,700	5.17	1.4
	Category III	1,700 < Rm	6.9	1.7

5/ Except:
- vehicles designed to carry more than six occupants including the driver;
- vehicles whose maximum mass exceeds 2,500 kg.

6/ And those category M vehicles which are specified in note 5/."

Paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3. should be deleted.

Paragraph 5.3.1.4.3.1., amend to read:

"5.3.1.4.3.1. For vehicles equipped with a compression-ignition engine fuelled with diesel fuel, the limits shall be:

Category of vehicle		Reference mass	Limit values		
			Mass of carbon monoxide	Combined mass of hydrocarbons and oxides of nitrogen	Mass of particulates
		Rm (kg)	L1 (g/km)	L2 (g/km)	L4 (g/km)
M 5/		All	2.72	0.97	0.14
N1 6/	Category I	Rm ≤ 1,250	2.72	0.97	0.14
	Category II	1,250 < Rm ≤ 1,700	5.17	1.4	0.19
	Category III	1,700 < Rm	6.9	1.7	0.25

5/ Except:
- vehicles designed to carry more than six occupants including the driver;
- vehicles whose maximum mass exceeds 2,500 kg.

6/ And those category M vehicles which are specified in note 5/."

Paragraphs 5.3.1.4.3.2. and 5.3.1.4.3.3. should be deleted.

Paragraphs 5.3.2.1. and 5.3.2.2., amend to read:

"5.3.2.1. This test is carried out on vehicles powered by a positive-ignition engine and referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A), and on vehicles with a mass exceeding 3.5 tonnes (Approval B).

5.3.2.2. When tested in accordance with annex 5, the carbon monoxide content by volume of the exhaust gases emitted with the engine idling must not exceed 3.5% at the setting specified by the manufacturer, or at the settings used for Type I test (Approval A), and must not exceed 4.5 per cent within the range of adjustments specified in annex 5."

Paragraph 5.3.4.1., amend to read:

"5.3.4.1. This test shall be carried out on all vehicles referred to in paragraph 1 except those vehicles having a compression-ignition engine and those vehicles referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A), and those vehicles fuelled with unleaded petrol having a maximum mass exceeding 3.5 tonnes."

Paragraph 5.3.5.1., amend to read:

"5.3.5.1. This test shall be carried out on all vehicles referred to in paragraph 1 to which the test specified in paragraph 5.3.1. applies, with the exception of those vehicles referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A)."

Paragraph 7.1.1.1., amend to read:

"7.1.1.1. Vehicles other than those referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A):

Approvals may be extended only to vehicle types of a reference mass requiring the use of the next higher equivalent inertia or any lower equivalent inertia."

Insert a new paragraph 7.1.1.2., to read:

"7.1.1.2. In the case of vehicles of category N_1 and vehicles of category M referred to in note 5/ of paragraph 5.3.1.4., if the reference mass of the vehicle type for which extension of the approval is requested requires the use of a flywheel of equivalent inertia lower than that used for the vehicle type already approved, extension of the approval is granted if the masses of the pollutants obtained from the vehicle already approved are within the limits prescribed for the vehicle for which extension of the approval is requested."

Paragraph 7.1.1.2. (former), renumber as 7.1.1.3. and amend to read:

"7.1.1.3. Vehicles referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A):"

Paragraphs 7.1.1.2.1. to 7.1.1.2.3., renumber as paragraphs 7.1.1.3.1. to 7.1.1.3.3.

Paragraph 8.3.1.1.2.1., amend to read:

"8.3.1.1.2.1. The limits shown in paragraph 5.3.1.4.2.1. are replaced by:

Category of vehicle	Reference mass	Limit values	
		Mass of carbon monoxide	Combined mass of hydrocarbons and oxides of nitrogen
	Rm (kg)	L1 (g/km)	L2 (g/km)
M 5/	All	3.16	1.13
N1 6/	Rm ≤ 1,250	3.16	1.13
	1,250 < Rm ≤ 1,700	6.0	1.6
	1,700 < Rm	8.0	2.0

5/ Except:
- vehicles designed to carry more than six occupants including the driver;
- vehicles whose maximum mass exceeds 2,500 kg.

6/ And those category M vehicles which are specified in note 5/."

Paragraphs 8.3.1.1.2.2. and 8.3.1.1.2.3. should be deleted.

Paragraph 8.3.1.1.3.1., amend to read:

"8.3.1.1.3.1. The limits shown in paragraph 5.3.1.4.3.1. are replaced by:

Category of vehicle	Reference mass	Limit values		
		Mass of carbon monoxide	Combined mass of hydrocarbons and oxides of nitrogen	Mass of particulates
	Rm (kg)	L1 (g/km)	L2 (g/km)	L4 (g/km)
M 5/	All	3.16	1.13	0.18
N1 6/	Rm ≤ 1,250	3.16	1.13	0.18
	1,250 < Rm ≤ 1,700	6.0	1.6	0.22
	1,700 < Rm	8.0	2.0	0.29

5/ Except:
- vehicles designed to carry more than six occupants including the driver;
- vehicles whose maximum mass exceeds 2,500 kg.

6/ And those category M vehicles which are specified in note 5/."

Paragraphs 8.3.1.1.3.2. and 8.3.1.1.3.3. should be deleted.

Paragraph 13.1.2., amend to read:

"13.1.2. For the approval and production conformity of category M_1 vehicles (Approval B), equipped with positive-ignition engines and a capacity of more than 2,000 c^3, the test method shall be as described in paragraph 5.3.1.2.4."

Paragraph 13.2., amend to read:

"13.2. Approval of vehicles equipped with direct injection compression-ignition engines:

For vehicles of category M_1 5/ up to 1 July 1994 for type-approval and up to 31 December 1994 for the initial entry into service, and

for vehicles of category N_1 6/ up to 1 October 1994 for type-approval and up to 1 October 1995 for the initial entry into service,

the limit values for the combined mass of hydrocarbons and nitrogen oxides and for the mass of particulates of vehicles fitted with compression-ignition engines of the direct-injection type are those obtained by multiplying the values L2 and L4 in the tables in paragraph 5.3.1.4. (type-approval) and 8.1.1.1. (conformity check) by a factor of 1.4.

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5/ Except:
- vehicles designed to carry more than six occupants including the driver;
- vehicles whose maximum mass exceeds 2,500 kg.

6/ And those category M vehicles which are specified in note 5/."

Paragraph 13.3., amend to read:

"13.3. B or C approval for underpowered vehicles with a maximum speed not exceeding 130 km/h:

13.3.1. For vehicles of category M 5/ with a maximum engine power of no more than 30 kW and a maximum speed not exceeding 130 km/h, the maximum speed of the extra-urban cycle (part two) is limited to 90 km/h until 1 July 1994.

13.3.2. For vehicles of category N_1 6/ with a power-to-weight ratio of no more than 30 kW/t 11/ and a maximum speed not exceeding 130 km/h, the maximum speed of the extra-urban cycle (part two) is limited to 90 km/h until 1 January 1996 for vehicles of category I and until 1 January 1997 for vehicles of categories II and III.

After these dates, vehicles which do not attain the acceleration and maximum speed values required in the operating cycle must be operated with the accelerator control fully depressed until they once again reach the required operating curve. Deviations from the operating cycle must be recorded in the test report.

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5/ Except:
- vehicles designed to carry more than six occupants including the driver;
- vehicles whose maximum mass exceeds 2,500 kg.

6/ And those category M vehicles which are specified in note 5/.

11/ Technically permissible laden mass as stated by the manufacturer."

Annex 2, amend to read:

Item 7, should be deleted;

Items 8., 8.1., 9. and 10., renumber as items 7., 7.1., 8. and 9.;

Item 11., should be deleted;

Items 12. to 12.3., renumber as items 10. to 10.3.;

Item 12.4., should be deleted;

Items 13. to 17., renumber as items 11. to 15;

Items 18. and 18.1., renumber as items 16. and 16.1., and amend to read:

"16. Test type I:

16.1. Results of approval tests: Carried out according to annex 4: 2/

CO: . . . . g/test or g/km 2/

(HC + NO_x): . . . . g/test or g/km 2/

Particulates: . . . . g/test or g/km 2/"

Items 18.2. to 18.6., renumber as items 16.2. to 16.6.;

Items 19. to 19.3., should be deleted;

Items 20. to 23., renumber as items 17. to 20.;

Item 24., renumber as item 21. and delete the text reading
"1 Photograph of the engine and its compartment."

Annex 3, in the examples of the approval marks and in the captions below, amend the approval No. "012439" to read "02 2439" (6 times), and the words "01 series of amendments" amend to read "02 series of amendments." (three times)

Annex 4,

Paragraph 7.1., amend the reference to paragraph "6.6.2." to read paragraph "6.2.2."

Annex 5,

Paragraph 2.2., amend to read:

"2.2. The type II test

2.2.1. For Approval A, the type II test shall be carried out immediately after the completion of the urban cycle (part one) of the type I test, with the engine at idle and without using the cold-start device. Immediately before each measurement of carbon monoxide content, an elementary urban cycle as described in annex 4, paragraph 2.1. to this Regulation, shall be effected.

2.2.2. For Approval B, vehicles having a mass exceeding 3.5 tonnes, during the test the environmental temperature must be between 293 and 303 K (20 and 30°C). The engine shall be warmed up until all temperatures of cooling and lubrication means and the pressure of lubrication means have reached equilibrium."

Paragraph 2.5.2.1., amend to read:

"2.5.2.1. For Approval A, a measurement at setting used for type I test shall be performed first;

For Approval B, vehicles having a mass exceeding 3.5 tonnes, a measurement at the setting in accordance with the conditions fixed by the manufacturer is performed first."

Annex 6, paragraph 2.1., amend to read:

"2.1. The type III test shall be carried out according to provisions given in Table 1 of this Regulation."

E/ECE/324
E/ECE/TRANS/505 } Rev.1/Add.82/Rev.1/Corr.2

24 March 1995

AGREEMENT

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

done at Geneva on 20 March 1958

Addendum 82: *Regulation No. 83*

Revision 1 - Corrigendum 2

Corrigendum 2 to the 01 series of amendments to the Regulation referred to in the Depositary Notification C.N.315.1994.TREATIES-36 of 21 November 1994

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES WITH REGARD TO THE EMISSIONS OF POLLUTANTS ACCORDING TO ENGINE FUEL REQUIREMENTS

UNITED NATIONS

Paragraph 5.3.1.4.3.1., in the table, for "Mass of particulates L3 (g/km)", read "Mass of particulates L4 (g/km)" [concerns the English text only].

Paragraph 5.3.1.4.4., second paragraph, amend to read:

"... (i.e. carbon monoxide and/or the combined mass of hydrocarbons and nitrogen oxides and/or the mass of particulates), it shall be immaterial ..."

Paragraph 7.1.1.2.2., for "a flywheel of equivalent inertia higher than that used" read "equivalent inertia higher than that used."

Paragraph 7.1.1.2.3., for "a flywheel of equivalent inertia lower than that used" read "equivalent inertia lower than that used."

Paragraph 8.3.1.1.3.1., in the table, for "Mass of nitrogen oxides L4 (g/km)" read "Mass of particulates L4 (g/km)" [concerns the English text only].

Annex 4,

Insert the following new paragraph 4.1.4.5.:

"4.1.4.5. The distance actually driven by the vehicle shall be measured by the movement of rotation of the roller (the front roller in the case of a two-roller dynamometer)."

Paragraph 4.5.1., in the list of "pure gases", insert the following:

"...

Carbon monoxide (minimum purity 99.5%)
Propane (minimum purity 99.5%)".

Paragraph 5.1., delete "of the rotating masses".

Paragraph 5.2., amend the reference to "4.1.4." to read "4.1.5.".

Annex 4, Appendix 2, paragraph 1.2.2., amend to read:

"...

if $V \leq 12$ km/h:
P_a will be between 0 and $P_a = KV_{12}^3 \pm 5\% \; KV_{12}^3 \pm 5\% \; PV_{80}$
(without being negative),

where K is a characteristic ..."

Annex 4, Appendix 3,

Paragraphs 5.1.2.2.6. and 5.2.2.2.3., amend the reference to paragraph "4.1.4.1." to read "4.1.4.2." (twice).

Paragraph 5.4.1.2.7., amend to read:

"5.4.1.2.7. Calculate the average force absorbed:

$F_{road} = M \cdot \Gamma$

where: M = ..."

Paragraph 5.4.2.2.1., amend to read:

"5.4.2.2.1. Adjustment of the force on the rim at steady speed

On chassis dynamometer, the total resistance is of the type:

$F_{road} = F_{indicated} + F_{driving\ axle\ rolling}$

where:

$F_{indicated}$: is the force absorbed by the dynamometer brake (indicated on the display system);

F_{road}: is the road load power defined in paragraph 5.4.1.2.7.;

$F_{driving\ axle\ rolling}$: shall be

(a) measured on a chassis dynamometer if possible. The test vehicle, gearbox in neutral position, is driven by the chassis dynamometer at the test speed; the total resistance of the driving axle is then measured on the force indicating device of the chassis dynamometer;

(b) determined on chassis dynamometer unable to work as a generator.

For two-roller chassis dynamometers, the R_R value is the one which is determined beforehand on the road.

For single-roller chassis dynamometers, the R_R value is the one which is determined on the road multiplied by a coefficient (R) which is equal to the ratio between the driving axle mass and the vehicle total mass.

Note: $F_{driving\ axle\ rolling}$ is obtained from the curve:

$F = f(V)$.

Methods (a) and (b) are valid for chassis dynamometers with compensation of frictional losses."

Paragraph 5.4.2.2.4., amend to read:

"5.4.2.2.4. Set the force F indicated on the absorption brake for the speed chosen."

Paragraph 5.4.2.2.5., replace "F_A" by "$F_{indicated}$".

Annex 4, Appendix 6,

Paragraph 3.2, amend to read:

"3.2. Via a T-fitting, oxygen or synthetic air is added continuously to the span gas flow until ..."

Paragraph 4.1.1., amend the reference to paragraph numbers "4.2.2. and 4.2.3." to read "4.4.1. and 4.4.2."

Annex 4, Appendix 8, paragraph 1.1., amend to read:

"1.1. Mass emissions of gaseous pollutants shall be calculated by means of the following equation:

$$m_i = V_{mix} \times Q_i \times k_H \times C_i \times 10^{-6} \quad \text{(g/test)}$$

when mass emissions are expressed in g/test;

$$M_i = \frac{m_i}{d} \quad \text{(g/km)}$$

when emissions are expressed in g/km;

in these formulae:

m_i = mass emission of the pollutant (i) in g/test;

M_i = mass emission of the pollutant (i) in g/km;

V_{mix} = volume ..."

Annex 7

Paragraphs 7.2.2. and 7.3.2, amend the value "370 ± 10 mm of H_20" to read "3.630 ± O.1 kPa" (twice).

Paragraph 7.2.4., amend the value "50 mm H_20" to read "0.490 kPa".

Paragraph 7.3.5., amend the value "100 mm H_20" to read "0.980 kPa".

E/ECE/324
E/ECE/TRANS/505 } Rev.1/Add.82/Rev.1/Corr.1

24 August 1993

ENGLISH ONLY

AGREEMENT

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

done at Geneva on 20 March 1958

Addendum 82: *Regulation No. 83*

Revision 1 - Corrigendum 1 */*

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES WITH REGARD TO THE EMISSION OF POLLUTANTS ACCORDING TO ENGINE FUEL REQUIREMENTS

UNITED NATIONS

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*/ **Erratum.**

Paragraph 1.1., the third subparagraph correct to read:

"...
to exhaust emission and durability of pollution control devices of all vehicles of categories M_1 */ and N_1 */ equipped with compression-ignition engines, and having at least four wheels.
It does not ..."

Annex 4-Appendix 8, page 121, the first formula correct to read:

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

Annex 4-Appendix 8, page 123, the first formula correct to read:

"
$$k_H = \frac{1}{1 - 0.0329\ (H - 10.71)} \quad (6)"$$

E/ECE/324
E/ECE/TRANS/505 } Rev.1/Add.82/Rev.1

1 July 1993

AGREEMENT

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

done at Geneva on 20 March 1958

Addendum 82: *Regulation No. 83*

Revision 1

Incorporating:

- **01 series of amendments - Date of entry into force: 30 December 1992**
- **Corrections referred to in the depositary notification C.N.232.1992.TREATIES-32: 11 September 1992**

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES WITH

REGARD TO THE EMISSION OF POLLUTANTS ACCORDING TO ENGINE FUEL REQUIREMENTS

UNITED NATIONS

Regulation No. 83

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES WITH REGARD TO THE EMISSION OF POLLUTANTS ACCORDING TO ENGINE FUEL REQUIREMENTS

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Regulation No. 83

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES WITH REGARD TO THE EMISSION OF POLLUTANTS ACCORDING TO ENGINE FUEL REQUIREMENTS

1. SCOPE

1.1. This Regulation applies:

to exhaust emissions and crankcase gaseous emissions of all vehicles of categories M1 */ and N1 */, equipped with positive-ignition engines fuelled with leaded petrol,

to exhaust emissions, crankcase gaseous emissions, evaporative emissions, and durability of pollution-control devices of all vehicles of categories M1 */ and N1 */ equipped with positive-ignition engines fuelled with unleaded petrol, and

to exhaust emission and durability of pollution control devices of all vehicles of categories M1 */ and N2 */ equipped with compression-ignition engines, and having at least four wheels.

It does not apply to vehicles with an unladen mass of less than 400/kg, or to vehicles with a design speed not exceeding 50 km/h.

At the request of the manufacturers, type-approval according to this Regulation may be extended from M1 or N1 vehicles equipped with compression-ignition engines which have already been type-approved to M2 or N2 vehicles having a reference mass not exceeding 2,840 kg and meeting the conditions of paragraph 7 (extension of approval).

1.2. Any Contracting Party applying the present Regulation can specify, in the framework of its own national regulations, the classes of vehicles that must run on unleaded petrol and comply with the paragraphs 5.3.1.4.2. and 8.3.1.1.2. of this Regulation.

1.3. Paragraph 7.5. of the present Regulation, allows a manufacturer to ask for an approval corresponding to the specifications (cf. para. 5.3.1.4.1.) for vehicles designed to run on unleaded petrol notwithstanding the provisions of paragraph 1.2. above.

1.4. The basic measurement methods in the present Regulation are taken from Regulation No. 15, as amended by the 04 series of amendments; so all test results obtained according to Regulation No. 15 as amended by the 04 series can be used, whenever appropriate, when granting an approval according to this Regulation.

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*/ As defined in annex 7 of the Consolidated Resolution on the Construction of Vehicles (R.E.3) (document TRANS/SC1/WP29/78/Amend.3).

1.5. More specifically, for cars designed to run on leaded petrol, the Regulation No. 15 as amended by the 04 series and this Regulation are identical, hence an approval according to Regulation No. 15 as amended by the 04 series can be automatically converted into an approval to this Regulation granted according to paragraph 5.3.1.4.1.

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 limitation of the following conditions:

Limitation of emissions of gaseous pollutants by the engine and crankcase emissions of vehicles fuelled with leaded petrol (Approval A);

Limitation of emissions of gaseous pollutants by the engine, evaporative emissions, crankcase emissions and durability of pollution control devices of vehicles fuelled with unleaded petrol (Approval B);

Limitation of emissions of gaseous and particulate pollutants, crankcase emissions and durability of pollution control devices of vehicles fuelled with diesel fuel (Approval C);

2.2. "Fuel requirement by the engine", the type of fuel normally used by the engine:

leaded petrol,
unleaded petrol,
diesel fuel;

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

2.3.1. the equivalent inertia determined in relation to the reference mass as prescribed in annexes 4 and 4A, paragraph 5.1., to this Regulation, and,

2.3.2. the engine and vehicle characteristics as defined in paragraph 1 of annex 1 and in annex 2 to this Regulation;

2.4. "Reference mass" means

the "unladen mass" of the vehicle increased by a uniform figure of 100 kg for test according to annex 4,

the "unladen mass" of the vehicle increased by a uniform figure of 136 kg for test equivalent according to annex 4A;

2.4.1. "Unladen mass" means the mass of the vehicle in running order without crew, passengers or load, but with the fuel tank full and the usual set of tools and spare wheel on board, where applicable;

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

2.6. "Gaseous pollutants" means carbon monoxide, hydrocarbons (assuming a ratio of $CH_{1.85}$), and oxides of nitrogen, the latter being expressed in nitrogen dioxide (NO_2) equivalent;

2.7. "Particulate pollutants" means components of the exhaust gas which are removed from the diluted exhaust gas at a maximum temperature of 325 K (52° C) by means of the filters described in annexes 4 and 4A;

2.8. "Exhaust emissions" means:

for positive-ignition engines, emissions of gaseous pollutants;

for compression-ignition engines, emissions of gaseous and particular pollutants;

2.9. "Evaporative emissions" means the hydrocarbon vapours lost from the fuel system of a motor vehicle other than those from exhaust emissions;

2.9.1. "Tank breathing losses" are hydrocarbon emissions caused by temperature changes in the fuel tank (expressed as $C_1H_{2.33}$ equivalent);

2.9.2. "Hot soak losses" are hydrocarbon emissions arising from the fuel system of a stationary vehicle after a period of driving (expressed as $C_1H_{2.20}$ equivalent).

2.10. "Engine crankcase" means the spaces in or external to an engine which are connected to the oil sump by internal or external ducts through which gases and vapours can escape;

2.11. "Cold start device" means a device which enriches the air/fuel mixture of the engine temporarily. Thus, assisting engine start up;

2.12. "Off-road vehicle" means a vehicle which meets the conditions specified in annex 10;

2.13. "Starting aid" means a device which assists engine start up without enrichment of the air/fuel mixture of the engine, e.g. glow plug, injection timing change, etc.;

2.14. Engine capacity means;

2.14.1. For reciprocating piston engines, the nominal engine swept volume;

2.14.2. For rotary piston engines (Wankel), twice the nominal swept volume of a combustion chamber per piston;

2.15. "Pollution control devices" means those components of a vehicle that control and/or limit exhaust and evaporative emissions.

3. APPLICATION FOR APPROVAL

Exhaust emissions, evaporative emissions and durability of pollution-control devices according to the fuel requirements of the engine.

3.1. The application for approval of a vehicle type with regard to exhaust emissions, evaporative emissions and durability of pollution control devices shall be submitted by the vehicle manufacturer or by his authorized representative.

3.2. It shall be accompanied by the undermentioned documents in triplicate and the following particulars:

3.2.1. a description of the engine type comprising all the particulars referred to in annex 1;

3.2.2. drawings of the combustion chamber and of the piston, including the piston rings;

3.2.3. maximum lift of valves and angles of opening and closing in relation to dead centres;

3.2.4. a description of the evaporation control system installed in the vehicle;

3.2.5. particulars concerning the vehicle as shown in annex 2;

3.2.6. in the case of vehicles equipped with positive-ignition engines, a statement of whether either paragraph 5.1.2.1. (restricted orifice) or paragraph 5.1.2.2. (marking) applies, and in the latter case, a description of the marking;

3.2.7. when appropriate, copies of other approvals with the relevant data for extensions of approvals and establishment of deterioration factors.

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

4. APPROVAL

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

4.2. An approval number shall be assigned to each type approved. Its first two digits 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 Agreement which apply this Regulation by means of a form conforming to the model in annex 2 to this Regulation.

4.3.1. In the event of amendment to the present Regulation, for example, if new limit values are prescribed, the Parties to the Agreement shall be informed which vehicle types already approved comply with the new provisions.

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 described in paragraph 4.4.1.

4.4.3. The following additional symbols corresponding to emission level normally required according to fuel requirements shall be affixed near the above approval mark:

A - if corresponding to level of emissions of gaseous pollutants normally required for an engine fuelled with leaded petrol,

B - if corresponding to the level of emissions of gaseous pollutants, crankcase emissions, evaporative emissions and durability of pollution control devices normally required for an engine fuelled with unleaded petrol;

C - if corresponding to the level of gaseous and particulate emissions, and durability of pollution control devices normally required for an engine fuelled with diesel fuel.

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 3 to this Regulation gives examples of arrangements of the approval mark.

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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 Yugoslavia, 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 Russian Federation, 23 for Greece and 26 for Slovenia. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify the Agreement concerning the Adoption for Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, or in which they accede to that Agreement, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

5. SPECIFICATIONS AND TESTS [2]

5.1. General

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

The technical measures taken by the manufacturer must be such as to ensure that in conformity with the provisions of this Regulation, exhaust gas and evaporative emissions are effectively limited throughout the normal life of the vehicle and under normal conditions of use. For exhaust emissions, these provisions are deemed to be met if the provisions of paragraphs 5.3.1.4. and 8.3.1.1. respectively are complied with.

If an oxygen sensor is used in the catalytic converter system, steps must be taken to ensure that the stoichiometric air-fuel ratio (lambda) is maintained when a certain speed is reached or when accelerating. However, temporary variations in this ratio are permissible if they also occur during the test defined in paragraphs 5.3.1. and 8.3.1. respectively, or if these variations are necessary for safe driving and for the correct operation of the engine and of components which affect pollutant emissions or if these variations are necessary for cold starting.

5.1.2. A vehicle equipped with a positive-ignition engine and fuelled with unleaded petrol shall satisfy paragraphs 5.1.2.1. or 5.1.2.2. below.

5.1.2.1. Subject to paragraph 5.1.2.2., the inlet orifice of the fuel tank shall be so designed as to prevent the tank from being filled from a petrol pump delivery nozzle which has an external diameter of 23.6 mm or greater.

5.1.2.2. Paragraph 5.1.2.1. shall not apply to a vehicle in respect of which both of the following conditions are satisfied, i.e.:

5.1.2.2.1. the vehicle is so designed and constructed that no device designed to control the emission of gaseous pollutants shall be adversely affected by leaded petrol, and;

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2 As an alternative to the requirements of this section, vehicle manufacturers whose worldwide annual production is less than 10,000 units may obtain type-approval on the basis of the corresponding technical requirements in:

The Code of Federal Regulations, Title 40, Part 86, Subparts A and B, applicable to 1987 model year light duty vehicles, revised as of 1 July 1989 and published by the US Government printing office, or;

The "Master Document", in its final version dated 25 September 1987, prepared by the international meeting in Stockholm on Air Pollution by Motor Vehicles, entitled "Control of Air Pollution from Motor Vehicles - General Provisions for Emission Regulations for Light Motor Vehicles".

5.1.2.2.2. the vehicle is conspicuously, legibly and indelibly marked with the symbol for unleaded petrol, specified in ISO 2575-1982, in a position immediately visible to a person filling the fuel tank. Additional markings are permitted.

5.2. Test procedure

Table 1 illustrates the various possibilities for type-approval of a vehicle.

5.2.1. With the exception of vehicles referred to in paragraph 5.3.1.4.1. (Approval A) and paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3. (Approval B), positive-ignition vehicles shall be subjected to the following tests:

Type I (verifying the average exhaust emissions after a cold start);
Type III (emissions of crankcase gases);
Type IV (evaporative emissions);
Type V (durability of pollution control devices).

5.2.2. The vehicles equipped with positive-ignition engines referred to in paragraph 5.3.1.4.1. (Approval A) and paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3. (Approval B) shall be subjected to the following tests:

Type I (verifying the average exhaust emissions after a cold start);
Type II (carbon monoxide emission at idling speed);
Type III (emissions of crankcase gases).

5.2.3. With the exception of the vehicles referred to in paragraphs 5.3.1.4.3.2. and 5.3.1.4.3.3. (Approval C), vehicles equipped with compression-ignition engines shall be subjected to the following tests:

Type I (verifying the average exhaust emissions after a cold start);
Type V (durability of pollution control devices).

5.2.4. The vehicles equipped with compression-ignition engines referred to in paragraphs 5.3.1.4.3.2. and 5.3.1.4.3.3. shall be subjected to the following test:

Type I (verifying the average exhaust emissions after a cold start - gaseous pollutants only).

Table 1: Approval system

Type-Approval Test	Vehicles fuelled with leaded petrol Approval A	Vehicles fuelled with unleaded petrol Approval B		Vehicles fuelled with diesel fuel Approval C	
	(identical to Regulation No. 15.04) M1, N1	M1 vehicles with [3] Mass ≤ 2.5 tonnes; Maximum 6 places.	N1 vehicles; [4] M1 > 2.5 tonnes; [5] M1 > 6 places; Off-road vehicles.	M1 vehicles with Mass ≤ 2.5 tonnes; Maximum 6 places.	N1 vehicles; [6] M1 > 2.5 tonnes; M1 > 6 places; Off-road vehicles.
Type I:	YES PART 1	YES PART 1 AND PART 2	YES (mass ≤ 3.5 tonnes) PART 1	YES PART 1 AND PART 2	YES (mass ≤ 3.5 tonnes) PART 1
Type II:	YES	...	YES	...	...
Type III:	YES	YES	YES	...	...
Type IV:	...	YES	...	...	...
Type V:	...	YES	...	YES	...
Extension:	paragraph 7	paragraph 7	paragraph 7	paragraph 7	M2 and N2 vehicles; Reference mass < 2,840 kg; paragraph 7

[3] [4] In application of paragraphs 5.1.2.1. (restricted filler orifice) and 5.1.2.2. (marking).

[5] For vehicles corresponding to paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3. (Approval B).

[6] For vehicles corresponding to paragraphs 5.3.1.4.3.2. and 5.3.1.4.3.3. (Approval C).

5.3. Description of tests

5.3.1. Type I test (verifying the average exhaust emissions after a cold start)

5.3.1.1. Figure 2 illustrates the various possibilities for the type I test.

This test must be carried out on all vehicles referred to in paragraph 1, of a maximum mass not exceeding 3.5 tonnes.

5.3.1.2. The vehicle is placed on a chassis dynamometer equipped with a means of load and inertia simulation.

5.3.1.2.1. With the exception of the vehicles referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A), paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3. (Approval B) and paragraphs 5.3.1.4.3.2. and 5.3.1.4.3.3. (Approval C), a test lasting a total of 19 minutes and 40 seconds, made up of two parts, one and two, shall be carried out without interruption.

The idling period between the last deceleration of the last elementary urban cycle (part one) and the first acceleration of the extra-urban cycle (part two) may be extended, with the manufacturer's approval, for an unsampled period of not more than 20 seconds in order to facilitate adjustment of the test equipment.

5.3.1.2.2. Part one of the test is made up of four elementary urban cycles. Each elementary urban cycle comprises 15 phases (idling, acceleration, steady speed, deceleration, etc.).

5.3.1.2.3. Part two of the test is made up of one extra-urban cycle. The extra-urban cycle comprises 13 phases (idling, acceleration, steady speed, deceleration, etc.).

5.3.1.2.4. For the vehicles referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A), paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3. (Approval B) and paragraphs 5.3.1.4.3.2. and 5.3.1.4.3.3. (Approval C), a test lasting a total of 13 minutes and comprising only four elementary urban cycles (part one) shall be carried out without interruption.

5.3.1.2.5. During the test, the exhaust gases shall be diluted and a proportional sample collected in one or more bags. The exhaust gases of the vehicle tested shall be diluted, sampled and analysed, following the procedure described below, and the total volume of the diluted exhaust gases measured.

Not only the carbon monoxide, hydrocarbon and nitrogen oxide emissions, but also the particulate pollutant emissions from vehicles equipped with compression-ignition engines must be recorded.

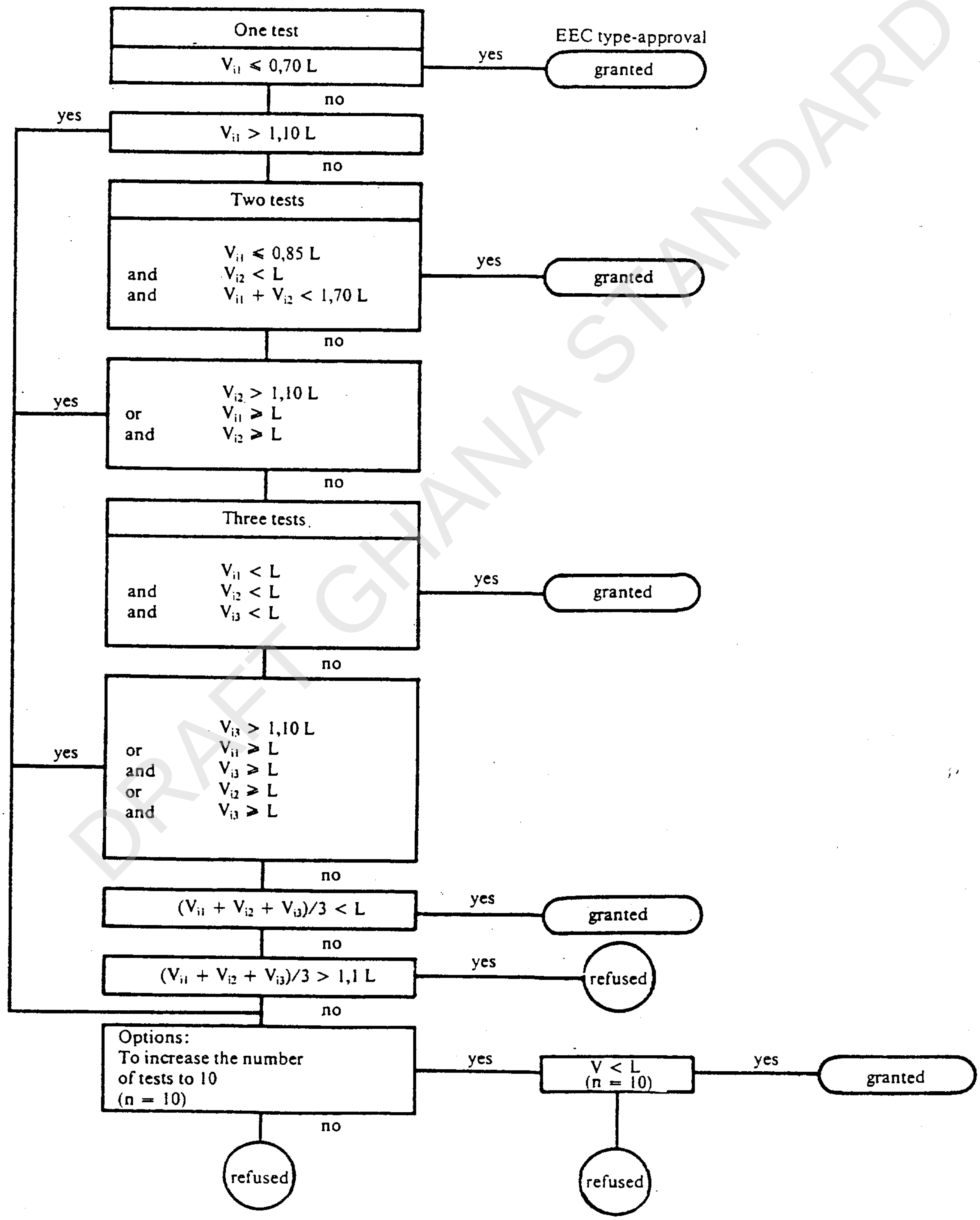
5.3.1.3. The test shall be carried out using the procedure described in annex 4. The methods used to collect and analyse the gases and collect and weigh the particulates must be as prescribed.

5.3.1.4. Subject to the requirements of paragraphs 5.3.1.4.5. and 5.3.1.5. the test shall be repeated three times. Except for the vehicles referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A), paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3. (Approval B) and paragraphs 5.3.1.4.3.2. and 5.3.1.4.3.3. (Approval C), for each test the results shall be multiplied by the appropriate deterioration factors set out in paragraph 5.3.5. The resulting masses of gaseous emissions and, in the case of vehicles equipped with compression-ignition engines, the mass of particulates obtained in each test must be less than the limits shown in the tables below for the appropriate category of vehicle:

FIGURE 1

Flow chart for the approval system

Type I tests (see paragraph 5.3.1.)



5.3.1.4.1. Emission levels of gaseous pollutants normally required for vehicles fuelled with leaded petrol (Approval A)

5.3.1.4.1.1. For all vehicles of category M1 equipped with a positive-ignition engine fuelled with leaded petrol, the limits, as a function of given reference mass, shall be:

Reference mass (Rm) (kg)	Carbon monoxide L1 (g/test)	Hydrocarbons and Oxides of Nitrogen combined L2 (g/test)
Rm ≤ 1 020	58	19
1 020 < Rm ≤ 1 250	67	20.5
1 250 < Rm ≤ 1 470	76	22
1 470 < Rm ≤ 1 700	84	23.5
1 700 < Rm ≤ 1 930	93	25
1 930 < Rm ≤ 2 150	101	26.5
2 150 < Rm	110	28

5.3.1.4.1.2. For vehicles of category N1 equipped with a positive-ignition engine, fuelled with leaded petrol, the limits are those specified in paragraph 5.3.1.4.1.1.; however, the limits for the combined mass of hydrocarbons and nitrogen oxides (L2) are to be multiplied by a factor of 1.25.

5.3.1.4.2. Emission levels of gaseous pollutants normally required for vehicles fuelled with unleaded petrol (Approval B)

5.3.1.4.2.1. For all M1 vehicles equipped with a positive-ignition engine fuelled with unleaded petrol (except for those defined in paragraph 5.3.1.4.2.2.), the limits shall be:

Carbon monoxide L1 (g/km)	Hydrocarbons and Oxides of Nitrogen combined L2 (g/km)
2.72	0.97

5.3.1.4.2.2. For vehicles of category M1 equipped with a positive-ignition engine fuelled with unleaded petrol, that are either:

off-road vehicles (as defined in paragraph 1 of annex 10),
vehicles with a maximum mass exceeding 2.5 tonnes,
vehicles designed to carry more than six occupants including the driver,

the limits to be applied are those specified in the table of paragraph 5.3.1.4.1.1. of this Regulation.

5.3.1.4.2.3. For vehicles of category N1 equipped with a positive-ignition engine fuelled with unleaded petrol, the limits to be applied are those specified in the table of paragraph 5.3.1.4.1.1. of this Regulation.

5.3.1.4.3. <u>Exhaust emission levels normally required for vehicles fuelled with diesel fuel (Approval C)</u>

5.3.1.4.3.1. For vehicles of category M1 equipped with a compression-ignition engine fuelled with diesel fuel (except for those defined in paragraph 5.3.1.4.3.2., the limits shall be:

Mass of carbon monoxide L1 (g/km)	Mass of hydrocarbons and nitrogen oxides combined L2 (g/km)	Mass of Particulates L3 (g/km)
2.72	0.97	0.14

5.3.1.4.3.2. For vehicles of category M1 equipped with a compression-ignition engine fuelled with diesel fuel, that are either:

off-road vehicles (as defined in paragraph 1 of annex 10),
vehicles with maximum mass exceeding 2.5 tonnes,
vehicles designed to carry more than six occupants including the driver,

the limits to be applied are those specified in the table of paragraph 5.3.1.4.1.1. of this Regulation.

5.3.1.4.3.3. For vehicles of category N1 equipped with a compression-ignition engine fuelled with diesel fuel, the limits to be applied are those specified in the table of paragraph 5.3.1.4.1.1. of this Regulation.

5.3.1.4.4. Nevertheless, for each of the pollutants referred to in the foregoing paragraphs, not more than one of the three results obtained may exceed by not more than 10% the limit prescribed in that paragraph for the vehicle concerned, provided the arithmetical mean of the three results is below the prescribed limit.

Where the prescribed limits are exceeded for more than one pollutant (i.e. carbon monoxide and/or the combined mass of hydrocarbons and nitrogen oxides and/or nitrogen oxides), it shall be immaterial whether this occurs in the same test or in different tests.[7]

5.3.1.4.5. The number of tests prescribed in paragraph 5.3.1.4. may, at the request of the manufacturer, be increased to 10 provided that the arithmetical mean ($\bar{x}_i$) of the first three results obtained for each pollutant or combined total of two pollutants falls between 100% and 110% of the limit.In this case, the decision, after testing, shall depend exclusively on the average results obtained from all 10 tests ($\bar{x} < L$).

5.3.1.5. The number of tests prescribed in paragraph 5.3.1.4. shall be reduced in the conditions hereinafter defined, where V_1, is the result of the first test and V_2 the

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[7] If one of the three results obtained for any of the pollutants exceeds by more than 10% the limit prescribed in paragraph 5.3.1.4. for the vehicle concerned, the test may be continued as specified in paragraph 5.3.1.4.5.

result of the second test for each pollutant or for the combined emission of two pollutants subject to limitation.

5.3.1.5.1. Only one test shall be performed if the result obtained for each pollutant or for the combined emission of two pollutants, subject to limitation, is less than or equal to 0.70L (i.e. $V_1 \leq 0.70L$).

5.3.1.5.2. If the requirement of paragraph 5.3.1.5.1. is not satisfied, only two tests shall be performed if, for each pollutant, or for the combined emission of two pollutants subject to limitation, the following requirements are met:

$$V_1 \leq 0.85L; \quad V_1 + V_2 \leq 1.70L: \quad V_2 \leq L$$

5.3.2. <u>Type II test</u> (carbon monoxide emission test at idling speed)

5.3.2.1. With the exception of vehicles equipped with compression-ignition engines, this test shall be carried out on all vehicles referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A), and paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3. (Approval B).

5.3.2.2. When tested in accordance with conditions set out in annex 5, the carbon monoxide content by volume of the exhaust gases emitted with the engine idling must not exceed 3.5% at the settings used for the Type I test and must not exceed 4.5% within the range of adjustments specified in annex 5.

5.3.2.3. Conformity with the last preceding requirement shall be checked by a test carried out by the procedure described in annex 5 to this Regulation.

5.3.3. <u>Type III test</u> (verifying emissions of crankcase gases)

5.3.3.1. This test shall be carried out on all vehicles referred to in paragraph 1. except those having compression-ignition engines.

5.3.3.2. When tested in accordance with the conditions set out in annex 6, the crankcase ventilation system must not permit the emission of any of the crankcase gases into the atmosphere.

5.3.3.3. Conformity with the last preceding requirement shall be checked by a test carried out by the procedure described in annex 6 to this Regulation.

5.3.4. <u>Type IV test</u> (determination of evaporative emissions)

5.3.4.1. This test shall be carried out on all vehicles referred to in section 1 except those vehicles having compression-ignition engines and those vehicles referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A) and paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3. (Approval B).

5.3.4.2. When tested in accordance with the conditions set out in annex 7, evaporative emissions shall be less than 2 g/test.

5.3.5. Type V test (durability of pollution control equipment)

5.3.5.1. This test shall be carried out on all vehicles referred to in section 1, with the exception of those vehicles referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A), paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3. (Approval B) and paragraphs 5.3.1.4.3.2. and 5.3.1.4.3.3. (Approval C).

The test represents an endurance test of 80,000 km driven in accordance with a programme described in annex 8 on a test track, on the road or on a chassis dynamometer.

5.3.5.2. Notwithstanding the requirements of paragraph 5.3.5.1., a manufacturer may choose to use the deterioration factors from the following table as an alternative to the test set out in paragraph 5.3.5.1:

Engine Category	Deterioration Factors		
	CO	HC + NOx	Particulates
(i) Positive-ignition	1.2	1.2	-
(ii) Compression-ignition	1.1	1.0	1.2

At the request of the manufacturer, the technical service may carry out the type I test before the type V test has been completed using the deterioration factors in the table above. On completion of the type V test, the technical service may then amend the type-approval results, recorded in annex 2, by replacing the deterioration factors in the table above with those measured in the type V test.

5.3.5.3. Deterioration factors shall be determined either by using the procedure set out in paragraph 5.3.5.1. or by using the values in the table in paragraph 5.3.5.2. The factors are used to establish compliance with the requirements of paragraphs 5.3.1.4.2, 5.3.1.4.3, 8.3.1.1.2. and 8.3.1.1.3.

6. MODIFICATIONS OF THE VEHICLE TYPE

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

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

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

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

6.3 The competent authority issuing the extension of approval shall assign a series number to the 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 2 to this Regulation.

7. EXTENSION OF APPROVAL

7.1. Extensions concerning exhaust emissions (type I and type II tests)

7.1.1. Vehicle types of different reference masses

Approval granted to a vehicle type may, under the following conditions, be extended to vehicle types which differ from the type approved only in respect of their reference mass.

7.1.1.1. Vehicles other than those referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A), paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3. (Approval B) and paragraphs 5.3.1.4.3.2. and 5.3.1.4.3.3. (Approval C).

Approvals may be extended only to vehicle types of a reference mass requiring the use of the next higher equivalent inertia or any lower equivalent inertia.

7.1.1.2. Vehicles other than those referred to in paragraphs 5.3.1.4.1.1. and 5.3.1.4.1.2. (Approval A), paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3. (Approval B) and paragraphs 5.3.1.4.3.2. and 5.3.1.4.3.3. (Approval C).

7.1.1.2.1. Approval may be extended only to vehicle types of a reference mass requiring merely the use of the next higher or next lower equivalent inertia.

7.1.1.2.2. If the reference mass of the vehicle type for which extension of the approval is requested requires the use of a flywheel of equivalent inertia higher than that used for the vehicle type already approved, extension of the approval shall be granted.

7.1.1.2.3. If the reference mass of the vehicle type for which extension of the approval is requested requires the use of a flywheel of equivalent inertia lower than that used for the vehicle type already approved, extension of the approval shall be granted if the masses of the pollutants obtained from the vehicle already approved are within the limits prescribed for the vehicle for which extension of the approval is requested.

7.2. Vehicle types with different overall gear ratios

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

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

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

where V_1 and V_2 are respectively the speed at 1,000 rpm. of the engine of the vehicle type approved and the speed of the vehicle type for which extension of the approval is requested.

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

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

7.3. Vehicle types of different reference masses and different overall transmission ratios

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

7.4. Vehicle types equipped with a positive-ignition engine which presents only differences about fuel requirements

A vehicle type equipped with a positive-ignition engine adjusted according to the manufacturer's specifications to run on unleaded petrol, but for which the emission level requirements correspond to the limits specified in paragraph 5.3.1.4.1.1. can be granted an "A" approval as provided for in paragraph 4.4.3.

In this case, approval shall be extended for the leaded petrol functioning adjustments.

7.5. Note

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

7.6. Evaporative emissions (type IV test)

7.6.1. Approval granted to a vehicle equipped with a control system for evaporative emissions may be extended under the following conditions;

7.6.1.1. The basic principle of fuel/air metering (e.g. single point injection, carburettor) must be the same.

7.6.1.2. The shape of the fuel tank and the material of the fuel tank and liquid fuel hoses must be identical. The cross-section and approximate hose length must be identical, with the worst case (length of hoses) for a family which has been tested. The technical service responsible for the type-approval tests shall decide whether non-identical vapour/liquid separators are acceptable.

The fuel tank volume shall be within a range of $\pm$ 10%. The setting of the tank relief valve must be identical.

7.6.1.3. The method of storage of the fuel vapour must be identical, e.g. carbon trap form and volume, storage substance, air filter (if used for evaporative emission control).

7.6.1.4. The fuel volume of the carburettor chamber must fall within a 10 millilitre range.

7.6.1.5. The method of purging the stored vapour must be identical (e.g. air flow, start point or purge volume over driving cycle).

7.6.1.6. The method of sealing and venting of the carburettor must be identical.

7.6.2. Further notes:

(i) Different engine sizes shall be allowed.
(ii) Different engine powers shall be allowed.
(iii) Automatic and manual gearboxes, two and four wheel transmissions shall be allowed.
(iv) Different body styles shall be allowed.
(v) Different sizes of wheels and tyres shall be allowed.

7.7. <u>Durability of pollution control devices (type V test)</u>

7.7.1. Approval granted to a vehicle type may be extended to different vehicle types, provided that the engine/pollution control system combination is identical to that of the vehicle already approved.

To this end, those vehicle types whose parameters described below are identical to or remain within the limit values prescribed shall be considered as belonging to the same engine/pollution control system combination:

7.7.1.1. Engine:

Number of cylinders,
Engine capacity ($\pm$ 15%),
Configuration of the cylinder block,
Number of valves,
Fuel system,
Type of cooling system,
Combustion cycle.

7.7.1.2. Pollution control system:

Catalytic converter:

Number of catalytic converters and elements,
Size and shape of catalytic converters (volume ± 10%),
Type of catalytic activity (oxidizing, three-way, etc.),
Precious metal load (identical or higher),
Precious metal ratio (± 15%),
Substrate (structure and material),
Cell density,
Type of casing for the catalytic converter(s),
Location of catalytic converter(s) (position and dimension in the exhaust system that does not produce a temperature variation of more than 50 K at the inlet to the catalytic converter).

Air injection:

With or without.
Type (pulsair, air pumps, etc.).

EGR (exhaust gas recycle) (with or without).

7.7.1.3. Inertia category: the inertia category immediately above and any equivalent inertia category below.

7.7.1.4. The durability test may be carried out by using a vehicle, the body style, gear box (automatic or manual) and size of the wheels or tyres of which are different from those of the vehicle type for which the type-approval is sought.

8. CONFORMITY OF PRODUCTION

8.1. Every vehicle bearing an approval mark as prescribed under this Regulation shall conform, with regard to components affecting exhaust emissions and evaporation emissions, to the vehicle type approved.

8.2. In order to verify conformity as prescribed in paragraph 8.1., a sufficient number of random checks shall be made on serially-manufactured vehicles bearing the approval mark required by this Regulation.

8.3. As a general rule, conformity of the vehicle with the approved type shall be verified on the basis of the description given in the approval form and its annexes, and if necessary a vehicle shall be subjected to all or some of the tests of types I, II, III and IV referred to in paragraph 5.3.

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

8.3.1.1. A vehicle shall be taken from the series and subjected to the test described in paragraph 5.3.1. The deterioration factors shall be applied in the same way for vehicles having category B or C approvals. However, the limits shown in paragraph 5.3.1.4. shall be replaced by the following:

8.3.1.1.1. Emissions levels of gaseous pollutants normally required for vehicles fuelled with leaded petrol (Approval A)

8.3.1.1.1.1. The limits shown in paragraph 5.3.1.4.1.1. are replaced by:

Reference mass (Rm) (kg)	Mass of carbon monoxide L1 (g/test)	Mass of hydrocarbons and nitrogen oxides combined L2 (g/test)
Rm ≤ 1 020	70	23.8
1 020 < Rm ≤ 1 250	80	25.6
1 250 < Rm ≤ 1 470	91	27.5
1 470 < Rm ≤ 1 700	101	29.4
1 700 < Rm ≤ 1 930	112	31.3
1 930 < Rm ≤ 2 150	121	33.1
2 150 < Rm	132	35.0

8.3.1.1.1.2. The limits given in paragraph 5.3.1.4.1.2. are replaced by the limit values given in the table of paragraph 8.3.1.1.1.1.; however, the values for combined mass of hydrocarbon and nitrogen oxides are to be multiplied by a factor of 1.25.

8.3.1.1.2. Emission levels of gaseous pollutants normally required for vehicles fuelled with unleaded petrol (Approval B)

8.3.1.1.2.1. The limits shown in paragraph 5.3.1.4.2.1. are replaced by:

Mass of carbon monoxide L1 (g/km)	Mass of hydrocarbons and nitrogen oxides combined L2 (g/km)
3.16	1.13

8.3.1.1.2.2. The limits given in paragraph 5.3.1.4.2.2. are replaced by the limit values given in the table of paragraph 8.3.1.1.1.1.

8.3.1.1.2.3. The limits given in paragraph 5.3.1.4.2.3. are replaced by the limit values given in the table of paragraph 8.3.1.1.1.1.

8.3.1.1.3. Emission levels of gaseous pollutants normally required for vehicles fuelled with diesel fuel (Approval C)

8.3.1.1.3.1. The limits shown in paragraph 5.3.1.4.3.1. are replaced by:

Mass of carbon monoxide L1 (g/km)	Mass of hydrocarbons and nitrogen oxides combined L2 (g/km)	Mass of nitrogen oxides L4 (g/km)
3.16	1.13	0.18

8.3.1.1.3.2. The limits given in paragraph 5.3.1.4.3.2. are replaced by the limit values given in the table of paragraph 8.3.1.1.1.1.

8.3.1.1.3.3. The limits given in paragraph 5.3.1.4.3.3. are replaced by the limit values given in the table of paragraph 8.3.1.1.1.1.

8.3.1.2. If the vehicle taken from the series does not satisfy the requirements of paragraph 8.3.1.1. above, the manufacturer may ask for measurements to be performed on a sample of vehicles taken from the series and including the vehicles originally taken. The manufacturer shall determine the size n of the sample. Vehicles other than the vehicle originally taken shall be subjected to a single type I test. The result to be taken into consideration for the vehicle taken originally is the arithmetical mean of the three type I tests carried out on the vehicle. The arithmetic mean (x) of the results obtained with the sample and the standard deviation S [8], shall be determined for the carbon monoxide emission, for the combined hydrocarbon and nitrogen oxides emissions and the particulate emissions:

Production models are then deemed to conform if the following condition is met:

$$\bar{x} + k \cdot S \leq L$$

Where

"L" is the limit value laid down in paragraph 8.3.1.1. for the emissions of carbon monoxide (L1), the combined emissions of hydrocarbons and nitrogen oxides (L2) and the emissions of particulates (L4);

"k" is the statistical factor depending on n and given in the following table:

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

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

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

8.3.2. In a type II or type III test carried out on a vehicle taken from the series, the conditions laid down in paragraphs 5.3.2.2. and 5.3.3.2. above must be complied with.

8.3.3. Notwithstanding the requirements of paragraph 3.1.1. of annex 4 to this Regulation, the technical service responsible for verifying the conformity of production may, with the consent of the manufacturer, carry out tests of types I, II, III and IV on vehicles which have been driven less than 3,000 km.

8.4. When tested in accordance with annex 7, the average evaporative emissions for all production vehicles of the type approved must be less than the limit value specified in paragraph 5.3.4.2.

8.5. For routine end of production line testing, the holder of the approval may demonstrate compliance by sampling vehicles which meet the requirements of paragraph 7 of annex 7.

9. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

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

9.2. If a Party to the Agreement 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 2 to this Regulation.

10. MODIFICATION AND EXTENSION OF APPROVAL OF A VEHICLE TYPE

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

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

10.1.2. Require a further test report from the technical service responsible for conducting the tests.

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

10.3. The competent authority issuing the extension of 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 2 to 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 copies of the communication form conforming to the model in annex 2 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 of the administrative departments which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval, issued in other countries, are to be sent.

13. TRANSITIONAL PROVISIONS RELATING TO APPROVED B OR C VEHICLES

13.1 The following provisions shall remain applicable until 31 December 1994 for vehicles newly put into service and type-approved before 1 July 1993:

13.1.1. At the request of the manufacturer, a test equivalent to the type I test for verifying emissions after a cold start may be conducted according to the requirements of paragraphs 13.1.1.1. and 13.1.1.2., for the approval and verification of production of category M1 vehicles equipped with an engine whose capacity is greater than or equal to 1,400 cm^3 and fuelled with unleaded petrol or with diesel fuel.

The technical service in this case shall carry out the equivalent test described in annex 4A (EPA cycle) instead of that described in paragraph 5.3.1.

13.1.1.1. Approval B for category M1 vehicles equipped with an engine whose capacity is greater than or equal to 1,400 cm^3 and fuelled with unleaded petrol.

For this vehicle type-approval, the limit values specified in the tables in paragraphs 5.3.1.4.2.1. are replaced by the following:

mass of carbon monoxide (L1): 2.11 g/km
mass of hydrocarbons (L2): 0.25 g/km
mass of nitrogen oxides (L3): 0.62 g/km

These limit values shall be deemed to be met if they are not exceeded by the results of tests on a vehicle type when the masses of each pollutant are multiplied by the appropriate deterioration factor from the following table:

Emission Control System	Deterioration Factor		
	CO	HC	NOx
Positive-ignition engine equipped with oxidizing catalytic converter:	1.2	1.3	1.0
Positive-ignition engine not equipped with catalytic converter:	1.2	1.3	1.0
Positive-ignition engine equipped with a three-way catalytic converter:	1.2	1.3	1.1

13.1.1.2. Approval C for category M1 vehicles equipped with an engine whose capacity is greater than or equal to 1,400 cm^3 and fuelled with diesel fuel.

For this vehicle type-approval, the limit values specified in the table in paragraph 5.3.1.4.3.1. are replaced by the following:

mass of carbon monoxide (L1): 2.11 g/km
mass of hydrocarbons (L2): 0.25 g/km
mass of nitrogen oxides (L3): 0.62 g/km
mass of particulates (L4): 0.124 g/km

These limit values shall be deemed to be met if they are not exceeded by the results of tests on a vehicle type when the masses of each pollutant are multiplied by the appropriate deterioration factor from the following table:

Emission Control System	Deterioration Factor			
	CO	HC	NOx	Particulates
1. Compression-ignition engine:	1.1	1.0	1.0	1.2

13.1.1.3. When a manufacturer has obtained evidence of deterioration factors specific to the vehicle type using other certification procedures, those factors may be used as an alternative when establishing compliance with the limit values set out in this paragraph.

13.1.1.4. For the control of production conformity, vehicles may be taken from the series and subjected to the test described in annex 4A.

13.1.1.4.1. A failed vehicle is one whose test results, when corrected by the deterioration factors established for the type approved in accordance with the provisions of section 13 exceed one or more of the limit values in paragraphs 13.1.1.1. and 13.1.1.2.

13.1.2. For the approval and production conformity of category M1 vehicles (Approval B), other than those referred to in paragraphs 5.3.1.4.2.2. and 5.3.1.4.2.3., equipped with positive-ignition engines and a capacity of more than 2,000 cm^3, the test method shall be as described in paragraph 5.2.2.

13.1.2.1. Subject to the requirements of paragraphs 5.3.1.4.5. and 5.3.1.5. the test shall be performed three times. The mass of carbon monoxide, the combined mass of hydrocarbons and nitrogen oxides and the mass of nitrogen oxides must be less than the amounts approved shown in the table below for the corresponding vehicle categories:

Engine Capacity C (cm^3)	Mass of Carbon Monoxide L1 (g/test)	Mass of Hydrocarbons and Nitrogen Oxides combined L2 (g/test)	Mass of Nitrogen Oxides L3 (g/test)
C > 2,000	25	6.5	3.5

13.1.2.2. For the control of production conformity a vehicle shall be taken from the series and subjected to the test described in paragraph 5.2.2. However, the limit values shown in paragraph 13.1.2.1. are replaced by the following (production) values:

Engine Capacity C (cm^3)	Mass of Carbon Monoxide L1 (g/test)	Mass of Hydrocarbons and Nitrogen Oxides combined L2 (g/test)	Mass of Nitrogen Oxides L3 (g/test)
C > 2,000	30	8.1	4.4

13.1.3. Approvals B and C for category M1 vehicles equipped with an engine whose capacity is less than 1,400 cm^3.

13.1.3.1. The limit values applicable to this category of vehicle are given in the following table:

Engine Capacity C (cm^3)	Mass of Carbon Monoxide L1 (g/test)	Mass of Hydrocarbons and Nitrogen Oxides combined L2 (g/test)	Mass of Particulates [9] L4(g/test)
C < 1,400	19	5	1.1

13.1.3.2. For the control of production conformity the limit values applicable are shown in the following table:

Engine Capacity C (cm^3)	Mass of Carbon Monoxide L1 (g/test)	Mass of Hydrocarbons and Nitrogen Oxides combined L2 (g/test)	Mass of Particulates [10] L4 (g/test)
C < 1,400	22	5.8	1.4

13.1.4. At the manufacturer's request, the tests carried out in accordance with these requirements may be type-approved instead of the tests referred to in paragraphs 5.3.1.4.2.1., 5.3.1.4.3.1., 5.3.5., 8.3.1.1.2.1. and 8.3.1.1.3.1.).

13.2. Approval of vehicles equipped with direct injection compression-ignition engines (with the exception of those vehicles referred to in paragraphs 5.3.1.4.3.2. and 5.3.1.4.3.3)

Up to 1 July 1994 for type-approval and 31 December 1994 for the initial entry into service, the limit values for the combined mass of hydrocarbons and nitrogen oxides and for the mass of particulates of vehicles fitted with direct injection compression-ignition engines, with the exception of the vehicles referred to in paragraphs 5.3.1.4.3.2. and 5.3.1.4.3.3., shall be those obtained by multiplying the values L2 and L4 in the tables in paragraphs 5.3.1.4.3.1. (type-approval) and 8.3.1.1.3.1. (conformity check) by a factor of 1.4.

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9 For vehicles equipped with compression-ignition engines.

10 For vehicles equipped with compression-ignition engines.

13.3. B or C approval for vehicles with a maximum power of no more than 30 kW and a maximum speed not exceeding 130 km/h

Up to 1 July 1994, the maximum speed of the extra-urban cycle (part two) for this category of vehicle shall be limited to 90 km/h. Subsequently, the requirements of annex 4, paragraph 2.3.2., shall be applicable.

Annex 1

ESSENTIAL CHARACTERISTICS OF THE 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 2/

1.2.1.2. Number, arrangement and firing order of cylinders:

1.2.1.2.1. Bore: .... mm 3/

1.2.1.2.2. Stroke: .... mm 3/

1.2.1.3. Engine capacity: .... cm^3 4/

1.2.1.4. Volumetric compression ratio 2/ ....

1.2.1.5. Drawings of combustion chamber and piston crown: ....

1.2.1.6. Idle speed: 2/ ....

1.2.1.7. Carbon monoxide content by volume in the exhaust gas with the engine idling .... % (according to the manufacturer's specifications 2/ ....

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

1.2.2. Fuel: petrol, leaded/petrol, unleaded/diesel oil 1/

1.2.3. RON unleaded: ....

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 2/ ....

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/ 2/ ....

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/ 2/ .... mm^3/stroke or cycle at a pump speed of: .... min^{-1} 1/ 2/
or characteristic diagram ....

1.2.4.2.3.4. Injection timing: 2/ ....

1.2.4.2.3.5. Injection advance curve: 2/ ....

1.2.4.2.3.6. Calibration procedure: test bench/engine 1/

1.2.4.2.4. Govemor

1.2.4.2.4.1. Type: ....

1.2.4.2.4.2. Cut-off point: ....

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

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

1.2.4.2.4.3. 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: 2/ .... 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. Make(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: intake manifold (single/multi-point)/ direct injection/other (specify)

Control unit - type (or No.):)
Fuel regulator - type:)
Air flow sensor - type:)
Fuel distributor - type:) information to be given
Pressure regulator - type:) in the case of continuous
Microswitch - type:) injection;
Idle adjusting screw - type:) in the case of other
Throttle housing - type:) systems, equivalent
Water temperature sensor - type:) details
Air temperature sensor - type:)
Air temperature switch - type:)

Electromagnetic interference protection. Description and/or drawing ....

....

....

....

1.2.4.3.3. Make(s): ....

1.2.4.3.4. Type(s): ....

1.2.4.3.5. Injectors: Opening pressure: 2/ ...... kPa or characteristic diagram: 2/ .....

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/ 2/ ....

1.2.4.4. Feed pump:

1.2.4.4.1. Pressure: 2/ .... kPa or characteristic diagram ....

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: 2/ ....

1.2.5.5. Static ignition timing: 2/ .... degrees before TDC ....

1.2.5.6. Contact-point gap: 2/ ....

1.2.5.7. Dwell-angle: 2/ ....

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 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. 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 opening 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 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. Oxygen sensor: type ....

1.2.11.2.1.10.1. Location of oxygen sensor: ....

1.2.11.2.1.10.2. 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: ....

1.2.11.2.6. Other systems (description and working): ....

2. ADDITIONAL INFORMATION ON TEST CONDITIONS

2.1. Information to be supplied for the tests described in annex 4A

2.1.1. Gear change-over points (from first to second gear, etc): ....

2.1.2. Cold start procedure: ....

1/ Strike out what does not apply.

2/ Specify the tolerance.

3/ This value must be rounded off to the nearest tenth of a millimetre.

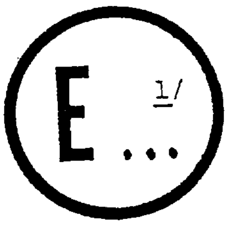
4/ This value must be calculated with = 3,1416 and rounded off, to the nearest cm^3.

Annex 2

(maximum format: A4 (210 x 297 mm))

COMMUNICATION

issued by: Name of administration
....
....
....



Concerning: 2/ APPROVAL GRANTED
APPROVAL EXTENDED
APPROVAL REFUSED
APPROVAL WITHDRAWN
PRODUCTION DEFINITELY DISCONTINUED

of a vehicle type with regard to the emission of pollutants by the engine: emission levels according to the approval A/B/C 2/ pursuant to Regulation No. 83

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

1. Category of the vehicle type (M1, N1, etc): ....

2. Engine fuel requirements: leaded petrol/unleaded petrol/ diesel fuel: 2/ ....

3. Trade name or mark of the vehicle: ....

4. Vehicle type: .... Engine type: ....

5. Manufacturer's name and address: ....

6. If applicable, name and address of manufacturer's representative: ....

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

8. Unladen mass of the vehicle: ....

8.1 Reference mass of the vehicle: ....

9. Maximum mass of the vehicle: ....

10. Number of seats (including the driver): ....

11. If necessary, off road vehicles (in conformity with the requirements of annex 10): 2/ yes/no: ....

12. Transmission:

12.1. Manual or automatic or continuously variable transmission: 2/ 3/ ....

12.2. Number of gear ratios: ....

12.3. Transmission ratio of gearbox: 2/

First gear N/V: ....
Second gear N/V: ....
Third gear N/V: ....
Fourth gear N/V: ....
Fifth gear N/V: ....
Final drive ratio: ....
Tyres: dimensions: ....
dynamic rolling circumference: ....
Wheel drive: front, rear, 4 x 4: 2/ ....

12.4. Check of performance referred to in paragraph 3.1.6. of annex 4 to this Regulation: ....

13. Vehicle submitted for test on: ....

14. Technical service conducting approval tests: ....

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

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

17. Approval granted/refused/extended/withdrawn: 2/ ....

18. Results of approval tests carried out in accordance with annex 4/annex 4A: 2/

Equivalent inertia mass: ....kg
Absorbed power Pa (annex 4): ....kW at 50 km/h 2/
Absorbed power Pa (annex 4A): ....kW at 80.5 km/h 2/
Method of setting: ....

18.1. Test type I: Carried out according to annex 4: 2/

	Limit values required for the emission level:
CO: .... g/test or g/km 2/	CO: .... g/test or g/km 2/
NOx: .... g/test or g/km 2/	NOx: .... g/test 2/
(HC + NOx): ...... g/test or g/km 2/	(HC + NOx): .... g/test or g/km 2/
Particulates: .... g/test or g/km 2/	Particulates: .... g/test or g/km 2/

18.2. Test carried out according to annex 4A 2/
Test equivalent to Type I:

Results of tests calculated with deterioration factors:

CO: .... g/km HC: .... g/km NOx: .... g/km

Particulates: .... g/km

Limit values:

CO: 2.11. g/km HC: 0.25 g/km NOx: 0.62 g/km Particulates: 0.124 g/km

18.3. Test type II: 2/

CO: .... % at idling speed: .... min^{-1} (measured at the exhaust).

18.4. Test type III: 2/

18.5. Test type IV: 2/ .... g/test

18.6. Test type V: 2/

Durability

type of durability test: 80,000 km/not applicable: 2/

deterioration factors (DF): calculated/fixed: 2/

Specify the values

19. Gas sampling system used: ....

19.1. PDP/CVS: 2/ ....

19.2. CFV/CVS: 2/ ....

19.3. CFO/CVS: 2/ ....

20. Position of approval mark on vehicle: ....

21. Place: ....

22. Date ....

23. Signature ....

24. The following documents, bearing the approval number shown above, are annexed to this communication:

1 copy of annex 1 to this Regulation completed and with the drawings and diagrams referred to attached;

1 Photograph of the engine and its compartment.

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

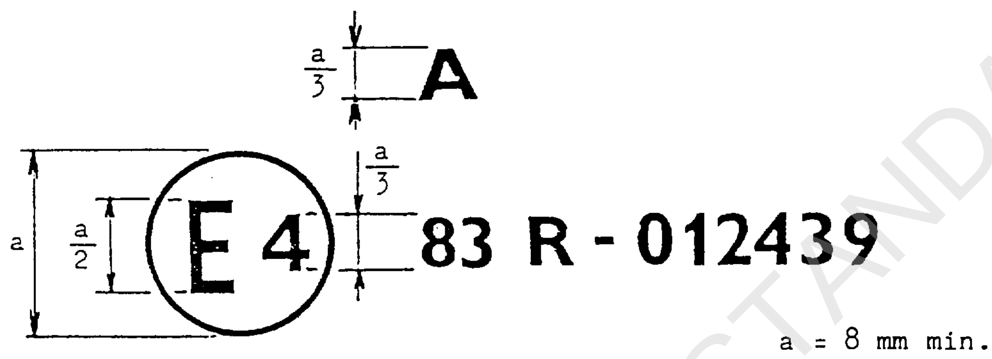
2/ Strike out what does not apply.

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

Annex 3

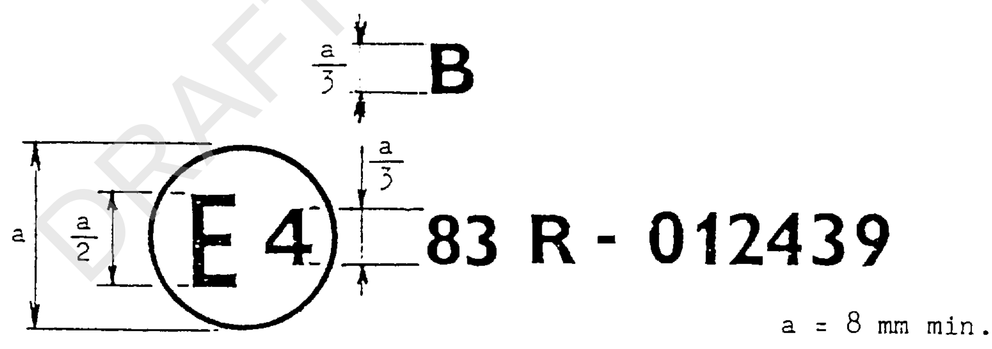
ARRANGEMENTS OF THE APPROVAL MARK

Vehicles approved to the emission levels of gaseous pollutants normally required for feeding the engine with leaded petrol - approval A - including also, if necessary, some vehicles that satisfied the same requirement levels but capable of running on unleaded petrol



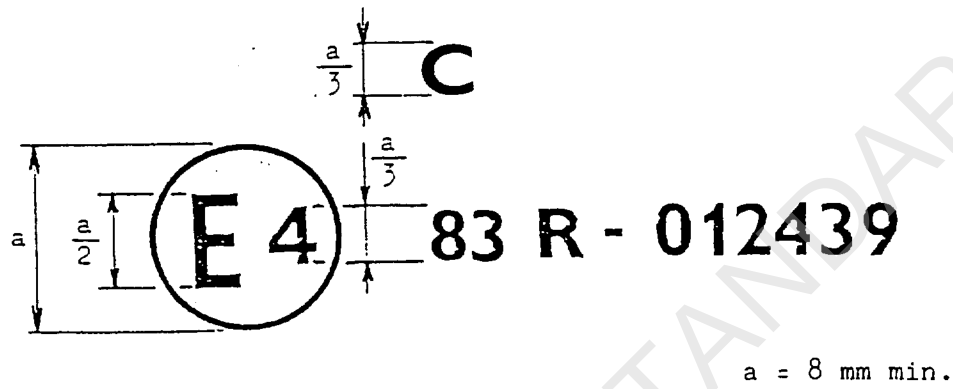
The above approval mark affixed to a vehicle in conformity with paragraph 5.3.1.4.1. shows that the vehicle type concerned has been approved in the Netherlands (E4), pursuant to Regulation No. 83 level A under approval No. 012439. The first two digits of the approval number indicate that Regulation No. 83 already included the 01 series of amendments when the approval was granted.

Vehicles approved to the emission levels of gaseous pollutants required for feeding the engine with unleaded petrol - approval B



The above approval mark affixed to a vehicle in conformity with paragraph 5.3.1.4.2. shows that the vehicle type concerned has been approved in the Netherlands (E4), pursuant to Regulation No. 83 level B under approval No. 012439. The first two digits of the approval number indicate that Regulation No. 83 already included the 01 series of amendments when the approval was granted.

Vehicles approved to the emission levels of gaseous pollutants required for feeding the engine with diesel fuel - approval C



The above approval mark affixed to a vehicle in conformity with paragraph 5.3.1.4.3. shows that the vehicle type concerned has been approved in the Netherlands (E4), pursuant to Regulation No. 83 level C under approval No. 012439. The first two digits of the approval number indicate that Regulation No. 83 already included the 01 series of amendments when the approval was granted.

Annex 4

TYPE I TEST

(Verifying exhaust emissions after a cold start)

1. INTRODUCTION

This annex describes the procedure for the type I test defined in paragraph 5.3.1 of this Regulation.

2. OPERATING CYCLE ON THE CHASSIS DYNAMOMETER

2.1. Description of the cycle

The operating cycle on the chassis dynamometer shall be that indicated in the appendix 1 to this annex.

2.2. General conditions under which the cycle is carried out

Preliminary testing cycles should be carried out if necessary to determine how best to actuate the accelerator and brake controls so as to achieve a cycle approximating to the theoretical cycle within the prescribed limits.

2.3. Use of the gearbox

2.3.1. If the maximum speed which can be attained in first gear is below 15 km/h, the second, third and fourth gears shall be used for the urban cycle (part one) and the second, third, fourth and fifth gears for the extra-urban cycle (part two). The second, third and fourth gears may also be used for the urban cycle (part one) and the second, third, fourth and fifth gears for the extra-urban cycle (part two) when the manufacturer's instructions recommend starting in second gear on level ground, or when first gear is therein defined as a gear reserved for cross-country driving, crawling or towing.

Vehicles which do not attain the acceleration and maximum speed values required in the operating cycle must be operated with the accelerator control fully depressed until they once again reach the required operating curve. Deviations from the operating cycle must be recorded in the test report.

2.3.2. Vehicles equipped with semi-automatic-shift gearboxes shall be tested by using the gears normally employed for driving, and the gear shift is used in accordance with the manufacturer's instructions.

2.3.3. Vehicles equipped with automatic-shift gearboxes shall be tested with the highest gear ("Drive") engaged. The accelerator shall be used in such a way as to obtain the steadiest acceleration possible, enabling the various gears to be engaged in the normal order. Furthermore, the gear-change points shown in appendix 1 to this annex shall not apply; acceleration shall continue throughout the period represented by the straight line connecting the end of each period of idling with the beginning of the next following period of steady speed. The tolerances given in 2.4 below shall apply.

2.3.4. Vehicles equipped with an overdrive which the driver can actuate shall be tested with the overdrive out of action for the urban cycle (part one) and with the overdrive in action for the extra-urban cycle (part two).

2.4. Tolerances

2.4.1. A tolerance of ± 2 km/h shall be allowed between the indicated speed and the theoretical speed during acceleration, during steady speed, and during deceleration when the vehicle's brakes are used. If the vehicle decelerates more rapidly without the use of the brakes, only the provisions of 6.5.3 shall apply. Speed tolerances greater than those prescribed shall be accepted during phase changes provided that the tolerances are never exceeded for more than 0.5/s on any one occasion.

2.4.2. The time tolerances shall be ± 0.1 s. The above tolerances shall apply equally at the beginning and at the end of each gear-changing period [1] for the urban cycle (part one) and for the operations No. 3, 5 and 7 of the extra-urban cycle (part two).

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

3. VEHICLE AND FUEL

3.1. Test vehicle

3.1.1. The vehicle shall be presented in good mechanical condition. It shall have been run-in and driven at least 3,000 km before the test.

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

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

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

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

3.1.5. The vehicle to be tested, or an equivalent vehicle, shall be fitted, if necessary, with a device to permit the measurement of the characteristic parameters necessary for chassis dynamometer setting, in conformity with paragraph 4.1.1. of this annex.

3.1.6. The technical service responsible for the tests may verify that the vehicle's performance conforms to that stated by the manufacturer, that it can be used for normal driving and, more particularly, that it is capable of starting when cold and when hot.

3.2. Fuel

The appropriate reference fuel as defined in annex 9 to this Regulation shall be used for testing.

4. TEST EQUIPMENT

4.1. Chassis dynamometer

4.1.1. The dynamometer must be capable of simulating road load within one of the following classifications:

dynamometer with fixed load curve, i.e. a dynamometer whose physical characteristics provide a fixed load curve shape,

dynamometer with adjustable load curve, i.e. a dynamometer with at least two road load parameters that can be adjusted to shape the load curve.

4.1.2. The setting of the dynamometer shall not be affected by the lapse of time. It shall not produce any vibrations perceptible to the vehicle and likely to impair the vehicle's normal operations.

4.1.3. It must be equipped with means to simulate inertia and load. These simulators are connected to the front roller in the case of a two-roller dynamometer.

4.1.4. Accuracy

4.1.4.1. It shall be possible to measure and read the indicated load to an accuracy of ± 5%.

4.1.4.2. In the case of a dynamometer with a fixed load curve, the accuracy of the load setting at 80 km/h must be ± 5%. In the case of a dynamometer with adjustable load curve, the accuracy of matching dynamometer load to road load must be 5% at 100, 80, and 60 km/h and 10% at 20 km/h. Below this, dynamometer absorption must be positive.

4.1.4.3. The total inertia of the rotating parts (including the simulated inertia where applicable) must be known and must be within ± 20 kg of the inertia class for the test.

4.1.4.4. The speed of the vehicle shall be measured by the speed of rotation of the roller (the front roller in the case of a two-roller dynamometer). It shall be measured with an accuracy of ± 1 km/h at speeds above 10 km/h.

4.1.5. Load and inertia setting

4.1.5.1. Dynamometer with fixed load curve: the load simulator shall be adjusted to absorb the power exerted on the driving wheels at a steady speed of 80 km/h and the absorbed power at 50 km/h shall be noted. The means by which this load is determined and set are described in appendix 3.

4.1.5.2. Dynamometer with adjustable load curve: the load simulator shall be adjusted in order to absorb the power exerted on the driving wheels at steady speeds of 100, 80, 60 and 40 and 20 km/h. The means by which these loads are determined and set are described in appendix 3.

4.1.5.3. Inertia

Dynamometers with electric inertia simulation must be demonstrated to be equivalent to mechanical inertia systems. The means by which equivalence is established are described in appendix 4.

4.2. Exhaust gas-sampling system

4.2.1. The exhaust gas-sampling system is designed to enable the measurement of the true mass emissions of vehicle exhaust. The system that shall be used is the constant volume sampler (CVS) system. This requires that the vehicle exhaust be continuously diluted with ambient air under controlled conditions. In the constant volume sampler concept of measuring mass emissions, two conditions must be satisfied, the total volume of the mixture of exhaust and dilution air must be measured and a continuously proportional sample of the volume must be collected for analysis. Mass emissions are determined from the sample concentrations, corrected for the pollutant content of the ambient air and the totalized flow over the test period.

The particulate pollutant emission level is determined by using suitable filters to collect the particulates from a proportional part flow throughout the test and determining the quantity thereof gravimetrically in accordance with paragraph 4.3.2.

4.2.2. The flow through the system shall be sufficient to eliminate water condensation at all conditions which may occur during a test, as defined in appendix 5 to this annex.

4.2.3. Figure 1 gives a schematic diagram of the general concept. Appendix 5 gives examples of three types of constant volume sampler system which satisfy the requirements of this annex.

4.2.4. The gas and air mixture shall be homogeneous at point S2 of the sampling probe.

4.2.5. The probe shall extract a true sample of the diluted exhaust gases.

4.2.6. The system shall be free of gas leaks. The design and materials shall be such that the system does not influence the pollutant concentration in the diluted exhaust gas. Should any component (heat exchanger, blower, etc.) change the concentration of any pollutant gas in the diluted gas, the sampling for that pollutant shall be carried out before that component if the problem cannot be corrected.

4.2.7. If the vehicle being tested is equipped with an exhaust pipe comprising several branches, the connecting tubes shall be connected as near as possible to the vehicle.

4.2.8. Static pressure variations at the tailpipe(s) of the vehicle shall remain within ± 1.25 kPa of the static pressure variations measured during the dynamometer driving cycle and with no connection to the tailpipe(s). Sampling systems capable of maintaining the static pressure to within ± 0.25 kPa are used if a written request from a manufacturer to the administration granting the approval substantiates the need for the closer tolerance. The back-pressure shall be measured in the exhaust pipe as near as possible to its end or in an extension having the same diameter.

4.2.9. The various valves used to direct the exhaust gases must be of a quick-adjustment, quick-acting type.

4.2.10. The gas samples are collected in sample bags of adequate capacity. These bags must be made of such materials as will not change the pollutant gas by more than ± 2% after 20 minutes of storage.

4.3. Analytical equipment

4.3.1. Provisions

4.3.1.1. Pollutant gases shall be analysed with the following instruments:

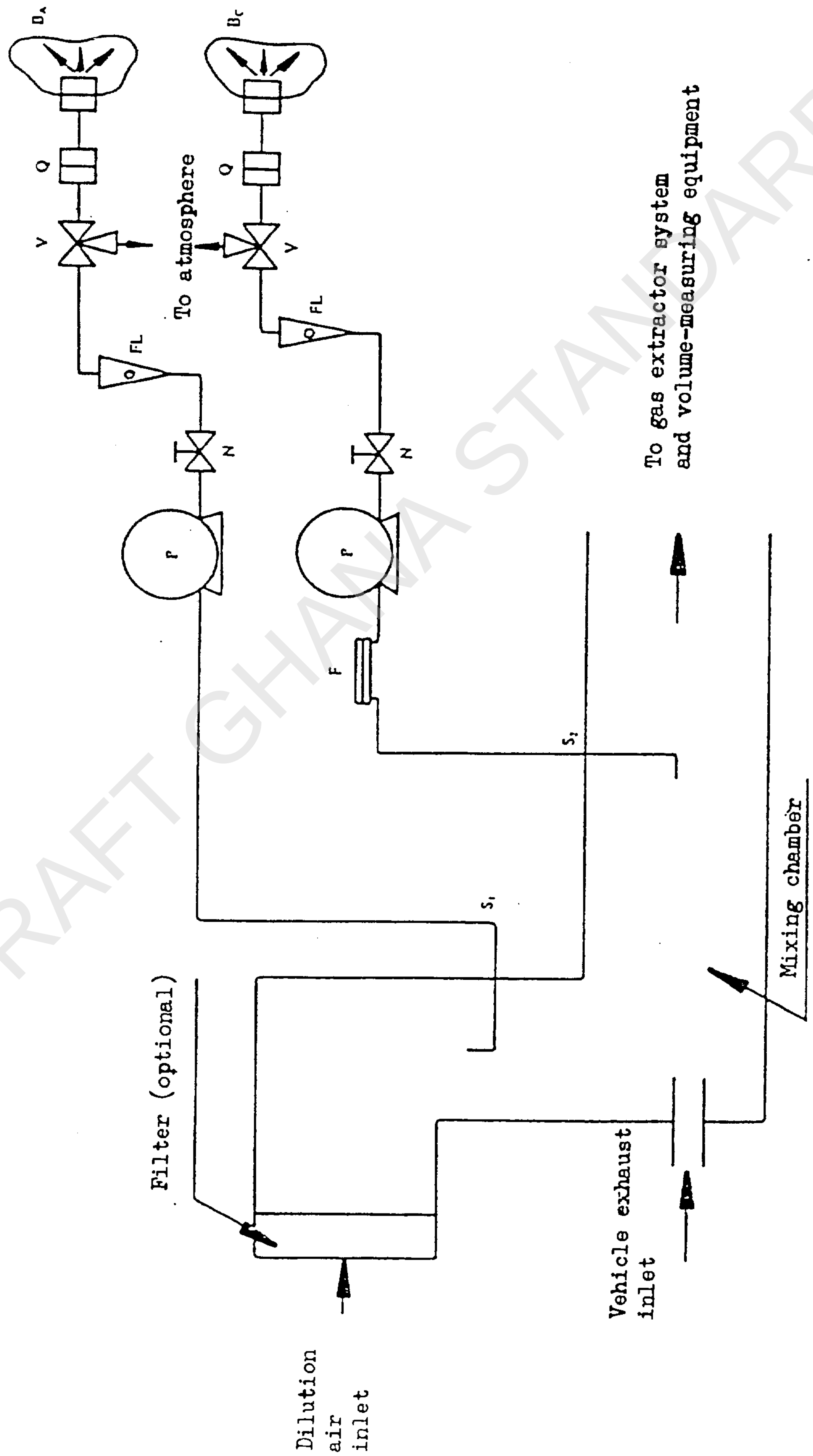
Carbon monoxide (CO) and carbon dioxide (CO_2) analysis: analysers shall be of the non-dispersive infra-red (NDIR) absorption type.

Hydrocarbons (HC) analysis - spark-ignition engines: the analyser shall be of the flame ionization (FID) type calibrated with propane gas expressed equivalent to carbon atoms (C_1).

Hydrocarbons (HC) analysis - compression-ignition engines: the analyser shall be of the flame ionization type with detector, valves, pipework, etc., heated to 463 K (190° C) ± 10 K (HFID). It shall be calibrated with propane gas expressed equivalent to carbon atoms (C_1).

Figure 1

Diagram of exhaust gas sampling system



Nitrogen oxide (NOx) analysis: the analyser shall be either of the chemiluminescent (CLA) or of the non-dispersive ultra-violet resonance absorption (NDUVR) type, both with an NOx-NO converter.

Particulates:

Gravimetric determination of the particulates collected. These particulates shall in each case be collected by two series-mounted filters in the sample gas flow. The quantity of particulates collected by each pair of filters shall be as follows:

$$M = \frac{V_{mix}}{V_{ep} \times d} m \rightarrow m = M \times d \times \frac{V_{ep}}{V_{mix}}$$

where:

V_{ep}: flow through filters;

V_{mix}: flow through tunnel;

M: particulate mass (g/km);

M_{limit}: limit mass of particulates (limit mass in force, g/km);

m: mass of particulates collected by filters (g);

d: distance corresponding to the operating cycle (km).

The particulates sample rate (V_{ep}/V_{mix}) shall be adjusted so that for $M = M_{limit}$, $1 \leq m \leq 5$ mg (when 47 mm filters are used).

The filter surface shall consist of a material that is hydrophobic and inert towards the components of the exhaust gas (fluorocarbon coated glass fibre filters or equivalent).

4.3.1.2. Accuracy

The analysers shall have a measuring range compatible with the accuracy required to measure the concentrations of the exhaust gas sample pollutants.

Measurement error shall not exceed ± 3% disregarding the true value of the calibration gases.

For concentrations of less than 100 ppm the measurement error must not exceed ± 3 ppm.

The ambient air sample shall be measured on the same analyser and range as the corresponding diluted exhaust sample.

Measurement of the particulates collected shall have a guaranteed accuracy of 1 μg.

The microgram balance used to determine the weight of all filters shall have a precision (standard deviation) and readability of 1 μg.

4.3.1.3. Ice-trap

No gas drying device shall be used before the analysers unless shown to have no effect on the pollutant content of the gas stream.

4.3.2. Particular requirements for compression-ignition engines

A heated sample line for a continuous HC-analysis with the flame ionization detector (HFID), including recorder (R) shall be used. The average concentration of the measured hydrocarbons shall be determined by integration. Throughout the test, the temperature of the heated sample line shall be controlled at 463 K (190°C) ± 10 K. The heated sampling line shall be fitted with a heated filter (F_H) 99% efficient with particle $\geq$ 0.3 μm to extract any solid particles from the continuous flow of gas required for analysis.

The sampling system response time (from the probe to the analyser inlet) shall be no more than four seconds.

The HFID shall be used with a constant flow (heat exchanger) system to ensure a representative sample, unless compensation for varying CFV or CFO flow is made.

The particulate sampling unit shall consist of a dilution tunnel, a sampling probe, a filter unit, a partial-flow pump, and flow rate regulators and measuring units. The particulate-sampling part flow is drawn through two series-mounted filters. The sampling probe for the test gas flow for particulates shall be so arranged within the dilution tract that a representative sample gas flow can be taken from the homogeneous air/exhaust mixture and an air/exhaust gas mixture temperature of 325 K (52° C) is not exceeded at the sampling point. The temperature of the gas flow in the flow meter may not fluctuate by more than ± 3 K, nor may the mass flow rate fluctuate by more than ± 5%. Should the volume of flow change unacceptably as a result of excessive filter loading, the test must be stopped. When it is repeated, the rate of flow must be decreased and/or a larger filter used. The filters shall be removed from the chamber no earlier than an hour before the test begins.

The necessary particle filters shall be conditioned (as regards temperature and humidity) in an open dish which has been protected against dust ingress for at least 8 and for not more than 56 hours before the test in an air-conditioned chamber. After this conditioning the uncontaminated filters will be weighed and stored until they are used.

If the filters are not used within one hour of their removal from the weighing chamber they shall be re-weighed.

The one-hour limit may be replaced by an eight-hour limit if one or both of the following conditions are met;

a stabilized filter is placed and kept in a sealed filter holder assembly with the ends plugged, or;

a stabilized filter is placed in a sealed filter holder assembly which is then immediately placed in a sample line through which there is no flow.

4.3.3. Calibration

Each analyser shall be calibrated as often as necessary and in any case in the month before type-approval testing and at least once every six months for verifying conformity of production.

The calibration method to be used is described in appendix 6 to this annex for the analysers referred to in paragraph 4.3.1. above.

4.4. Volume measurement

4.4.1. The method of measuring total dilute exhaust volume incorporated in the constant volume sampler shall be such that measurement is accurate to ± 2%.

4.4.2. Constant volume sampler calibration

The constant volume sampler system volume measurement device shall be calibrated by a method sufficient to ensure the prescribed accuracy and at a frequency sufficient to maintain such accuracy.

An example of a calibration procedure which will give the required accuracy is given in appendix 6 to this annex. The method shall utilize a flow metering device which is dynamic and suitable for the high flow-rate encountered in constant volume sampler testing. The device shall be of certified accuracy traceable to an approved national or international standard.

4.5. Gases

4.5.1. Pure gases

The following pure gases shall be available, if necessary, for calibration and operation:

purified nitrogen (purity $\leq$ 1 ppm C, $\leq$ 1 ppm CO, $\leq$ 400 ppm CO_2, $\leq$ 0.1 ppm NO);

purified synthetic air (purity $\leq$ 1 ppm C, $\leq$ 1 ppm CO, $\leq$ 400 ppm CO_2, $\leq$ 0.1 ppm NO); oxygen content between 18 and 21% volume;

purified oxygen (purity ≥ 99.5% vol 0_2);

purified hydrogen (and mixture containing helium) (purity ≤ 1ppm C, ≤ 400 ppm $C0_2$).

4.5.2. Calibration and span gases

Gases having the following chemical compositions shall be available:mixtures of:

C_3H_8 and purified synthetic air (see paragraph 4.5.1 of this annex);

C0 and purified nitrogen;

$C0_2$ and purified nitrogen;

N0 and purified nitrogen.

(The amount of $N0_2$ contained in this calibration gas must not exceed 5% of the N0 content.)

The true concentration of a calibration gas must be within ± 2% of the stated figure.

The concentrations specified in appendix 6 to this annex may also be obtained by means of a gas divider, diluting with purified N_2 or with purified synthetic air. The accuracy of the mixing device shall be such that the concentrations of the diluted calibration gases may be determined to within ± 2%.

4.6. Additional equipment

4.6.1. Temperatures

The temperatures indicated in appendix 8 to this annex shall be measured with an accuracy of ± 1.5 K.

4.6.2. Pressure

The atmospheric pressure shall be measurable to within ± 0.1 kPa.

4.6.3. Absolute humidity

The absolute humidity (H) must be measurable to within ± 5%.

4.7. The exhaust gas-sampling system must be verified by the method described in paragraph 3 of appendix 7 to this annex. The maximum permissible deviation between the quantity of gas introduced and the quantity of gas measured is 5%.

5. PREPARING THE TEST

5.1. Adjustment of inertia simulators to the vehicle's translatory inertias

An inertia simulator shall be used enabling a total inertia of the rotating masses to be obtained proportional to the reference mass within the following limits:

Reference mass of vehicle RW (kg)	Equivalent inertias I (kg)
RW ≤ 750	680
750 < RW ≤ 850	800
850 < RW ≤ 1 020	910
1 020 < RW ≤ 1 250	1 130
1 250 < RW ≤ 1 470	1 360
1 470 < RW ≤ 1 700	1 590
1 700 < RW ≤ 1 930	1 810
1 930 < RW ≤ 2 150	2 040
2 150 < RW ≤ 2 380	2 270
2 380 < RW ≤ 2 610	2 270
2 610 < RW	2 270

5.2. Setting of dynamometer

The load shall be adjusted according to methods described in paragraph 4.1.4. above.

The method used and the values obtained (equivalent inertia - characteristic adjustment parameter) shall be recorded in the test report.

5.3. Conditioning of vehicle

5.3.1. For compression-ignition engine vehicles for the purpose of measuring particulates, at most 36 hours and at least 6 hours before testing, the part two cycle described in appendix 1 shall be used. Three consecutive cycles shall be driven. The dynamometer setting shall be indicated in paragraphs 5.1. and 5.2.

After this preconditioning, specific for compression-ignition engines, and before testing, compression-ignition and positive-ignition engine vehicles shall be kept in a room in which the temperature remains relatively constant between 293 and 303 K (20 and 30° C). This conditioning shall be carried out for at least six hours and continue until the engine oil temperature and coolant, if any, are within ± 2 K of the temperature of the room.

If the manufacturer so requests, the test shall be carried out not later than 30 hours after the vehicle has been run at its normal temperature.

5.3.2. The tyre pressure shall be the same as that specified by the manufacturer and used for the preliminary road test for brake adjustment. The tyre pressure may be increased by up to 50% from the manufacturer's recommended setting in the case of a two-roller dynamometer. The actual pressure used shall be recorded in the test report.

6. PROCEDURE FOR BENCH TESTS

6.1. Special conditions for carrying out the cycle

6.1.1. During the test, the test cell temperature must be between 293 K (20° C) and 303 K (30° C). The absolute humidity (H) of either the air in the test cell or the intake air of the engine shall be such that:

$$5.5 \leq H \leq 12.2 \text{ g } H_20\text{/kg dry air}$$

6.1.2. The vehicle shall be approximately horizontal during the test so as to avoid any abnormal distribution of the fuel.

6.1.3. The test shall be carried out with the bonnet raised unless this is technically impossible. An auxiliary ventilating device acting on the radiator (water-cooling) or on the air intake (air-cooling) may be used if necessary to keep the engine temperature normal.

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

6.2. Starting-up the engine

6.2.1. The engine shall be started up by means of the devices provided for this purpose according to the manufacturer's instructions, as incorporated in the drivers' handbook of production vehicles.

6.2.2. The engine shall be kept idling for a period of 40 seconds. The first cycle shall begin at the end of the aforesaid period of 40 seconds at idle.

6.3. Idling

6.3.1. Manual-shift or semi-automatic gearbox

6.3.1.1. During periods of idling the clutch shall be engaged and the gears in neutral.

6.3.1.2. To enable the accelerations to be performed according to the normal cycle, the vehicle shall be placed in first gear, with the clutch disengaged, five seconds before the acceleration following each idling period of the elementary urban cycle (part one).

6.3.1.3. The first idling period at the beginning of the urban cycle (part one) shall consist of six seconds of idling in neutral with the clutch engaged and five seconds in first gear with the clutch disengaged.

The two idling periods referred to above shall be consecutive. The idling period at the beginning of the extra-urban cycle (part two) shall consist of 20 seconds of idling in first gear with the clutch disengaged.

6.3.1.4. For the idling periods during each elementary cycle (part one) the corresponding times shall be 16 seconds in neutral and 5 seconds in first gear with the clutch disengaged.

6.3.1.5. The idling period between two successive elementary cycles (part one) shall comprise 13 seconds in neutral with the clutch engaged.

6.3.1.6. At the end of the deceleration period (halt of the vehicle on the rollers) of the extra-urban cycle (part two), the idling period shall consist of 20 seconds in neutral with the clutch engaged.

6.3.2. <u>Automatic-shift gearbox</u>

After initial engagement the selector shall not be operated at any time during the test except in the case specified in paragraph 6.4.3. or if the selector can actuate the overdrive, if any.

6.4. <u>Accelerations</u>

6.4.1. Accelerations must be so performed that the rate of acceleration is as constant as possible throughout the phase.

6.4.2. If an acceleration cannot be carried out in the prescribed time, the extra time required shall be deducted from the time allowed for changing the combination, if possible, and in any case from the subsequent steady-speed period.

6.4.3. <u>Automatic-shift gearboxes</u>

If an acceleration cannot be carried out in the prescribed time, the gear selector shall operate in accordance with requirements for manual-shift gearboxes.

6.5. <u>Deceleration</u>

6.5.1. All decelerations of the elementary urban cycle (part one) shall be effected by removing the foot completely from the accelerator, the clutch remaining engaged. The clutch shall be disengaged, without use of the gear lever, at a speed of 10 km/h.

All decelerations of the extra-urban cycle (part two) shall be effected by removing the foot completely from the accelerator, the clutch remaining engaged. The clutch shall be disengaged, without use of the gear lever, at a speed of 50 km/h for the last deceleration.

6.5.2. If the period of deceleration is longer than that prescribed for the corresponding phase, the vehicle's brakes shall be used to enable the timing of the cycle to be complied with.

6.5.3. If the period of deceleration is shorter than that prescribed for the corresponding phase, the timing of the theoretical cycle shall be restored by constant speed or idling period merging into the following operation.

6.5.4. At the end of the deceleration period (halt of the vehicle on the rollers) of the elementary urban cycle (part one) the gears shall be placed in neutral and the clutch engaged.

6.6. Steady speeds

6.6.1. "Pumping" or the closing of the throttle shall be avoided when passing from acceleration to the following steady speed.

6.6.2. Periods of constant speed shall be achieved by keeping the accelerator position fixed.

7. PROCEDURE FOR SAMPLING AND ANALYSIS

7.1. Sampling

Sampling shall begin at the beginning of the first elementary urban cycle as defined in paragraph 6.6.2. and shall end on conclusion of the final idling period in the extra-urban cycle (part two) or of the final idling period of the last elementary urban cycle (part one) depending on the type of test carried out.

7.2. Analysis

7.2.1. The exhaust gases contained in the bag shall be analysed as soon as possible and in any event not later than 20 minutes after the end of the test cycle. The spent particulate filters shall be taken to the chamber no later than one hour after conclusion of the test on the exhaust gases and shall there be conditioned for between 2 and 36 hours and then be weighed.

7.2.2. Prior to each sample analysis, the analyser range to be used for each pollutant shall be set to zero with the appropriate zero gas.

7.2.3. The analysers shall then be set to the calibration curves by means of span gases of nominal concentrations of 70 to 100% of the range.

7.2.4. The analysers' zeros shall then be rechecked. If the reading differs by more than 2% of the range from that set in paragraph 7.2.2, the procedure shall be repeated.

7.2.5. The samples shall then be analysed.

7.2.6. After the analysis, zero and span points shall be rechecked using the same gases. If these rechecks are within 2% of those in paragraph 7.2.3, the analysis shall be considered acceptable.

7.2.7. At all points in this section, the flow-rates and pressures of the various gases must be the same as those used during calibration of the analysers.

7.2.8. The figure adopted for the content of the gases in each of the pollutants measured shall be that read off after stabilization of the measuring device. Hydrocarbon mass emissions of compression-ignition engines shall be calculated from the integrated HFID reading, corrected for varying flow if necessary, as shown in appendix 5 to this annex.

8. DETERMINATION OF THE QUANTITY OF GASEOUS AND PARTICULATE POLLUTANTS EMITTED

8.1. The volume considered

The volume to be considered shall be corrected to conform to the conditions of 101.33 kPa and 273.2 K.

8.2. Total mass of gaseous and particulate pollutants emitted

The mass M of each pollutant emitted by the vehicle during the test shall be determined by obtaining the product of the volumetric concentration and the volume of the gas in question, with due regard for the following densities under above-mentioned reference conditions:

in the case of carbon monoxide (C0) d = 1.25 g/l

in the case of hydrocarbons ($CH_{1.85}$) d = 0.619 g/l,

in the case of nitrogen oxides ($N0_2$) d = 2.05 g/l.

The mass m of particulate pollutant emissions from the vehicle during the test shall be defined by weighing the mass of particulates collected by the two filters, m1 by the first filter, m2 by the second filter:

if 0.95 (m1 + m2) $\leq$ m1, m = m1,

if 0.95 (m1 + m2) > m1, m = m1 + m2,

if m2 > m1, the test is cancelled.

Appendix 8 to this annex gives calculations relative to the various methods, followed by examples, to determine the quantity of gaseous pollutants emitted.

Annex 4

Appendix 1

BREAKDOWN OF THE OPERATING CYCLE USED FOR THE TYPE 1 TEST

1. OPERATING CYCLE

The operating cycle, made up of a part one (urban cycle) and part two (extra-urban cycle), is illustrated in figure 1/1.

2. ELEMENTARY URBAN CYCLE (PART ONE)

See figure 1/2 and table 1.2.

2.1 Breakdown by phases

	Time	%	
Idling	60 s	30.8)	
Idling, vehicle moving, clutch engaged on one combination	9 s	4.6)	) 35.4
Gear-shift	9 s	4.1	
Accelerations	36 s	18.5	
Steady-speed periods	57 s	29.2	
Decelerations	25 s	12.8	
	195 s	100.0	

2.2 Breakdown by use of gears

	Time	%	
Idling	60 s	30.8)	
Idling, vehicle moving, clutch engaged on one combination	9 s	4.6)	) 35.4
Gear-shift	8 s	4.1	
First gear	24 s	12.3	
Second gear	53 s	27.2	
Third gear	41 s	21.0	
	195 s	100.0	

2.3 General information

Average speed during test	19 km/h
Effective running time	195 s
Theoretical distance covered per cycle	1.013 km
Equivalent distance for the four cycles	4.052 km

Figure 1/1

Operating cycle for the type 1 test

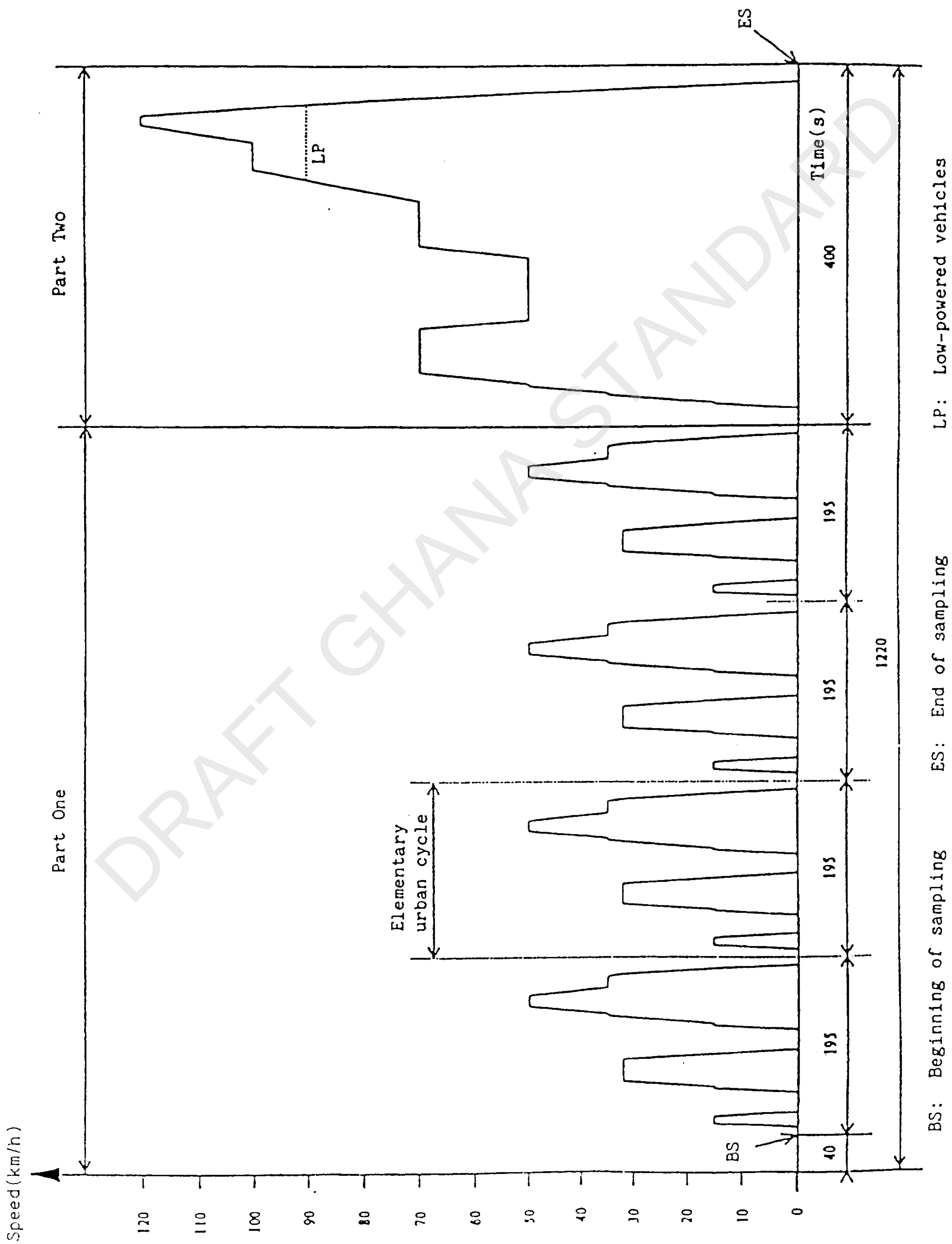


Table 1.2

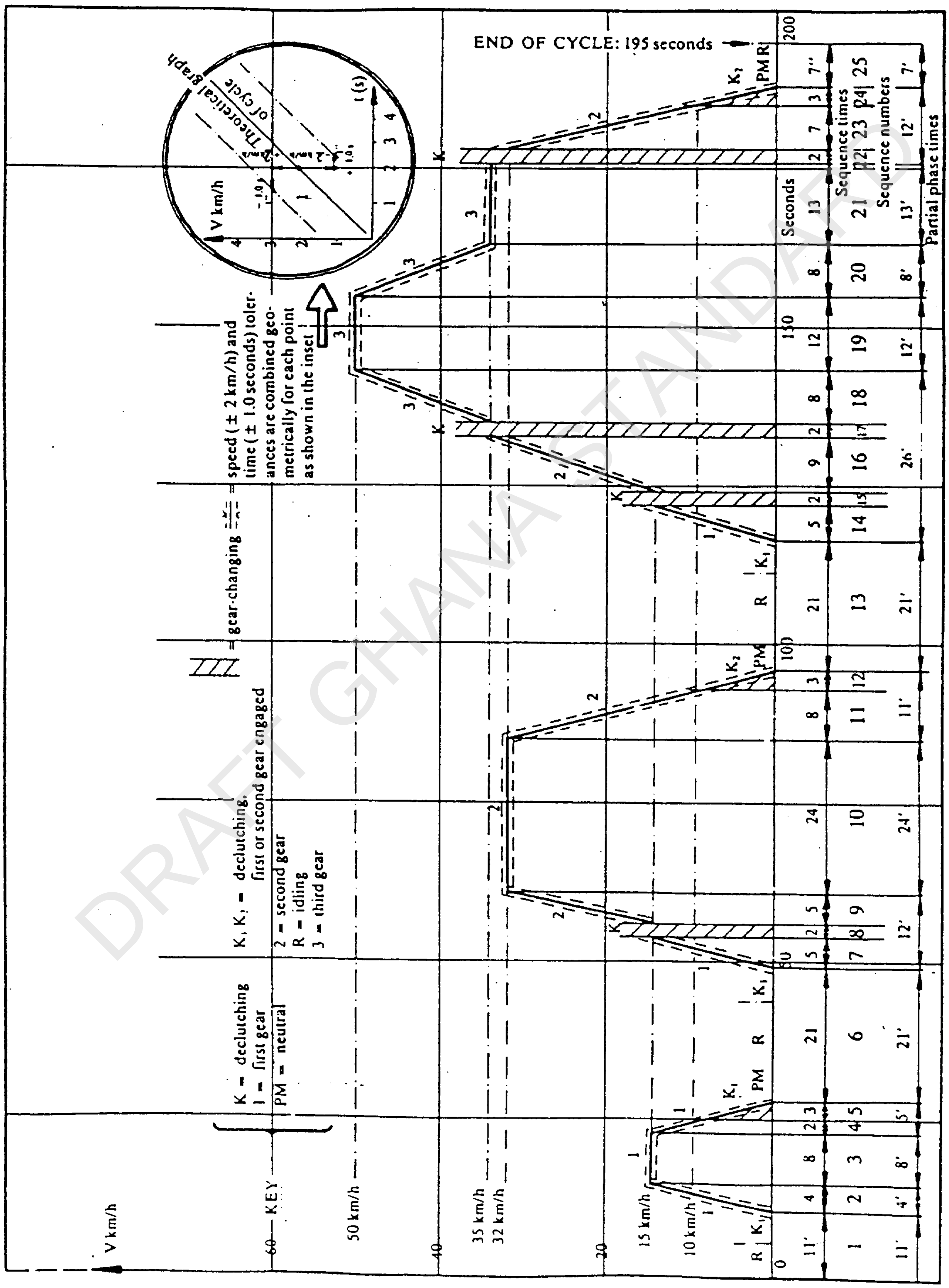
Elementary urban operating cycle on the chassis dynamometer (part one)

No of operation	Operation	Phase	Acceleration (m/s^2)	Speed (km/h)	Duration of each: Operation (s)	Duration of each: Phase (s)	Cumulative time (s)	Gear to be used in the case of a manual gearbox
1	Idling	1			11	11	11	6 s PM + 5 s K_1 (*)
2	Acceleration	2	1.04	0-15	4	4	15	1
3	Steady speed	3		15	9	8	23	1
4	Deceleration	)	-0.69	15-10	2	)	25	1
5	Deceleration, clutch disengaged	) 4	-0.92	10-0	3	) 5	28	K_1(*)
6	Idling	5			21	21	49	16 s PM + 5 s K_1(*)
7	Acceleration	)	0.83	0-15	5	)	54	1
8	Gear change	) 6			2	) 12	56	
9	Acceleration	)	0.94	15-32	5	)	61	2
10	Steady speed	7		32	24	24	85	2
11	Deceleration	)	-0.75	32-10	8	)	93	2
12	Deceleration, clutch disengaged	) 8	-0.92	10-0	3	) 11	96	K_2(*)
13	Idling	9	0-15	0-15	21		117	16 s PM + 5 s K_1(*)
14	Acceleration	)			5	)	122	1
15	Gear change	)			2	)	124	
16	Acceleration	) 10	0.62	15-35	9	) 26	133	2
17	Gear change	)			2	)	135	
18	Acceleration	)	0.52	35-50	8	)	143	3
19	Steady speed	11		50	12	12	155	3
20	Deceleration	12	-0.52	50-35	8	8	163	3
21	Steady speed	13		35	13	13	176	3
22	Gear change	)			2	)	178	
23	Deceleration	) 14	-0.86	32-10	7	) 12	185	2
24	Deceleration, clutch disengaged	)	-0.92	10-0	3	)	188	K_2(*)
25	Idling	15			7	7	195	7 s PM (*)

(*) PM = gearbox in neutral, clutch engaged.
K_1, K_2 = first or second gear engaged, clutch disengaged.

Figure 1/2

Elementary urban cycle for the type 1 test



3. EXTRA-URBAN CYCLE (PART TWO)
See Figure 1/3 and Table 1.3.

3.1 Breakdown by phases

	Time	%
Idling:	20 s	5.0
Idling, vehicle moving, clutch engaged on one combination:	20 s	5.0
Gear-shift:	6 s	1.5
Accelerations:	103 s	25.8
Steady-speed periods:	209 s	52.2
Decelerations:	42 s	10.5
	-----------	---------
	400 s	100%

3.2 Breakdown by use of gears

Idling:	20 s	5.0
Idling, vehicle moving, clutch engaged on one combination:	20 s	5.0
Gear-shift:	6 s	1.5
First gear:	5 s	1.3
Second gear:	9 s	2.2
Third gear:	8 s	2.0
Fourth gear:	99 s	24.8
Fifth gear:	233 s	58.2
	---------	--------
	400 s	100%

3.3 General information

Average speed during test:	62.6 km/h
Effective running time:	400 s
Theoretical distance covered per cycle:	6.955 km
Maximum speed:	120 km/h
Maximum acceleration:	0.833 m/s^2
Maximum deceleration:	-1.389 m/s^2

Table 1.3
Extra urban cycle (part two) for the type 1 test

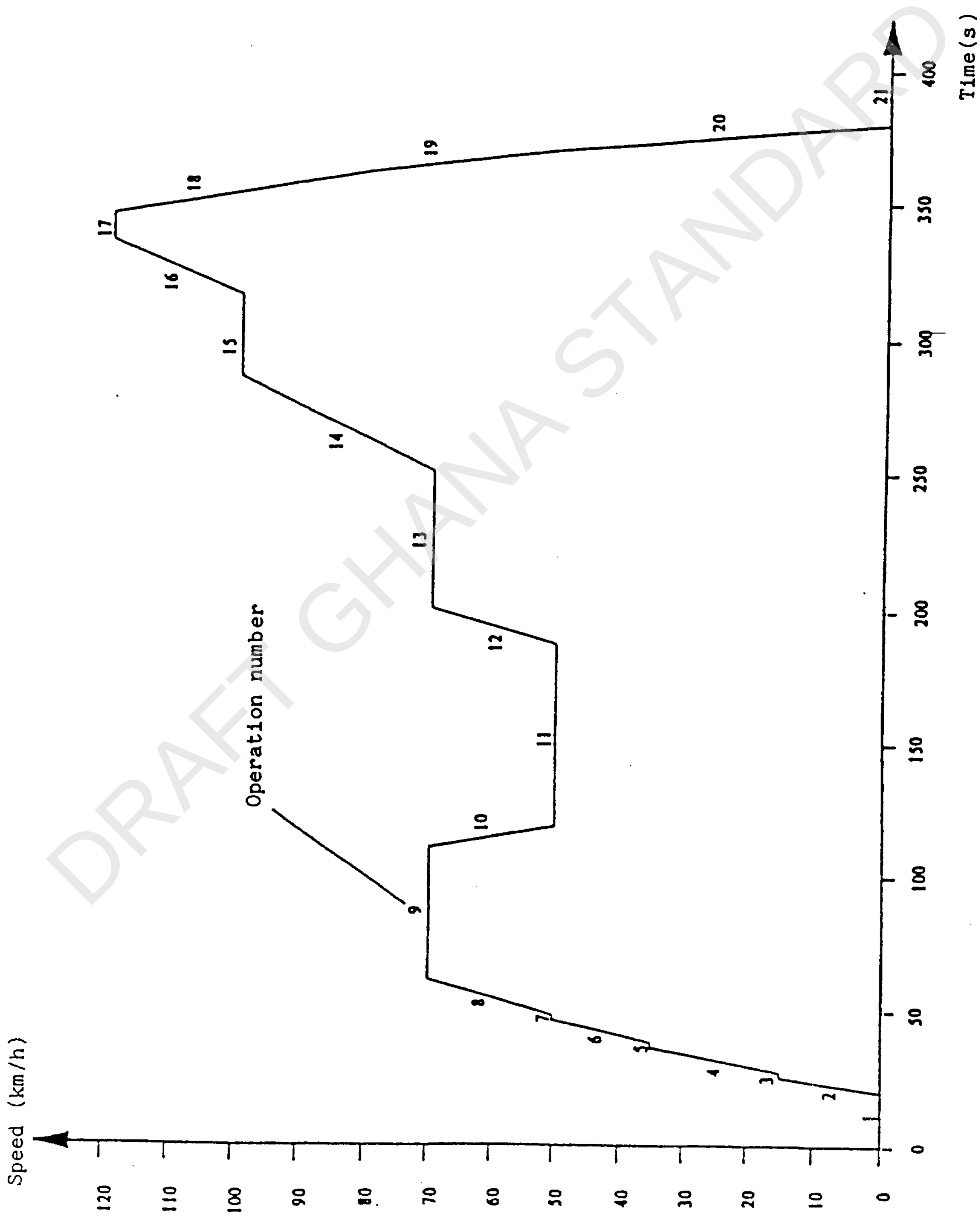
No of operation	Operation	Phase	Acceleration (m/s^2)	Speed (km/h)	Duration of each: Operation(s)	Duration of each: Phase(s)	Cumulative time(s)	Gear to be used in the case of a manual gearbox
1	Idling	1			20	20	20	K1 [1]
2	Acceleration		0.83	0-15	5		25	1
3	Gear change				2		27	-
4	Acceleration		0.62	15-35	9		36	2
5	Gear change				2	41	38	-
6	Acceleration		0.52	35-30	8		46	3
7	Gear change				2		48	-
8	Acceleration		0.43	50-70	13		61	4
9	Steady speed	3		70	50	50	111	5
10	Deceleration	4	-0.69	70-50	8	8	119	4 s.5 + 4 s.4
11	Steady speed	5		50	69	69	188	4
12	Acceleration	6	0.43	50-70	13	13	201	4
13	Steady speed	7		70	50	50	251	5
14	Acceleration	8	0.24	70-100	35	35	286	5
15	Steady speed **/	9		100	30	30	316	5 [2]
16	Acceleration **/	10	0.28	100-120	20	20	336	5 [2]
17	Steady speed **/	11		120	10	20	346	5 [2]
18	Deceleration **/	12	-0.69	120-80	16	34	362	5 [2]
19	Deceleration **/		-1.04	80-50	8		370	5 [2]
20	Deceleration, clutch disengaged		1.39	50-0	10		380	K5 [1]
21	Idle	13			20	20	400	PM [1]

[1] PM = gearbox in neutral, clutch engaged.
K1, K5 = first or second gear engaged, clutch disengaged.

[2] Additional gears can be used according to the manufacturer's recommendations if the vehicle is equipped with a transmission with more than five gears.

Figure 1/3

Extra-urban cycle (part two) for the type 1 test



4. EXTRA-URBAN CYCLE (LOW-POWERED VEHICLES)
See Figure 1/4 and Table 1.4.

4.1 Breakdown by phases

	Time	%
Idling:	20 s	5.0
Idling, vehicle moving, clutch engaged on one combination:	20 s	5.0
Gear-shift:	6 s	1.5
Accelerations:	72 s	18.0
Steady-speed periods:	252 s	63.0
Decelerations:	30 s	7.5
	--------	--------
	400 s	100%

4.2 Breakdown by use of gears

Idling:	20 s	5.0
Idling, vehicle moving, clutch engaged on one combination:	20 s	5.0
Gear-shift:	6 s	1.5
First gear:	5 s	1.3
Second gear:	9 s	2.2
Third gear:	8 s	2.0
Fourth gear:	99 s	24.8
Fifth gear:	233 s	58.2
	--------	--------
	400 s	100%

4.3 General information

Average speed during test:	59.3 km/h
Effective running time:	400 s
Theoretical distance covered per cycle:	6.594 km
Maximum speed:	90 km/h
Maximum acceleration:	0.833 m/s^2
Maximum deceleration:	-1.389 m/s^2

Table 1.4

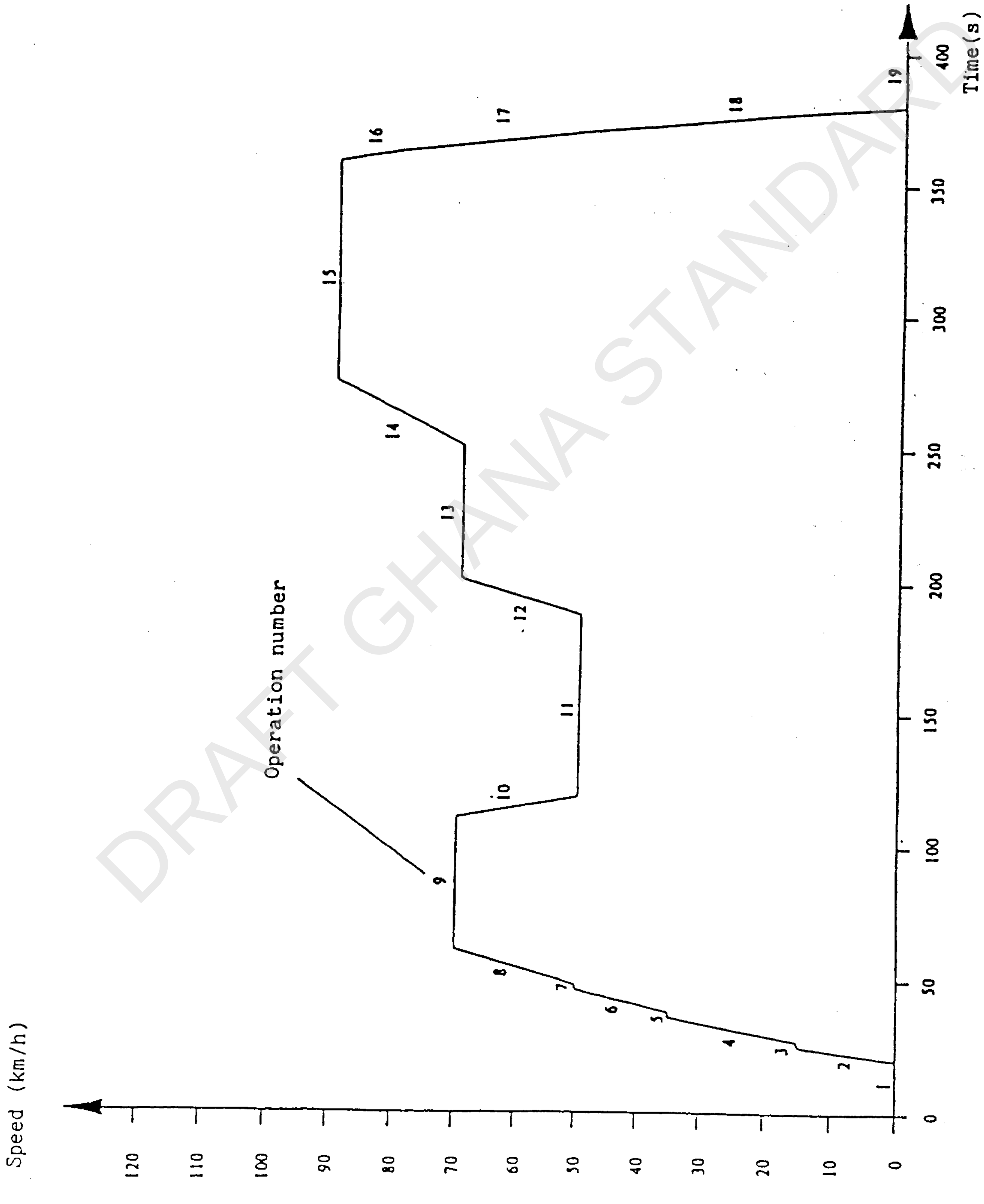
Extra urban cycle (low-powered vehicles) (part two) for the type 1 test

No of operation	Operation	Phase	Acceleration (m/s^2)	Speed (km/h)	Duration of each		Cumulative time(s)	Gear to be used in the case of a manual gearbox
					Operation(s)	Phase(s)		
1	Idling	1			20	20	20	K1 [3]
2	Acceleration	)	0.83	0-15	5	)	25	1
3	Gear change	)			2	)	27	-
4	Acceleration	)	0.62	15-35	9	)	36	2
5	Gear change	) 2			2	) 41	38	-
6	Acceleration	)	0.52	35-30	8	)	46	3
7	Gear change	)			2	)	48	-
8	Acceleration	)	0.43	50-70	13	)	61	4
9	Steady speed	3		70	50	50	111	5
10	Deceleration	4	-0.69	70-50	8	8	119	4 s.5 + 4 s.4
11	Steady speed	5		50	69	69	188	4
12	Acceleration	6	0.43	50-70	13	13	201	4
13	Steady speed	7		70	50	50	251	5
14	Acceleration	8	0.24	70-90	24	24	275	5
15	Steady speed	9		90	83	83	358	5
16	Deceleration	)	-0.69	90-80	4	)	362	5
17	Deceleration	) 10	-1.04	80-50	8	) 22	370	5
18	Deceleration	)	1.39	50-00	10	)	380	K5 [3]
19	Idle	11			20	20	400	PM 3
						) 34		
						)		
						20		

[3] PM = gearbox in neutral, clutch engaged.
K1, K5 = first or second gear engaged, clutch disengaged.

Figure 1/4

Extra-urban cycle (low-powered vehicles) (part two) for the type 1 test



Annex 4 - Appendix 2

CHASSIS DYNAMOMETER

1. DEFINITION OF A CHASSIS DYNAMOMETER WITH FIXED LOAD CURVE

1.1 Introduction

In the event that the total resistance to progress on the road cannot be reproduced on the chassis dynamometer between speeds of 10 and 100 km/h, it is recommended that a chassis dynamometer having the characteristics defined below should be used.

1.2 Definition

1.2.1. The chassis dynamometer may have one or two rollers.

The front roller shall drive, directly or indirectly, the inertial masses and the power absorption device.

1.2.2. Once the load at 80 km/h has been set by one of the methods described in paragraph 3, K can be determined from $P = KV^3$.

The power absorbed (P_a) by the brake and the chassis internal frictional effects from the reference setting to a vehicle speed at 80 km/h, shall be as follows:

If V > 12 km/h:

$$P_a = KV^3 \pm 5\% \, KV^3 \pm 5\% \, PV_{80}$$

(without being negative).

If V ≤ 12 km/h:

P_a will be between O and $P_a = KV^3_{12} + 5\% \, KV^3_{12} + 5\% \, PV_{80}$, where K is a characteristic of the chassis dynamometer and PV_{80} is the power absorbed at 80 km/h.

2. METHOD OF CALIBRATING THE DYNAMOMETER

2.1 Introduction

This appendix describes the method to be used to determine the power absorbed by a dynamometric brake. The power absorbed comprises the power absorbed by frictional effects and the power absorbed by the power-absorption device.

The dynamometer is brought into operation beyond the range of test speeds. The device used for starting up the dynamometer is then disconnected: the rotational speed of the driven roller decreases.

The kinetic energy of the rollers is dissipated by the power-absorption unit and by the frictional effects. This method disregards variations in the roller's internal frictional effects caused by rollers with or without the vehicle. The frictional effects of the rear roller shall be disregarded when the roller is free.

2.2 Calibration of the power indicator to 80 km/h as a function of the power absorbed

The following procedure shall be used (see also figure 2/1).

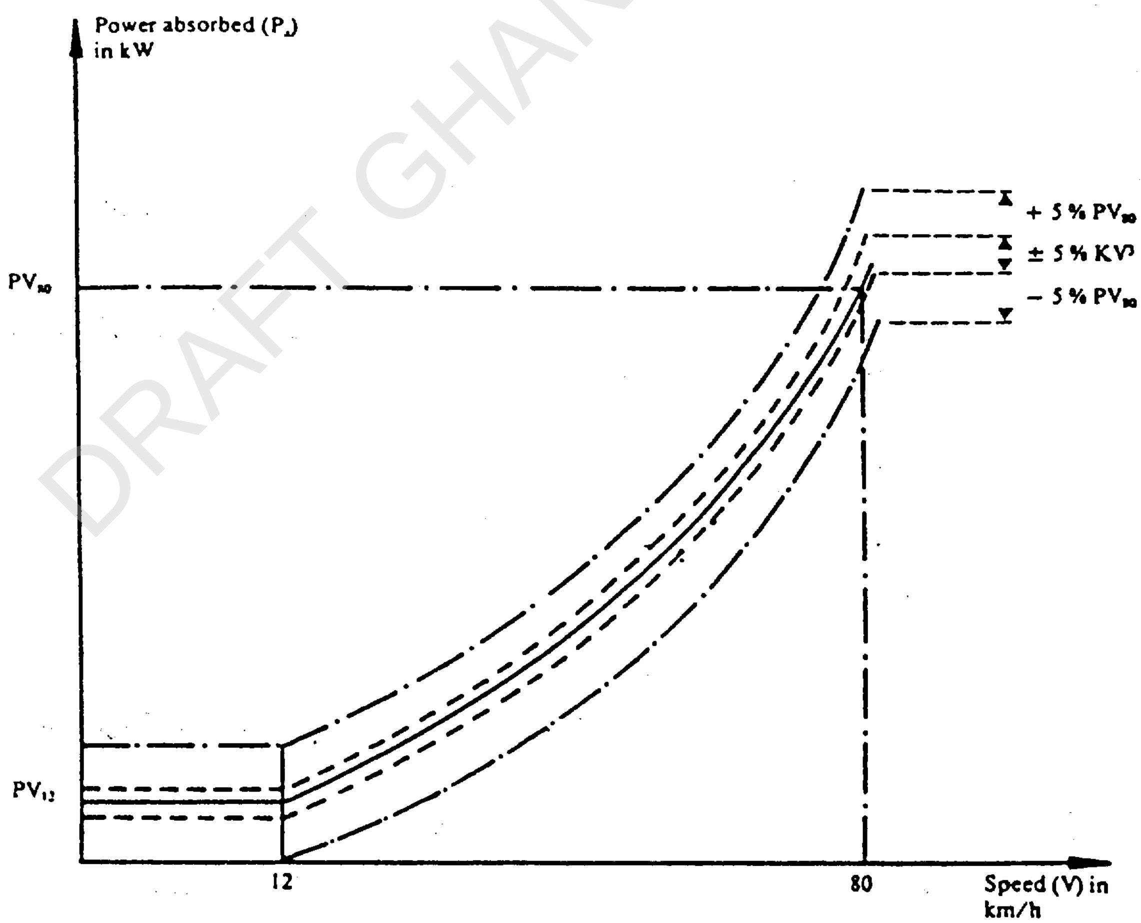
2.2.1. Measure the rotational speed of the roller if this has not already been done. A fifth wheel, a revolution counter or some other method may be used.

2.2.2. Place the vehicle on the dynamometer or devise some other method of starting up the dynamometer.

2.2.3. Use the fly-wheel or any other system of inertia simulation for the particular inertia class to be used.

Figure 2/1

Diagram illustrating the power absorbed by the chassis dynamometer



2.2.4. Bring the dynamometer to a speed of 80 km/h.

2.2.5. Note the power indicated (Pi).

2.2.6. Bring the dynamometer to a speed of 90 km/h.

2.2.7. Disconnect the device used to start up the dynamometer.

2.2.8. Note the time taken by the dynamometer to pass from a speed of 85 km/h to a speed of 75 km/h.

2.2.9. Set the power-absorption device at a different level.

2.2.10. The requirements of paragraphs 2.2.4. to 2.2.9. shall be repeated sufficiently often to cover the range of road powers used.

2.2.11. Calculate the power absorbed, using the formula:

$$P_a = \frac{M_1 (V_1^2 - V_2^2)}{2\,000\ t}$$

where

P_a = power absorbed in kW,

M_1 = equivalent inertia in kg (excluding the inertial effects of the free rear roller),

V_1 = initial speed in m/s (85 km/h = 23.61 m/s),

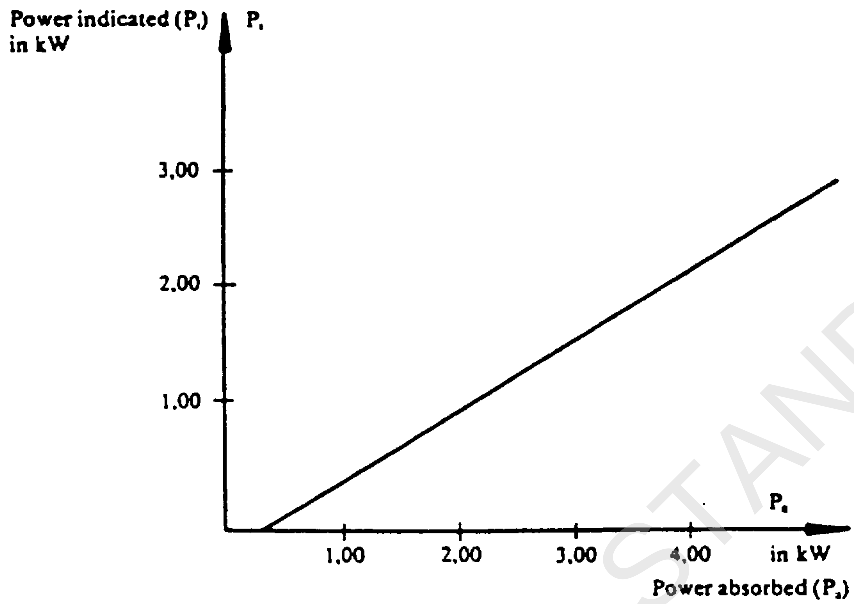
V_2 = final speed in m/s (75 km/h = 20.83 m/s),

t = time taken by the roller to pass from 85 to 75 km/h.

2.2.12. Figure 2/2 shows the power indicated at 80 km/h in terms of power absorbed at 80 km/h.

Figure 2/2

Power indicated at 80 km/h in terms of power absorbed at 80 km/h



2.2.13. The requirements of paragraphs 2.2.3. to 2.2.12. shall be repeated for all inertia classes to be used.

2.3 Calibration of the power indicator as a function of the absorbed power for other speeds

The procedures described in 2.2. shall be repeated as often as necessary for the chosen speeds.

2.4 Verification of the power-absorption curve of the dynamometer from a reference setting at a speed of 80 km/h

2.4.1 Place the vehicle on the dynamometer or devise some other method of starting up the dynamometer.

2.4.2. Adjust the dynamometer to the absorbed power (P_a) at 80 km/h.

2.4.3. Note the power absorbed at 100, 80, 60, 40 and 20 km/h.

2.4.4. Draw the curve $P_a(V)$ and verify that it corresponds to the requirements of paragraph 1.2.2. of this appendix.

2.4.5. Repeat the procedure set out in paragraphs 2.4.1. to 2.4.4. for other values of power P_a at 80 km/h and for other values of inertias.

2.5 The same procedure must be used for force or torque calibration.

3. SETTING OF THE DYNAMOMETER

3.1 Vacuum method

3.1.1. Introduction

This method is not a preferred method and should be used only with fixed load curve shape dynamometers for determination of load setting at 80 km/h and cannot be used for vehicles with compression-ignition engines.

3.1.2. Test instrumentation

The vacuum (or absolute pressure) in the vehicle's intake manifold shall be measured to an accuracy of ± 0.25 kPa. It shall be possible to record this reading continuously or at intervals of no more than one second. The speed shall be recorded continuously with a precision of ± 0.4 km/h.

3.1.3. Road test

3.1.3.1. Ensure that the requirements of paragraph 4 of appendix 3 to this annex are met.

3.1.3.2. Drive the vehicle at a steady speed of 80 km/h, recording speed and vacuum (or absolute pressure) in accordance with the requirements of paragraph 3.1.2.

3.1.3.3. Repeat procedure set out in 3.1.3.2. three times in each direction. All six runs must be completed within four hours.

3.1.4. Data reduction and acceptance criteria

3.1.4.1. Review results obtained in accordance with paragraphs 3.1.3.2. and 3.1.3.3. (speed must not be lower than 49.5 km/h or greater than 50.5 km/h for more than one second). For each run, read vacuum level at one-second intervals, calculate mean vacuum ($\bar{v}$) and standard deviation (s). This calculation shall consist of no less than 10 readings of vacuum.

3.1.4.2. The standard deviation must not exceed 10% of mean ($\bar{v}$) for each run.

3.1.4.3. Calculate the mean value ($\bar{v}$) for the six runs (three runs in each direction).

3.1.5. Dynamometer setting

3.1.5.1. Preparation

Perform the operations specified in paragraphs 5.1.2.2.1. to 5.1.2.2.4. of appendix 3 to this annex.

3.1.5.2 Load setting

After warm-up, drive the vehicle at a steady speed of 80 km/h and adjust dynamometer load to reproduce the vacuum reading ($\bar{v}$) obtained in accordance with paragraph 3.1.4.3. Deviation from this reading shall be no greater than 0.25 kPa. The same instruments shall be used for this exercise as were used during the road test.

3.2 Other setting methods

The dynamometer setting may be carried out at a constant speed of 80 km/h in accordance with the requirements of appendix 3 to this annex.

3.3 Alternative method

With the manufacturer's agreement, the following method may be used:

3.3.1. The brake is adjusted so as to absorb the power exerted at the driving wheels at a constant speed of 80 km/h in accordance with the following table:

Reference mass of vehicle: RW (kg)	Power absorbed by the dynamometer: P_a (kW)
RW ≤ 750	4.7
750 < RW ≤ 850	5.1
850 < RW ≤ 1 020	5.6
1 020 < RW ≤ 1 250	6.3
1 250 < RW ≤ 1 470	7.0
1 470 < RW ≤ 1 700	7.5
1 700 < RW ≤ 1 930	8.1
1 930 < RW ≤ 2 150	8.6
2 150 < RW ≤ 2 380	9.0
2 380 < RW ≤ 2 610	9.4
2 610 < RW	9.8

3.3.2. In the case of vehicles, other than passenger cars, with a reference mass of more than 1,700 kg, or vehicles with permanent all-wheel drive, the power values given in the table in paragraph 3.3.1 shall be multiplied by the factor 1.3.

Annex 4 - Appendix 3

RESISTANCE TO PROGRESS OF A VEHICLE - MEASUREMENT METHOD ON THE ROAD - SIMULATION ON A CHASSIS DYNAMOMETER

1. OBJECT OF THE METHODS

The object of the methods defined below is to measure the resistance to progress of a vehicle at stabilized speeds on the road and to simulate this resistance on a dynamometer, in accordance with the conditions set out in paragraph 4.1.5. of this annex.

2. DEFINITION OF THE ROAD

The road shall be level and sufficiently long to enable the measurements specified below to be made. The slope must be constant to within ± 0.1% and must not exceed 1.5%.

3. ATMOSPHERIC CONDITIONS

3.1. Wind

Testing must be limited to wind speeds averaging less than 3 m/s with peak speeds of less than 5 m/s. In addition, the vector component of the wind speed across the test road must be less than 2 m/s. Wind velocity shall be measured 0.7 m above the road surface.

3.2. Humidity

The road shall be dry.

3.3. Pressure - Temperature

Air density at the time of the test must not deviate by more than ± 7.5% from the reference conditions, P = 100 kPa and T = 293.2 K.

4. VEHICLE PREPARATION

4.1. Running-in

The vehicle shall be in normal running order and adjustment after having been run-in for at least 3,000/km. The tyres shall be run-in at the same time as the vehicle or have a tread depth within 90 and 50% of the initial tread depth.

4.2. Verifications

The following checks shall be made in accordance with the manufacturer's specifications for the use considered:

wheels, wheel trims, 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 level, etc.

4.3. Preparation for the test

4.3.1. The vehicle shall be loaded to its reference mass. The level of the vehicle shall be that obtained when the centre of gravity of the load is situated midway between the 'R' points of the front outer seats and on a straight line passing through those points.

4.3.2. In the case of road tests, the windows of the vehicle shall be closed. Any covers of air climatization systems, headlamps, etc. shall be in the non-operating position.

4.3.3. The vehicle shall be clean.

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

5. METHODS

5.1. Energy variation during coast-down method

5.1.1. On the road

5.1.1.1. Test equipment and error

Time shall be measured to an error lower than 0.1 s.

Speed shall be measured to an error lower than 2%.

5.1.1.2. Test procedure

5.1.1.2.1. Accelerate the vehicle to a speed 10 km/h greater than the chosen test speed V.

5.1.1.2.2. Place the gearbox in 'neutral' position

5.1.1.2.3. Measure the time taken (t) for the vehicle to decelerate from

$V_2 = V + \Delta V$ km/h to $V_1 = V - \Delta V$ km/h,
where $\Delta V \leq 5$ km/h

5.1.1.2.4. Perform the same test in the opposite direction: t_2.

5.1.1.2.5. Take the average T of the two times t_1 and t_2.

5.1.1.2.6. Repeat these tests several times such that the statistical accuracy (p) of the average

$$T = \frac{1}{n} \cdot \sum_{i=1}^{n} Ti$$ is equal to or less than 2% ($p \leq 2\%$)

The statistical accuracy (p) is defined by:

$$P = \frac{ts}{\sqrt{n}} \cdot \frac{100}{T}$$

where:

t = coefficient given by the table below,

s = standard deviation,

n = number of tests.

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

n	4	5	6	7	8	9	10	11	12	13	14	15
t	3.2	2.8	2.6	2.5	2.4	2.3	2.3	2.2	2.2	2.2	2.2	2.2
$\frac{t}{\sqrt{n}}$	1.6	1.25	1.06	0.94	0.85	0.77	0.73	0.66	0.64	0.61	0.59	0.57

5.1.1.2.7. Calculate the power by the formula:

$$P = \frac{M \cdot V \cdot \Delta V}{500\ T}$$

where:

P is expressed in kW,

V = speed of the test in m/s,

Δ V = speed deviation from speed V, in m/s.

M = reference mass in kg,

T = time in seconds.

5.1.2. On the dynamometer

5.1.2.1. Measurement equipment and accuracy

The equipment shall be identical to that used on the road.

5.1.2.2. Test procedure

5.1.2.2.1. Install the vehicle on the test dynamometer.

5.1.2.2.2. Adjust the tyre pressure (cold) of the driving wheels as required by the dynamometer.

5.1.2.2.3. Adjust the equivalent inertia of the dynamometer.

5.1.2.2.4. Bring the vehicle and dynamometer to operating temperature in a suitable manner.

5.1.2.2.5. Carry out the operations specified in 5.1.1.2. (with the exception of paragraphs 5.1.1.2.4. and 5.1.1.2.5.), replacing M by I in the formula set out in paragraph 5.1.1.2.7.

5.1.2.2.6. Adjust the brake setting to meet the requirement of paragraph 4.1.4.1. of this annex.

5.2. Torque measurements method at constant speed

5.2.1. On the road

5.2.1.1. Measurement equipment and error

Torque measurement shall be carried out with an appropriate measuring device accurate to within 2%.

Speed measurement shall be accurate to within 2%.

5.2.1.2. Test procedure

5.2.1.2.1. Bring the vehicle to the chosen stabilized speed V.

5.2.1.2.2. Record the torque $C_{(t)}$ and speed over a period of at least 10 s by means of class 1,000 instrumentation meeting ISO standard No. 970.

5.2.1.2.3. Differences in torque $C_{(t)}$ and speed relative to time shall not exceed 5% for each second of the measurement period.

5.2.1.2.4. The torque C_{t1} is the average torque derived from the following formula:

$$C_{t1} = \frac{1}{\Delta t} \int_{t}^{t+\Delta t} C(t)dt$$

5.2.1.2.5. Carry out the test in the opposite direction, i.e. C_{t2}.

5.2.1.2.6. Determine the average of these two torques C_{t1} and C_{t2}, i.e. C_t.

5.2.2. <u>On the dynamometer</u>

5.2.2.1. Measurement equipment and error

The equipment shall be identical to that used on the road.

5.2.2.2. Test procedure

5.2.2.2.1. Perform the operations specified in paragraphs 5.1.2.2.1. to 5.1.2.2.4. above.

5.2.2.2.2. Perform the operations specified in paragraphs 5.2.1.2.1. to 5.2.1.2.4. above.

5.2.2.2.3. Adjust the brake setting to meet the requirements of paragraph 4.1.4.1. of this annex.

5.3. <u>Integrated torque over variable driving pattern</u>

5.3.1. This method is a non-obligatory complement to the constant speed method described in paragraph 5.2. above.

5.3.2. In this dynamic procedure, the mean torque value $\bar{M}$ is determined. This is accomplished by integrating the actual torque values with respect to time during operation of the test vehicle with a defined driving cycle. The integrated torque is then divided by the time difference.

The result is:

$$\bar{M} = \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} M(t) \cdot dt \text{ (with } M(t) > 0)$$

$\bar{M}$ is calculated from six sets of results.

It is recommended that the sampling rate of $\bar{M}$ be not less than two samples per second.

5.3.3. Dynamometer setting

The dynamometer load is set by the method described in paragraph 5.2. If $\bar{M}$ dynamometer does not then match $\bar{M}$ road, the "brake" inertia setting shall be adjusted until the values are equal to within ± 5%.

Note: This method can be used only for dynamometers with electrical inertia simulation or fine adjustment.

5.3.4. Acceptance criteria

Standard deviation of six measurements must not exceed 2% of the mean value.

5.4. Method of deceleration measurement by gyroscopic platform

5.4.1. On the road

5.4.1.1. Measurement equipment and error

Speed shall be measured with an error lower than 2%.

Deceleration shall be measured with an error lower than 1%.

The slope of the road shall be measured with an error lower than 1%.

Time shall be measured with an error lower than 0.1 s.

The level of the vehicle shall be measured on a reference horizontal ground; as an alternative, it is possible to have the slope of the road (α_1).

5.4.1.2. Test procedure

5.4.1.2.1. Accelerate the vehicle to a speed 5 km/h greater than the chosen test speed: V.

5.4.1.2.2. Record the deceleration between V + 0.5 km/h and V - 0.5 km/h.

5.4.1.2.3. Calculate the average deceleration attributed to the speed V by the formula:

$$\overline{\gamma_1} = \frac{1}{t}\int_0^t \gamma_1(t)\,dt - (g.\sin\alpha_1)$$

where:

$\bar{\gamma}_1$ = average deceleration value at the speed V in one direction of the road,

t = time between V + 0.5 km/h and V - 0.5 km/h,

$\bar{\gamma}_1(t)$ = deceleration recorded with the time,

g = 9.81 m s^{-2}.

5.4.1.2.4. Perform the same test in the other direction: $\bar{\gamma}_2$.

5.4.1.2.5. Calcuate the average of $\Gamma_1 = \frac{\bar{\gamma}_1 + \bar{\gamma}_2}{2}$ for test i.

5.4.1.2.6. Perform a sufficient number of tests as specified in paragraph 5.1.1.2.6, replacing T by Γ where:

$$\Gamma = \frac{1}{n} \sum_{1=i}^{n} \Gamma_i$$

5.4.1.2.7. Calculate the average force absorbed F = M · Γ .

where:

M = vehicle reference mass in kg.

Γ = average deceleration calculated beforehand.

5.4.2. <u>Dynamometer method</u>

5.4.2.1. Measurement equipment and error

The measurement instrumentation of the dynamometer itself shall be used as defined in paragraph 2 of appendix 2 to this annex.

5.4.2.2. Test procedure

5.4.2.2.1. Adjustment of the force on the rim at steady speed

On chassis dynamometer, the total resistance is of the type:

$(F_{total}) = (F_{indicated}) + (F_{driving\ axle\ rolling})$, with

$(F_{total}) = (F_{road})$,

$(F_{indicated}) = (F_{road}) - (F_{driving\ axle\ rolling})$,

where:

$(F_{indicated})$ is the force indicated on the force indicating device of the chassis dynamometer,

(F_{road}) is known,

$(F_{driving\ axle\ rolling})$ can be:

- measured on chassis dynamometer able to work as a generator.

  The text vehicle, gearbox in neutral position, is driven by the chassis dynamometer at the test speed; the rolling resistance of the driving axle is then measured on the force indicating device of the chassis dynamometer;

- determined on chassis dynamometer unable to work as a generator.

  For two-roller chassis dynamometers, the R_R value is the one which is determined beforehand on the road.

  For single-roller chassis dynamometers the R_R value is the one which is determined on the road multiplied by a coefficient (R) which is equal to the ratio between the driving axle mass and the vehicle total mass.

Note:

R_R is obtained from the curve: $F = f(V)$.

5.4.2.2.2. Calibrate the force indicator for the chosen speed as defined in paragraph 2 of appendix 2 to this annex.

5.4.2.2.3. Perform the same operations as in paragraphs 5.1.2.2.2.1. to 5.1.2.2.4. above.

5.4.2.2.4. Set the force $F_A = F - F_R$ on the indicator for the speed chosen.

5.4.2.2.5. Carry out a sufficient number of tests as indicated in paragraph 5.1.1.2.6. above, replacing T by F_A.

Annex 4 - Appendix 4

VERIFICATION OF INERTIAS OTHER THAN MECHANICAL

1. OBJECT

The method described in this appendix makes it possible to check that the simulated total inertia of the dynamometer is carried out satisfactorily in the running phase of the operating cycle.

2. PRINCIPLE

2.1. Drawing up working equations

Since the dynamometer is subjected to variations in the rotating speed of the roller(s), the force at the surface of the roller(s) can be expressed by the formula:

$$F = I \cdot \gamma = I_M \cdot \gamma + F_1$$

where:

F = force at the surface of the roller(s),

I = total inertia of the dynamometer (equivalent inertia of the vehicle: cf. table in 5.1),

I_M = inertia of the mechanical masses of the dynamometer,

γ = tangential acceleration at roller surface,

F_1 = inertia force.

Note: An explanation of this formula with reference to dynamometers with mechanically simulated inertias is appended.

Thus, total inertia is expressed as follows:

$$I = I_M + \frac{F_1}{\gamma}$$

where:

I_M can be calculated or measured by traditional methods,

F_1 can be measured on the dynamometer,

γ can be calculated from the peripheral speed of the rollers.

The total inertia (I) will be determined during an acceleration or deceleration test with values higher than or equal to those obtained on an operating cycle.

2.2. Specification for the calculation of total inertia

The test and calculation methods must make it possible to determine the total inertia I with a relative error (Δ I/I) of less than 2%.

3. SPECIFICATION

3.1. The mass of the simulated total inertia I must remain the same as the theoretical value of the equivalent inertia (see paragraph 5.1. of this annex) within the following limits:

3.1.1. ± 5% of the theoretical value for each instantaneous value;

3.1.2. ± 2% of the theoretical value for the average value calculated for each sequence of the cycle.

3.2. The limit given in paragraph 3.1.1. is brought to ± 50% for one second when starting and, for vehicles with manual transmission, for two seconds during gear changes.

4. VERIFICATION PROCEDURE

4.1. Verification is carried out during each test throughout the cycle defined in paragraph 2.1. of this annex.

4.2. However, if the requirements of paragraph 3 are met, with instantaneous accelerations which are at least three times greater or smaller than the values obtained in the sequences of the theoretical cycle, the verification described above will not be necessary.

5. TECHNICAL NOTE

Explanation of drawing-up working equations.

5.1. Equilibrium of the forces on the road:

$$CR = k_1 Jr_1 \frac{d\Theta 1}{dt} + k_2 Jr_2 \frac{d\Theta 2}{dt} + k_3 M \gamma r_1 + k_3 F_s r_1$$

5.2. Equilibrium of the forces on dynamometers with mechanically simulated inertias:

$$Cm = k_1 Jr_1 \frac{d\Theta 1}{dt} + k_3 \frac{JRm \frac{dWm}{dt}}{Rm} r_1 + k_3 F_s r_1$$

$$= k_1 Jr_1 \frac{d\Theta 1}{dt} + k_3 I\gamma r_1 + k_3 F_s r_1$$

5.3. Equilibrium of the forces of dynamometers with non-mechanically simulated inertias:

$$Ce = k_1 Jr_1 \frac{d\Theta 1}{dt} + k_3 \left(\frac{JRe \frac{dWe}{dt}}{Re} r_1 + \frac{C_1}{Re} r_1 \right) + k_3 F_s r_1$$

$$= k_1 Jr_1 \frac{d\Theta 1}{dt} + k_3 (I_m\gamma + F_1) r_1 + k_3 F_s r_1$$

In these formulae:

CR = engine torque on the road,

Cm = engine torque on the dynamometer with mechanically simulated inertias,

Ce = engine torque on the dynamometer with electrically simulated inertias,

Jr_1 = moment of inertia of the vehicle transmission brought back to the driving wheels,

Jr_2 = moment of inertia of the non-driving wheels,

JRm = moment of inertia of the dynamometer with mechanically simulated inertias,

JRe = moment of mechanical inertia of the dynamometer with electrically simulated inertias,

M = mass of the vehicle on the road,

I = equivalent inertia of the dynamometer with mechanically simulated inertias,

I_M = mechanical inertia of the dynamometer with electrically simulated inertias,

F_s = resultant force at stabilized speed,

C_1 = resultant torque from electrically simulated inertias,

F_1 = resultant force from electrically simulated inertias,

$\frac{d\Theta 1}{dt}$ = angular acceleration of the driving wheels,

$\frac{d\Theta 2}{dt}$ = angular acceleration of the non-driving wheels,

$\frac{dWm}{dt}$ = angular acceleration of the mechanical dynamometer,

$\frac{dWe}{dt}$ = angular acceleration of the electrical dynamometer,

γ = linear acceleration,

r_1 = radius under load of the driving wheels,

r_2 = radius under load of the non-driving wheels,

Rm = radius of the rollers of the mechanical dynamometer,

Re = radius of the rollers of the electrical dynamometer,

k_1 = coefficient dependent on the gear reduction ratio and the various inertias of transmission and 'efficiency',

k_2 = ratio transmission $\frac{r_1}{r_2}$ 'efficiency'

k_3 = ratio transmission 'efficiency'.

5.4. Assuming the two types of dynamometer (5.2 and 5.3) are made equal and simplified, one obtains:

$$k_3 (I_M \cdot \gamma + F_1) \; r_1 = k_3 I \cdot \gamma \cdot r_1$$

hence,

$$I = I_M + \frac{F_1}{\gamma}$$

Annex 4 - Appendix 5

DEFINITION OF GAS-SAMPLING SYSTEMS

1. INTRODUCTION

1.1. There are several types of sampling devices capable of meeting the requirements set out in paragraph 4.2 of annex 4. The devices described in paragraphs 3.1, 3.2 and 3.3 shall be deemed acceptable if they satisfy the main criteria relating to the variable dilution principle.

1.2. In its communications, the laboratory shall mention the system of sampling used when performing the test.

2. CRITERIA RELATING TO THE VARIABLE-DILUTION SYSTEM FOR MEASURING EXHAUST-GAS EMISSIONS

2.1. Scope

This section shall specify the operating characteristics of an exhaust-gas sampling system intended to be used for measuring the true mass emissions of a vehicle exhaust in accordance with the provisions of this Regulation.

The principle of variable-dilution sampling for measuring mass emissions shall require three conditions to be satisfied:

2.1.1. The vehicle exhaust gases shall be continuously diluted with ambient air under specified conditions;

2.1.2. The total volume of the mixture of exhaust gases and dilution air shall be measured accurately;

2.1.3. A continuously proportional sample of the diluted exhaust gases and the dilution air shall be collected for analysis.

Mass gaseous emissions shall be determined from the proportional sample concentrations and the total volume measured during the test. The sample concentrations shall be corrected to take account of the pollutant content of the ambient air.

In addition, where vehicles are equipped with compression-ignition engines, their particulate emissions shall be plotted.

2.2. Technical summary

Figure 5/1 gives a schematic diagram of the sampling system.

2.2.1. The vehicle exhaust gases shall be diluted with a sufficient amount of ambient air to prevent any water condensation in the sampling and measuring system.

2.2.2. The exhaust-gas sampling system shall be so designed as to make it possible to measure the average volume concentrations of the CO_2, CO, HC and NOx, and, in addition, in the case of vehicles equipped with compression-ignition engines, of the particulate emissions, contained in the exhaust gases emitted during the vehicle testing cycle.

2.2.3. The mixture of air and exhaust gases shall be homogeneous at the point where the sampling probe is located (see paragraph 2.3.1.2.).

2.2.4. The probe shall extract a representative sample of the diluted gases.

2.2.5. The system shall enable the total volume of the diluted exhaust gases to be measured.

2.2.6. The sampling system shall be gas-tight. The design of the variable-dilution sampling system and the materials that go to make it up shall be such that they do not affect the pollutant concentration in the diluted exhaust gases. Should any component in the system (heat exchanger, cyclone separator, blower, etc.) change the concentration of any of the pollutants in the diluted exhaust gases and the fault cannot be corrected, then sampling for that pollutant shall be carried out upstream from that component.

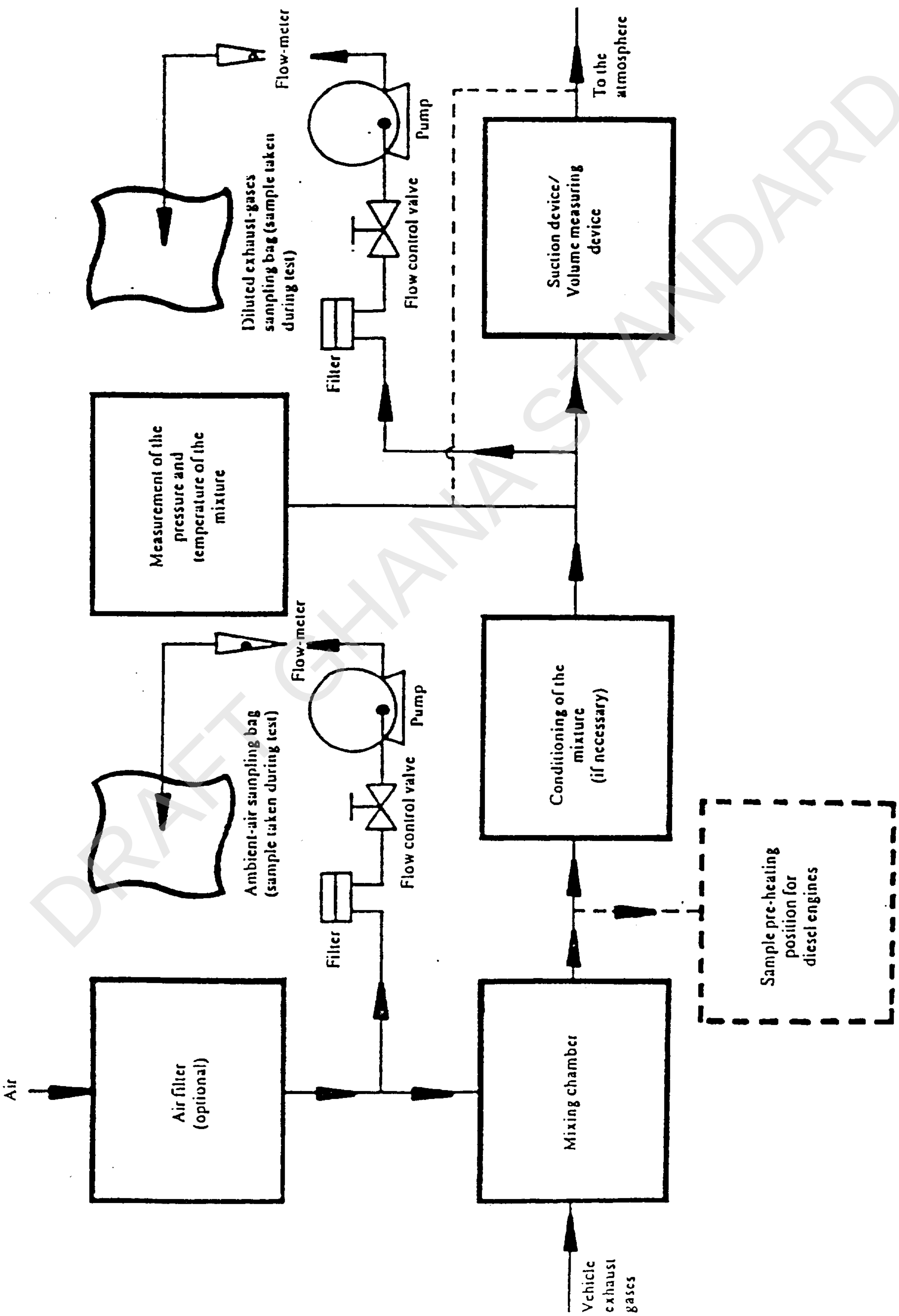
2.2.7. If the vehicle tested is equipped with an exhaust system with several outlets, the connecting tubes shall be connected by a manifold installed as near as possible to the vehicle.

2.2.8. The gas samples shall be collected in sampling bags of adequate capacity so as not to hinder the gas flow during the sampling period. These bags shall be made of materials which will not affect the concentration of pollutant gases (see paragraph 2.3.4.4.).

2.2.9. The variable-dilution system shall be so designed as to enable the exhaust gases to be sampled without appreciably changing the back-pressure at the exhaust pipe outlet (see paragraph 2.3.1.1.).

<u>Figure 5/1</u>

Diagram of a variable-dilution system for measuring exhaust gas emissions



2.3. <u>Specific requirements</u>

2.3.1. Exhaust-gas collection and dilution device

2.3.1.1. The connecting tube between the vehicle exhaust outlets and the mixing chamber shall be as short as possible; it shall in no event

cause the static pressure at the exhaust outlets on the vehicle being tested to differ by more than ± 0.75 kPa at 50 km/h or more than ± 1.25 kPa for the whole duration of the test from the static pressures recorded when nothing is connected to the vehicle exhaust outlets. The pressure shall be measured in the exhaust outlet or in an extension having the same diameter, as near as possible to the end of the pipe;

change the nature of the exhaust gas.

2.3.1.2. Provision shall be made for a mixing chamber in which the vehicle exhaust gases and the dilution air are mixed so as to produce a homogeneous mixture at the chamber outlet.

The homogeneity of the mixture in any cross-section at the location of the sampling probe shall not vary by more than ± 2% from the average of the values obtained for at least five points located at equal intervals on the diameter of the gas stream. In order to minimize the effects on the conditions at the exhaust outlet and to limit the drop in pressure inside the dilution-air conditioning device, if any, the pressure inside the mixing chamber shall not differ by more than ± 0.25 kPa from atmospheric pressure.

2.3.2. Suction device/volume measuring device

This device may have a range of fixed speeds as to ensure sufficient flow to prevent any water condensation. This result is generally obtained by keeping the concentration of CO_2 in the dilute exhaust-gas sampling bag lower than 3% by volume.

2.3.3. Volume measurement

2.3.3.1. The volume measuring device shall retain its calibration accuracy to within ± 2% under all operating conditions. If the device cannot compensate for variations in the temperature of the mixture of exhaust gases and dilution air at the measuring point, a heat exchanger shall be used to maintain the temperature to within ± 6 K of the specified operating temperature.

If necessary, a cyclone separator may be used to protect the volume measuring device.

2.3.3.2. A temperature sensor shall be installed immediately before the volume measuring device. This temperature sensor shall have an accuracy and a precision of ± 1 K and a response time of 0.1 s at 62% of a given temperature variation (value measured in silicone oil).

2.3.3.3. The pressure measurements shall have a precision and an accuracy of ± 0.4 kPa during the test.

2.3.3.4. The measurement of the pressure difference from atmospheric pressure shall be taken upstream from and, if necessary, downstream from the volume measuring device.

2.3.4. Gas sampling

2.3.4.1. Dilute exhaust gases

2.3.4.1.1. The sample of dilute exhaust gases shall be taken upstream from the suction device but downstream from the conditioning devices (if any).

2.3.4.1.2. The flow-rate shall not deviate from the average by more than ± 2%.

2.3.4.1.3. The sampling rate shall not fall below 5 litres per minute and shall not exceed 0.2% of the flow-rate of the dilute exhaust gases.

2.3.4.1.4. An equivalent limit shall apply to constant-mass sampling systems.

2.3.4.2. Dilution air

2.3.4.2.1. A sample of the dilution air shall be taken at a constant flow-rate near the ambient air-inlet (after the filter if one is fitted).

2.3.4.2.2. The air shall not be contaminated by exhaust gases from the mixing area.

2.3.4.2.3. The sampling rate for the dilution air shall be comparable to that used in the case of the dilute exhaust gases.

2.3.4.3. Sampling operations

2.3.4.3.1. The materials used for the sampling operations shall be such as not to change the pollutant concentration.

2.3.4.3.2. Filters may be used in order to extract the solid particles from the sample.

2.3.4.3.3. Pumps are required in order to convey the sample to the sampling bag(s).

2.3.4.3.4. Flow control valves and flow-meters are needed in order to obtain the flow-rates required for sampling.

2.3.4.3.5. Quick-fastening gas-tight connections may be used between the three-way valves and the sampling bags, the connections sealing themselves automatically on the bag side. Other systems may be used for conveying the samples to the analyser (three-way stop valves, for example).

2.3.4.3.6. The various valves used for directing the sampling gases shall be of the quick-adjusting and quick-acting type.

2.3.4.4. Storage of the sample

The gas samples shall be collected in sampling bags of adequate capacity so as not to reduce the sampling rate. The bags shall be made of a material such as will not change the concentration of synthetic pollutant gases by more than ± 2% after 20 minutes.

2.4. Additional sampling unit for the testing of vehicles equipped with a compression-ignition engine

2.4.1. Unlike the taking of gas samples from vehicles equipped with spark-ignition engines, the hydrocarbon and particulate sampling points are located in a dilution tunnel.

2.4.2. In order to reduce heat losses in the exhaust gases between the exhaust outlet and the dilution tunnel inlet, the pipe may not be more than 3.6 m long, or 6.1 m long if heat insulated. Its internal diameter may not exceed 105 mm.

2.4.3. Predominantly turbulent flow conditions (Reynolds number $\geq$ 4000) shall apply in the dilution tunnel, which shall consist of a straight tube of electrically-conductive material, in order to guarantee that the diluted exhaust gas is homogeneous at the sampling points and that the samples consist of representative gases and particulates. The dilution tunnel shall be at least 200 mm in diameter and the system shall be earthed.

2.4.4. The particulate sampling system shall consist of a sampling probe in the dilution tunnel and two series-mounted filters. Quick-acting valves shall be located both up and downstream of the two filters in the direction of flow.

The configuration of the sample probe shall be as indicated in Figure 5/2.

2.4.5. The particulate sampling probe shall meet the following conditions:

It shall be installed in the vicinity of the tunnel centreline, roughly ten tunnel diameters downstream of the gas inlet, and have an internal diameter of at least 12 mm.

The distance from the sampling tip to the filter mount shall be at least five probe diameters, but must not exceed 1,020 mm.

2.4.6. The sample gas flow measuring unit shall consist of pumps, gas flow regulators and flow measuring units.

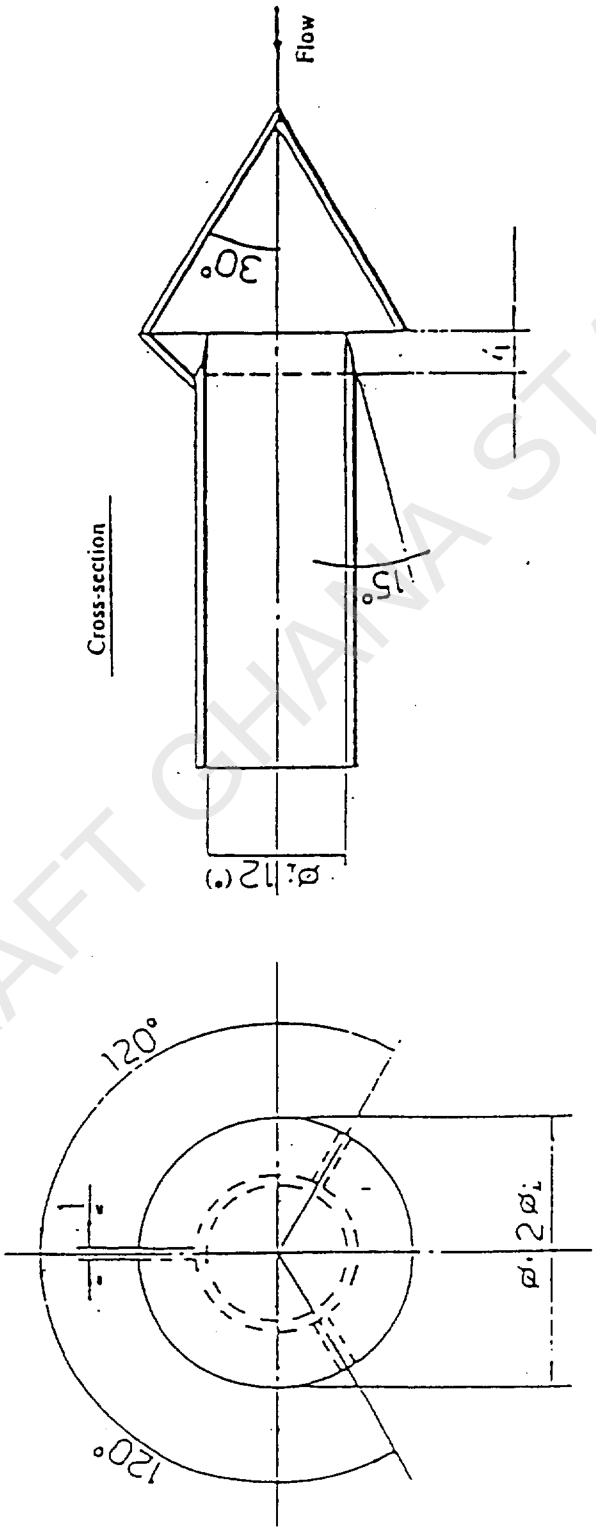
2.4.7. The hydrocarbon sampling system shall consist of a heated sampling probe, line, filter and pump. The sampling probe shall be installed at the same distance from the exhaust gas inlet as the particulate sampling probe, in such a way that neither interferes with samples taken by the other. It shall have a minimum internal diameter of 4 mm.

2.4.8. All heated parts shall be maintained at a temperature of 473 K (200° C) ± 10 K by the heating system.

2.4.9. If it is not possible to compensate for variations in the flow rate provision shall be made for a heat exchanger and a temperature control device as specified in paragraph 2.3.3.1. so as to ensure that the flow rate in the system is constant and the sampling rate accordingly proportional.

Figure 5/2

Particulate sampling probe configuration



(*) Minimum internal diameter

Wall thickness: ~ 1 mm — Material: stainless steel

3. DESCRIPTION OF THE DEVICES

3.1. Variable dilution device with positive displacement pump (PDP-CVS) (Figure 5/3)

3.1.1. The positive displacement pump - constant volume sampler (PDP-CVS) satisfies the requirements of this annex by metering the flow of gas through the pump at constant temperature and pressure. The total volume is measured by counting the revolutions made by the calibrated positive displacement pump. The proportional sample is achieved by sampling with pump, flow-meter and flow control valve at a constant flow-rate.

3.1.2. Figure 5/3 is a schematic drawing of such a sampling system. Since various configurations can produce accurate results, exact conformity with the drawing is not essential. Additional components such as instruments, valves, solenoids and switches may be used to provide additional information and co-ordinate the functions of the component system.

3.1.3. The sampling equipment consists of:

3.1.3.1. A filter (D) for the dilution air, which can be preheated if necessary. This filter shall consist of activated charcoal sandwiched between two layers of paper, and shall be used to reduce and stabilize the hydrocarbon concentrations of ambient emissions in the dilution air;

3.1.3.2. A mixing chamber (M) in which exhaust gas and air are mixed homogeneously;

3.1.3.3. A heat exchanger (H) of a capacity sufficient to ensure that throughout the test the temperature of the air/exhaust-gas mixture measured at a point immediately upstream of the positive displacement pump is within ± 6 K of the designed operating temperature. This device shall not affect the pollutant concentrations of diluted gases taken off after for analysis;

3.1.3.4. A temperature control system (TC), used to preheat the heat exchanger before the test and to control its temperature during the test, so that deviations from the designed operating temperature are limited to ± 6° C;

3.1.3.5. The positive displacement pump (PDP), producing a constant-volume flow of the air/exhaust-gas mixture; the flow capacity of the pump must be large enough to eliminate water condensation in the system under all operating conditions which may occur during a test; this can be generally ensured by using a positive displacement pump with a flow capacity:

3.1.3.5.1. twice as high as the maximum flow of exhaust gas produced by accelerations of the driving cycle, or

3.1.3.5.2. sufficient to ensure that the CO_2 concentration in the dilute-exhaust sample bag is less than 3% by volume;

3.1.3.6. A temperature sensor (T_1) (accuracy and precision ± 1 K), fitted at a point immediately upstream of the positive displacement pump; it must be designed to monitor continuously the temperature of diluted exhaust-gas mixture during the test;

3.1.3.7. A pressure gauge (G_1) (accuracy and precision ± 0.4 kPa) fitted immediately upstream of the positive displacement pump and used to register the pressure gradient between the gas mixture and the ambient air;

3.1.3.8. Another pressure gauge (G_2) (accuracy and precision ± 0.4 kPa) fitted so that the differential pressure between pump inlet and pump outlet can be registered;

3.1.3.9. Two sampling probes (S_1 and S_2) for continuous sampling of the dilution air and of the diluted exhaust-gas/air mixture;

3.1.3.10. A filter (F), to extract solid particles from the flows of gas collected for analysis;

3.1.3.11. Pumps (P), to collect a constant flow of the dilution air as well as of the diluted exhaust-gas/air mixture during the test;

3.1.3.12. Flow controllers (N), to ensure a constant flow of the gas samples taken during the course of the test from sampling probes S_1 and S_2 and flow of the gas samples must be such that, at the end of each test, the quantity of the samples is sufficient for analysis (∼10 litres per minute);

3.1.3.13. Flow meters (FL), for adjusting and monitoring the constant flow of gas samples during the test;

3.1.3.14. Quick-acting valves (V), to divert a constant flow of gas samples into the sampling bags or to the outside vent;

3.1.3.15. Gas-tight, quick-lock coupling elements (Q) between the quick-acting valves and the sampling bags; the coupling shall close automatically on the sampling-bag side; as an alternative, other ways of transporting the samples to the analyzer may be used (three-way stopcocks, for instance);

3.1.3.16. Bags (B), for collecting samples of the diluted exhaust gas and of the dilution air during the test; they shall be of sufficient capacity not to impede the sample flow; the bag material shall be such as to affect neither the measurements themselves nor the chemical composition of the gas samples (for instance: laminated polyethylene/polymide films, or fluorinated polyhydrocarbons);

3.1.3.17. A digital counter (C), to register the number of revolutions performed by the positive displacement pump during the test.

3.1.4. Additional equipment required when testing compression-ignition- engined vehicles

To comply with the requirements of paragraphs 4.3.1.1. and 4.3.2. of this annex, the additional components within the dotted lines in Figure 5/3 shall be used when testing compression-ignition-engined vehicles:

Fh is a heated filter,

S_3 is a sampling point close to the mixing chamber,

V_h is a heated multiway valve,

Q is a quick connector to allow the ambient air sample BA to be analysed on the HFID,

HFID is a heated flame ionization analyzer,

R and I are a means of integrating and recording the instantaneous hydrocarbon concentrations,

Lh is a heated sample line.

All heated components must be maintained at 463 K (190°C) ± 10 K.

Particulate sampling system

S_4 Sampling probe in the dilution tunnel,

F_p Filter unit consisting of two series-mounted filters; switching arrangement for further parallel-mounted pairs of filters,

Sampling line,

Pumps, flow regulators, flow measuring units.

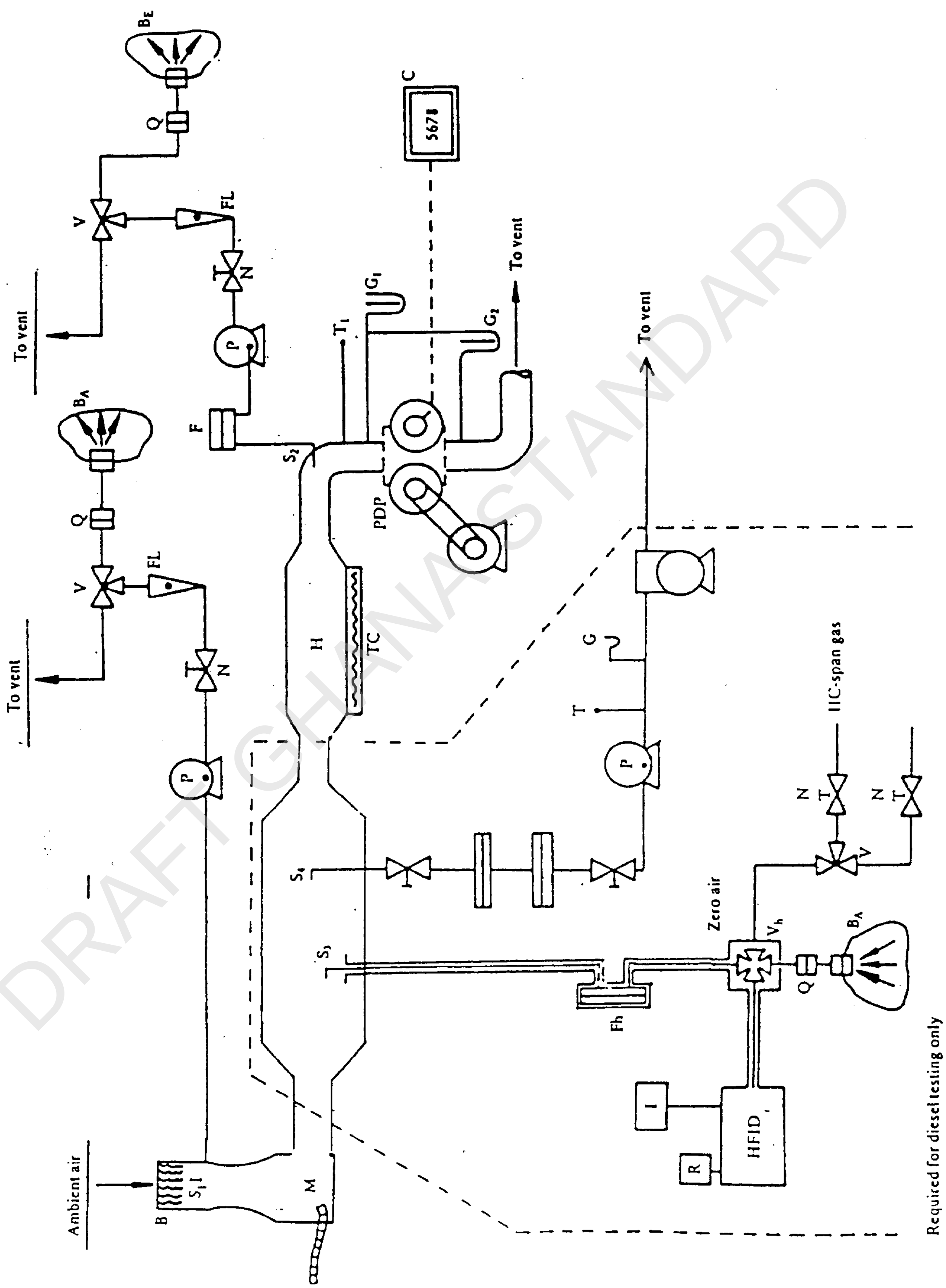
3.2. Critical-flow venturi dilution device (CFV-CVS) (Figure 5/4)

3.2.1. The use of a critical-flow venturi in connection with the CVS sampling procedure is based on the principles of flow mechanics for critical flow. The variable mixture flow rate of dilution and exhaust gas is maintained at sonic velocity which is directly proportional to the square root of the gas temperature. Flow is continually monitored, computed and integrated throughout the test.

The use of an additional critical-flow sampling venturi ensures the proportionality of the gas samples taken. As both pressure and temperature are equal at the two venturi inlets the volume of the gas flow diverted for sampling is proportional to the total volume of diluted exhaust-gas mixture produced, and thus the requirements of this annex are met.

Figure 5/3

Constant volume sampler with positive displacement pump (PDP-CVS)



3.2.2. Figure 5/4 is a schematic drawing of such a sampling system. Since various configurations can produce accurate results, exact conformity with the drawing is not essential. Additional components such as instruments, valve, solenoids, and switches may be used to provide additional information and co-ordinate the functions of the component system.

3.2.3. The collecting equipment consists of:

3.2.3.1. A filter (D) for the dilution air, which can be preheated if necessary: the filter shall consist of activated charcoal sandwiched between layers of paper, and shall be used to reduce and stabilize the hydrocarbon background emission of the dilution air;

3.2.3.2. A mixing chamber (M), in which exhaust gas and air are mixed homogeneously;

3.2.3.3. A cyclone separater (CS), to extract particles;

3.2.3.4. Two sampling probes (S_1 and S_2), for taking samples of the dilution air, as well as of the diluted exhaust gas;

3.2.3.5. A sampling critical-flow venturi (SV), to take proportional samples of the diluted exhaust gas at sampling probe S_2;

3.2.3.6. A filter (F), to extract solid particles from the gas flows diverted for analysis;

3.2.3.7. Pumps (P), to collect part of the flow of air and diluted exhaust gas in bags during the test;

3.2.3.8. A flow controller (N), to ensure a constant flow of the gas samples taken in the course of the test from sampling probe S_1; the flow of the gas samples must be such that, at the end of the test, the quantity of the samples is sufficient for analysis ($\sim$10 litres per minute);

3.2.3.9. A snubber (PS), in the sampling line;

3.2.3.10. Flow meters (FL), for adjusting and monitoring the flow of gas samples during tests;

3.2.3.11. Quick-acting solenoid valves (V), to divert a constant flow of gas samples into the sampling bags or the vent;

3.2.3.12. Gas-tight, quick-lock coupling elements (Q), between the quick-acting valves and the sampling bags; the couplings shall close automatically on the sampling-bag side. As an alternative, other ways of transporting the samples to the analyzer may be used (three-way stopcocks, for instance).

3.2.3.13. Bags (B) for collecting samples of the diluted exhaust gas and the dilution air during the tests; they shall be of sufficient capacity not to impede the sample flow; the bag material shall be such as to affect neither the measurements themselves nor the chemical composition of the gas samples (for instance: laminated polyethylene/polyamide films, or fluorinated polyhydrocarbons);

3.2.3.14. A pressure gauge (G), which shall be precise and accurate to within ± 0.4 kPa;

3.2.3.15. A temperature sensor (T), which is precise and accurate to within ± 1 K and has a response time of 0.1 seconds to 62% of a temperature change (as measured in silicon oil);

3.2.3.16. A measuring critical-flow venturi tube (MV), to measure the flow volume of the diluted exhaust gas;

3.2.3.17. A blower (BL), of sufficient capacity to handle the total volume of diluted exhaust gas;

3.2.3.18. The capacity of the CFV-CVS system must be such that, under all operating conditions which may possibly occur during a test, there will be no condensation of water. This is generally ensured by using a blower whose capacity is:

3.2.3.18.1. twice as high as the maximum flow of exhaust gas produced by accelerations of the driving cycle; or

3.2.3.18.2. sufficient to ensure that the CO_2 concentration in the dilute exhaust sample bag is less than 3% by volume.

3.2.4. Additional equipment required when testing compression-ignition- engined vehicles

To comply with the requirements of paragraphs 4.3.1.1. and 4.3.2. of this annex, the additonal components shown within the dotted lines of Figure 5/4 shall be used when testing compression-ignition-engined vehicles.

Fh is a heated filter,

S_3 is a sample point close to the mixing chamber,

Vh is a heated multiway valve,

Q is a quick connector to allow the ambient air sample BA to be analysed on the HFID,

HFID is a heated flame ionization analyzer,

R and I are a means of integrating and recording the instantaneous hydrocarbon concentrations,

Lh is a heated sample line.

All heated components shall be maintained at 463 K (190°C) ± 10 K.

If compensation for varying flow is not possible, then a heat exchanger (H) and temperature control system (TC) as described in paragraph 3.1.3. of this appendix will be required to ensure constant flow through the venturi (MV) and thus proportional flow through S_3.

Particulate sampling system

S_4 Sampling probe in dilution tunnel,

F_p Filter unit, consisting of two series-mounted filters; switching unit for further parallel-mounted pairs of filters,

Sampling line,

Pumps, flow regulators, flow measuring units.

3.3. Variable dilution device with constant flow control by orifice (CFO-CVS) (Figure 5/5) only for vehicles equipped with spark-ignition engines

3.3.1. The collection equipment consists of:

3.3.1.1. A sampling tube connecting the vehicle's exhaust pipe to the device itself;

3.3.1.2. A sampling device consisting of a pump device for drawing in a diluted mixture of exhaust gas and air;

3.3.1.3. A mixing chamber (M) in which exhaust gas and air are mixed homogeneously;

3.3.1.4. A heat exchanger (H) of a capacity sufficient to ensure that throughout the test the temperature of the air/exhaust-gas mixture measured at a point immediately before the flow-rate measuring device is within ± 6 K of the designed operating temperature. This device shall not alter the pollutant concentration of diluted gases taken off for analysis.

Should this condition not be satisfied for certain pollutants, sampling will be effected before the cyclone for one or several considered pollutants.

If necessary, a device for temperature control (TC) is used to preheat the heat exchanger before testing and to keep up its temperature during the test at ± 6 K of the designed operating temperature;

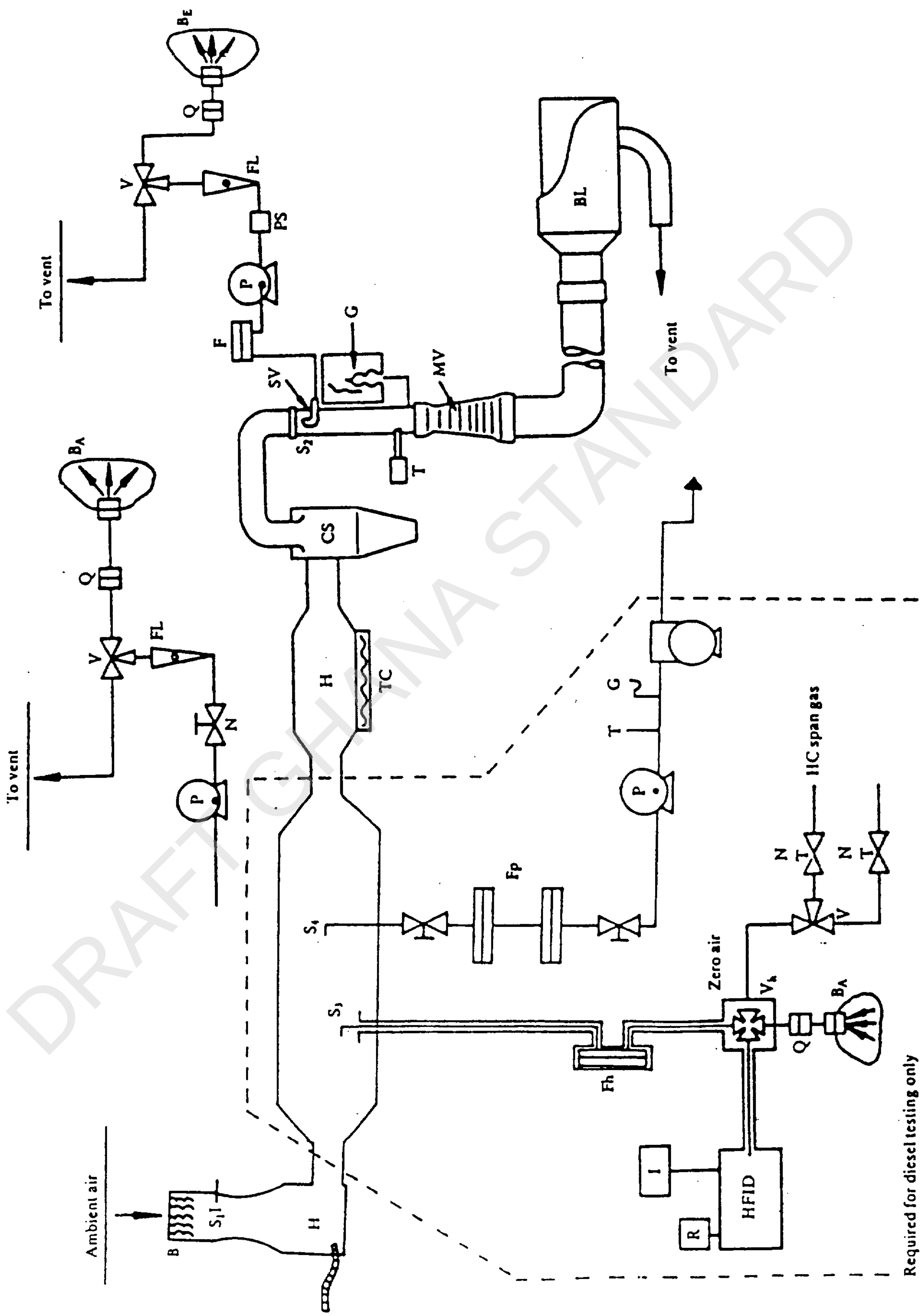
3.3.1.5. Two probes (S_1 and S_2) for sampling by means of pumps (P) flow-meters (FL) and, if necessary, filters (F) allowing for the collection of solid particles from gases used for the analysis;

3.3.1.6. One pump for dilution air and another one for diluted mixture;

3.3.1.7. A volume-meter with an orifice;

Figure 5/4

Constant volume sampler with critical-flow venturi (CFV-CVS)



3.3.1.8. A temperature censor (T_1) (accuracy and precision ± 1 K), fitted at a point immediately before the volume measurement device; it shall be designed to monitor continuously the temperature of the diluted exhaust-gas mixture during the test;

3.3.1.9. A pressure gauge (G_1) (accuracy and precision ± 0.4 kPa) fitted immediately before the volume meter and used to register the pressure gradient between the gas mixture and the ambient air;

3.3.1.10 Another pressure gauge (G_2) (accuracy and precision ± 0.4 kPa) fitted so that the differential pressure between pump inlet and pump outlet can be registered;

3.3.1.11. Flow controllers (N) to ensure a constant uniform flow of gas samples taken during the course of the test from sampling outlets S_1 and S_2. The flow of the gas samples shall be such that, at the end of each test, the quantity of the samples is sufficient for analysis (~10 litres per minute);

3.3.1.12. Flow-meters (FL) for adjusting and monitoring the constant flow of gas samples during the test;

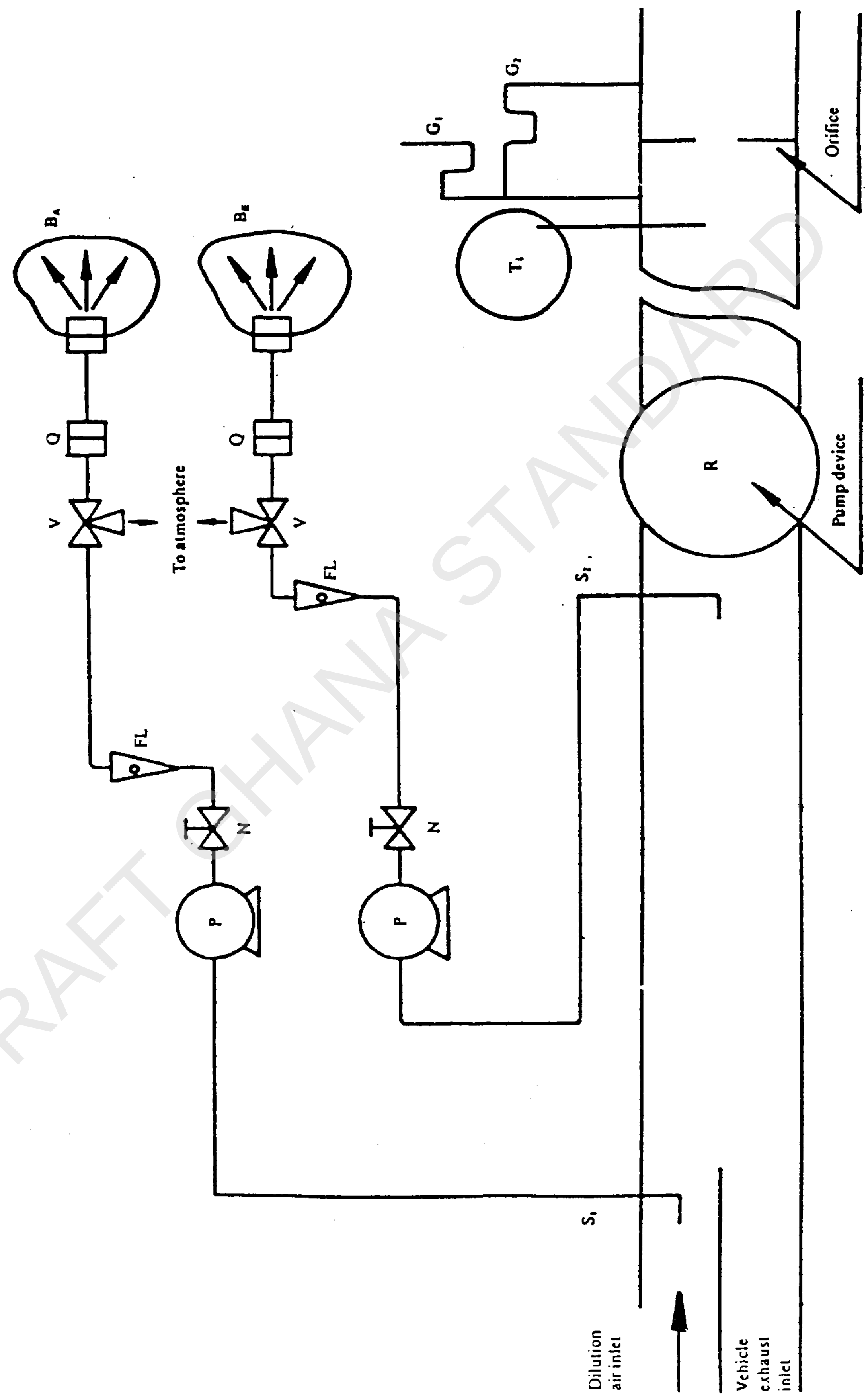
3.3.1.13. Three-way valves (V) to divert a constant flow of gas samples into the sampling bags or to the outside vent;

3.3.1.14. Gas-tight, quick-lock coupling elements (Q) between the three-way valves and the sampling bags; the coupling shall close automatically on the sampling-bag side. Other ways of transporting the samples to the analyzer may be used (three-way stopcocks, for instance);

3.3.1.15. Bags (B) for collecting samples of diluted exhaust gas and of dilution air during the test. They shall be of sufficient capacity not to impede the sample flow. The bag material shall be such as to affect neither the measurements themselves nor the chemical composition of the gas samples (for instance: laminated polyethylene/polyamide films, or fluorinated polyhydrocarbons).

Figure 5/5

Diagram of a variable dilution device with constant flow control by orifice (CFO-CVS)



Annex 4 - Appendix 6

METHOD OF CALIBRATING THE EQUIPMENT

1. ESTABLISHMENT OF THE CALIBRATION CURVE

1.1. Each normally used operating range is calibrated in accordance with the requirements of paragraph 4.3.3. of this annex by the following procedure:

1.2. The analyser calibration curve is established by at least five calibration points spaced as uniformly as possible. The nominal concentration of the calibration gas of the highest concentration shall be not less than 80% of the full scale.

1.3. The calibration curve is calculated by the least squares method. If the resulting polynomial degree is greater than 3, the number of calibration points must be at least equal to this polynomial degree plus 2.

1.4. The calibration curve shall not differ by more than 2% from the nominal value of each calibration gas.

1.5. Trace of the calibration curve

From the trace of the calibration curve and the calibration points, it is possible to verify that the calibration has been carried out correctly. The different characteristic parameters of the analyser shall be indicated, particularly:

the scale,

the sensitivity,

the zero point,

the date of carrying out the calibration.

1.6. If it can be shown to the satisfaction of the technical service that alternative technology (e.g. computer, electronically controlled range switch, etc.) can give equivalent accuracy, then these alternatives may be used.

1.7. Verification of the calibration

1.7.1. Each normally used operating range shall be checked prior to each analysis in accordance with the following:

1.7.2. The calibration shall be checked by using a zero gas and a span gas whose nominal value is within 80-95% of the supposed value to be analysed.

1.7.3. If, for the two points considered, the value found does not differ by more than ± 5% of the full scale from the theoretical value, the adjustment parameters may be modified. Should this not be the case, a new calibration curve must be established in accordance with paragraph 1 of this appendix.

1.7.4. After testing, zero gas and the same span gas are used for re-checking. The analysis is considered acceptable if the difference between the two measuring results is less than 2%.

2. CHECKING FOR FID HYDROCARBON RESPONSE

2.1. Detector response optimization

The FID must be adjusted, as specified by the instrument manufacturer. Propane in air should be used, to optimize the response, on the most common operating range.

2.2. Calibration of the HC analyser

The analyser should be calibrated using propane in air and purified synthetic air. See paragraph 4.5.2. of this annex (calibration and span gases).

Establish a calibration curve as described in paragraphs 1.1. to 1.5. of this appendix.

2.3. Response factors of different hydrocarbons and recommended limits

The response factor (Rf), for a particular hydrocarbon species is the ratio of the FID C1 reading to the gas cylinder concentration, expressed as ppm C1.

The concentration of the test gas must be at a level to give a response of approximately 80% of full-scale deflection, for the operating range. The concentration must be known, to an accuracy of ± 2% in reference to a gravimetric standard expressed in volume. In addition, the gas cylinder must be pre-conditioned for 24 hours at a temperature between 293 K and 303 K (20 and 30° C).

Response factors should be determined when introducing an analyser into service and thereafter at major service intervals. The test gases to be used and the recommended response factors are:

Methane and purified air	$1.00 \leq Rf \leq 1.15$
Propylene and purified air	$0.90 \leq Rf \leq 1.00$
Toluene and purified air	$0.90 \leq Rf \leq 1.00$

Relative to a response factor (Rf) of 1.00 for propane and purified air.

2.4. Oxygen interference check and recommended limits

The response factor shall be determined as described in paragraph 2.3. above. The test gas to be used and recommended response factor range are:

Propane and nitrogen	$0.95 \leq Rf \leq 1.05$

3. EFFICIENCY TEST OF THE NO_x CONVERTER

The efficiency of the converter used for the conversion of NO_2 into NO is tested as follows:

Using the test set up as shown in Figure 6/1 and the procedure described below, the efficiency of converters can be tested by means of an ozonator.

3.1. Calibrate the CLD in the most common operating range following the manufacturer's specifications using zero and span gas (the NO content of which shall amount to about 80% of the operating range and the NO_2 concentration of the gas mixture shall be less than 5% of the NO concentration). The NO_x analyser shall be in the NO mode so that the span gas does not pass through the converter. Record the indicated concentration.

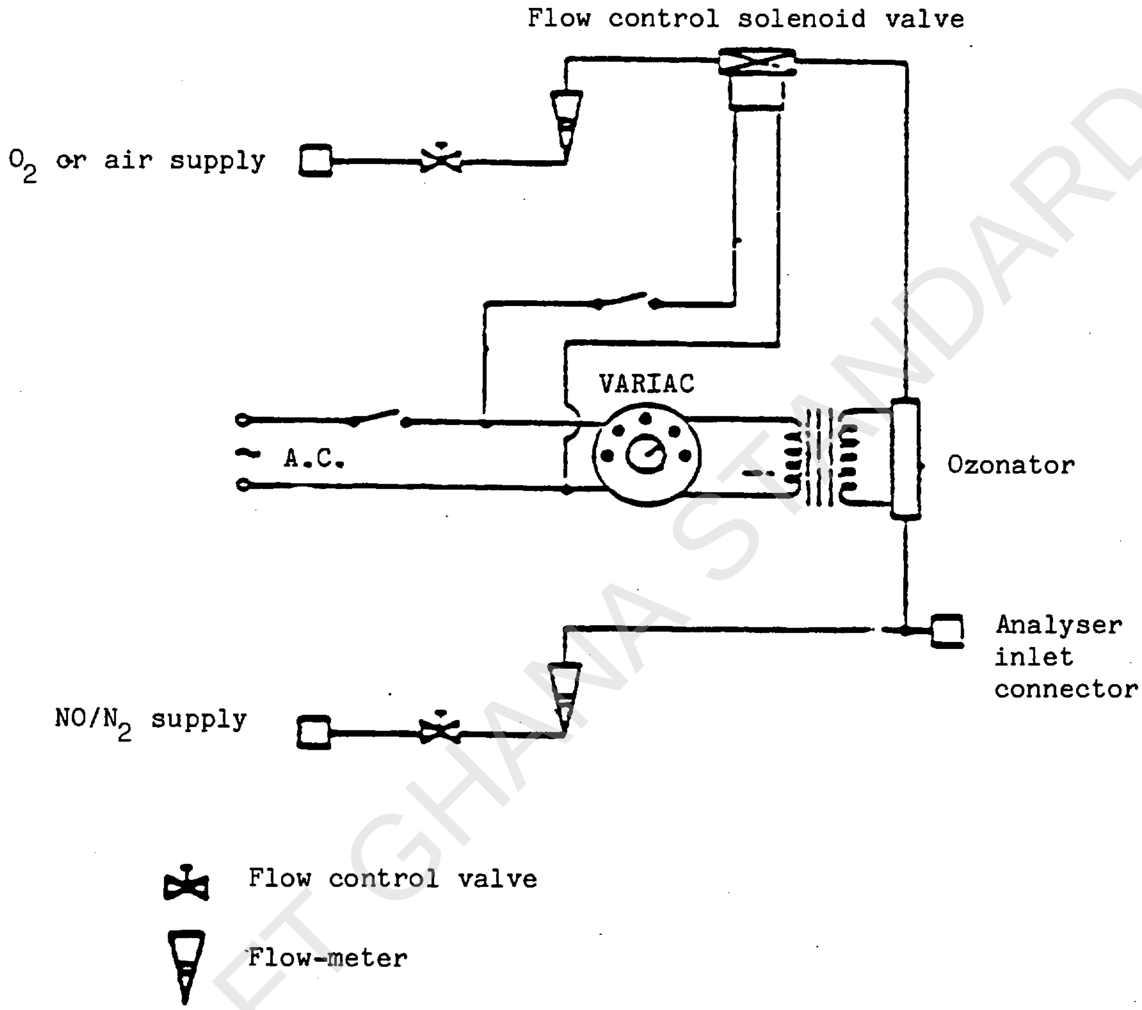
3.2. Via a T-fitting, oxygen or synthetic air is added continuously to the gas flow until the concentration indicated is about 10% less than the indicated calibration concentration given in 3.1. Record the indicated concentration (C). The ozonator is kept deactivated throughout this process.

3.3. The ozonator is now activated to generate enough ozone to bring the NO concentration down to 20% (minimum 10%) of the calibration concentration given in paragraph 3.1. above. Record the indicated concentration (d).

3.4. The NO_x analyser is then switched to the NO_x mode, which means that the gas mixture (consisting of NO, NO_2, O_2 and N_2) now passes through the converter. Record the indicated concentration (a).

3.5. The ozonator is now deactivated. The mixture of gases described in paragraph 3.2. above passes through the converter into the detector. Record the indicated concentration (b).

Figure 6/1



3.6. With the ozonator deactivated, the flow of oxygen or synthetic air is also shut off. The NO_x reading of the analyser must then be no more than 5% above the figure given in paragraph 3.1. above.

3.7. The efficiency of the NO_x converter is calculated as follows:

$$\text{Efficiency } (\%) = (1 + \frac{a - b}{c - d}) \times 100$$

3.8. The efficiency of the converter shall not be less than 95%.

3.9. The efficiency of the converter shall be tested at least once a week.

4. CALIBRATION OF THE CVS SYSTEM

4.1. The CVS system shall be calibrated by using an accurate flow-meter and a restricting device. The flow through the system must be measured at various pressure readings and the control parameters of the system measured and related to the flows.

4.1.1. Various types of flow-meter may be used, e.g. calibrated venturi, laminar flow-meter, calibrated turbine-meter, provided that they are dynamic measurement systems and can meet the requirements of paragraphs 4.2.2. and 4.2.3. of this annex.

4.1.2. The following sections give details of methods of calibrating PDP and CFV units, using a laminar flow-meter, which gives the required accuracy, together with a statistical check on the calibration validity.

4.2. Calibration of the positive displacement pump (PDP)

4.2.1. The following calibration procedure outlines the equipment, the test configuration and the various parameters which are measured to establish the flow-rate of the CVS pump. All the parameters related to the pump are simultaneously measured with the parameters related to the flow-meter which is connected in series with the pump. The calculated flow-rate (given in m^3/min at pump inlet, absolute pressure and temperature) can then be plotted versus a correlation function which is the value of a specific combination of pump parameters. The linear equation which relates the pump flow and the correlation function is then determined. In the event that a CVS has a multiple speed drive, a calibration for each range used must be performed.

4.2.2. This calibration procedure is based on the measurement of the absolute values of the pump and flow-meter parameters that relate the flow-rate at each point. Three conditions must be maintained to ensure the accuracy and integrity of the calibration curve:

4.2.2.1. The pump pressures must be measured at tappings on the pump rather than at the external piping on the pump inlet and outlet. Pressure taps that are mounted at the top centre and bottom centre of the pump drive headplate are exposed to the actual pump cavity pressures, and therefore reflect the absolute pressure differentials;

4.2.2.2. Temperature stability must be maintained during the calibration. The laminar flow-meter is sensitive to inlet temperature oscillations which cause the data points to be scattered. Gradual changes of ± 1 K in temperature are acceptable as long as they occur over a period of several minutes;

4.2.2.3. All connections between the flow-meter and the CVS pump shall be free of any leakage.

4.2.3. During an exhaust emission test, the measurement of these same pump parameters enables the user to calculate the flow-rate from the calibration equation.

4.2.3.1. Figure 6/2 of this appendix shows one possible test set-up. Variations are permissible, provided that they are approved by the administration granting the approval as being of comparable accuracy. If the set-up shown in appendix 5, figure 5/3, is used, the following data shall be found within the limits of precision given:

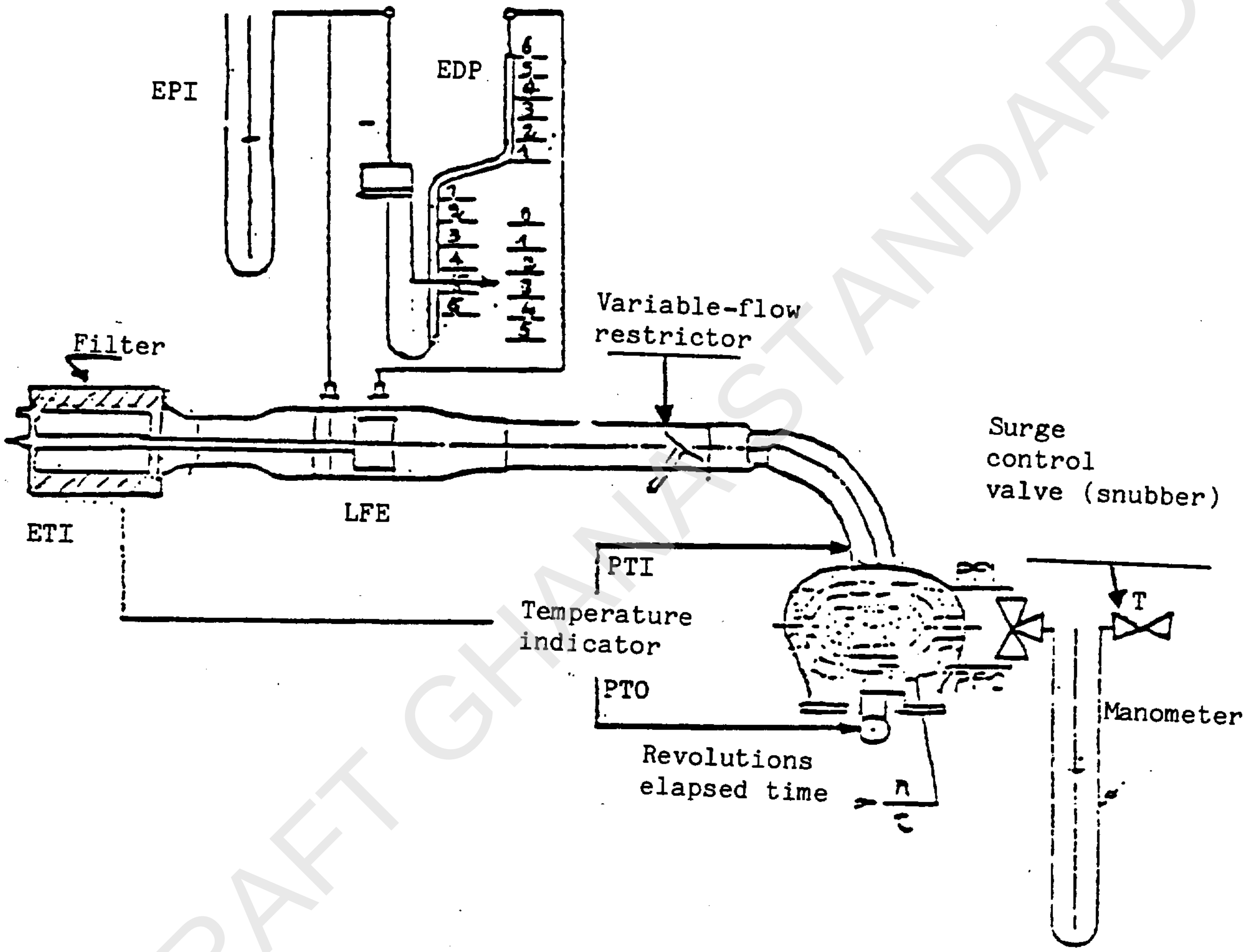
barometric pressure (corrected) (P_B)	± 0.03 kPa
ambient temperature (T)	± 0.2 K
air temperature at LFE (ETI)	± 0.15 K
pressure depression upstream of LFE (EPI)	± 0.01 kPa
pressure drop across the LFE matrix (EDP)	± 0.0015 kPa
air temperature at CVS pump inlet (PTI)	± 0.2 K
air temperature at CVS pump outlet (PTO)	± 0.2 K
pressure depression at CVS pump inlet (PPI)	± 0.22 kPa
pressure head at CVS pump outlet (PPO)	± 0.22 kPa
pump revolutions during test period (n)	± 1 rev
elapsed time for period (minimum 250 s) (t)	± 0.1 s

4.2.3.2. After the system has been connected as shown in figure 6/2 of this appendix, set the variable restrictor in the wide-open position and run the CVS pump for 20 minutes before starting the calibration.

4.2.3.3. Reset the restrictor valve to a more restricted condition in an increment of pump inlet depression (about 1 kPa) that will yield a minimum of six data points for the total calibration. Allow the system to stabilize for three minutes and repeat the data acquisition.

Figure 6/2

PDP-CVS calibration configuration



4.2.4. Data analysis

4.2.4.1. The air flow-rate (Q_s) at each test point is calculated in standard m^3/min from the flow-meter data using the manufacturer's prescribed method.

4.2.4.2. The air flow-rate is then converted to pump flow (V_o) in m^3/rev at absolute pump inlet temperature and pressure.

$$V_o = \frac{Q_s}{n} \cdot \frac{T_p}{273.2} \cdot \frac{101.33}{P_p}$$

where:

V_o = pump flow-rate at T_p and P_p given in m^3/rev,

Q_s = air flow at 101.33 KPa and 273.2 K given in m^3/min,

T_p = pump inlet temperature (K),

P_p = absolute pump inlet pressure (KPa),

n = pump speed in revolutions per minute.

To compensate for the interaction of pump speed pressure variations at the pump and the pump slip rate, the correlation function (X_o) between the pump speed (n), the pressure differential from pump inlet to pump outlet and the absolute pump outlet pressure is then calculated as follows:

$$x_o = \frac{1}{n}\sqrt{\frac{\Delta P_p}{P_e}}$$

where:

x_o = correlation function,

ΔP_p = pressure differential from pump inlet to pump outlet (kPa),

P_e = absolute outlet pressure (PPO + P_B)(kPa).

A linear least-square fit is performed to generate the calibration equations which have the formulae:

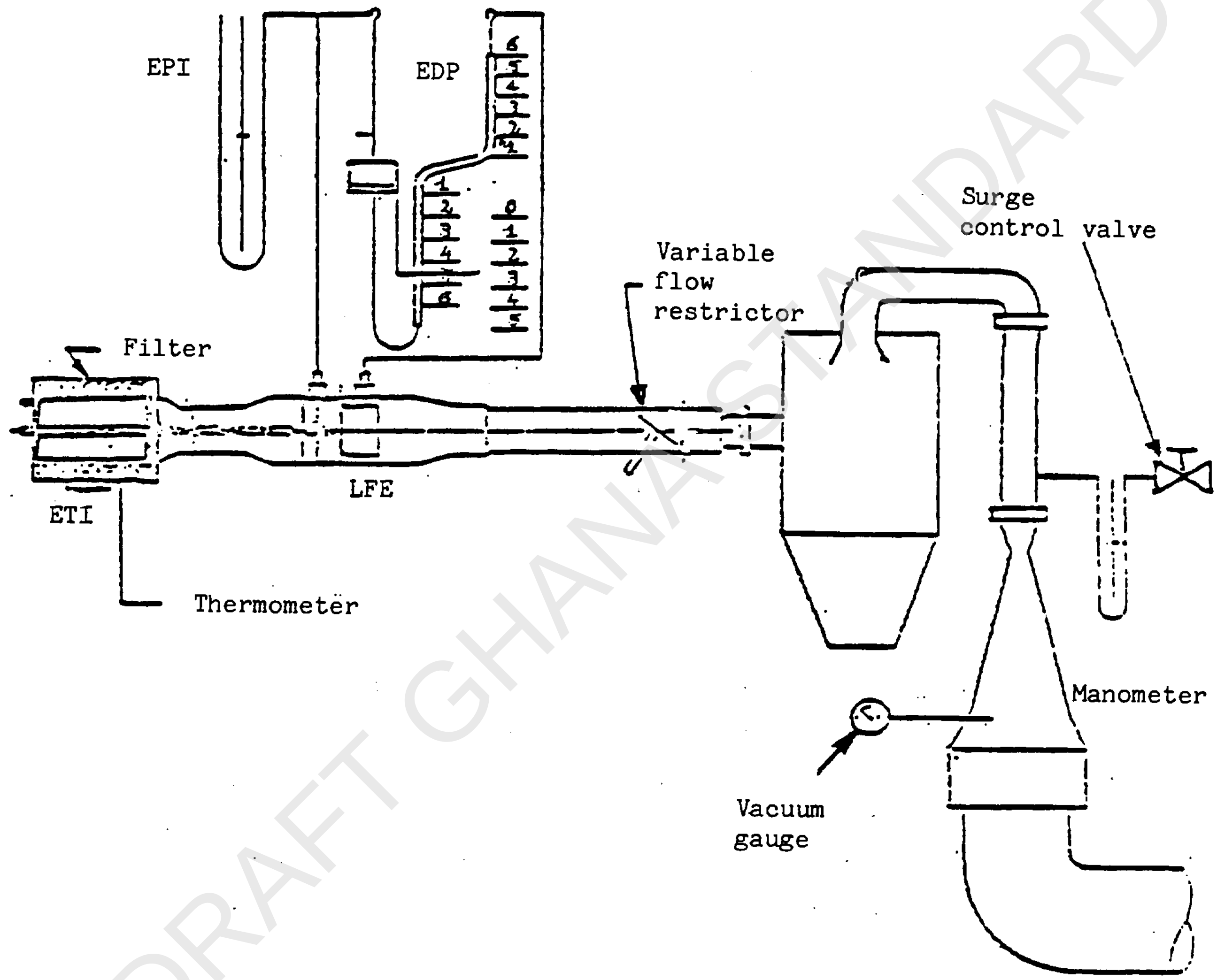
$V_o = D_o - M (X_o)$

$n = A - B (\Delta P_p)$

D_o, M, A and B are the slope-intercept constants describing the lines.

Figure 6/3

CFV-CVS calibration configuration



4.2.4.3. A CVS system that has multiple speeds must be calibrated on each speed used. The calibration curves generated for the ranges shall be approximately parallel and the intercept values (D_o) shall increase as the pump flow range decreases.

If the calibration has been performed carefully, the calculated values from the equation will be within ± 0.5% of the measured value of V_o. Values of M will vary from one pump to another. Calibration is performed at pump start-up and after major maintenance.

4.3. Calibration of the critical-flow venturi (CFV)

4.3.1. Calibration of the CFV is based upon the flow equation for a critical venturi:

$$Q_s = \frac{K_v \cdot P}{\sqrt{T}}$$

where:

Q_s = flow,

K_v = calibration coefficient,

P = absolute pressure (KPa),

T = absolute temperature (K).

Gas flow is a function of inlet pressure and temperature.

The calibration procedure described below establishes the value of the calibration coefficient at measured values of pressure, temperature and air flow.

4.3.2. The manufacturer's recommended procedure shall be followed for calibrating electronic portions of the CFV.

4.3.3. Measurements for flow calibration of the critical flow venturi are required and the following data shall be found within the limits of precision given:

barometric pressure (corrected) (P_B)	± 0.03 kPa,
LFE air temperature, flow-meter (ETI)	± 0.15 K,
pressure depression upstream of LFE (EPI)	± 0.01 kPa,
pressure drop across (EDP) LFE matrix	± 0.0015 kPa,
air flow (Q_s)	± 0.5%,

CFV inlet depression (PPI) ± 0.02 kPa,

temperature at venturi inlet (T_v) ± 0.2 K.

4.3.4. The equipment shall be set up as shown in figure 3 of this appendix and checked for leaks. Any leaks between the flow-measuring device and the critical-flow venturi will seriously affect the accuracy of the calibration.

4.3.5. The variable-flow restrictor shall be set to the open position, the blower shall be started and the system stabilized. Data from all instruments shall be recorded.

4.3.6. The flow restrictor shall be varied and at least eight readings across the critical flow range of the venturi shall be made.

4.3.7. The data recorded during the calibration shall be used in the following calculations. The air flow-rate (Q_s) at each test point is calculated from the flow-meter data using the manufacturer's prescribed method.

Calculate values of the calibration coefficient for each test point:

$$K_v = \frac{Q_s \cdot \sqrt{T_v}}{P_v}$$

where:

Q_s = flow-rate in m^3/min at 273.2 K and 101.33 kPa,

T_v = temperature at the venturi inlet (K),

P_v = absolute pressure at the venturi inlet (kPa).

Plot K_v, as a function of venturi inlet pressure. For sonic flow, K_v will have a relatively constant value. As pressure decreases (vacuum increases) the venturi become unchoked and K_v decreases. The resultant K_v changes are not permissible.

For a minimum of eight points in the critical region, calculate an average K_v and the standard deviation.

If the standard deviation exceeds 0.3% of the average K_v, take corrective action.

Annex 4 - Appendix 7

TOTAL SYSTEM VERIFICATION

1. To comply with the requirements of paragraph 4.7. of this annex, the total accuracy of the CVS sampling system and analytical system shall be determined by introducing a known mass of a pollutant gas into the system whilst it is being operated as if during a normal test and then analysing and calculating the pollutant mass according to the formulae in appendix 8 to this annex except that the density of propane shall be taken as 1,967 grams per litre at standard conditions. The following two techniques are known to give sufficient accuracy.

2. METERING A CONSTANT FLOW OF PURE GAS (CO OR C_3H_8) USING A CRITICAL FLOW ORIFICE DEVICE

2.1. A known quantity of pure gas (CO or C_3H_8) is fed into the CVS system through the calibrated critical orifice. If the inlet pressure is high enough, the flow-rate (q), which is adjusted by means of the critical flow orifice, is independent of orifice outlet pressure (critical flow). If deviations exceeding 5% occur, the cause of the malfunction shall be determined and corrected. The CVS system is operated as in an exhaust emission test for about 5 to 10 minutes. The gas collected in the sampling bag is analysed by the usual equipment and the results compared to the concentration of the gas samples which was known beforehand.

3. METERING A LIMITED QUANTITY OF PURE GAS (CO OR C_3H_8) BY MEANS OF A GRAVIMETRIC TECHNIQUE

3.1. The following gravimetric procedure may be used to verify the CVS system. The weight of a small cylinder filled with either carbon monoxide or propane is determined with a precision of ±001 g. For about 5 to 10 minutes, the CVS system is operated as in a normal exhaust emission test, while CO or propane is injected into the system. The quantity of pure gas involved is determined by means of differential weighing. The gas accumulated in the bag is then analysed by means of the equipment normally used for exhaust-gas analysis. The results are then compared to the concentration figures computed previously.

Annex 4 - Appendix 8

CALCULATION OF THE MASS EMISSIONS OF POLLUTANTS

1. GENERAL PROVISIONS

Emissions of gaseous pollutants shall be calculated by means of the following equation:

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

where:

M_i = mass emission of the pollutant i in grams per test,

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),

k_H = humidity correction factor used for the calculation of the mass emissions of oxides of nitrogen. There is no humidity correction for HC and CO,

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,

d = distance corresponding to the operating cycle in kilometres.

1.2. VOLUME DETERMINATION

1.2.1. 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.

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

$$V = V_o \times N$$

where:

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

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

N = number of revolutions per test.

1.2.3. Correction of the diluted exhaust-gas volume to standard conditions

The diluted exhaust-gas volume is corrected by means of the following formula:

$$V_{mix} = V \times K_1 \times \frac{P_B - P_1}{T_p} \quad (2)$$

in which:

$$K_1 = \frac{273.2\ K}{101.33\ kPa} = 2.6961\ (K \times kPa^{-1}) \quad (3)$$

where

P_B = barometric pressure in the test room in kPa,

P_i = vacuum at the inlet to the positive displacement pump in kPa relative to the ambient barometric pressure,

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

1.3. CALCULATION OF THE CORRECTED CONCENTRATION OF POLLUTANTS IN THE SAMPLING BAG

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

where:

C_i = concentration of the pollutant i in the diluted exhaust gas, expressed in ppm 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,

C_d = concentration of pollutant i in the air used for dilution, expressed in ppm,

DF = dilution factor.

The dilution factor is calculated as follows:

$$DF = \frac{13.4}{C_{CO2} + (C_{HC} + C_{CO})\ 10^{-4}} \quad (5)$$

In this equation:

C_{CO2} = concentration of CO_2 in the diluted exhaust gas contained in the sampling bag, expressed in % 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. DETERMINATION OF THE NO HUMIDITY CORRECTION FACTOR

In order to correct the influence of humidity on the results of oxides of nitrogen, the following calculations are applied:

$$k_h = \frac{1}{1 - 0.0329\ (H - 10.71)} \qquad (6)$$

in which:

$$H = \frac{6.211 \times R_a \times P_d}{P_B - P_d \times R_a \times 10^{-2}} \qquad (6)$$

where:

H = absolute humidity expressed in grams of water per kilogram of dry air,

R_a = relative humidity of the ambient air expressed as a percentage,

P_d = saturation vapour pressure at ambient temperature expressed in kPa,

P_B = atmospheric pressure in the room, expressed in kPa.

1.5. EXAMPLE

1.5.1. Data

1.5.1.1. Ambient conditions:

ambient temperature: 23° C = 297.2 K,

barometric pressure: P_B = 101.33 kPa,

relative humidity: R_a = 60%,

saturation vapour pressure: P_d = 3.20 kPa of H_20 at 23° C.

1.5.1.2. Volume measured and reduced to standard conditions (para. 1)

V = 51.961 m^3

1.5.1.3. Analyser readings:

	Diluted exhayst sample	Dilution-air sample
HC 1/	92 ppm	3.0 ppm
CO	470 ppm	0 ppm
NO_x	70 ppm	0 ppm
CO_2	1.6% vol	0.03% vol

1/ in ppm carbon equivalent.

1.5.2. Calculation

1.5.2.1. Humidity correction factor (k_H) (see formula (6))

$$H = \frac{6.211 \times R_a \times P_d}{P_B - P_d \times R_a \times 10^{-2}}$$

$$H = \frac{6.211 \times 60 \times 3.2}{101.33 - (3.2 \times 0.60)}$$

H = 11,9959

$$k_H = \frac{1}{1 - 0.0329 \times (H - 10.71)}$$

$$k_H = \frac{1}{1 - 0.0329 \times (11.9959 - 10.71)}$$

k_H = 1.0442

1.5.2.2. Dilution factor (DF) (see formula (5))

$$DF = \frac{13.4}{C_{CO2} + (C_{HC} + C_{CO}) \times 10^{-4}}$$

$$DF = \frac{13.4}{1.6 + (92 + 4.70) \times 10^{-4}}$$

DF = 8.091

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

HC, mass emissions (see formulae (4) and (1))

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

$$C_i = 92 - 3\left(1 - \frac{1}{8.091}\right)$$

$C_i = 89.371$

$$M_{HC} = C_{HC} \times V_{mix} \times Q_{HC} \frac{1}{d}$$

$Q_{HC} = 0.619$

$$M_{HC} = 89.371 \times 51.961 \times 0.619 \times 10^{-6} \times \frac{1}{d}$$

$$M_{HC} = \frac{2.88}{d}\ g/km$$

CO, mass emissions (see formula (1))

$$M_{CO} = C_{CO} \times V_{mix} \times Q_{CO} \times \frac{1}{d}$$

$Q_{CO} = 1.25$

$$M_{CO} = 470 \times 51{,}961 \times 1.25 \times 10^{-6} \times \frac{1}{d}$$

$$M_{CO} = \frac{30.5}{d}\ g/km$$

NO_x, mass emissions (see formula (1))

$$M_{NO_x} = C_{NO_x} \times V_{mix} \times Q_{NO_x} \times k_H \times \frac{1}{d}$$

$Q_{NO_x} = 2.05$

$$M_{NO_x} = 70 \times 51{,}961 \times 2.05 \times 1.0442 \times 10^{-6} \times \frac{1}{d}$$

$$M_{NO_x} = \frac{7.79}{d} \ g/km$$

2. SPECIAL PROVISIONS FOR VEHICLES EQUIPPED WITH COMPRESSION-IGNITION ENGINES

To calculate HC-mass emission for compression-ignition engines, the average HC concentration is calculated as follows:

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

where:

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

C_e = concentration of HC measured in the diluted exhaust in ppm of C_i,

C_i is substituted for C_{HC} in all relevant equations.

2.2 <u>Determination of particulates</u>

Particulate emission M_p (g/km) is calculated by means of the following equation:

$$Mp = \frac{(V_{mix} + V_{ep}) \ x \ P_e}{V_{ep} \ x \ d}$$

where exhaust gases are vented outside tunnel:

$$M_p = \frac{V_{mix} \ x \ P_e}{V_{ep} \ x \ d}$$

where exhaust gases are returned to the tunnel, where:

V_{mix}: Volume of diluted exhaust gases (see para. 1.1.), under standard conditions,

V_{ep}: Volume of exhaust gas flowing through particulate filter under standard conditions,

P_e: Particulate mass collected by filters,

d: Distance corresponding to the operating cycle in km,

M_p: Particulate emission in g/km.

Annex 4A

TEST EQUIVALENT TO THE TYPE I TEST FOR VERIFYING EMISSIONS AFTER A COLD START

1. INTRODUCTION

The present annex describes the procedure to be followed for the type I test as defined in paragraph 13 of this Regulation.

2. OPERATING CYCLE ON THE CHASSIS DYNAMOMETER

2.1. Description of cycle

The operating cycle to be applied on the chassis dynamometer is that indicated in the table depicted in the graph in appendix 1 to this annex.

2.2. General conditions

Preliminary test cycles shall be run if the best operation of the gas and brake pedals has to be determined, so that the effective cycle corresponds to the theoretical cycle within the prescribed limits.

2.3. Transmissions

2.3.1. All test conditions, except as noted, will be run according to the manufacturer's recommendations.

2.3.2. Vehicles equipped with free wheeling or overdrive, except as noted, will be tested with these features operated according to the manufacturer's recommendations.

2.3.3. Idle modes are to be run with automatic transmission in "drive" and the wheels braked: manual transmissions to be in gear with the clutch disengaged except in the first idle mode.

The vehicle must be driven with minimum accelerator pedal movement to maintain the desired speed.

2.3.4. Acceleration must be smooth, following representative gear speeds and procedures. For manual transmissions, the operator must release the accelerator pedal during each gear change and complete the change in the minimum amount of time. If the vehicle cannot accelerate at the specified rate, it is to be operated at maximum available power until its speed reaches the value prescribed for that time in the driving schedule.

2.3.5. The deceleration modes must be run in gear using brakes or accelerator pedal as necessary to maintain the desired speed. Manual transmission vehicles must have the clutch engaged and must not change gears from the previous mode. For those modes which decelerate to zero, manual transmission clutches must be depressed when the speed drops below 24.1 km/h, when engine roughness is evident, or when engine stalling is imminent.

2.3.6. Manual transmission

2.3.6.1. In the case of test vehicles equipped with manual transmission, the transmission must be shifted according to the procedures recommended by the manufacturer, subject to the agreement of the technical service responsible for the tests.

2.4. Tolerances

2.4.1. The dynamometer driving schedule is listed in appendix 1. The driving schedule is defined by a smooth trace drawn through the specified speed versus time relationships. It consists of a non-repetitive series of idle, acceleration, cruise, and deceleration modes of various time sequences and rates.

2.4.2. The speed tolerances are:

The upper limit is 3.2 km/h higher than the highest point on the trace within one second of the given time;

The lower limit is 3.2 km/h lower than the lowest point on the trace within one second of the given time;

Speed variations greater than the tolerances (such as may occur during gear changes) are acceptable provided they do not occur for more than 2 seconds on any occasion;

Speeds lower than those prescribed are acceptable provided the vehicle is operated at maximum available power during such occurrences;

The speed tolerance must be as specified above, except the upper and lower limits which are 6.4 km/h;

The following figures show the range of acceptable speed tolerances for typical points. Figure A is typical of portions of the speed curve which are increasing or decreasing throughout the 2-second time interval. Figure B is typical of portions of the speed curve which include a maximum or minimum.

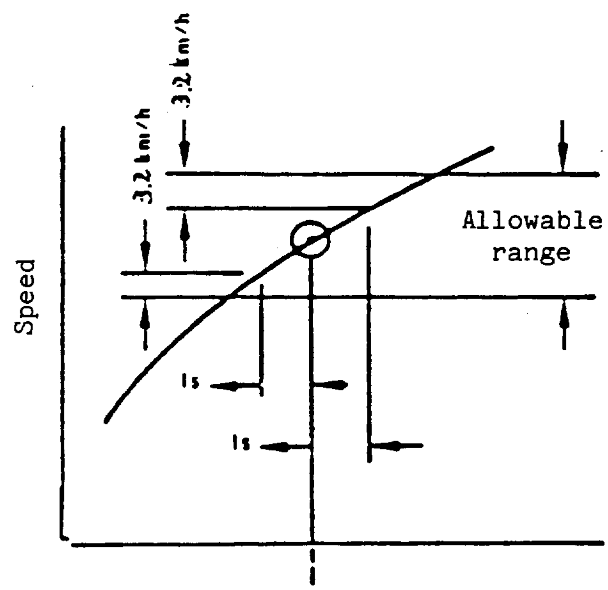


Figure A

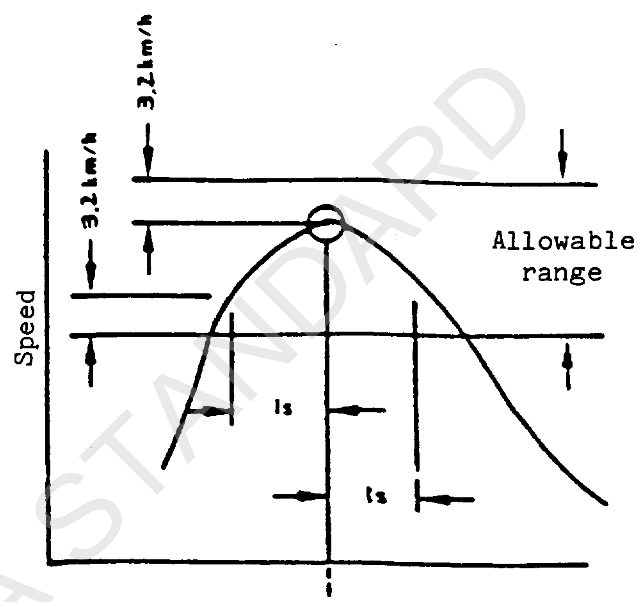


Figure B

3. VEHICLE AND FUEL

3.1. Test vehicles

3.1.1.)
3.1.2.)
3.1.3.) Idem sections 3.1.1. to 3.1.6. of annex 4.
3.1.4.)
3.1.5.)
3.1.6.)

3.2. Fuel

The appropriate reference fuel as defined in annex 9 must be used for testing, or the equivalent reference fuels used by the competent authorities in Community export markets.

4. TEST EQUIPMENT

4.1. Chassis dynamometer

4.1.1. The dynamometer shall be capable of simulating road load within one of the following classifications:

dynamometer with fixed load curve: i.e. a dynamometer whose physical characteristics provide a fix load curve shape,

dynamometer with adjustable load curve: i.e. a dynamometer with at least two road load parameters that can be adjusted to shape the load curve,

dynamometers with adjustable load curve may be considered as having a fixed load curve if they meet the requirements of a fixed load curve dynamometer and are used as a fixed load curve dynamometer.

4.1.2.
4.1.3. } Idem sections 4.1.1., 4.1.2. and 4.1.3. of annex 4.

4.1.4. Accuracy

4.1.4.1. Idem 4.1.4.1. annex 4.

4.1.4.2. In the case of a dynamometer with a fixed load curve, the accuracy of matching dynamometer load to road must be 5% at 80.5 km/h.

In the case of a dynamometer with adjustable load curve, the accuracy of matching dynamometer load to road must be 5% at 80.5, 60 and 40 km/h and 10% at 20 km/h. Below this, dynamometer absorption must be positive.

4.1.4.3.
4.1.4.4. } Idem sections 4.1.4.3. and 4.1.4.4. of annex 4.

4.1.5. Load and inertia setting

4.1.5.1. Dynamometers with fixed load curve: the load simulator must be adjusted to absorb the power exerted on the driving wheels at a steady speed of 80.5 km/h. The alternative means by which this load is determined and set are described in appendix 2, paragraph 3 and appendix 3.

4.1.5.2. Dynamometers with adjustable load curve: the load simulator must be adjusted in order to absorb the power exerted on the driving wheels at steady speeds of 20, 40, 60 and 80.5 km/h. The means by which these loads are determined and set are described in appendix 2, paragraph 3 and appendix 3.

4.1.5.3. Idem section 4.1.5.3. of annex 4.

4.2.)
4.3.)
4.4.) Idem sections 4.2. to 4.7. of annex 4.
4.5.)
4.6.)
4.7.)

5. PREPARING THE TEST

5.1. Adjustment of inertia simulators to the vehicle's translatory inertias

Reference mass of the vehicle (kg)	Equivalent inertia mass (kg)
Pr ≤ 480	450
480 < Pr ≤ 540	510
540 < Pr ≤ 600	570
600 < Pr ≤ 650	620
650 < Pr ≤ 710	680
710 < Pr ≤ 770	740
770 < Pr ≤ 820	800
820 < Pr ≤ 880	850
880 < Pr ≤ 940	910
940 < Pr ≤ 990	960
990 < Pr ≤ 1 050	1 020
1 050 < Pr ≤ 1 110	1 080
1 110 < Pr ≤ 1 160	1 130
1 160 < Pr ≤ 1 220	1 190
1 220 < Pr ≤ 1 280	1 250
1 280 < Pr ≤ 1 330	1 300
1 330 < Pr ≤ 1 390	1 360
1 390 < Pr ≤ 1 450	1 420
1 450 < Pr ≤ 1 500	1 470
1 500 < Pr ≤ 1 560	1 530
1 560 < Pr ≤ 1 620	1 590
1 620 < Pr ≤ 1 670	1 640
1 670 < Pr ≤ 1 730	1 700
1 730 < Pr ≤ 1 790	1 760
1 790 < Pr ≤ 1 870	1 810
1 870 < Pr ≤ 1 980	1 930
1 980 < Pr ≤ 2 100	2 040
2 100 < Pr ≤ 2 210	2 150
2 210 < Pr ≤ 2 320	2 270
2 320 < Pr ≤ 2 440	2 380
2 440 < Pr	2 490

Flywheels, electrical or other means of simulating test mass as shown in the table may be used. If the equivalent test mass specified is not available on the dynamometer being used, the next higher equivalent test mass (not exceeding 115 kg) available is to be used.

Note: The reference mass of the vehicle is the mass of the vehicle in running order less the uniform mass of the driver and increased by a uniform mass of 136 kg.

5.2. Idem section 5.2. of annex 4.

5.3. Conditioning of vehicle

5.3.1. Before the test, the vehicle must be kept in a room in which the temperature remains relatively constant between 293 K and 303 K (20 and 30° C).

This conditioning must continue for at least six hours if the engine oil temperature is measured or for at least 12 hours if it is not.

If the manufacturer so requests, the test must be carried out not later than 36 hours after the vehicle has been run at its normal temperature.

5.3.2. Idem section 5.3.2. of annex 4.

6. PROCEDURE FOR BENCH TESTS

6.1.)
6.1.2.) Idem sections 6.1. to 6.1.4. of annex 4.
6.1.3.)
6.1.4.)

6.2. Test and sampling

6.2.1. The vehicle must be stored prior to the emission test in such a manner that precipitation (e.g. rain or dew) does not occur on the vehicle. The complete dynamometer test consists of a cold start drive of 12.1 km and simulates a hot start drive of 12.1 km. The vehicle is allowed to stand on the dynamometer during the 10-minute time period between the cold and hot start tests. The cold start test is divided into two periods. The first period, representing the cold start "transient" phase, terminates at the end of the deceleration which is scheduled to occur at 505 seconds of the driving schedule. The second period, representing the "stabilized" phase, consists of the remainder of the driving schedule including engine shutdown. The hot start test similarly consists of two periods. The first period, representing the hot start "transient" phase, terminates at the same point in the driving schedule as the first period of the cold start test. The second period of the hot start test, "stabilized" phase, is assumed to be identical to the second period of the cold start test. Therefore the hot start test terminates after the first period (505 seconds) is run.

6.2.2. The following steps shall be taken for each test:

6.2.2.1. Place drive wheels of vehicle on dynamometer without starting engine. Reset and engage the roll revolution counter.

6.2.2.2. Open the vehicle engine compartment cover and position the cooling fan.

6.2.2.3. With the sample selector valves in the "standby" position, connect evacuated sample collection bags to the dilute exhaust and dilution air sample collection systems.

6.2.2.4. Start the CVS (constant volume sampler) (if not already on), the sample pumps, the temperature recorder, the vehicle cooling fan and the heated hydrocarbon analysis recorder (diesel only). (The heat exchanger of the constant volume sampler if used, should be preheated to its operating temperature.) The diesel hydrocarbon analyser continuous sample line and filter (if applicable) should be preheated to 463 K ± 10 K (190° C ± 10° C).

6.2.2.5. Adjust the sample flow-rates to the desired flow-rate (minimum of 0.28 m^3/h) and set the gas flow measuring devices to zero.

Note: CFV-CVS sample flow-rate is fixed by the venturi design.

6.2.2.6. Attach the flexible exhaust tube to the vehicle tailpipe(s).

6.2.2.7. Start the gas flow measuring device, position the sample selector valves to direct the sample flow into the "transient" exhaust sample bag and the "transient" dilution air sample bag (turn on the diesel hydrocarbon analyser system integrator and mark the recorder chart, if applicable), position the values during sampling in such a way that the transient phase is directed on to the particulate filters, turn the key and start the engine.

6.2.2.8. Fifteen seconds after the engine starts, place the transmission in gear.

6.2.2.9. Twenty seconds after the engine starts, begin the initial vehicle acceleration of the driving schedule.

6.2.2.10. Operate the vehicle according to the dynamometer driving schedule.

6.2.2.11. At the end of the deceleration which is scheduled to occur at 505 seconds, simultaneously switch the sample flows from the "transient" to the "stabilized" bags, in such a way that they pass through the particulate filters for the stabilized flows, switch off gas-flow measuring device No. 1 (and the diesel hydrocarbon integrator No. 1) (mark the diesel hydrocarbon recorder chart) and start gas-flow measuring device No. 2 (and diesel hydrocarbon integrator No. 2). Before the acceleration which is scheduled to occur at 510 seconds, record the measured roller or shaft revolutions and reset the counter or switch to a second counter. As soon as possible transfer the "transient" exhaust and dilution air samples to the analytical system and process the samples so as to obtain a stabilized reading of the exhaust sample on all analysers within 20 minutes of the end of the sample collection part of the test.

6.2.2.12. Turn the engine off 2 seconds after the end of the last deceleration (at 1,369 seconds).

6.2.2.13. Five seconds after the engine stops running, simultaneously turn off gas-flow measuring device No. 2 (and diesel hydrocarbon integrator No. 2) (mark the hydrocarbon recorder chart, if applicable) close the valves for the stabilized-phase particulate filters and place the sample selector valves in the "standby" position. Record the measured roller or shaft revolutions and reset the counter. As soon as possible transfer the "stabilized" exhaust and dilution air samples to the analytical system and process the samples so as to obtain a stabilized reading of the exhaust sample on all analysers within 20 minutes of the end of the sample collection part of the test.

6.2.2.14. Immediately after the end of the sample period turn off the cooling fan and close the engine compartment cover.

6.2.2.15. Turn off the CVS or disconnect the exhaust tube from the tailpipe of the vehicle.

6.2.2.16. Repeat the steps in paragraphs 6.2.2.2. to 6.2.2.10. for the hot-start test, except that only one evacuated sample bag is required for sampling exhaust gas and one for dilution air.

In the case of vehicles equipped with a compression-ignition engine similarly only one pair of particulate filters is needed for the hot-start test.

The key-on operation set described in paragraph 6.2.2.7 shall begin between 9 and 11 minutes after the end of the sample period for the cold-start test.

6.2.2.17. At the end of the deceleration, which is scheduled to occur at 505 seconds, simultaneously tum off gas-flow measuring device No. 1 (and diesel hydrocarbon integrator No. 1) (mark the diesel hydrocarbon recorder chart, if applicable) close the valves for the particulate filter and place the sample selector valve to the "standby" position (engine shutdown does not form part of the hot-start test sampling period).

Record the measured roller or shaft revolutions.

6.2.2.18. As soon as possible transfer the hot start "transient" exhaust and dilution air samples to the analytical system and process the samples in order to obtain a stabilized reading of the exhaust sample on all analysers within 20 minutes of the end of the sample collection part of the test.

6.3. Engine starting and restarting

6.3.1. Petrol-engined vehicles

This section applies to petrol-engined vehicles.

6.3.1.1. The engine must be started according to the manufacturer's instructions as set out in the handbook for series-produced vehicles. The initial 20-second idle period begins when the engine starts.

6.3.1.2. Choke operation

Vehicles equipped wih automatic chokes must be operated according to the manufacturer's instructions as set out in the handbook for series-produced vehicles.

Vehicles equipped with manual chokes must be operated according to the manufacturer's instructions as set out in the handbook for series-produced vehicles.

6.3.1.3. The transmission must be placed in gear 15 seconds after the engine is started. If necessary, braking may be employed to keep the drive wheels from turning.

6.3.1.4. The operator may use the choke, accelerator pedal, etc. where necessary to keep the engine running.

6.3.1.5. If the manufacturer's instructions as set out in the handbook for series-produced vehicles do not specify a warm engine starting procedure, the engine (automatic-and-manual-choke engines) must be started by depressing the accelerator pedal about half way and letting the engine turn over until it starts.

6.3.2. Diesel vehicles

The engine must be started according to the manufacturer's instructions as set out in the handbook for series-produced vehicles. The initial 20-second idle period begins when the engine starts. The transmission must be placed in gear 15 seconds after the engine is started. If necessary, braking may be employed to keep the drive wheels from turning.

6.3.3. If the vehicle does not start after 10 seconds' use of the starter, the attempt is to cease and the reason for failure to start determined. The gas flow measuring device on the constant volume sampler (usually a revolution counter) or CFV (and the hydrocarbon integrator when testing diesel vehicles) must be turned off and the sampler selector valves placed in the "standby" position during this diagnostic period. In addition, either the CVS should be turned off, or the exhaust tube disconnected from the tailpipe during the diagnostic period. If failure to start is due to an operational error, the vehicle must be rescheduled for testing from a cold start.

6.3.3.1. If a failure to start occurs during the cold portion of the test and is caused by a vehicle malfunction, corrective action of less than 30 minutes duration may be taken and the test continued. All sampling system(s) must be reactivated at the same time as the engine begins to turn. When the engine starts, the driving schedule timing sequence begins. If failure to start is caused by vehicle malfunction and the vehicle cannot be started, the test is void.

6.3.3.2. If a failure to start occurs during the hot start portion of the test and is caused by vehicle malfunction, the vehicle must be started within one minute of key on. All sampling system(s) must be reactivated at the same time as the engine begins to turn. When the engine starts, the driving schedule timing sequence begins. If the vehicle cannot be started within one minute of key on, the test is void.

6.3.4. If the engine "false starts" the operator must repeat the recommended starting procedure (such as resetting the choke, etc.).

6.3.5. Stalling

If the engine stalls during an idle period, the engine must be restarted immediately and the test continued. If the engine cannot be started soon enough to allow the vehicle to follow the next acceleration as prescribed, the driving schedule indicator must be stopped. When the vehicle restarts, the driving schedule indicator must be reactivated.

If the engine stalls during some operating mode other than idle, the driving schedule must be stopped; the vehicle is then restarted and accelerated to the speed required at that point in the driving schedule and the test continued.

If the vehicle will not restart within one minute, the test is void.

7. PROCEDURE FOR ANALYSES

7.1. Idem section 7.2.2. of annex 4.

7.2. Idem section 7.2.3. of annex 4.

7.3. Idem section 7.2.4. of annex 4.

7.4. Idem section 7.2.5. of annex 4.

7.5. Idem section 7.2.6. of annex 4.

7.6. Idem section 7.2.7. of annex 4.

7.7. Idem section 7.2.8. of annex 4.

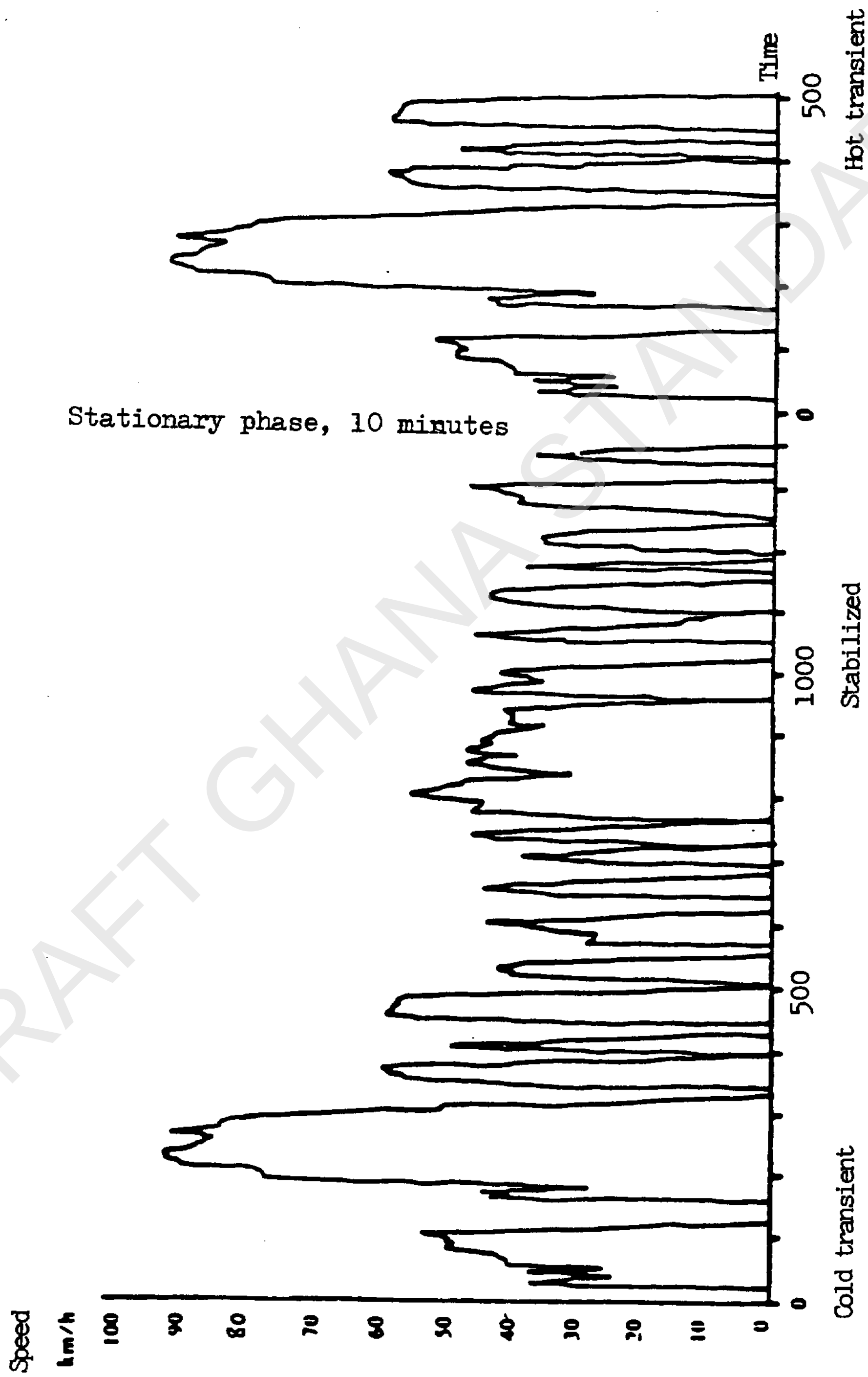
7.8. The spent particulate filters shall be taken to the chamber no later than one hour after conclusion of the test on the exhaust gases and shall there be conditioned for between 2 and 56 hours, and then be weighed.

8. DETERMINATION OF THE QUANTITY OF GASEOUS AND PARTICULATE POLLUTANTS EMITTED

8.1.
8.2. } Idem sections 8.1. and 8.2. of annex 4.

Annex 4A - Appendix 1

DRIVING CYCLE



t	v	t	v	t	v	t	v	t	v	t	v	t	v
0	0,0	20	0,0	40	24,0	60	38,9	80	41,4	100	48,8	120	24,8
1	0,0	21	4,8	41	24,5	61	39,6	81	42,0	101	49,4	121	19,5
2	0,0	22	9,5	42	24,9	62	40,1	82	43,0	102	49,7	122	14,2
3	0,0	23	13,8.	43	25,7	63	40,2	83	44,3	103	49,9	123	8,9
4	0,0	24	16,5	44	27,5	64	39,6	84	46,0	104	49,7	124	3,5
5	0,0	25	23,0	45	30,7	65	39,4	85	47,2	105	48,9	125	0,0
6	0,0	26	27,2	46	34,0	66	39,8	86	48,0	106	48,0	126	0,0
7	0,0	27	27,8	47	36,5	67	39.9	87	48,4	107	48,1	127	0,0
8	0,0	28	29,1	48	36,9	68	39,8	88	48,9	108	48,6	128	0,0
9	0,0	29	33,3	49	36,5	69	39,6	89	49,4	109	49,4	129	0,0
10	0,0	30	34,9	50	36,4	70	39,6	90	49,4	110	50,2	130	0,0
11	0,0	31	36,0	51	34,3	71	40,4	91	49,1	111	51,2	131	0,0
12	0,0	32	36,2	52	30,6	72	41,2	92	48,9	112	51,8	132	0,0
13	0,0	33	35,6	53	27,5	73	41,4	93	48,8	113	52,1	133	0,0
14	0,0	34	34,6	54	25,4	74	40,9	94	48,9	114	51,8	134	0,0
15	0,0	35	33,6	55	25,4	75	40,1	95	49,6	115	51,0	135	0,0
16	0,0	36	32,8	56	28,5	76	40,2	96	48,9	116	46,0	136	0,0
17	0,0	37	31,9	57	31,9	77	40,9	97	48,1	117	40,7	137	0,0
18	0,0	38	27,4	58	34,8	78	41,8	98	47,5	118	35,4	138	0,0
19	0,0	39	24,0	59	37,3	79	41,8	99	48,0	119	30,1	139	0,0

t	v	t	v	t	v	t	v	t	v	t	v	t	v
140	0,0	160	0,0	180	41,5	200	67,8	220	80,5	240	91,2	260	87,1
141	0,0	161	0,0	181	43,8	201	70,0	221	81,4	241	91,2	261	86.6
142	0,0	162	0,0	182	42,6	202	72,6	222	82,1	242	90,9	262	85,9
143	0,0	163	0,0	183	38,6	203	74,0	223	82,9	243	90,9	263	85,3
144	0,0	164	5,3	184	36,5	204	75,3	224	84,0	244	90,9	264	84.7
145	0,0	165	10,6	185	31,2	205	76.4	225	85,6	245	90,9	265	83,8
146	0,0	166	15,9	186	28,5	206	76,4	226	87,1	246	90,9	266	84,3
147	0,0	167	21,2	187	27,7	207	76,1	227	87,9	247	90,9	267	83,7
148	0,0	168	26,6	188	29,1	208	76,0	228	88,4	248	90,8	268	83,5
149	0,0	169	31,9	189	29,9	209	75.6	229	88,5	249	90,3	269	83.2
150	0,0	170	35,7	190	32,2	210	75,6	230	88,4	250	89,8	270	82.9
151	0,0	171	39,1	191	35,7	211	75,6	231	87,9	251	88,7	271	83,0
152	n,o	172	41,5	192	39,4	212	75,6	232	87,9	252	87,9	272	83,4
153	0,0	173	42,5	193	43,9	213	75,6	233	88,2	253	87.2	273	83,8
154	0,0	174	41,4	194	49,1	214	76,0	234	88,7	254	86,9	274	84,5
155	0,0	175	40,4	195	53,9	215	76,3	235	89,3	255	86,4	275	85,3
156	0,0	176	39,8	196	58,3	216	77,1	236	89,6	256	86,3	276	86,1
157	0,0	177	40,2	197	60,0	217	78,1	237	90,3	257	86,7	277	86.9
158	0,0	178	40,6	198	63,2	218	79,0	238	90,6	258	86,9	278	88,4
159	0,0	179	40,9	199	65,2	219	79,7	239	91,1	259	87,1	279	89,2

t	v	t	v	t	v	t	v	t	v	t	v	t	v
280	89,5	300	79,0	320	44,3	340	0,0	360	49,0	380	58,7	400	0,0
281	90,1	301	78,2	321	39,9	341	0,0	361	50,9	381	58,6	401	0,0
282	90,1	302	77,4	322	34,6	342	0,0	362	51,7	382	57,9	402	0,0
283	89,8	303	76,0	323	32,3	343	0,0	363	52,3	383	56,5	403	4,2
284	88,8	304	74,2	324	30,7	344	0,0	364	54,1	384	54,9	404	9,5
28S	87,7	305	72,4	325	29,8	345	0,0	365	55,5	385	53,9	405	14,5
286	86,3	306	70,5	326	27,4	346	0,0	366	55,7	386	50,5	406	20,1
287	84 5	307	68,6	327	24,9	347	1,6	367	56,2	387	46,7	407	25,4
288	82 9	308	66,8	328	20,1	348	6,9	368	56,0	388	41,4	408	30,7
289	82,9	309	64,9	329	17,4	349	12,2	369	55,5	389	37,0	409	36,0
290	82,9	310	62,0	330	12,9	350	17,5	370	55,8	390	32,7	410	40,2
291	82,2	311	59,5	331	7,6	351	22,9	371	57,1	391	28,2	411	41,2
292	80,6	312	56,6	332	2,3	352	27,8	372	57,9	392	23,3	412	44,3
293	80,5	313	54,4	333	0,0	353	32,2	373	57,9	393	19,3	413	46,7
294	80,6	314	52,3	334	0,0	354	36,2	374	57,9	394	14,0	414	48,3
295	80,5	315	50,7	335	0,0	355	38,1	375	57,9	395	8,7	415	48,4
296	79,8	316	49,2	336	0,0	356	40,6	376	57,9	396	3,4	416	48,3
297	79,7	317	49,1	337	0,0	357	42,8	377	57,9	397	0,0	417	47,8
298	79,7	318	48,3	338	0,0	358	45,2	378	58,1	398	0,0	418	47,2
299	79,7	319	46,7	339	0,0	359	46,3	379	58,6	399	0,0	419	46,3

t	v	t	v	t	v	t	v	t	v	t	v	t	v
420	45,1	440	0,0	460	54,1	480	56,6	500	21,2	520	25,7	540	40,6
421	40,2	441	0,0	461	56,0	481	56,3	501	16,6	521	28,5	541	40,2
422	34,9	442	0,0	462	56,5	482	56,5	502	11,6	522	30,6	542	40,2
423	29,6	443	0,0	463	57,3	483	56,6	503	6,4	523	32,3	543	40,2
424	24,3	444	0,0	464	58,1	484	57,1	504	1,6	524	33,6	544	39,3
425	19,0	445	0,0	465	57,9	485	56,6	505	0,0	52S	35,4	545	37,2
426	13,7	446	0,0	466	58,1	486	56,3	506	0,0	526	37,0	546	31,9
427	8,4	447	0,0	467	58,3	487	56,3	507	0,0	527	38,3	547	26,6
428	3,1	448	5,3	468	57,9	488	56,3	508	0,0	528	39,4	548	21,2
429	0,0	449	10,6	469	57,5	489	56,0	509	0,0	529	40,1	549	15,9
430	0 0	450	15,9	470	57,9	490	55,7	510	0,0	530	40,2	550	10,6
431	0,0	451	21,2	471	57,9	491	55,8	511	1,9	531	40,2	551	5,3
432	0,0	452	26,6	472	57,3	492	53,9	512	5,6	532	40,2	552	0,0
433	0,0	453	31,0	473	57,1	493	51,5	513	8,9	533	40,2	553	0,0
434	0,0	454	37,2	474	57,0	494	46,4	514	10,5	534	40,2	554	0,0
435	0,0	455	42,5	475	56,6	495	45,1	515	13,7	535	40,2	555	0,0
436	0,0	456	44,7	476	56,6	496	41,0	516	15,4	536	41,2	556	0,0
437	0,0	457	46,8	477	56,6	497	36,2	517	16,9	537	41,5	557	0,0
438	0,0	458	50,7	478	56,6	498	31,9	518	19,2	538	41,8	558	0,0
439	0,0	459	53,1	479	56,6	499	26,6	519	22,5	539	41,2	559	0,0

t	v	t	v	t	v	t	v	t	v	t	v	t	v
560	0,0	580	28,5	600	34,8	620	0,0	640	0,0	660	41,2	680	0,0
561	0,0	581	28,2	601	35,4	621	0,0	641	0,0	661	41,8	681	0,0
562	0,0	582	27,4	602	36,0	622	0,0	642	0,0	662	43,9	682	0,0
563	0,0	583	27,2	603	36,2	623	0,0	643	0,0	663	43,1	683	0,0
564	0,0	584	26,7	604	36,2	624	0,0	644	0,0	664	42,3	684	0,0
565	0,0	585	27,4	605	36,2	625	0,0	645	0,0	665	42,5	685	0,0
566	0,0	586	27,5	606	36,5	626	0,0	646	3,2	666	42,6	686	0,0
567	0,0	587	27,4	607	38,1	627	0,0	647	7,2	667	42,6	687	0,0
568	0,0	588	26,7	608	40,4	628	0,0	648	12,6	668	41,8	688	0,0
569	5,3	589	26,6	609	41,8	629	0,0	649	16,4	669	41,0	689	0,0
570	10,6	590	26,6	610	42,6	630	0,0	650	20,1	670	38,0	690	0,0
571	15,9	591	26,7	611	43,5	631	0,0	651	22,5	671	34,4	691	0,0
572	20,9	592	27,4	612	42,0	632	0,0	652	24,6	672	29,8	692	0,0
573	23,5	593	28,3	613	36,7	633	0,0	653	28,2	673	26,4	693	0,0
574	25,7	594	29,8	614	31,4	634	0,0	654	31,5	674	23,3	694	2,3
575	27,4	595	30,9	615	26,1	635	0,0	655	33,8	675	18,7	695	5,3
576	27,4	596	32,5	616	20,8	636	0,0	656	35,7	676	14,0	696	7,1
577	21,4	597	33,8	617	15,4	637	0,0	657	37,5	677	9,3	697	10,5
578	28,2	598	34,0	618	10,1	638	0,0	658	39,4	678	5,6	698	14,8
579	28,5	599	34,1	619	4,8	639	0,0	659	40,7	679	3,2	699	18,2

t	v	t	v	t	v	t	v	t	v	t	v	t	v
700	21,7	720	24,1	740	41,0	760	15,1	780	44,3	800	45,1	820	50,9
701	23,5	721	19,3	741	42,6	761	10,0	781	45,1	801	45,9	821	50,7
702	26,4	722	14,5	742	43,6	762	4,8	782	45,5	802	48,3	822	49,2
703	26,9	723	10,0	743	44,4	763	2,4	783	46,5	803	49,9	823	48,3
704	26,6	724	7,2	744	44,9	764	2,4	784	46,5	804	51,5	824	48,1
705	26,6	725	4,8	745	45,5	765	0,8	785	46,5	805	53,1	825	48,1
706	29,3	726	3,4	746	46,0	766	0,0	786	46,3	806	53,1	826	48,1
707	30,9	727	0,8	747	46,0	767	4,8	787	45,9	807	54,1	827	48,1
708	32,3	728	0,8	748	45,5	768	10,1	788	45,5	808	54,7	828	47,6
709	34,6	729	5,1	749	45,4	769	15,4	789	45,5	809	55,2	829	47,5
710	36,2	730	10,5	750	45,1	770	20,8	790	45,5	810	55,0	830	47,5
711	36,2	731	15,4	751	44,3	771	25,4	791	45,4	811	54,7	831	47,2
712	35,6	732	20,1	752	43,1	772	28,2	792	44,4	812	54,7	832	46,5
713	36,5	733	22,5	753	41,0	773	29,6	793	44,3	813	54,6	833	45,4
714	37,5	734	25,7	754	37,8	774	31,4	794	44,3	814	54,1	834	44,6
715	37,8	735	29,0	755	34,6	775	33,3	795	44,3	815	53,3	835	43,5
716	36,2	736	31,5	756	30,6	776	35,4	796	44,3	816	53,1	836	41,0
717	34,8	737	34,6	757	26,6	777	37,3	797	44,3	817	52,3	837	38,1
718	33,0	738	37,2	758	24,0	778	40,2	798	44,3	818	51,5	838	35,4
719	29,0	739	39,4	759	20,1	779	42,6	799	44,4	819	51,3	839	33,0

t	v	t	v	t	v	t	v	t	v	t	v	t	v
840	30,9	860	46,7	880	46,8	900	43,3	920	36,4	940	40,2	960	3,2
841	30 9	861	46,8	881	46,7	901	42,8	921	37,7	941	39,6	961	8,5
842	32,3	862	46,7	882	46,5	902	42,6	922	38,6	942	39,6	962	13,8
843	33,6	863	45,2	883	45,9	903	42,6	923	38,9	943	38,8	963	19,2
844	34,4	864	44,3	884	45,2	904	42,6	924	39,3	944	39,4	964	24,5
845	35,4	865	43,5	885	45,1	905	42,3	925	40,1	945	40,4	965	28,2
846	36 4	866	41,5	886	45,1	906	42,2	926	40,4	946	41,2	966	29,9
847	37,3	867	40,2	887	44,4	907	42,2	927	40,6	947	40,4	967	32,2
848	38,6	868	39,4	888	43,8	908	41,7	928	40,7	948	38,6	968	34,0
849	40,2	869	39,9	889	42,8	909	41,2	929	41,0	949	35,4	969	35,4
850	41,8	870	40,4	890	43,5	910	41,2	930	40,6	950	32,3	970	37,0
851	42,8	871	41,0	891	44,3	911	41,7	931	40,2	951	27,2	971	39,4
852	42,8	872	41,4	892	44,7	912	41,5	932	40,3	952	21,9	972	42,3
853	43,1	873	42,2	893	45,1	913	41,0	933	40,2	953	16,6	973	44,3
854	43,5	874	43,3	894	44,7	914	39,6	934	39,8	954	11,3	974	45,2
855	43,8	875	44,3	895	45,1	915	37,8	935	39,4	955	6,0	975	45,7
856	44,7	876	44,7	896	45,1	916	35,7	936	39,1	956	0,6	976	45,9
857	45,2	877	45,7	897	45,1	917	34,8	937	39,1	957	0,0	977	45,9
858	46,3	878	46,7	898	44,6	918	34,8	938	39,4	958	0,0	978	45,9
859	46,5	879	47,0	899	44,1	919	34,9	939	40,2	959	0,0	979	44,6

t	v	t	v	t	v	t	v	t	v	t	v	t	v
980	44,3	1000	37,8	1020	12,2	1040	0,0	1060	32,2	1080	29,0	1100	0,0
981	43,8	1001	38,6	1021	6,9	1041	0,0	1061	35,1	1081	24,1	1101	0,2
982	43,1	1002	39,6	1022	1,6	1042	0,0	1062	37,0	1082	19,8	1102	1,0
983	42,6	1003	39,9	1023	0,0	1043	0,0	1063	38,6	1083	17,9	1103	2,6
984	41,8	1004	40,4	1024	0,0	1044	0,0	1064	39,9	1084	17,1	1104	5,8
985	41,4	1005	41,0	1025	0,0	1045	0,0	1065	41,2	1085	16,1	1105	11,1
986	40,6	1006	41,2	1026	0,0	1046	0,0	1066	42,6	1086	15,3	1106	16,1
987	38,6	1007	41,0	1027	0,0	1047	0,0	1067	43,1	1087	14,6	1107	20,6
988	35,4	1008	40,2	1028	0,0	1048	0,0	1068	44,1	1088	14,0	1108	22,5
989	34,6	1009	38,8	1029	0,0	1049	0,0	1069	44,9	1089	13,8	1109	23,3
990	34,6	1010	38,1	1030	0,0	1050	0,0	1070	45,5	1090	14,2	1110	25,7
991	35,1	1011	37,3	1031	0,0	1051	0,0	1071	45,1	1091	14,5	1111	29,1
992	36,2	1012	36,9	1032	0,0	1052	0,0	1072	44,3	1092	14,0	1112	32,2
993	37,0	1013	36,2	1033	0,0	1053	1,9	1073	43,5	1093	13,8	1113	33,8
994	36,7	1014	35,4	1034	0,0	1054	6,4	1074	43,5	1094	12,9	1114	34,1
995	36,7	1015	34,8	1035	0,0	1055	11,7	1075	42,3	1095	11,3	1115	34,3
996	37,0	1016	33,0	1036	0,0	1056	17,1	1076	39,4	1096	8,0	1116	34,4
997	36,5	1017	28,2	1037	0,0	1057	22,4	1077	36,2	1097	6,8	1117	34,9
998	36,5	1018	22,9	1038	0,0	1058	27,4	1078	34,6	1098	4,2	1118	36,2
999	36,5	1019	17,5	1039	0,0	1059	29,8	1079	33,2	1099	1,6	1119	37,0

t	v	t	v	t	v	t	v	t	v	t	v	t	v
1120	38,3	1140	41,8	1160	0,0	1180	32,2	1200	10,5	1220	34,6	1240	9,7
1121	39,4	1141	41,0	1161	0,0	1181	26,9	1201	15,8	1221	35,1	1241	6,4
1122	40,2	1142	39,6	1162	0,0	1182	21,6	1202	19,3	1222	35,4	1242	4.0
1123	40,1	1143	37,8	1163	0,0	1183	16,3	1203	20,8	1223	35,2	1243	1,1
1124	39,9	1144	34,6	1164	0,0	1184	10,9	1204	20,9	1224	34,9	1244	0,0
1125	40,2	1145	32,2	1165	0,0	1185	5,6	1205	20,3	1225	34,6	1245	0,0
1126	40,9	1146	28,2	1166	0,0	1186	0,3	1206	20,6	1226	34,6	1246	0,0
1127	41,5	1147	25,7	1167	0,0	1187	0,0	1207	21,1	1227	34,4	1247	0,0
1128	41,8	1148	22,5	1168	0,0	1188	0,0	1208	21,1	1228	32,3	1248	0,0
1129	42,5	1149	17,2	1169	3,4	1189	0,0	1209	22,5	1229	31,4	1249	0,0
1130	42,8	1150	11,9	1170	8,7	1190	0,0	1210	24,9	1230	30,9	1250	0,0
1131	43,3	1151	6,6	1171	14,0	1191	0,0	1211	27,4	1231	31,5	1251	0,0
1132	43,5	1152	1,3	1172	19,3	1192	0,0	1212	29,9	1232	31,9	1252	1,6
1133	43,5	1153	0,0	1173	24,6	1193	0,0	1213	31,7	1233	32,2	1253	1,6
1134	43,5	1154	0,0	1174	29,9	1194	0,0	1214	33,8	1234	31,4	1254	1,6
1135	43,3	1155	0,0	1175	34,0	1195	0,0	1215	34,6	1235	28,2	1255	1,6
1136	43,1	1156	0,0	1176	37,0	1196	0,0	1216	35,1	1236	24,9	1256	1,6
1137	43,1	1157	0,0	1177	37,8	1197	0,3	1217	35,1	1237	20,9	1257	2,6
1138	42,6	1158	0,0	1178	37,0	1198	2,4	1218	34,6	1238	16,1	1258	4,8
1139	42,5	1159	0,0	1179	36,2	1199	5,6	1219	34,1	1239	12,9	1259	6,4

t	v	t	v	t	v	t	v	t	v	t	v
1260	8,0	1280	39,4	1300	45,5	1320	0,0	1340	13,0	1360	26,6
1261	10,1	1281	38,6	1301	46,7	1321	0,0	1341	18,3	1361	24,9
1262	12,9	1282	37,8	1302	46,8	1322	0,0	1342	21,2	1362	22,5
1263	16,1	1283	37,8	1303	46,7	1323	0,0	1343	24,3	1363	17,7
1264	16,9	1284	37,8	1304	45,1	1324	0,0	1344	27,0	1364	12,9
1265	15,3	1285	37,8	1305	39,8	1325	0,0	1345	29,5	1365	6,4
1266	13,7	1286	37,8	1306	34,4	1326	0,0	1346	31,4	1366	4,0
1267	12,2	1287	37,8	1307	29,1	1327	0,0	1347	32,7	1367	0,0
1268	14,2	1288	38,6	1308	23,8	1328	0,0	1348	34,3	1368	0,0
1269	17,7	1289	38,8	1309	18,5	1329	0,0	1349	35,2	1369	0,0
1270	22,5	1290	39,4	1310	13,2	1330	0.0	1350	35,6	1370	0,0
1271	27,4	1291	39,8	1311	7,9	1331	0,0	1351	36,0	1371	0,0
1272	31,4	1292	40,2	1312	2,6	1332	0,0	1352	35,4		
1273	33,8	1293	40,9	1313	0,0	1333	0.0	1353	34,8		
1274	35,1	1294	41,2	1314	0,0	1334	0,0	1354	34,0		
1215	35,7	1295	41,4	1315	0,0	1335	0,0	1355	33,0		
1276	37,0	1296	41,8	1316	0,0	1336	0,0	1356	32,2		
1277	38,0	1297	42,2	1317	0,0	1337	0,0	1357	31,5		
1278	38,8	1298	43,5	1318	0,0	1338	2,4	1358	29,8		
1279	39,4	1299	44,71	1319	0,0	1339	7,7	1359	28,2		

Annex 4A - Appendix 2

CHASSIS DYNAMOMETER

1. DEFINITION

1.1 Introduction

In the event that the total resistance to progress on the road cannot be reproduced on the chassis dynamometer between speeds of 10 and 80.5 km/h, it is recommended that a chassis dynamometer having the characteristics defined below should be used.

2. METHOD OF CALIBRATING THE DYNAMOMETER

2.1. Idem paragraph 2.1. of appendix 2 to annex 4

2.2. Calibrating the power indicator to 80.5 km/h

2.2.1. The dynamometer must be calibrated at least once each month or performance verified at least once each week with a view to calibration if required. Calibration must be carried out at 80.5 km/h in accordance with the procedure described below. The measured absorbed power comprises the power absorbed by frictional effects and the power absorbed by the power absorption device. The dynamometer is driven above the test speed range. The device used for starting up the dynamometer is then disengaged from the dynamometer and the roller(s) is (are) allowed to coast down. The kinetic energy of the roller is dissipated by the power absorption device and frictional effects. This method disregards variations in the internal friction of the rollers when carrying a load or running free. The frictional effects of the rear roll shall be disregarded when this is free.

2.2.1.1. Measure the rotational speed of the drive roller if this has not already been done. A fifth wheel, a revolution counter or other suitable means may be used.

2.2.1.2. Place a vehicle on the dynamometer or use another method of starting up the dynamometer.

2.2.1.3. Engage the flywheel or other system of inertia simulation for the most common vehicle mass category for which the dynamometer is used. In addition other vehicle mass categories may be calibrated, if desired.

2.2.1.4. Drive the dynamometer up to 80.5 km/h.

2.2.1.5. Record indicated road power.

2.2.1.6. Drive the dynamometer up to 96.9 km/h.

2.2.1.7. Disengage the device used to drive the dynamometer.

2.2.1.8. Record the time for the dynamometer drive roller to coast down from 88.5 km/h to 72.4 km/h.

2.2.1.9. Adjust the power absorption device to a different level.

2.2.1.10. Repeat operations of paragraphs 2.2.1.1. to 2.2.1.9. above a sufficient number of times to cover the range of absorbed power used.

2.2.1.11. Calculate the power absorbed. See paragraph 2.2.3.

2.2.1.12. Plot power indicated at 80.5 km/h versus absorbed power (as shown in figure A).

2.2.2. The performance check consists of conducting a dynamometer coastdown at one or more inertia-horsepower settings and comparing the coastdown time to that recorded during the last calibration. If the coastdown times differ by more than 1 s a new calibration is required.

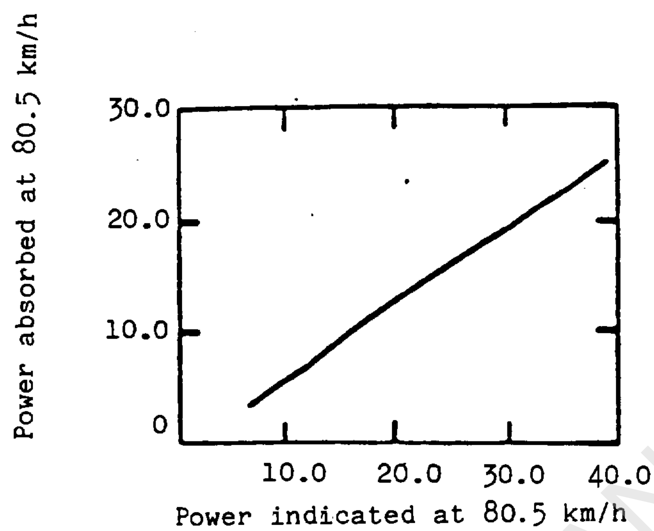
2.2.3. Calculations

The power actually absorbed by the dynamometer is calculated from the following equation:

$$P_a = W \frac{V_1^2 - V_2^2}{2\ 000\ t}$$

where:

Pa = power (kW)
W = equivalent inertia (kg)
V_1 = initial velocity (m/s)
V_2 = final velocity (m/s)
t = elapsed time for rollers to coast from 88.5 to 72.4 km/h.



Power absorbed = f/power indicated

Figure A

2.3. Idem paragraph 2.3. of appendix 2 to annex 4.

3. SETTING OF THE DYNAMOMETER

3.1. Vacuum Method

3.1.1. Introduction

This method is not a preferred method and should be used only with fixed load curve shape dynamometers for determination of load setting at 80.5 km/h and cannot be used for vehicles with compression-ignition engines.

3.1.2. Test Instrumentation

The vacuum (or obsolute pressure) in the vehicle's intake manifold shall be measured to an accuracy of ± 0.25 kPa. It shall be possible to record this reading continuously or at intervals of no more than 1 second. The speed shall be recorded continuously with a precision of ± 0.4 km/h.

3.1.3. Road Test

3.1.3.1. Ensure that the requirements of paragraph 4 of appendix 3 to this annex are met.

3.1.3.2. Drive the vehicle at a steady speed of 80.5 km/h, recording speed and vacuum (or absolute pressure) within the requirements of paragraph 3.1.2.

3.1.3.3. Repeat procedure of paragraph 3.1.3.2. three times in each direction. All six runs must be completed within four hours.

3.1.4. Data Reduction and Acceptance Criteria

3.1.4.1. Review results obtained in accordance with paragraphs 3.1.3.2. and 3.1.3.3. (speed must not be lower than 79.5 km/h or greater than 81.0 km/h for more than 1 second). For each run, read vacuum level at 1 second intervals, calculate mean vacuum ($\bar{v}$) and standard deviation(s); this calculation shall consist of no less than 10 readings of vacuum.

3.1.4.2. The standard deviation shall not exceed 10% of mean ($\bar{v}$) for each run.

3.1.4.3. Calculate the mean value ($\bar{v}$) for the six runs (three runs in each direction).

3.1.5. Dynamometer setting

3.1.5.1. Preparation

Perform the operations specified in paragraphs 5.1.2.2.1. to 5.1.2.2.4. of appendix 3 to this annex.

3.1.5.2. Power absorption device setting

After warm-up, drive the vehicle at a steady speed of 80.5 km/h and adjust power absorption device to reproduce the vacuum reading (v) obtained in accordance with paragraph 3.1.4.3. Deviation from this reading shall be no greater than 0.25 kPa. The same instruments shall be used for this exercise as were used during the road test.

3.2. Other setting methods

The dynamometer may be carried out at a constant speed of 80.5 km/h in accordance with the provisions of appendix 3 to this annex.

3.3. Alternative method

3.3.1. The power absorption device is adjusted to reproduce power absorbed at 80.5 km/h true speed. The dynamometer power absorption must take into account friction.

The following method has been established for small twin-roll dynamometers having a nominal roll diameter of 220 mm and a nominal roll spacing of 432 mm and large single-roll dynamometers having a nominal roll-diameter of 1,219 mm. Dynamometers with other roll specifications may be used if approved by the technical service.

3.3.2. The dynamometer road load setting is determined from the equivalent test mass, the reference frontal area, the body shape, the vehicle protuberances and the tyre type according to the following equations.

3.3.2.1. For light-duty vehicles to be tested on a twin-roller dynamometer:

$$P_A = aA + P + tw$$

where:

P_A = setting at 80.5 km/h (kW)

A = the vehicle reference frontal area (m^2). The vehicle reference frontal area is defined as the area of the orthogonal projection of the vehicle including tyres and suspension components, but excluding vehicle protuberances, on to a plane perpendicular to both the longitudinal plane of the vehicle and the surface upon which the vehicle is positioned. Measurements of this area are computed to the nearest hundredth of a square metre using a method approved in advance by the technical service responsible for the tests.

P = the protuberance power correction factor from table 1 of this section

w = vehicle equivalent test mass (kg)

a = 3.45 for fastback-shaped vehicles: = 4.01 for all other light-duty vehicles

t = 0.0 for vehicles equipped with radial-ply tyres:
= 4.93×10^{-4} for all other vehicles

A vehicle is considered to have a fastback shape if the rearward projection of that portion of the rear surface (A2) which slopes at an angle of less than 20° from the horizontal is at least 25% as large as the vehicle reference frontal area. In addition, this surface must be smooth, continuous, and free from any local transitions greater than 4°. An example of a fastback shape is presented in figure 1.

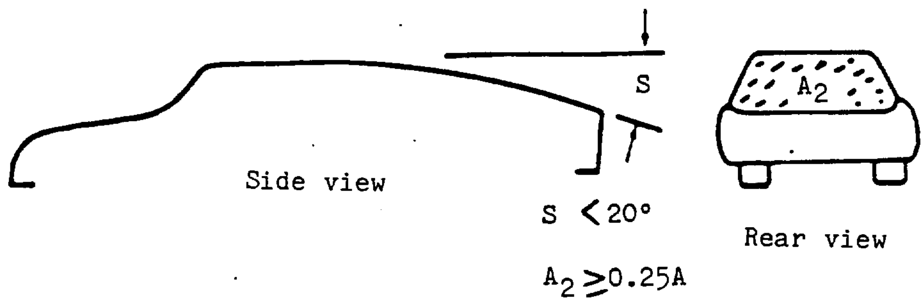


Figure 1

TABLE 1

Protuberance power (P) versus total protuberance frontal area (Ap)

Ap (m^2)	P
Ap < 0.03	0.0
0.03 ≤ Ap < 0.06	0.30
0.06 ≤ Ap < 0.08	0.52
0.08 ≤ Ap < 0.11	0.75
0.11 ≤ Ap < 0.14	0.97
0.14 ≤ Ap < 0.17	1.19
0.17 ≤ Ap < 0.19	1.42
0.19 ≤ Ap < 0.22	1.64
0.22 ≤ Ap < 0.25	1.87
0.25 ≤ Ap < 0.28	2.09
0.28 ≤ Ap	2.31

The protuberance frontal area, Ap, is defined in a manner analogous to the definition of the vehicle reference frontal area, i.e. the total area of the orthogonal projections of the vehicle mirrors, handles, roof racks, and other protuberances on to a plane perpendicular to both the longitudinal plane of the vehicle and the surface upon which the vehicle is positioned. A protuberance is defined as any fixture attached to the vehicle protruding more than 2.54 cm from the vehicle surface and having a projected area greater than 0.00093 m^2 with the area calculated by a method approved in advance by the technical service responsible for the tests. Included in the total protuberance frontal area are all fixtures which occur as standard equipment. The area of any optional equipment is also included if it is expected that more than 33% of the vehicle range sold will be equipped with this option.

3.3.2.2. The dynamometer power absorber setting for light-duty vehicles is rounded off to the nearest 0.1 kW.

3.3.2.3. The equation to be used for testing light-duty vehicles on a single large-roller dynamometer is as follows:

$$PA = aA + P + (8.22 \times 10^{-4} + 0.33\ t)w$$

All symbols in the above equation are defined in section 3.3.2.1.

Annex 4A - Appendix 3

RUNNING RESISTANCE - ROAD MEASUREMENT AND C/D SETTING

(Idem appendix 3 to annex 4)

Annex 4A - Appendix 4

VERIFICATION OF INERTIAS OTHER THAN MECHANICAL

(*Idem* appendix 4 of annex 4)

Annex 4A - Appendix 5

DESCRIPTION OF SAMPLING SYSTEMS FOR GASEOUS AND PARTICULATE POLLUTANTS

This appendix is identical to annex 4, appendix 5, except for:

Paragraph 2.2.4., amend as follows:

"2.2.4 The particulate sampling system consists of a sampling probe in the dilution tunnel and three filter units comprising two series-mounted filters towards which the sample gas flow can be directed during a test phase. The sample gas flows pass successively through the three filter units during the 'transient after cold start', 'stabilized after cold start' and 'transient after hot start' phases."

Paragraph 3. becomes:

"3. DESCRIPTION OF THE DEVICES

The systems coincide with those described in annex 4, appendix 5, paragraph 3, with the exception that in each case three sample bags for exhaust gas samples and ambient air samples are arranged in parallel in such a way that they can in turn have the sample gas flow directed towards them via quick-acting valves.

Accordingly, in the tests on vehicles equipped with diesel engines, three pairs of particulate measurement filters are arranged in parallel."

Annex 4A - Appendix 6

METHOD OF CALIBRATING THE EQUIPMENT

(Idem appendix 6 to annex 4)

Annex 4A - Appendix 7

TOTAL SYSTEM VERIFICATION

(Idem appendix 7 to annex 4)

Annex 4A - Appendix 8

CALCULATION OF THE MASS EMISSIONS OF POLLUTANTS

1. The mass emissions of pollutants are calculated by the following equation:

$$Mi = 0.43 \frac{M_{icT} M_{is}}{S_{cT} + S_s} + 0.57 \frac{M_{iHT} + M_{is}}{S_{HT} + S_s}$$

where:

Mi = mass emission of the pollutant, i, in grams per kilometre

M_{icT} = mass emission of the pollutant, i, in grams, during the first phase (transient cold)

M_{iHT} = mass emission of the pollutant, i, in grams, during the last phase (transient hot)

M_{is} = mass emission of the pollutant, i, in grams, during the second phase (stabilized)

S_{cT} = distance (in km) which has been run during the first phase

S_{HT} = distance (in km) which has been run during the last phase

S_s = distance (in km) which has been run during the second phase

2. The mass emissions of pollutants are calculated by means of the following:

$$Mi = V_{mix} \times Q_i \times k_H \times C_i \times 10^{-6}$$

where:

Mi = mass emission of the pollutant, i, in grams, per phase

V_{mix} = volume of the diluted exhaust gas, expressed in litres, per phase 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)

k_H = humidity correction factor used for the calculation of the mass emissions of oxides of nitrogen. There is no humidity correction for HC and CO.

C_i = concentration of the pollutant, i, in the diluted exhaust gas expressed in parts per million and corrected by the amount of the pollutant, i, contained in the dilution air.

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

3.1. HC measurement

The HC emissions in the individual phases shall be determined in accordance with annex 4, appendix 8, paragraph 2.1.

3.2. Particulate measurement

The particulate emissions in the individual phases shall be determined in accordance with annex 4, appendix 8, paragraph 2.2.

The total emission shall be calculated in accordance with paragraph 1 of this appendix.

Annex 4A - Appendix 9

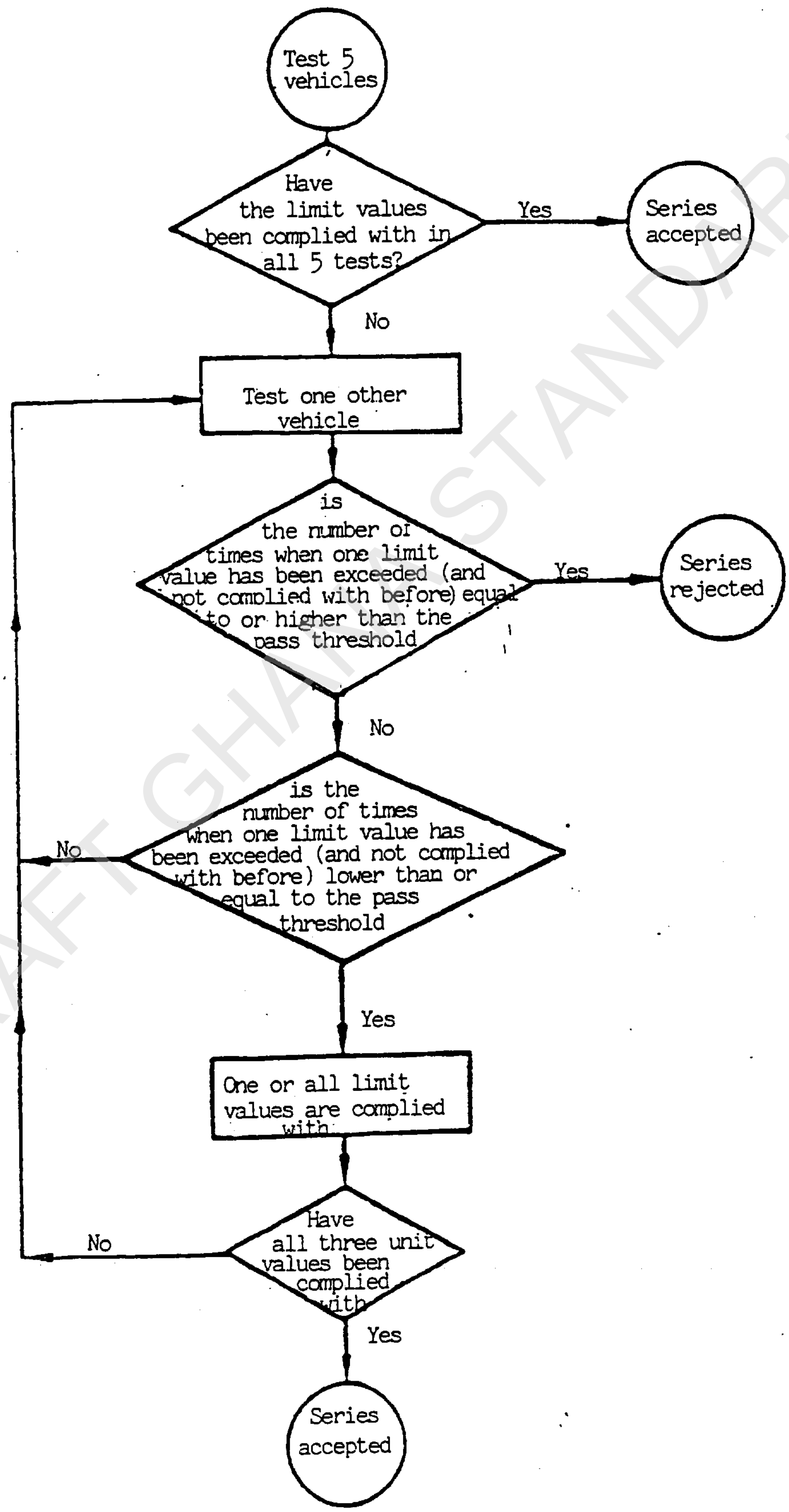
CONFORMITY OF PRODUCTION

Cumulative number of vehicles tested	Pass decision (number of failures)	Fail decision (number of failures)
1	1/	2/
2	1/	2/
3	1/	2/
4	1/	2/
5	0	2/
6	0	6
7	1	7
8	2	8
9	2	8
10	3	9
11	3	9
12	4	10
13	4	10
14	5	11
15	5	11
16	6	12
17	6	12
18	7	13
19	7	13
20	8	14
21	8	14
22	9	15
23	9	15
24	10	16
25	11	16
26	11	17
27	12	17
27	12	18
28	13	19
29	13	19
30	14	20
31	14	20
32	15	21
33	15	21
34	16	22
35	16	22
36	17	23
37	17	23
38	18	24
39	18	24
40	19	25
41	19	26
42	20	26
43	21	27
44	21	27
45	22	28
46	22	28
47	23	29
48	23	29
49	24	30
50	24	30
51	25	31
52	25	31
53	26	32
54	26	32
55	27	33
56	27	33
57	28	33
58	28	33
59	32	33
60		

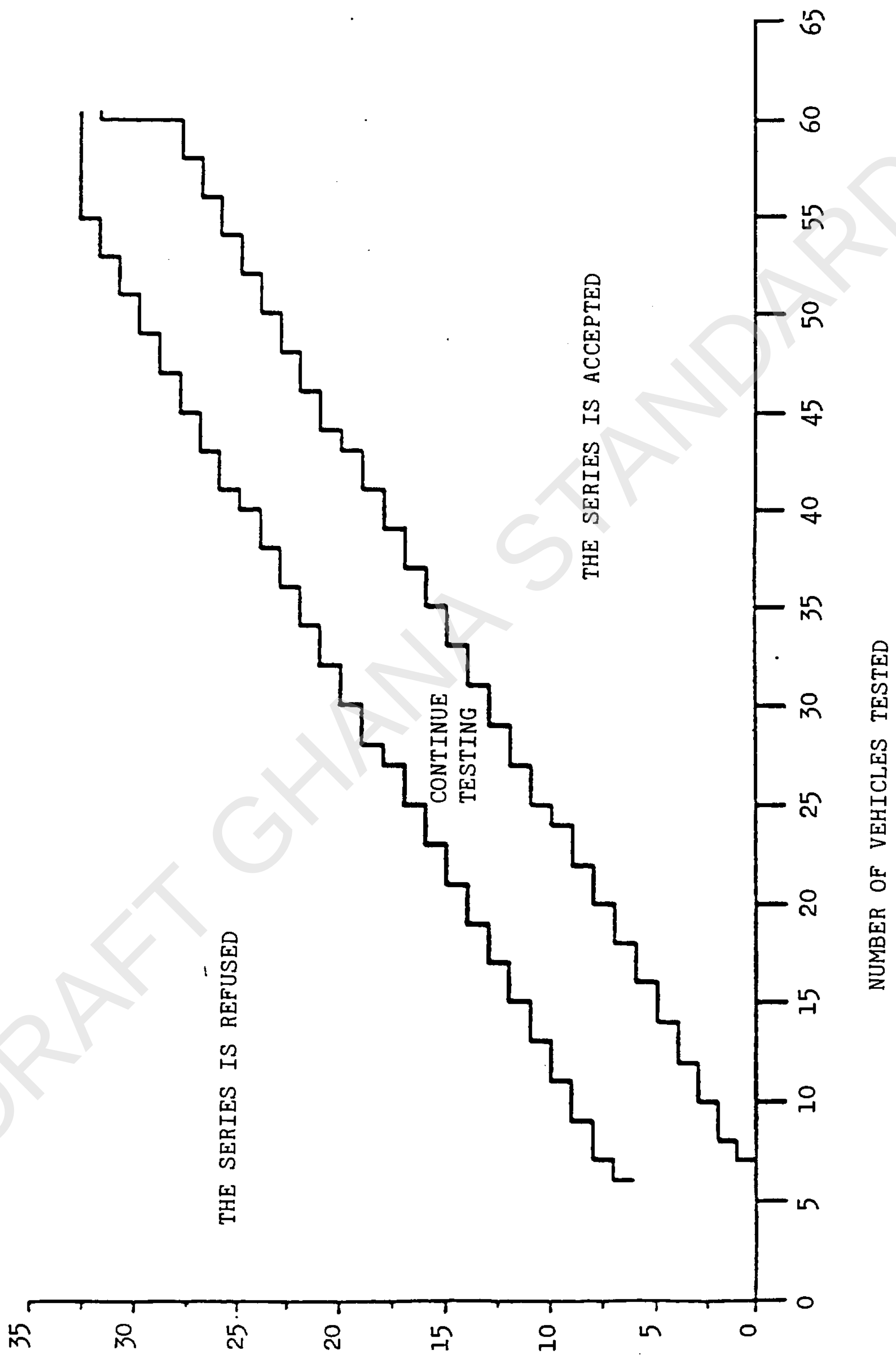
1/ Series not able to pass at this stage.

2/ Series not able to fail at this stage.

SAMPLING PLAN FOR USE WITH ANNEX 4A TEST



SAMPLING PLAN FOR USE WITH ANNEX 4A TEST



Annex 5

TYPE II TEST

(Carbon monoxide emission test at idling speed)

1. INTRODUCTION

This annex describes the procedure for the type II test defined in paragraph 5.3.2. of this Regulation.

2. CONDITIONS OF MEASUREMENT

2.1. The fuel shall be the reference fuel, specifications for which are given in annex 9 to this Regulation.

2.2. The type II test shall be carried out immediately after the completion of the urban cycle (part one) of the type I test, with the engine at idle and without using the cold-start device. Immediately before each measurement of carbon monoxide content, an elementary urban cycle as described in annex 4, paragraph 2.1. to this Regulation, shall be effected.

2.3. In the case of vehicles with manually-operated or semi-automatic-shift gearboxes, the test shall be carried out with the gear lever in the "neutral" position and with the clutch engaged.

2.4. In the case of vehicles with automatic-shift gear-boxes, the test shall be carried out with the gear selector in either the "neutral" or the "parking" position.

2.5. Components for adjusting the idling speed

2.5.1. Definition

For the purposes of this Regulation, "components for adjusting the idling speed" means controls for changing the idling conditions of the engine which may be easily operated by a mechanic using only the tools described in paragraph 2.5.1.1. In particular, devices for calibrating fuel and air flows are not considered as adjustment components if their setting requires the removal of the set-stops, an operation which cannot normally be performed except by a professional mechanic.

2.5.1.1 Tools which may be used to control components for adjusting the idling speed: screwdrivers (ordinary or cross-headed), spanners (ring, open-end or adjustable), pliers, Allen keys.

2.5.2. Determination of measurement points

2.5.2.1. A measurement at the setting used for the type I test shall be performed first.

2.5.2.2. For each adjustment component with a continuous variation, a sufficient number of characteristic positions shall be determined.

2.5.2.3. The measurement of the carbon-monoxide content of exhaust gases shall be carried out for all the possible positions of the adjustment components, but for components with a continuous variation only the positions defined in paragraph 2.5.2.2. shall be adopted.

2.5.2.4. The type II test shall be considered satisfactory if one or both of the two following conditions is met:

2.5.2.4.1. none of the values measured in accordance with paragraph 2.5.2.3. exceeds the limit values;

2.5.2.4.2. the maximum content obtained by continuously varying one of the adjustment components while the other components are kept stable does not exceed the limit value, this condition being met for the various combinations of adjustment components other than the one which was varied continuously.

2.5.2.5. The possible positions of the adjustment components shall be limited:

2.5.2.5.1. on the one hand, by the larger of the following two values: the lowest idling speed which the engine can reach; the speed recommended by the manufacturer, minus 100 revolutions per minute;

2.5.2.5.2. on the other hand, by the smallest of the following three values: the highest speed the engine can attain by activation of the idling speed components; the speed recommended by the manufacturer, plus 250 revolutions per minute; the cut-in speed of automatic clutches.

2.5.2.6. In addition, settings incompatible with correct running of the engine shall not be adopted as measurement settings. In particular, when the engine is equipped with several carburettors all the carburettors shall have the same setting.

3. SAMPLING OF GASES

3.1. The sampling probe shall be placed in the pipe connecting the exhaust with the sampling bag and as close as possible to the exhaust.

3.2. The concentration in CO (C_{co}) and CO_2 (C_{co2}) shall be determined from the measuring instrument readings or recordings, by use of appropriate calibration curves.

3.3. The corrected concentration for carbon monoxide regarding four-stroke engines is:

$$C_{co}\ corr = C_{co} \frac{15}{C_{co} + C_{co_2}}\ (\%\ vol)$$

3.4. The concentration in C_{co} (see paragraph 3.2.) measured according to the formulae contained in paragraph 3.3. need not be corrected if the total of the concentrations measured (C_{co} + C_{co2}) is at least 15 for four-stroke engines.

Annex 6

TYPE III TEST

(Verifying emissions of crankcase gases)

1. INTRODUCTION

This annex describes the procedure for the type III test defined in paragraph 5.3.3. of this Regulation.

2. GENERAL PROVISIONS

2.1. Test III shall be carried out on the vehicle with positive-ignition engine subjected to the type I and the type II test.

2.2. The engines tested shall include leak-proof engines other than those so designed that even a slight leak may cause unacceptable operating faults (such as flat-twin engines).

3. TEST CONDITIONS

3.1. Idling shall be regulated in conformity with the manufacturer's recommendations.

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

Condition No.	Vehicle speed (km/h)
1	Idling
2	50 ± 2
3	50 ± 2
Condition No.	**Power absorbed by brake**
1	Nil
2	That corresponding to the settings for type I tests
3	That for conditions No. 2, multiplied by a factor of 1.7

4. TEST METHOD

4.1. For the operation conditions as listed in paragraph 3.2. above, reliable function of the crankcase ventilation system shall be checked.

5. METHOD OF VERIFICATION OF THE CRANKCASE VENTILATION SYSTEM

5.1. The engine's apertures shall be left as found.

5.2. The pressure in the crankcase shall be measured at an appropriate location. It shall be measured at the dipstick hole with an inclined-tube manometer.

5.3. The vehicle shall be deemed satisfactory if, in every condition of measurement defined in paragraph 3.2. above, the pressure measured in the crankcase does not exceed the atmospheric pressure prevailing at the time of measurement.

5.4. For the test by the method described above, the pressure in the intake manifold shall be measured to within ± 1 kPa.

5.5. The vehicle speed as indicated at the dynamometer shall be measured to within ± 2 km/h.

5.6. The pressure measured in the crankcase shall be measured to within ± 0.01 kPa.

5.7. If in one of the conditions of measurement defined in paragraph 3.2. above, the pressure measured in the crankcase exceeds the atmospheric pressure, an additional test as defined in paragraph 6 shall be performed if so requested by the manufacturer.

6. ADDITIONAL TEST METHOD

6.1. The engine's apertures shall be left as found.

6.2. A flexible bag impervious to crankcase gases and having a capacity of approximately five litres shall be connected to the dipstick hole. The bag shall be empty before each measurement.

6.3. The bag shall be closed before each measurement. It shall be opened to the crankcase for five minutes for each condition of measurement prescribed in paragraph 3.2. above.

6.4. The vehicle shall be deemed satisfactory if, in every condition of measurement defined in paragraph 3.2., no visible inflation of the bag occurs.

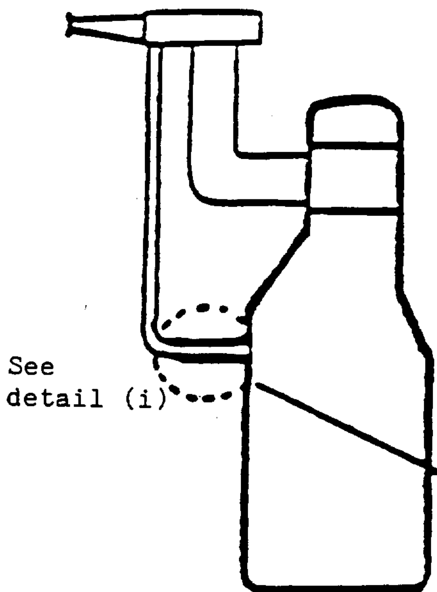
6.5. Remark

6.5.1. If the structural layout of the engine is such that the test cannot be performed by the methods described in paragraphs 6.1. to 6.4. above, the measurements shall be effected by that method modified as follows:

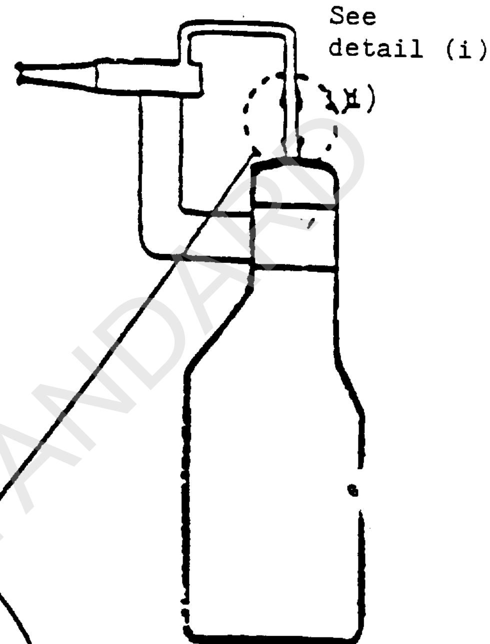
6.5.2. Before the test, all apertures other than that required for the recovery of the gases shall be closed;

6.5.3. The bag shall be placed on a suitable take-off which does not introduce any additional loss of pressure and is installed on the recycling circuit of the device directly at the engine-connection aperture.

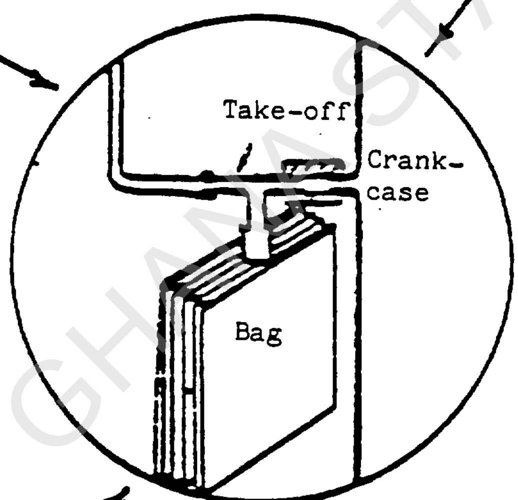
TYPE III TEST



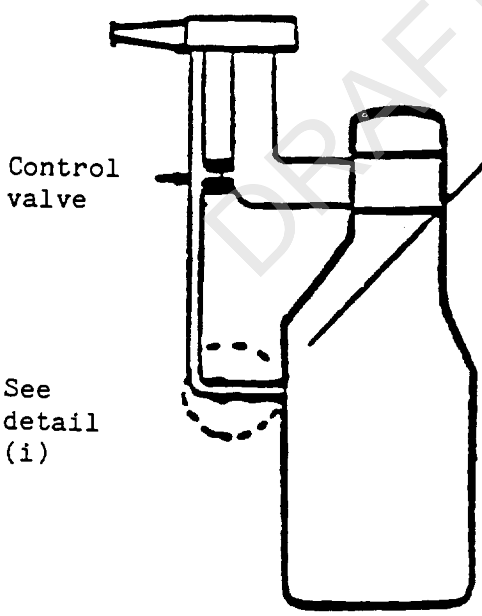
(a) direct recycling at slight vacuum



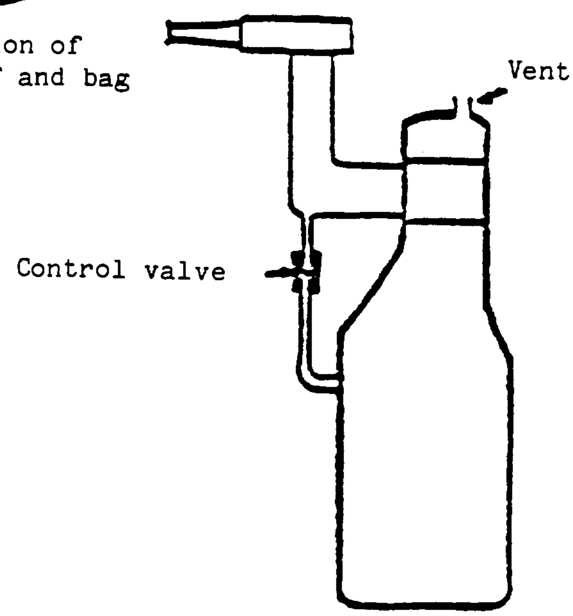
(b) Indirect recycling at slight vacuum



(i) Connection of take-off and bag



(c) Double-circuit direct recycling



(d) Venting of crank case with control valve (the bag must be connected to the vent)

Annex 7

TYPE IV TEST

Determination of evaporative emissions from vehicles equipped with positive-ignition engines

1. INTRODUCTION

This annex describes the procedure of the type IV test according to paragraph 5.3.4. of this Regulation. This procedure describes a method for the determination of the loss of hydrocarbons by evaporation from the fuel systems of vehicles equipped with spark-ignition engines.

2. DESCRIPTION OF TEST

2.1. The evaporative emission test (Figure 7/1) shall consist of four phases:

test preparation
tank breathing loss determination
urban (part one) and extra-urban (part two) driving cycle
hot soak loss determination.

2.2. Mass emissions of hydrocarbons from the tank breathing loss and the hot soak loss phases shall be added together to provide an overall result for the test.

3. VEHICLE AND FUEL

3.1. Vehicle

3.1.1. The vehicle shall be in good mechanical condition and have been run in and driven at least 3,000 km before the test. The evaporative emission control system shall be connected and functioning correctly over this period and the carbon canister subjected to normal use, neither undergoing abnormal purging nor abnormal loading.

3.2. Fuel

3.2.1. The appropriate reference fuel shall be used as defined in annex 9 to this Regulation.

4. TEST EQUIPMENT

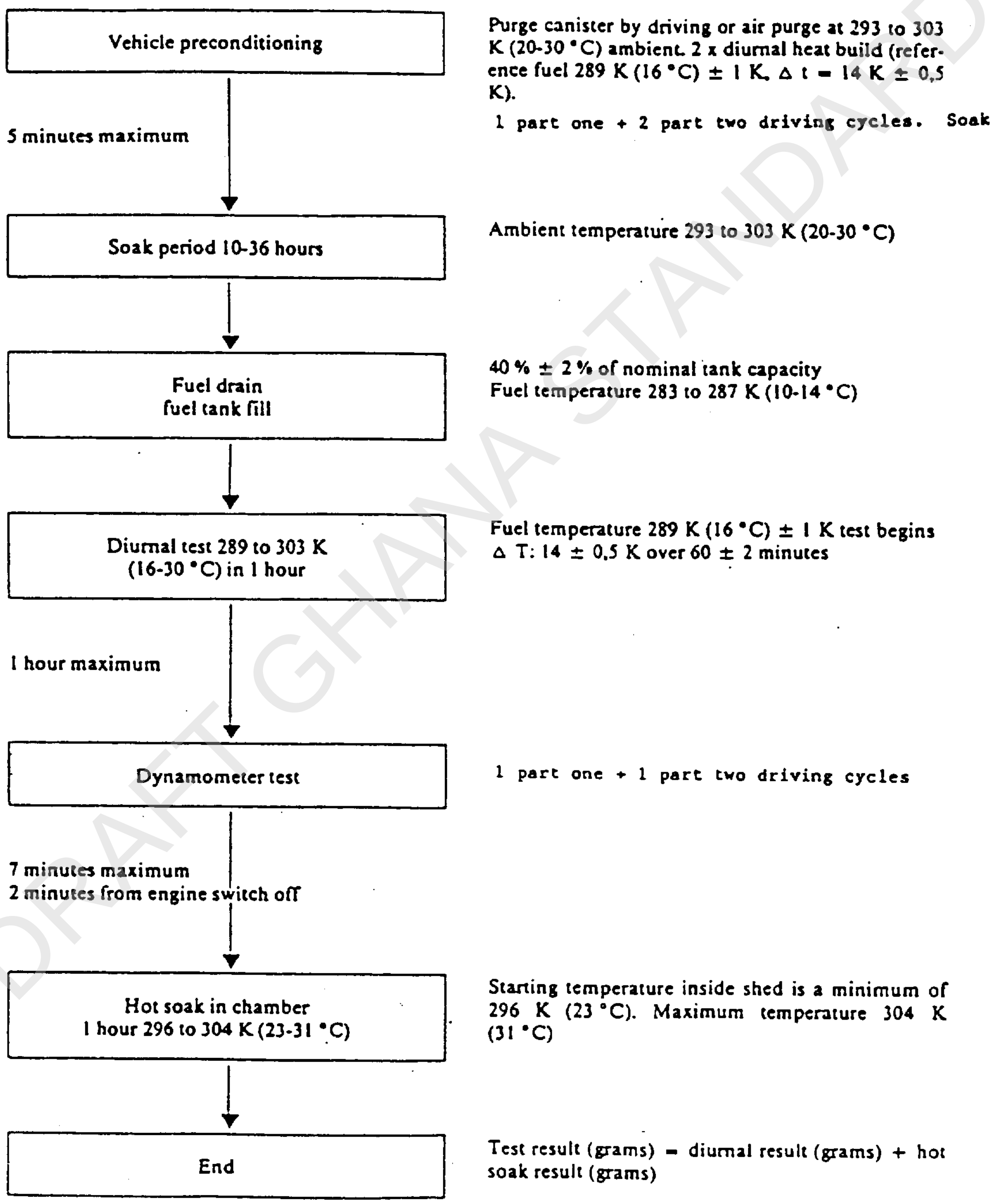
4.1. Chassis dynamometer

The chassis dynamometer shall meet the requirements of annex 4.

FIGURE 7/1

Determination of evaporative emissions

3,000 km run-in period (no excessive purge/load)
Steam clean of vehicle (if necessary)



Note:

1. Evaporative emission control families - details clarified.

2. Exhaust emissions may be measured during dynamometer test, but these are not used for legislative purposes. Exhaust emission legislative test remains separate.

4.2. Evaporative emission measurement enclosure

4.2.1. The evaporative emission measurement enclosure shall be a gas-tight rectangular measuring chamber able to contain the vehicle under test. The vehicle shall be accessible from all sides and the enclosure when sealed shall be gas-tight in accordance with appendix 1 of this annex. The inner surface of the enclosure shall be impermeable to hydrocarbons. At least one of the surfaces shall incorporate a flexible impermeable material to allow the equilibration of pressure changes resulting from small changes in temperature. Wall design shall be such as to promote good dissipation of heat. The temperature of the wall shall not drop below 293 K (20°C) at any point during testing.

4.3. Analytical Systems

4.3.1. Hydrocarbon analyser

4.3.1.1. The atmosphere within the chamber shall be monitored using a hydrocarbon detector of the flame ionization detector (FID) type. Sample gas shall be drawn from the midpoint of one side wall or roof of the chamber and any bypass flow shall be returned to the enclosure, preferably to a point immediately downstream of the mixing fan.

4.3.1.2. The hydrocarbon analyser shall have a response time to 90% of final reading of less than 1.5 s. Its stability shall be better than 2% of full scale at zero and at 80 $\pm$ 20% of full scale over a 15 minute period for all operational ranges.

4.3.1.3. The repeatability of the analyser expressed as one standard deviation shall be better than 1% at zero and at 80 $\pm$ 20% of full scale on all ranges used.

4.3.1.4. The operational ranges of the analyser shall be chosen to give best resolution over the measurement, calibration and leak-checking procedures.

4.3.2. Hydrocarbon analyser data recording system

4.3.2.1. The hydrocarbon analyser shall be fitted with a device to record electrical signal output either by strip chart recorder or other data processing system at a frequency of at least once per minute. The recording system shall have operating characteristics at least equivalent to the signal being recorded and shall provide a permanent record of results. The record shall show a positive indication of the beginning and end of the fuel tank heating and hot soak periods together with the time elapsed between start and completion of each test.

4.4. Fuel tank heating

4.4.1. The fuel in the vehicle tank(s) shall be heated by a controllable source of heat: for example, a heating pad of 2,000 W capacity is suitable. The heating system shall apply heat evenly to the tank walls beneath the level of the fuel so as not to cause local overheating of the fuel. Heat shall not be applied to the vapour in the tank above the fuel.

4.4.2 The tank heating device shall make it possible to heat the fuel in the tank evenly by 14 K from 289 K (16°C) within 60 minutes, with the temperature sensor position as in paragraph 5.1.1. The heating system shall be capable of controlling the fuel temperature to ± 1.5K of the required temperature during the tank heating process.

4.5. <u>Temperature recording</u>

4.5.1. The temperature in the chamber shall be recorded at two points by temperature sensors which are connected so as to show a mean value. The measuring points shall be extended approximately 0.1 m into the enclosure from the vertical centre line of each side wall at a height of 0.9 m ± 0.2 m.

4.5.2. The temperatures of the fuel tank(s) shall be recorded by means of the sensor positioned in the fuel tank as indicated in paragraph 5.1.1.

4.5.3. Temperatures shall throughout the evaporative emission measurements be recorded or entered into a data processing system at a frequency of at least once per minute.

4.5.4. The accuracy of the temperature recording system shall be within ± 1.0 K and the temperature shall be capable of being resolved to 0.4 K.

4.5.5. The recording or data processing system shall be capable of resolving time to ± 15 seconds.

4.6. <u>Fans</u>

4.6.1 The use of one or more fans or blowers with the shed door(s) open should enable the concentration of hydrocarbons in the chamber to be reduced to the ambient hydrocarbon level.

4.6.2. The chamber shall have one or more fans or blowers of a possible capacity of 0.1 to 0.5 m^3s^{-1} by means of which the atmosphere in the enslosure can be thoroughly mixed. It shall be possible to attain an even temperature and hydrocarbon concentration in the chamber during measurements. The vehicle in the enclosure shall not be subjected to a direct stream of air from the fans or blowers.

4.7. <u>Gases</u>

4.7.1. The following pure gases shall be available for calibration and operation.

Purified synthetic air:
(Purity: $\leq$ 1 ppm C_1, equivalent, $\leq$ 1 ppm CO, $\leq$ 400 ppm CO_2, $\leq$ 0.1 ppm NO);
Oxygen content between 18 and 21% by volume.

Hydrocarbon analyser fuel gas:
(40 ± 2% hydrogen, and balance helium with less than 1 ppm C_1, equivalent hydrocarbon, and less than 400 ppm CO_2).

Propane (C_3H_8):
99.5% minimum purity.

4.7.2. Calibration and span gases shall be available containing mixtures of propane (C_3H_8) and purified synthetic air. The true concentrations of a calibration gas must be within ± 2% of the stated figures. The accuracy of the diluted gases obtained when using a gas divider shall be to within ± 2% of the true value. The concentrations specified in appendix 1 may also be obtained by the use of a gas divider using synthetic air as the diluent gas.

4.8. Additional Equipment

4.8.1. The absolute humidity in the test area must be measurable to within ± 5%.

4.8.2. The pressure within the test area must be measurable to within ± 0.1 kPa.

5. TEST PROCEDURE

5.1. Test preparation

5.1.1. The vehicle shall be mechanically prepared before the test as follows:

The exhaust system of the vehicle must not exhibit any leaks.

The vehicle may be steam-cleaned before the test.

The fuel tank of the vehicle shall be equipped with a temperature sensor to enable the temperature to be measured at the midpoint of the fuel in the fuel(s) tank when filled to 40% of its(their) capacity.

Additional fittings, adaptors of devices shall be fitted to allow a complete draining of the fuel tank.

5.1.2. The vehicle shall be taken into the soak area where the ambient temperature is between 293 and 303 K (20°C and 30°C).

5.1.3. The carbon canister of the vehicle shall be purged by driving the car for 30 minutes at 60 km/h at the dynamometer setting prescribed in annex 4, appendix 2, or by passing air (at room temperature and humidity) through the canister at a flow rate which is identical to the actual air flow through the canister when operating the car at 60 km/h. The canister shall be subsequently loaded with two diurnal emissions tests.

5.1.4. The fuel tank(s) of the vehicle shall be emptied using the fuel tank drain(s) provided. This must be done so as not abnormally to purge nor abnormally to load the evaporative control devices fitted to the vehicle. Removal of the fuel cap(s) will normally be sufficient to achieve this.

5.1.5. The fuel tank(s) shall be refilled with the specified test fuel at a temperature of between 283 and 287 K (10°C and 14°C) to 40% ± 2% of its(their) normal fuel capacity. The vehicles fuel cap(s) shall not be replaced at this point.

5.1.6. In the case of vehicles fitted with more than one fuel tank, all the tanks shall be heated in the same way, as described below. The temperatures of the tanks shall be identical to within ± 1.5 K.

5.1.7. The fuel may be artificially heated to the starting temperature of 289 K (16°C) ± 1 K.

5.1.8 As soon as the fuel reaches a temperature of 287 K (14°C), the fuel tank(s) shall be sealed. When the temperature of the fuel tank reaches 289 K (16°C) ± 1 K a linear heat build of 14 K ± 0.5 K over a period of 60 ± 2 minutes begins. The temperature of the fuel during the heating shall conform to the function below to within ± 1.5 K.

$$T_r = T_o + 0.2333\, t$$

where:

T_r = required temperature (K)

T_o = initial temperature of tank (K)

t = time from start of the tank heat build in minutes

The elapsed time of the heat build and temperature rise shall be recorded.

5.1.9. After a period of not more than one hour, the operations of fuel draining and filling shall begin as indicated in paragraphs 5.1.4., 5.1.5, 5.1.6. and 5.1.7.

5.1.10. Within two hours of the end of the first tank heating period the second fuel tank heating operation shall begin as specified in paragraph 5.1.8. and shall be completed with the recording of the temperature rise and elapsed time of the heat build.

5.1.11. Within one hour of the end of the second tank heat build the vehicle shall be placed on a chassis dynamometer and shall be driven through one part one and two part two driving cycles. Exhaust emissions are not sampled during this operation.

5.1.12. Within five minutes of completing the preconditioning operation specified in paragraph 5.1.11. the engine bonnet shall be completely closed and the vehicle driven off the chassis dynamometer and parked in the soak area. The vehicle shall be parked for a minimum of 10 hours and a maximum of 36 hours. The engine oil and coolant temperatures must have reached the temperature of the area within ± 2 K at the end of the period.

5.2. Tank breathing evaporative emission test

5.2.1. The operation described in paragraph 5.2.4. may begin not less than nine hours nor more than 35 hours after the preconditioning driving sequence.

5.2.2. The measuring chamber shall be purged for several minutes immediately before the test until a stable background is obtained. The chamber mixing fan(s) shall also be switched on at this time.

5.2.3. The hydrocarbon analyser shall be zeroed and spanned immediately before the test.

5.2.4. The fuel tank(s) shall be emptied as indicated in paragraph 5.1.4. and refilled with test fuel at a temperature of between 283 and 287 K (10°C and 14°C) to 40 ± 2% of normal volumetric capacity. The fuel cap(s) of the vehicle shall not be fitted at this point.

5.2.5. In the case of vehicles fitted with more than one fuel tank, all the tanks shall be heated in the same way, as described below. The temperatures of the tanks shall be identical to within ± 1.5 K.

5.2.6. The test vehicle shall be brought into the test enclosure with the engine switched off and the windows and luggage compartment open. The fuel tank sensors and the fuel tank heating device, if necessary, shall be connected. Recording of the fuel temperature and the air temperature within the enclosure shall begin immediately. If still operating, the purging fan shall be switched off at this time.

5.2.7. The fuel may be artifically heated to the starting temperature of 289 K (16°C) ± 1 K.

5.2.8. As soon as the fuel temperature reaches 287 K (14°C), the fuel tank(s) shall be sealed, and the chamber sealed so that it is gas-tight.

5.2.9. As soon as the fuel reaches a temperature of 289 K (16°C) ± 1 K:

The hydrocarbon concentration, barometric pressure and the temperature shall be measured to give the initial readings $C_{HC,i}$, P_i and T_i for the tank heat build test.

A linear heat build of 14 K ± 0.5 K over a period of 60 ± 2 minutes shall begin. The temperature of the fuel during the heating shall conform to the function below to within ± 1.5 K.

$$T_r = T_o + 0.2333\,t$$

where:

T_r = required temperature (K)

T_o = initial temperature of tank (K)

t = time from start of the tank heat build in minutes

5.2.10. The hydrocarbon analyser shall be zeroed and spanned immediately before the end of the test.

5.2.11. If the temperature has risen by 14 K ± 0.5 K over the 60 ± 2 minute period of the test the final hydrocarbon concentration in the enclosure shall be measured ($C_{HC,f}$). The time or elapsed time of this together with the final temperature and barometric pressure T_f and P_f for the hot soak shall be recorded.

5.2.12. The heat source shall be turned off and the enclosure door unsealed and opened. The heating device and temperature sensor shall be disconnected from the enclosure apparatus. The vehicle doors and luggage compartment may now be closed and the vehicle removed from the enclosure with the engine switched off.

5.2.13. The vehicle shall be prepared for the subsequent driving cycles and hot soak evaporative emission test. The cold start test shall follow the tank breathing test within a period of not more than one hour.

5.2.14. The technical service may consider that the design of the vehicle's fuel system may allow losses to the outside atmosphere at some point. In this case an engineering analysis shall be carried out to the satisfaction of the technical service to establish that vapours are vented to the carbon canister and that these vapours are adequately purged during vehicle operation.

5.3. Driving Cycle

5.3.1. The determination of evaporative emissions shall conclude with the measurement of hydrocarbon emissions over a 60 minute hot soak period following four elementary urban cycles (part one) and one extra-urban driving cycle (part two). Following the tank breathing losses test, the vehicle is pushed or otherwise manoeuvred on to the chassis dynamometer with the engine switched off. It is then driven through four elementary urban cycles (part one) and one extra-urban cycle (part two) as described in annex 4. Exhaust emissions may be sampled during this operation but the results shall not be used for the purpose of exhaust emission type approval (type I test).

5.4. Hot soak evaporative emissions test

5.4.1. Before the completion of the test run the measuring chamber shall be purged for several minutes until a stable hydrocarbon background is obtained. The enclosure mixing fan(s) shall also be turned on at this time.

5.4.2. The hydrocarbon analyser shall be zeroed and spanned immediately prior to the test.

5.4.3. At the end of the driving cycle the engine bonnet shall be completely closed and all connections between the vehicle and the test stand disconnected. The vehicle shall then be driven to the measuring chamber with a minimum use of the accelerator pedal. The engine shall be turned off before any part of the vehicle enters the measuring chamber. The time at which the engine is switched off shall be recorded on the evaporative emission measurement data recording system and temperature recording shall begin. The vehicle's windows and luggage compartments shall be opened at this stage, if this is not already the case.

5.4.4. The vehicle shall be pushed or otherwise moved into the measuring chamber with the engine switched off.

5.4.5. The enclosure doors shall be closed and sealed gas-tight within two minutes of the engine being switched off and within seven minutes of the end of the driving cycle.

5.4.6. The start of a 60 ± 0.5 minute hot soak period shall begin when the chamber is sealed. The hydrocarbon concentration, temperature and barometric pressure shall be measured to give the initial readings $C_{HC,i}$, P_i and T_i for the hot soak test. These figures shall be used in the evaporative emission calculation (paragraph 6). The ambient shed temperature T shall not be less than 296 K (23°C) and no more than 304 K (31°C) during the 60 minute hot soak period.

5.4.7. The hydrocarbon analyser shall be zeroed and spanned immediately before the end of the 60 ± 0.5 minute test period.

5.4.8. At the end of the 60 ± 0.5 minute test period the hydrocarbon concentration in the chamber shall be measured. The temperature and the barometric pressure shall also be measured. These are the final readings $C_{HC,f}$, P_f and T_f for the hot soak test used for the calculation in section 6. This completes the evaporative emission test procedure.

6. CALCULATION

6.1. The evaporative emission tests described in section 5 shall allow the hydrocarbon emissions from the tank breathing and hot soak phases to be calculated. Evaporative losses from each of these phases shall be calculated using the initial and final hydrocarbon concentrations, temperatures and pressures in the enclosure, together with the net enclosure volume.

The following formula shall be used:

$$M_{HC} = K \cdot V \cdot 10^{-4} \left(\frac{C_{HC.f} \cdot P_f}{T_f} - \frac{C_{HC.i} \cdot P_i}{T_i} \right)$$

where:

M_{HC} = mass of hydrocarbon emitted over the test phase (grammes)

C_{HC} = measured hydrocarbon concentration in the enclosure (ppm(volume) C_1 equivalent)

V = net enclosure volume in cubic metres corrected for the volume of the vehicle, with the windows and the luggage compartment open. If the volume of the vehicle is not determined a volume of 1.42 m^3 is subtracted.

T = ambient chamber temperature, K

P = barometric pressure in kPa

H/C = hydrogen to carbon ratio

k = 1.2 (12 + H/C)

when:

i is the initial reading

f is the final reading

H/C is taken to be 2.33 for tank breathing losses

H/C is taken to be 2.20 for hot soak losses.

6.2. Overall results of test

The overall hydrocarbon mass emission for the vehicle is taken to be:

$$M_{total} = M_{TH} + M_{HS}$$

where:

M_{total} = overall mass emissions of the vehicle (grammes)

M_{TH} = hydrocarbon mass emission for the tank heat build (grammes)

M_{HS} = hydrocarbon mass emission for the hot soak (grammes).

7. CONFORMITY OF PRODUCTION

7.1. For routine end of production line testing, the holder of the approval may demonstrate compliance by sampling vehicles which shall meet the following requirements.

7.2. Test for leakage

7.2.1. Vents to the atmosphere from the emission control system shall be isolated.

7.2.2. A pressure of 370 ± 10 mm of H_2O shall be applied to the fuel system.

7.2.3. The pressure shall be allowed to stabilize prior to isolating the fuel system from the pressure source.

7.2.4. Following isolation of the fuel system, the pressure shall not drop by more than 50 mm of H_2O in five minutes.

7.3. Tests for venting

7.3.1. Vents to the atmosphere from the emission control shall be isolated.

7.3.2. A pressure of 370 $\pm$ 10 mm of H_2O shall be applied to the fuel system.

7.3.3. The pressure shall be allowed to stabilize prior to isolating the fuel system from the pressure source.

7.3.4. The venting outlets from the emission control systems to the atmosphere shall be reinstated in the production conditions.

7.3.5. The pressure of the fuel system shall drop to below 100 mm H_2O in not less than 30 seconds but within two minutes.

7.4. Purge test

7.4.1. Equipment capable of detecting an airflow rate of 1.0 litre per minute shall be attached to the purge inlet and a pressure vessel of sufficient size to have negligible effects on the purge system shall be connected by means of a switching valve to the purge inlet, or alternatively.

7.4.2. The manufacturer may use a flow meter of his own choice, if acceptable to the competent authority.

7.4.3. The vehicle shall be operated in such a manner that any design feature of the purge system which might restrict purge operation will be detected and the circumstances noted.

7.4.4. Whilst the engine is operating within the bounds noted in paragraph 7.4.3. above, the air flow shall be determined by either of the following:

7.4.4.1. if the device indicated in paragraph 7.4.1. is switched-in, a pressure drop from atmospheric to a level indicating that a volume of 1.0 litres of air has flowed into the evaporative emission control system within one minute shall be observed, or;

7.4.4.2. if an alternative flow measuring device is used, a reading of no less than 1.0 litre per minute shall be detectable.

7.5. The competent authority which has granted type-approval may at any time verify the conformity control methods applicable to each production unit.

7.5.1. The inspector shall take a sufficiently large sample from the series.

7.5.2. The inspector may test these vehicles by application of either paragraphs 8.4, or 8.5. of this Regulation.

7.5.3. If in pursuance of paragraph 8.5. of this Regulation, the vehicle test results fall outside the agreed limits of paragraph 5.3.4.2. of this Regulation, the manufacturer may request that the approval procedure referred to in paragraph 8.4. of this Regulation shall be applied.

7.5.3.1. The manufacturer shall not be allowed to adjust repair or modify any of the vehicles, unless they fail to comply with the requirements of paragraph 8.4. of this Regulation and unless such work is documented in the manufacturer's vehicle assembly and inspection procedures.

7.5.3.2. The manufacturer may request a single re-test for a vehicle whose evaporative emission characteristics are likely to have changed due to his actions as specified in paragraph 7.5.3.1. above.

7.6. If the requirements of paragraph 7.5. above are not met, the competent authority shall ensure that all necessary steps are taken to re-establish conformity of production as rapidly as possible.

Annex 7 - Appendix 1

CALIBRATION OF EQUIPMENT FOR EVAPORATIVE EMISSION TESTING

1. CALIBRATION FREQUENCY AND METHODS

1.1. All equipment shall be calibrated before its initial use and then calibrated as often as necessary and in any case in the month before type-approval testing. The calibration methods to be used are described in this appendix.

2. CALIBRATION OF THE ENCLOSURE

2.1. Initial determination of enclosure internal volume

2.1.1. Before its initial use, the internal volume of the chamber shall be determined as follows. The internal dimensions of the chamber shall be carefully measured, allowing for any irregularies such as bracing struts. The internal volume of the chamber shall be determined from these measurements.

2.1.2 The net internal volume shall be determined by subtracting 1.42 m^3 from the internal volume of the chamber. Alternatively the volume of the test vehicle with the luggage compartment and windows open may be used instead of the 1.42 m^3.

2.1.3 The leak proofness of the chamber shall be checked as specified in paragraph 2.3. below. If the propane mass does not agree with the injected mass to within $\pm$ 2% then corrective action is required.

2.2. Determination of chamber background emissions

This operation shall determine whether the chamber contains any materials that emit significant amounts of hydrocarbons. The check shall be carried out when the enclosure is brought into service, after any operations in it which may affect background emissions and at least once per year.

2.2.1. Calibrate the analyser (if required), then zero and span.

2.2.2. Purge the enclosure until a stable hydrocarbon reading is obtained. The mixing fan shall be turned on if this is not already the case.

2.2.3. Seal the chamber and measure the background hydrocarbon concentration, temperature and barometric pressure. These are the initial readings $C_{HC.i,}$ P_i et T_i used in the enclosure background calculation.

2.2.4. The enclosure shall be allowed to stand undisturbed with the mixing fan(s) on for a period of four hours.

2.2.5. At the end of this time the same analyser shall be used to measure the hydrocarbon concentration in the chamber. The temperature and the barometric pressure shall also be measured. These are the final readings $C_{HC.f,}$ P_f and $T_{f.}$

2.2.6. The change in mass of hydrocarbons in the enclosure over the time of the test shall be calculated as indicated in paragraph 2.4. The background emission of the enclosure shall not exceed 0.4g.

2.3. Calibration and hydrocarbon retention test of the chamber.

The calibration and hydrocarbon retention test in the chamber shall provide a check on the calculated volume (para. 2.1) and also measure any leak rate.

2.3.1. Purge the enclosure until a stable hydrocarbon concentration is reached. Turn on the mixing fan, if it has not already been done. The hydrocarbon analyser shall be zeroed, calibrated if required, and spanned.

2.3.2. Seal the enclosure and measure the background concentration, temperature and barometric pressure. These are the initial readings $C_{HC.i}$, P_i and T_i used in the enclosure calibration.

2.3.3. Inject a quantity of approximately 4 g of propane into the enclosure. The mass of propane shall be measured to an accuracy of $\pm$ 5% of the measured value.

2.3.4. Allow the contents of the chamber to mix for five minutes and then measure the hydrocarbon concentration, temperature and barometric pressure. These are the final readings $C_{HC.f}$, T_f and P_f for the calibration of the enclosure.

2.3.5. Using the readings taken in paragraphs 2.3.2 and 2.3.4 above and the formula set out in paragraph 2.4. below calculate the mass of propane in the enclosure. This shall be within $\pm$ 2% of the mass of propane measured in paragraph 2.3.3.

2.3.6. Allow the contents of the chamber to mix for a minimum of four hours. At the end of this period measure and record the final hydrocarbon concentration, temperature and barometric pressure.

2.3.7. Calculate, using the formula set out in paragraph 2.4. below, the hydrocarbon mass from the readings taken in paragraphs 2.3.6. and 2.3.2. above. The mass shall not differ by more than 4% from the hydrocarbon mass given in paragraph 2.3.5. above.

2.4. Calculations

The calculation of net hydrocarbon mass change within the enclosure shall be used to determine its hydrocarbon background and leak rate. Initial and final readings of hydrocarbon concentration, temperature and barometric pressure shall be used in the following formula to calculate the mass change.

$$M_{HC} = k \, . \, V \, . \, 10^{-4} \left(\frac{C_{HC.f} \, . \, P_f}{T_f} - \frac{C_{HC.f} \, . \, P_i}{T_i} \right)$$

where;

M_{hc} = hydrocarbon mass in grammes.

C_{hc} = Hydrocarbon concentration in the enclosure (ppm carbon (note ppm carbon = ppm propan ex 3))

V = enclosure volume in cubic metres.

T = ambient temperature in the enclosure, K.

P = barometric pressure, kPa.

k = 17.6

when;

i is the initial reading

f is the final reading

3. CHECKING OF FID HYDROCARBON ANALYSER (flame ionization detector)

3.1. Detector response optimization

The FID shall be adjusted as specified by the instrument manufacturer. Propane in air shall be used to optimize the response on the most common operating range.

Calibration of the HC analyser

The analyser shall be calibrated using propane in air and purified synthetic air. See annex 4, paragraph 4.5.2. (calibration gases).

Establish a calibration curve as described in paragraphs 4.1 and 4.5. of this appendix.

3.3. Oxygen interference check and recommended limits

The response factor (Rf), for a particular hydrocarbon species is the ratio of the FID C_1 reading to the gas cylinder concentration, expressed as ppm C_1.

The concentration of the test gas shall be at a level to give a response of approximately 80% of full-scale deflection, for the operating ranges normally used. The concentration must be known to an accuracy of $\pm$ 2% in reference to a gravimetric standard expressed in volume.

In addition the gas cylinder shall be preconditioned for 24 hours at a temperature between 293 and 303 K (20° C and 30° C).

Response factors shall be determined when introducing an analyser into service and thereafter at major service intervals.

The reference gas to be used is propane with balance purified air which shall be taken to give a response factor of 1.00.

The test gas to be used for oxygen interference and the recommended response factor range are given below:

Propane and nitrogen $0.95 \leq Rf \leq 1.05$

4. CALIBRATION OF THE HYDROCARBON ANALYSER

Each of the normally used operating ranges shall be calibrated by the following procedure.

4.1. The calibration curve shall be established by at least five calibration points spaced as evenly as possible over the operating range. The nominal concentration of the calibration gas with the highest concentrations shall be at least 80% of the full scale.

4.2. The calibration curve shall be calculated by the method of least squares. If the resulting polynomial degree is greater than 3, then the number of calibration points shall be at least the number of the polynomial degree plus 2.

4.3. The calibration curve shall not differ by more than 2% from the nominal value of each calibration gas.

4.4. Using the coefficients of the polynomial obtained in paragraph 3.2, a table of indicated reading against true concentration shall be drawn up in steps of no greater than 1% of full scale. This is to be carried out for each analyser range calibrated. The table shall also contain other relevant data such as;

Date of calibration.

Span and zero potentiometer readings (where applicable).

Nominal scale.

Reference data of each calibration gas used.

The actual and indicated value of each calibration gas used together with the percentage differences.

FID fuel and type.

FID air pressure.

FID sample pressure.

4.5. If it can be shown to the satisfaction of the technical service that alternative technology (e.g. computer, electronically controlled range switch) can give equivalent accuracy, then those alternatives may be used.

Annex 8

DESCRIPTION OF THE ENDURANCE TEST FOR VERIFYING THE DURABILITY OF POLLUTION CONTROL DEVICES

1. INTRODUCTION

This annex describes the test for verifying the durability of pollution control devices equipping vehicles with positive-ignition or compression-ignition engines during an endurance test of 80,000 km.

2. TEST VEHICLE

2.1. The vehicle shall be in good mechanical order. The engine and the pollution control devices shall be as new.

The vehicle may be the same as that presented for the Type 1 test; this test shall be carried out after the vehicle has run at least 3,000 km of the endurance test.

3. FUEL

The endurance test shall be conducted with commercially available unleaded petrol or diesel fuel.

4. VEHICLE MAINTENANCE AND ADJUSTMENTS

Maintenance, adjustments and the use of the test vehicle's controls shall be those recommended by the manufacturer.

5. VEHICLE OPERATION ON TRACK, ROAD OR ON CHASSIS DYNAMOMETER

5.1. Operating cycle

During operation on track, road or on chassis dynamometer, the distance shall be covered according to the driving schedule (Figure 8/1) described below:

the endurance test schedule shall be composed of 11 cycles covering 6 km each,

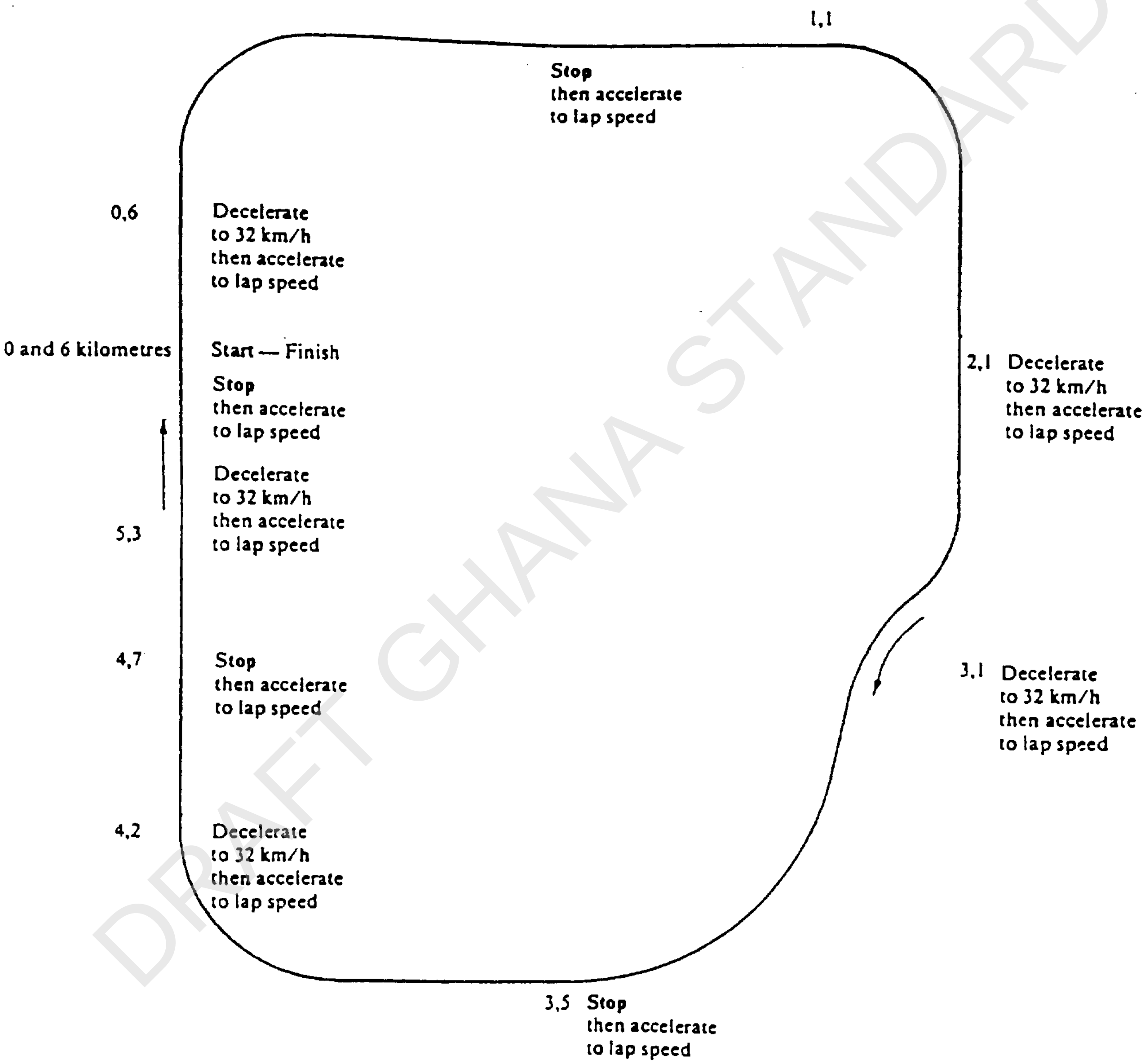
during the first nine cycles, the vehicle shall be stopped four times in the middle of the cycle, with the engine idling each time for 15 seconds,

normal acceleration and deceleration,

five decelerations in the middle of each cycle, dropping from cycle speed to 32 km/h; the vehicle shall be gradually accelerated again until cycle speed is atttained,

Figure 8/1

Driving schedule



the tenth cycle shall be carried out at a steady speed of 89 km/h,

the eleventh cycle shall begin with maximum acceleration from stop point up to 113 km/h. Half-way, braking shall be employed normally until the vehicle comes to a stop. This shall be followed by an idle period of 15 seconds and a second maximum acceleration.

The schedule shall then be restarted from the beginning. The maximum speed of each cycle is given in the following table;

Table 8.1

Maximum speed of each cycle

Cycle	Cycle speed in km/h
1	64
2	48
3	64
4	64
5	56
6	48
7	56
8	72
9	56
10	89
11	113

5.1.1. At the request of the manufacturer, an alternative road test schedule may be used. Such alternative test schedules shall be approved by the technical service in advance of the test and shall have substantially the same average speed, distribution of speeds, number of stops per kilometre and number of accelerations per kilometre as the driving schedule used on track or chassis dynamometer, as detailed in paragraph 5.1. and Table 8.1.

5.1.2. The durability test, or if the maufacturer has chosen it, the modified durability test shall be conducted until the vehicle has covered a minimum of 80,000 km.

5.2. Test equipment

5.2.1. Chassis dynamometer

5.2.1.1. When the endurance test is performed on a chassis dynamometer, the dynamometer shall enable the cycle described above in paragraph 5.1 to be carried out. In particular, it shall be equipped with systems simulating inertia and resistance to progress.

5.2.1.2. The brake shall be adjusted in order to absorb the power exerted on the driving wheels at a steady speed of 80 km/h. Methods to be applied to determine this power and to adjust the brake shall be the same as those described in annex 4, appendix 3 to this Regulation.

5.2.1.3. The vehicle cooling system shall enable the vehicle to operate at temperatures similar to those obtained on road (oil, water, exhaust system, etc.).

5.2.1.4. Certain other test bench adjustments and features shall be deemed to be identical, where necessary, to those described in annex 4 to this Regulation (inertia, for example, which may be mechanical or electronic).

5.2.1.5. The vehicle may be moved, where necessary, to a different dynamometer in order to conduct emission measurement tests.

5.2.2. Operation on track or road

When the durability test is completed on track or road, the vehicle's reference mass shall be at least equal to that retained for tests conducted on a chassis dynamometer.

6. MEASURING EMISSIONS OF POLLUTANTS

At the start of the test (o km), and every 10,000 km ($\pm$ 400 km) or more frequently, at regular intervals, until 80,000 km, have been covered, exhaust emissions shall be measured in accordandce with the type 1 test as defined in paragraph 5.3.1. of this Regulation. The limit values to be complied with shall be those laid down in paragraph 5.3.1.4.2.1. or paragraph 5.3.1.4.3.1. of this Regulation. However, the exhaust emissions may also be measured in accordance with the provisions of paragraph 13.1 of this Regulation.

All exhaust emissions results shall be plotted as a function of the running distance on the system rounded to the nearest kilometre and the best fit straight lines fitted by the method of least squares drawn through all these data points. This calculation will not take into account test results at 0 km.

The data will be acceptable for use in the calculation of the deterioration factor only if the interpolated 6,400 km and 80,000 km points on this line are within the above-mentioned limits.

The data shall still be acceptable when a best fit straight line crosses an applicable limit with a negative slope (the 6,400 km interpolated point is higher than the 80,000 km interpolated point) but the actual 80,000 km data point is below the limit.

A multiplicative exhaust emission deterioration factor (DEF) shall be calculated for each pollutant as follows:

$$DEF = \frac{Mi_2}{Mi_1}$$

where:

Mi_1 = mass emission of the pollutant i in grammes per km interpolated to 6,400 km.

Mi_2 = mass emission of the pollutant i n grammes per km interpolated to 80,000 km,

These interpolated values shall be given to a minimum of four places to the right of the decimal point before dividing one by the other to determine the deterioration factor.

The result shall be rounded to three places to the right of the decimal point. If a deterioration factor is less than one, it shall be deemed to be equal to one.

Annex 9

SPECIFICATIONS OF REFERENCE FUELS

1. TECHNICAL DATA OF THE REFERENCE FUEL TO BE USED FOR TESTING VEHICLES EQUIPPED WITH POSITIVE-IGNITION ENGINES

CEC Reference fuel RF-01-A-84. Type: Premium petrol, leaded 2/,5/

	Limits and units 4/	ASTM method*	ISO method
Research octane number	min. 98.0	D 2699	5164 - 1977
Density at 15°C	min. 0.741 kg/1 max. 0.755 kg/1	D 1298	3675 - 1976
Reid vapour pressure	min. 0.56 bar max. 0.64 bar	D 323	3007 - 1986
Distillation 1/		D 86	3405 - 1975
initial boiling point	min. 24°C max. 40°C		
10% vol. point	min. 42°C max. 58°C		
50% vol. point	min. 90°C max. 110°C		
90% vol. point	min. 150°C max. 170°C		
final boiling point	min. 185°C max. 205°C		
Residue	max. 2% vol.		
Hydrocarbon analysis:		D 1319	DIS 3837
olefins	max. 20% vol.		
aromatics	max. 45% vol.		
saturates	balance		
Oxidation stability 3/	min. 480 minutes	D 525	DP 7536
Existent gum	max. 4 mg/100 ml	D 381	6246 - 1981
Sulphur content	Max. 0.04% mass	D 1266, D 2622 or 2785	2192 - 1984
Lead content	min. 0.10 g/l max. 0.40 g/l	D 3341	3830 - 1981
Nature of scavenger	motor mix		
Nature of lead alkyl	not specified		
Carbon/hydrogen ratio	S.O		

* Acronym of the American Society for Testing Materials, 1916 Race Street, Philadelphia, Pennsylvania 19105, United States of America.

1/ The figures quoted show the evaporated quantities (% recovered + % loss).

2/ The blending of this fuel should only involve use of conventional European refinery components.

3/ The fuel may contain oxidation inhibitors and metal de-activators normally used to stabilize refinery gasoline streams, but detergent/dispersant additives and solvent oils must not be added.

4/ The values quoted in the specification are "true values". In establishment of their limit values the terms of ASTM D 3244 "Defining a basis for petroleum products quality disputes" have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility).

Notwithstanding this measure, which is necessary for statistical reasons, the manufacturer of a fuel should nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits.

Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specification, the terms of ASTM D 3244 should be applied.

5/ When a manufacturer recommends the use of an oil-petrol mixture, for example, in the case of a two-stroke engine, the type of oil recommended in the concentration indicated by the manufacturer shall be added to this reference fuel. If no recommendation is made for a two-stroke engine, the reference oil CEC RL 58, a copy of the specifications for which is attached, shall be used in a 2% concentration.

2. TECHNICAL DATA OF THE REFERENCE FUEL TO BE USED FOR TESTING VEHICLES EQUIPPED WITH POSITIVE-IGNITION ENGINES

Reference fuel: CEC RF-08-A-85

Type: Premium petrol, unleaded #/

	Limits and units 2/		ISO method	ASTM method 3/
	minimum	maximum		
Research octane number	95.0		ISO 5164-1977*	D 1699
Motor octane number	85.0		ISO 5163-1977	D 2700
Density at 15°C	0.748	0.762	ISO 3675-1976	D 1298
Reid vapour pressure	0.56 bar	0.64 bar	ISO 3007-1986	D 323
Distillation: 4/	24°C	40°C	ISO 3405-1975**	D 86
- initial boiling point	42°C	58°C		D 86
- 10% vol point	90°C	110°C		D 86
- 50% vol point	155°C	189°C		D 86
- 90% vol point	190°C	215°C		D 86
- final boiling point		2%		D 86
Residue				D 1319
Hydrocarbon analysis:		20% vol	DIS 3837	
- olefins				
- aromatics	(including			
	max. 5% vol			
	benzene 1/	45% vol		1/ D 3606/D 2267
- saturates		balance		D 1319
Carbon/hydrogen ratio	ratio	ratio		
Oxidation stability 5/	480 min.		DO 7536	D 525
Existent gum		4 mg/100 ml	ISO 6246-1981	D 381
Sulphur content		0.04% mass	ISO 2192-1984	D 1266/D 2611/D 2785
Copper corrosion at 50°C		1	ISO 2160-1985	D 130
Lead content		0.005 g/1		D 3237
Phosphorus content		0.0013 g/l	ISO 3830-1981	D 3231

* Under revision DIS 5164 equivalent to ASTM 2699-1986.
** Under revision.
#/ Addition of oxygenates prohibited.

Notes

1/ The blending of this fuel should only involve use of conventional European refinery components.

2/ Fuel may contain additives in usually marketed concentrations.

The values quoted in the specification are "true values". In establishment of their limit values the terms of ASTM D 3244 "Defining a basis for petroleum product quality disputes" have been applied and in fixing a maximum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility).

Notwithstanding this measure, which is necessary for statistical reasons, the manufacturer of a fuel should nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits.

Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specification, the terms of ASTM D 3244 should be applied.

3/ Equivalent ISO methods will be adopted when issued for all properties listed above.

4/ The figures quoted show the total evaporated quantities (% recovered + % loss).

5/ The fuel may contain oxidation inhibitors and metal de-activators normally used to stabilize refinery gasoline streams, but detergent/dispersant additives and solvent oils must not be added.

3. TECHNICAL DATA OF THE REFERENCE FUEL TO BE USED FOR TESTING VEHICLES EQUIPPED WITH A COMPRESSION-IGNITION ENGINE

CEC Reference fuel RF-03-A-84 1/

Type: Diesel fuel

	Limits and units 2/	ISO method	ASTM method 3/
Cetane number 4/	min. 49 max. 53	DIS 5165* ISO 3675-1976	D 613
Density 15°C (kg/1)	min. 0.835 max. 0.845		D 1298
Distillation: 5/		ISO 3405-1975**	
- 50% point	min. 245°C		D 86
- 90% point	min. 320°C max. 340°C		
- final boiling point	max. 370°C		
Flash point	min. 55°C	ISO 2719-1973	D 93
CFPP	min. - max. -5°C		EN 116 (CEN)
Viscosity 40°C	min. 2.5 mm²/g max. 3.5 mm²/g		
Sulphur content 6/	min. (to be reported) max. 0.3% mass	ISO 2192-1984	D 1266/D 2622 D 2785
Copper corrosion	max. 1	ISO 2160-1985	D 130
Conradson carbon residue (10% DR)	max. 0.2% mass	ISO 6615-1982	D 189
Ash content	max. 0.01% mass	ISO 6245-1982	D 482
Water content	max. 0.05% mass	ISO 3733-1976	D 95/D 1744
Neutralization (strong acid) number	max. 0.20 mg KOH/g	ISO 6618-1987	
Oxidation stability 7/	max. 2.5 mg/100 ml		D 2274
Additives 8/	-		

* Under revision DIS 5165 equivalent to ASTM D 613.
** Under revision.

Notes

1/ If the thermal efficiency of an engine or vehicle needs to be calculated, the calorific value of the fuel can be obtained from the following formula:

Specific energy (calorific value) (net) MJ/kg =
$(46.423 - 8.792d^2 + 3.170d)(1 - (x + y + s)) + 9.420s - 2.499x$
where:
d is the density at 288 K (15°C)
x is the proportion by mass of water (percentage divided by 100)
y is the proportion by mass of ash (percentage divided by 100)
s is the proportion by mass of sulphur (percentage divided by 100).

2/ The values quoted in the specification are "true values". In establishment of their limit values the terms of ASTM D 3244 "Defining a basis for petroleum product quality disputes" have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility).

Notwithstanding this measure, which is necessary for statistical reasons, the manufacturer of fuel should nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits.

Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specification, the terms of ASTM D 3244 should be applied.

3/ Equivalent ISO methods will be adopted when issued for all properties listed above.

4/ The range for cetane is not in accordance with the requirement of a minimum range of 4R. However, in cases of dispute between fuel supplier and fuel user, the terms in ASTM D 3244 can be used to resolve such disputes provided replicate measurements, of sufficient number to achieve the necessary precision, are made in preference to single determinations.

5/ The figures quoted show the evaporated quantities (percentage recovered + percentage loss).

6/ At the request of the manufacturer, diesel fuel with a 0.05% mass maximum sulphur content may be used to represent future market fuel quality, both for type approval and for conformity of production testing.

7/ Even though oxidation stabiity is controlled, it is likely that shelf life will be limited. Advice should be sought from the supplier as to storage conditions and life.

8/ This fuel should be based on straight run and cracked hydrocarbon distillate components only; desulphurization is allowed. It must not contain any metallic additives or cetane improver additives.

Annex 10

M1 and N1 CATEGORIES OF "OFF-ROAD VEHICLES": DEFINITIONS AND PROCEDURES*

1. CATEGORIES M1G and N1G - OFF-ROAD VEHICLES

1.1. Definition

M1 and N1 off-road vehicles mean vehicles which meet the specifications of this paragraph, tested under the conditions defined in paragraphs 1.2. and 1.3.

1.1.1. Vehicles in category N1 with a maximum mass not exceeding two tonnes and motor vehicles in category M1 are considered to be off-road vehicles if they have:

at least one front axle and at least one rear axle designed to be driven simultaneously, including vehicles where the drive to one axle can be disengaged,

at least one differential locking mechanism or at least one mechanism having a similar effect, and

if they can climb a 30% gradient calculated for a solo vehicle.

In addition, they must satisfy at least five of the following six requirements:

the front incidence angle must be at least 25°,

the rear incidence angle must be at least 20°,

the ramp angle must be at least 20°,

the ground clearance under the front axle must be at least 180 mm,

the ground clearance under the rear axle must be at least 180 mm,

the ground clearance between the axles must be at least 200 mm.

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* As defined in Annex 7 of the Consolidated Resolution on the Construction of Vehicles (R.E.3) (document: TRANS/SC1/WP29/78/Amend.3).

1.1.2. Vehicles in category N1 with a maximum mass exceeding two tonnes are considered to be off-road vehicles either if all their wheels are designed to be driven simultaneously, including vehicles where the drive to one axle can be disengaged, or if the following three requirements are satisfied:

at least one front axle and at least one rear axle are designed to be driven simultaneously, including vehicles where the drive to one axle can be disengaged,

there is at least one differential locking mechanism or at least one mechanism having a similar effect,

they can climb a 25% gradient calculated for a solo vehicle.

2. LOAD AND CHECKING CONDITIONS

2.1. Vehicles in category N1 with a maximum mass not exceeding two tonnes and vehicles in category M1 must be in running order, namely with coolant fluid, lubricants, fuel, tools, spare-wheel and a driver considered to weigh a standard 75 kilograms.

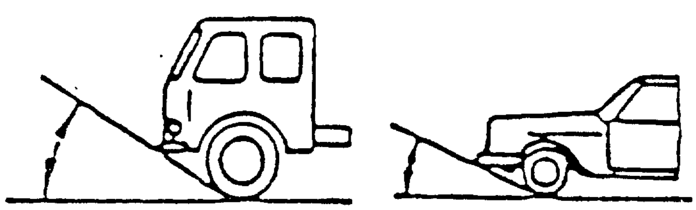
2.2. Motor vehicles other than those referred to in 2.1 must be loaded to the technically permissible maximum mass stated by the manufacturer.

2.3. The ability to climb the required gradients (25% and 30%) is verified by simple calculation. In exceptional cases, however, the technical services may ask for a vehicle of the type concerned to be submitted to it for an actual test.

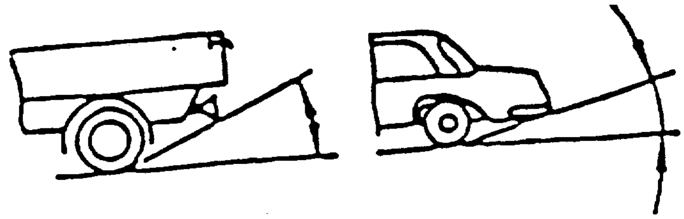
2.4. When measuring front and rear incidence angles and ramp angles, no account is taken of underrun protective devices.

3. DEFINITIONS AND SKETCHES OF FRONT AND REAR INCIDENCE ANGLES, RAMP ANGLE AND GROUND CLEARANCE

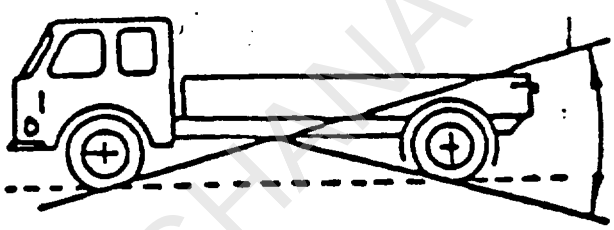
3.1. "Front incidence angle" means the maximum angle between the ground plane and planes tangential to the tyres of the front wheels, under a statics load, such that no point of the vehicle ahead of the front axle is situated below these planes and no rigid part of the vehicle, with the exception of any steps, is situated below these planes.



3.2. "Rear incidence angle" means the maximum angle between the ground plane and planes tangential to the tyres of the rear wheels, under a static load, such that no point of the vehicle behind the rearmost axle is situated below these planes and no rigid part of the vehicle is situated below these planes.

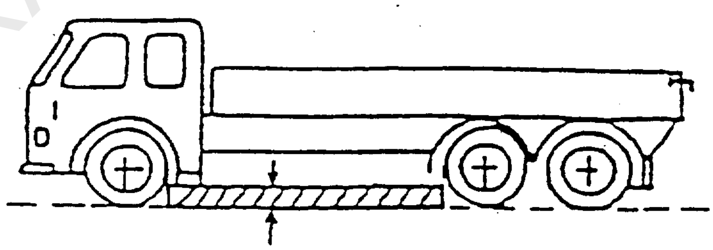


3.3. "Ramp angle" means the minimum acute angle between two planes, perpendicular to the median longitudinal plane of the vehicle, tangential to the tyres of the front wheels and to the tyres of the rear wheels respectively, under a static load, the intersection of which touches the rigid underside of the vehicle apart from the wheels. This angle defines the steepest ramp over which the vehicle can pass.

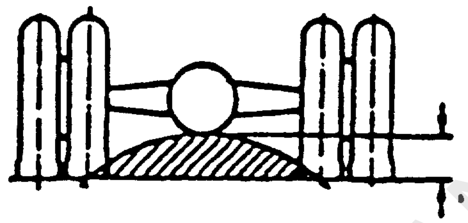


3.4. "Ground clearance between the axles" means the shortest distance between the ground plane and the lowest fixed point of the vehicle.

Multi-axle bogies are considered to be a single axle.



3.5. "Ground clearance beneath an axle" means the distance beneath the highest point of the arc of a circle passing through the centre of the tyre footprint of the wheels on one axle (the inner wheels in the case of twin tyres) and touching the lowest fixed point of the vehicle between the wheels. No rigid part of the vehicle may project into the shaded area of the diagram. Where appropriate, the ground clearance of several axles is indicated in accordance with their arrangement, for example 280/250/250.



4. Combined description

The symbols M and N may be combined with the symbol G. For example, an N1 category vehicle adapted for off-road use may be described by the symbol N1G.