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Legislation

Contents

I Acts whose publication is obligatory

.....

II Acts whose publication is not obligatory

Council

88/76/EEC :

- ★ Council Directive of 3 December 1987 amending Directive 70/220/EEC on the approximation of the laws of the Member States relating to measures to be taken against air pollution by gases from the engines of motor vehicles 1

88/77/EEC :

- ★ Council Directive of 3 December 1987 on the approximation of the laws of the Member States relating to the measures to be taken against the emission of gaseous pollutants from diesel engines for use in vehicles 33

II

(Acts whose publication is not obligatory)

COUNCIL

COUNCIL DIRECTIVE

of 3 December 1987

amending Directive 70/220/EEC on the approximation of the laws of the Member States relating to measures to be taken against air pollution by gases from the engines of motor vehicles

(88/76/EEC)

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

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

Having regard to the proposal from the Commission ⁽¹⁾,

In cooperation with the European Parliament ⁽²⁾;

Having regard to the opinion of the Economic and Social Committee ⁽³⁾,

Whereas it is important to adopt measures with the aim of progressively establishing the internal market over a period expiring on 31 December 1992; whereas the internal market shall comprise an area without internal frontiers in which the free movement of goods, persons, services and capital is ensured;

Whereas the first programme of action of the European Communities on the protection of the environment, approved by the Council on 22 November 1973, called for account to be taken of the latest scientific

advances in combating atmospheric pollution caused by gases emitted from motor vehicles and for Directives adopted previously to be amended accordingly; whereas the third programme of action provides for additional efforts to be made to reduce considerably the present level of emissions of pollutants from motor vehicles;

Whereas Directive 70/220/EEC ⁽⁴⁾ lays down the limit values for carbon monoxide and unburnt hydrocarbon emissions from such engines; whereas these limit values were first reduced by Directive 74/290/EEC ⁽⁵⁾ and supplemented, in accordance with Directive 77/102/EEC ⁽⁶⁾, by limit values for permissible emissions of nitrogen oxides; whereas the limit values for these three pollutants were successively reduced by Directives 78/665/EEC ⁽⁷⁾ and 83/351/EEC ⁽⁸⁾;

Whereas the work undertaken by the Commission in connection with its policy of pursuing a comprehensive approach to the development of rules for the motor vehicle industry has shown that the European industry already has available, or is currently perfecting, engine technology which will allow a further reduction in limit values; whereas during the period under consideration such a reduction will not jeopardize the aims of Community policy in other fields, and in particular in that of the rational use of energy;

⁽¹⁾ OJ No C 178, 6. 7. 1984, p. 9, OJ No C 318, 29. 11. 1984, p. 6, and OJ No C 257, 28. 9. 1987, p. 1.

⁽²⁾ Opinion published in OJ No C 12, 14. 1. 1985, p. 65, and OJ No C 190, 20. 7. 1987, p. 180, and position of Parliament on 18 November 1987 (OJ No C 345, 21. 12. 1987, p. 59).

⁽³⁾ OJ No C 25, 28. 1. 1985, p. 46.

⁽⁴⁾ OJ No L 76, 6. 4. 1970, p. 1.

⁽⁵⁾ OJ No L 159, 15. 6. 1974, p. 61.

⁽⁶⁾ OJ No L 32, 3. 2. 1977, p. 32.

⁽⁷⁾ OJ No L 223, 14. 8. 1978, p. 48.

⁽⁸⁾ OJ No L 197, 20. 7. 1983, p. 1.

Whereas it is necessary to promote innovation and industrial competitiveness respectively on the internal market and on foreign markets; whereas it is necessary that the Community adopt measures on vehicle emissions; whereas they should at the same time respect a high level of environmental protection and make it possible to achieve values adapted to European conditions so that their ultimate effect on the environment is equivalent to that of the standards for vehicle emissions in force in the United States of America; whereas to achieve this objective, it is advisable to provide for a solution which varies according to the category of vehicle engine capacity so as to allow, as far as possible, compliance with Community requirements at a reasonable cost and using different technical means; whereas the limit values laid down for vehicles with an engine capacity of less than 1,4 litres reflect the current technical and economic conditions of European manufacturers in this section of the market; whereas the limit values applicable in 1992/93 should be fixed in 1987;

Whereas the limit values in this Directive are based on the test method laid down in Directive 70/220/EEC, but this procedure must be adapted subsequently so that it is representative not only of traffic conditions in congested urban centres but also of those outside such centres; whereas a decision concerning such adaptation should be taken by 1987 at the latest;

Whereas Article 5 of Directive 70/220/EEC refers to the possibility of adapting the provisions of the Annexes to take account of technical progress;

Whereas petrol engines in all vehicles covered by this Directive should be designed to run on unleaded petrol so as to make it possible to stop the use of lead-based additives in fuels and thus make a decisive contribution to the reduction of environmental pollution by that element;

Whereas it is necessary to ensure that the provisions relating to the compression-ignition engines of vehicles covered by this Directive remain compatible, in view of the specific nature of all the pollutants emitted by such engines, with subsequent changes in the provisions relating to the other pollutants emitted by such engines, referred to in Directive 72/306/EEC⁽¹⁾;

Whereas, during the period between the adoption of European standards and the implementation of the modified European test cycle, it is desirable that vehicles which obtain type-approval in accordance with equivalent standards on Community export markets should also qualify for EEC type-approval;

Whereas, with due regard for the rules of the Treaty, Member States which so wish may apply in advance the new values laid down in this Directive, on the understanding that if they do so they may not prohibit the marketing or use of vehicles, whether manufactured at home or imported, which comply with Community requirements,

HAS ADOPTED THIS DIRECTIVE:

Article 1

Annexes I, II, III, VI and VII to Directive 70/220/EEC shall be amended in accordance with the Annex to this Directive. A new Annex IIIA shall be introduced.

Article 2

1. From 1 July 1988, no Member State may, on grounds relating to air pollution by gases from an engine or to engine fuel requirements:

— refuse to grant EEC type-approval, or to issue the document provided for in the second indent of Article 10 (1) of Directive 70/156/EEC⁽²⁾, as last amended by Directive 87/403/EEC⁽³⁾, or to grant national type-approval for a type of motor vehicle,

or

— prohibit the entry into service of such vehicles,

where the level of gaseous pollutants emitted from this type of motor vehicle or from such vehicles and the engine fuel requirements meet the provisions of Directive 70/220/EEC, as amended by this Directive.

2. Member States may: from 1 October 1988 in the case of the types of vehicle which have an engine capacity above 2 000 cm³,

⁽¹⁾ OJ No L 190, 20. 8. 1972, p. 1.

⁽²⁾ OJ No L 42, 23. 2. 1970, p. 1.

⁽³⁾ OJ No L 220, 8. 8. 1987, p. 44.

from 1 October 1990 in the case of the types of vehicle which have an engine capacity below 1 400 cm³,

from 1 October 1991 in the case of the types of vehicle which have an engine capacity of 1 400 to 2 000 cm³ inclusive, and from 1 October 1994 in the case of types of vehicle of the same capacity fitted with compression-ignition engines of the direct injection type,

- no longer issue the document provided for in the last indent of Article 10 (1) of Directive 70/156/EEC in respect of a type of motor vehicle, and
- refuse national type-approval for a type of motor vehicle,

which emits gaseous pollutants at levels which do not meet the requirements of the Annexes to Directive 70/220/EEC, as amended by this Directive.

3. From 1 October 1989 in the case of types of vehicle which have an engine capacity above 2 000 cm³,

from 1 October 1991 in the case of types of vehicle which have an engine capacity below 1 400 cm³,

from 1 October 1993 in the case of types of vehicle which have an engine capacity of 1 400 to 2 000 cm³ inclusive and from 1 October 1996 in the case of types of vehicle of the same capacity fitted with compression-ignition engines of the direct injection type,

Member States may prohibit the entry into service of vehicles where the gaseous pollutants emitted from such vehicles and their engine fuel requirements do not meet the requirements of the Annexes to Directive 70/220/EEC, as amended by this Directive.

Article 3

1. Member States may refuse national type-approval, EEC type-approval or the document provided for in the second indent of Article 10 (1) of Directive 70/156/EEC for a type of motor vehicle with a positive ignition engine whose engine fuel requirements do not meet the provisions of the Annexes to Directive 70/220/EEC, as amended by this Directive:

- from 1 October 1988, for types of vehicle having an engine capacity greater than 2 000 cm³, except for those defined in section 8.1,
- from 1 October 1989, for the other types.

2. From 1 October 1990, Member States may prohibit the entry into service of vehicles fitted with a positive ignition engine whose fuel requirements do

not meet the provisions of the Annexes to Directive 70/220/EEC, as amended by this Directive, except where the manufacturer provides a certificate accepted by the technical service which issued the initial emission type-approval stating that adapting such vehicles to the new fuel requirement entails major engineering changes, namely a change in material specification of the inlet or exhaust valve seats or a reduction in the compression ratio, or an increase in the engine capacity to compensate for power loss; in which case, such a ban is possible only from the dates laid down in Article 2 (3).

Article 4

By 31 December 1987 at the latest, the Council, on a proposal from the Commission, shall:

- decide on a further reduction in the limit values to be applied to vehicles with an engine capacity of less than 1 400 cm³ at the latest in 1992 for the issue of new national type-approvals and 1993 for the entry of vehicles into service,
- amend the test contained in Annex III to Directive 70/220/EEC in order to adapt to present conditions, in particular by the addition of non-urban driving sequences,
- decide on the procedures for the entry into force of the amended test contained in Annex III and on the conditions for repealing the present Annex III and Annex IIIA to Directive 70/220/EEC, as amended by this Directive including the transitional period.

Article 5

Member States shall bring into force the provisions necessary to comply with this Directive by 1 July 1988 and shall forthwith inform the Commission thereof.

Article 6

This Directive is addressed to the Member States.

Done at Brussels, 3 December 1987.

For the Council
The President
Chr. CHRISTENSEN

ANNEX

ANNEX I

1. Add the following :

'with the exception of those vehicles of category N₁, for which type-approval has been granted under Directive 88/76/EEC (1).

At the request of the manufacturers, type-approval to this Directive may be extended from M₁ or N₁ vehicles equipped with compression-ignition engines which have already been type-approved to M₂ and N₂ vehicles having a reference mass not exceeding 2 840 kg and meeting the conditions of section 6 of this Annex (extension of EEC type-approval).

(1) OJ No L 36, 9. 2. 1988, p. 1.'

2.2. The existing text is replaced by the following :

'For the purposes of Annex IIIA "reference mass" means the mass of the vehicle in running order less the uniform mass of the driver of 75 kg and increased by a uniform mass of 136 kg.'

The following new section 2.8 is added :

'2.8. "Engine capacity" means :

2.8.1. for reciprocating piston positive-ignition engines, the nominal engine swept volume,

2.8.1.1. for rotary piston (Wankel) positive-ignition engines, double the nominal engine swept volume.'

The following new section 3.2.4 is added :

'3.2.4. a description of the measures taken to ensure that a vehicle equipped with a positive-ignition engine is so constructed that it can only be supplied with unleaded petrol in accordance with Directive 85/210/EEC.

This condition is deemed to be met if it can be demonstrated that the inlet orifice of the fuel tank is so designed that it prevents the tank from being filled from a petrol pump delivery nozzle which has an external diameter of 23,6 mm or greater.'

In section 5.1, the existing text is given the number 5.1.1 and is supplemented as follows :

'The technical measures taken by the manufacturer must be such as to ensure that the emission of air-polluting gases is effectively limited throughout the normal life of the vehicle and under normal conditions of use.

5.1.2. A vehicle equipped with a positive-ignition engine must be designed to be capable of running on unleaded petrol as specified by Directive 85/210/EEC.'

Section 5.2.1.1.4 reads as follows :

'5.2.1.1.4. Subject to 5.2.1.1.4.2 and 5.2.1.1.5, the test is repeated three times. The mass of the carbon monoxide, the combined mass of the hydrocarbons and the nitrogen oxides and the mass of the nitrogen oxides obtained must be less than the amounts given below for the corresponding vehicle categories :

Engine capacity	Mass of carbon monoxide	Combined mass of hydrocarbons and nitrogen oxides	Mass of nitrogen oxides
C (cm ³)	L1 (g/test)	L2 (g/test)	L3 (g/test)
C > 2 000	25	6,5	3,5
1 400 ≤ C ≤ 2 000	30	8	
C < 1 400	45	15	6

Vehicles equipped with compression-ignition engines with a capacity exceeding 2 000 cm³ must comply with the limit values corresponding to the 1 400 cm³ to 2 000 cm³ inclusive engine capacity category.'

In sections 5.2.1.1.4.1, 5.2.1.1.4.2, 5.2.1.1.5.1 and 5.2.1.1.5.2 the words 'and the mass of nitrogen oxides' or 'and the emissions of nitrogen oxides' are to be added after any reference to combined figures for hydrocarbons and nitrogen oxides.

The following new section 6.5 is added :

'6.5. Positive-ignition engined vehicle types with different engine fuel requirements.

6.5.1. Approval shall be extended to vehicle types modified for engine fuel requirement purposes, provided the conditions set out in section 8.4.'

The following new section 6.6 is added :

'6.6. Vehicle types with automatic or continuously variable transmissions.

6.6.1. Approval granted to a vehicle type with a manual transmission may under the following conditions be extended to vehicle types with automatic or continuously variable transmissions :

6.6.1.1. the same basic forms of components and systems (other than the transmission) liable to affect the emissions of gaseous pollutants must be fitted and operational. However differences in detail to allow for the different operating characteristics of automatic or continuously variable transmissions are acceptable;

6.6.1.2. the vehicle type must have a reference mass within $\pm 5\%$ of the reference mass of the vehicle type with the manual transmission;

6.6.1.3. the vehicle type must be tested and satisfy the requirements of section 5 modified as follows :

the limit values for the nitrogen oxides are those resulting from the multiplication of the L3 values given in the table in section 5.2.1.1.4 by a factor of 1,3 and the limit values for the combined mass of the hydrocarbons and the nitrogen oxides are those resulting from the multiplication of the L2 values given in the table in section 5.2.1.1.4 by a factor of 1,2.'

The table in section 7.1.1.1 is replaced by the following :

'Engine capacity C (cm ³)	Mass of carbon monoxide L1 (g/test)	Combined mass of hydrocarbons and nitrogen oxides L2 (g/test)	Mass of nitrogen oxides L3 (g/test)
C > 2 000	30	8,1	4,4
1 400 ≤ C ≤ 2 000	36	10	
C < 1 400	54	19	7,5

Vehicles equipped with compression-ignition engines with a capacity exceeding 2 000 cm³ must comply with the limit values corresponding to the 1 400 to 2 000 cm³ inclusive engine capacity category.'

The second paragraph of section 7.1.1.2 reads as follows :

'L = the limit value laid down in section 7.1.1.1 for the emissions of carbon monoxide, the combined emissions of hydrocarbons and nitrogen oxides and the emissions of nitrogen oxides;'

The following new section 7.2 is added :

'7.2. Where type approval is extended under the provisions of section 6.6 (automatic and continuously variable transmissions) the limit values for the nitrogen oxides are those resulting from the multiplication of the values L3 given in the table in section 7.1.1.1 by a factor of 1,3, and the limit values for the combined mass of the hydrocarbons and the nitrogen oxides are those resulting from the multiplication of the values L2 given in the table in section 7.1.1.1 by a factor of 1,2.'

Section 8.1 reads as follows :

- 8.1. For the type-approval and verification of conformity of
- vehicles other than those of category M₁,
 - passenger vehicles of category M₁ designed to carry more than six occupants including the driver or whose maximum mass exceeds 2 500 kg,
 - off-road vehicles as defined in Annex I to Directive 70/156/EEC as last amended by Directive 87/403/EEC ⁽¹⁾,

the limit values shown in the tables in sections 5.2.1.1.4 (type-approval) and 7.1.1.1 (conformity check) of Directive 70/220/EEC, as last amended by Directive 83/351/EEC, are applicable as from 1 October 1989 in the case of new vehicle types and from 1 October 1990 in the case of vehicles entering into service for the first time.

⁽¹⁾ OJ No L 220, 8. 8. 1987, p. 44.

The following new sections 8.3 and 8.4 are added :

8.3. Test equivalent to the type I test for verifying emissions after a cold start.

- 8.3.1. For the type-approval and verification of production of vehicles of category M₁ equipped with an engine whose capacity $\geq 1\,400\text{ cm}^3$, the technical service may, at the request of a manufacturer, carry out the equivalent test described in Annex IIIA (EPA cycle) instead of that described in 5.2.1.1. In that event, the following provisions apply :

- 8.3.1.1. For vehicle type-approval, the limit values specified in the table in section 5.2.1.1.4 are replaced by the following :

- mass of carbon monoxide (L1): 2,11 g/km,
- mass of hydrocarbons: 0,25 g/km,
- mass of nitrogen oxides (L3): 0,62 g/km.

These limit values are 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	NO _x
1. Positive-ignition engine with oxidizing catalytic converter	1,2	1,3	1,0
2. Positive-ignition engine without catalytic converter	1,2	1,3	1,0
3. Positive-ignition engine with three-way catalytic converter	1,2	1,3	1,1
4. Compression-ignition engine	1,1	1,0	1,0

Where a manufacturer has obtained evidence of deterioration factors specific to the vehicle type using the certification procedures of Community export markets, those factors may be used as an alternative when establishing compliance with the limit values set out in this section.

- 8.3.1.2. For the verification of production conformity, vehicles may be taken from the series and subjected to the test described in Annex IIIA.

- 8.3.1.2.1. A failed vehicle is one whose test results, when adjusted by the deterioration factors established for the type approved in accordance with section 8.3.1 lead to one or more of the limit values in section 8.3.1.1 being exceeded.

- 8.3.1.2.2. The production of the series is deemed to conform or not to conform by testing vehicles comprising a test sample until a pass decision is reached for all limit values or a fail decision is reached for one limit value. A pass decision is reached when the cumulative number of failed vehicles as defined in section 8.3.1.2.1 for each limit value is less than or equal to the pass decision number appropriate to the cumulative number of vehicles tested. A fail decision is reached when the cumulative number of failed vehicles for one limit value is greater than or equal to the fail decision number appropriate to the cumulative number of vehicles tested.

Once a pass decision has been made for a particular limit value the number of vehicles whose final deteriorated test results exceed that limit value must not be considered any further for the purposes of checking conformity of production.

The pass and fail decision numbers associated with the cumulative number of vehicles tested are given in the following table :

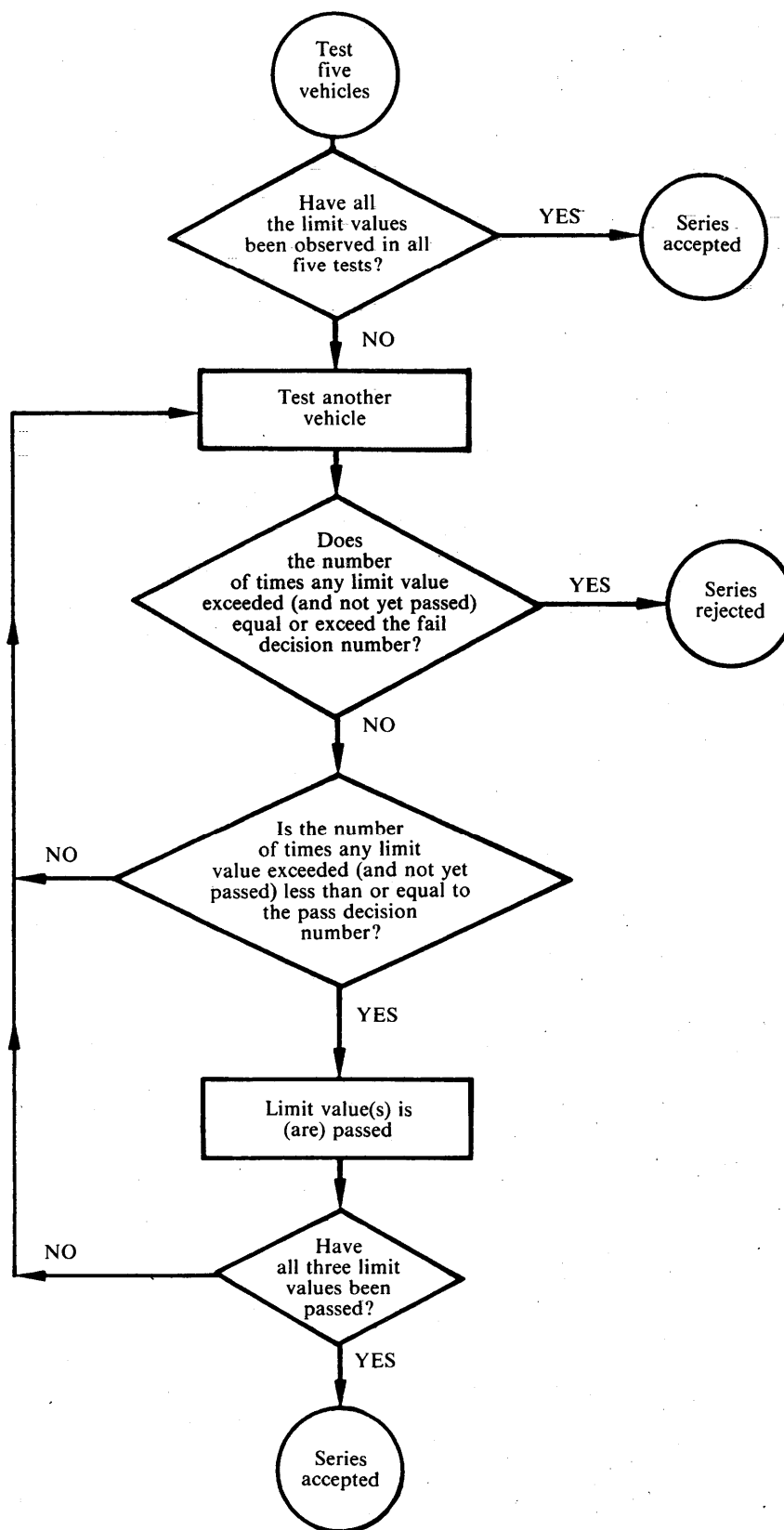
Cumulative number of vehicles tested	Pass decision (number of failures)	Fail decision (number of failures)
1	(1)	(2)
2	(1)	(2)
3	(1)	(2)
4	(1)	(2)
5	0	(2)
6	0	6
7	1	7
8	2	8
9	2	8
10	3	9
11	3	9
12	4	10
13	4	10
14	5	11
15	5	11
16	6	12
17	6	12
18	7	13
19	7	13
20	8	14
21	8	14
22	9	15
23	9	15
24	10	16
25	11	16
26	11	17
27	12	17
28	12	18
29	13	19
30	13	19
31	14	20
32	14	20
33	15	21
34	15	21
35	16	22
36	16	22
37	17	23
38	17	23
39	18	24
40	18	24
41	19	25
42	19	26
43	20	26
44	21	27
45	21	27
46	22	28
47	22	28
48	23	29
49	23	29
50	24	30
51	24	30
52	25	31
53	25	31
54	26	32
55	26	32
56	27	33
57	27	33
58	28	33
59	28	33
60	32	33

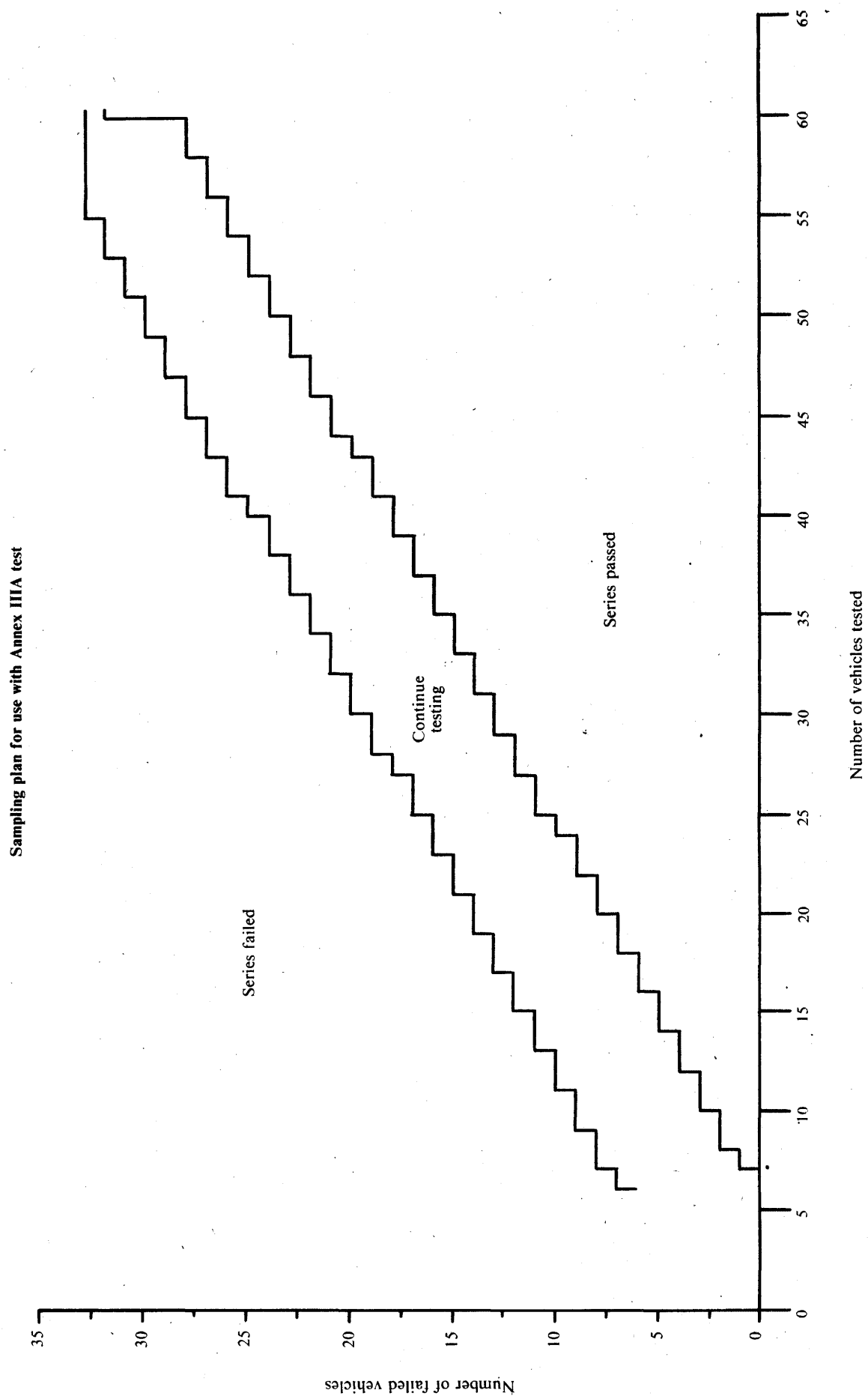
(1) Series not able to pass at this stage.

(2) Series not able to fail at this stage.

- 8.3.1.3. Manufacturers of vehicles in possession of certificates issued by government authorities in Community export markets incorporating results of tests equivalent to those set out in Annex IIIA to this Directive may present such results.
 - 8.4. For the extension of EEC type-approval to vehicles approved in accordance with the provisions of Directive 70/220/EEC, as last amended by Directive 83/351/EEC, but modified to satisfy the engine fuel requirements of this Directive, the manufacturers are to certify that :
 - 8.4.1. the vehicle type conforms with the requirement of section 5.1.2 regarding engine fuel requirements,
and
 - 8.4.2. the vehicle continues to meet the production conformity limits in accordance with Directive 70/220/EEC, as last amended by Directive 83/351/EEC.'
-

Sampling plan for use with Annex IIIA test





ANNEX II

A footnote reference '(4)' is inserted after sections 1.4 and 1.5.

A footnote reference '(5)' is inserted after section 1.7.

The following footnotes are added :

(4) This figure must be rounded off to the nearest tenth of a millimetre.

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

Add the following subsection to section 7 :

'Information to be supplied for the tests provided for in Annex IIIA'

Gear change-over point (for first to second, etc.):

Method of cold starting :

ANNEX III

Delete section 3.1.7.

The following new Annex IIIA is added :

ANNEX IIIA**TEST EQUIVALENT TO THE TYPE I TEST FOR VERIFYING
EMISSIONS AFTER A COLD START****1. INTRODUCTION**

See section 8.3 of Annex I.

2. OPERATING CYCLE ON THE CHASSIS DYNAMOMETER**2.1. Description of the cycle**

The operating cycle to be applied on the chassis dynamometer is that indicated in the following table and depicted in the graph in Appendix 1. The breakdown by operations is also given in that table.

2.2. *Idem* section 2.2 of Annex III.**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.**

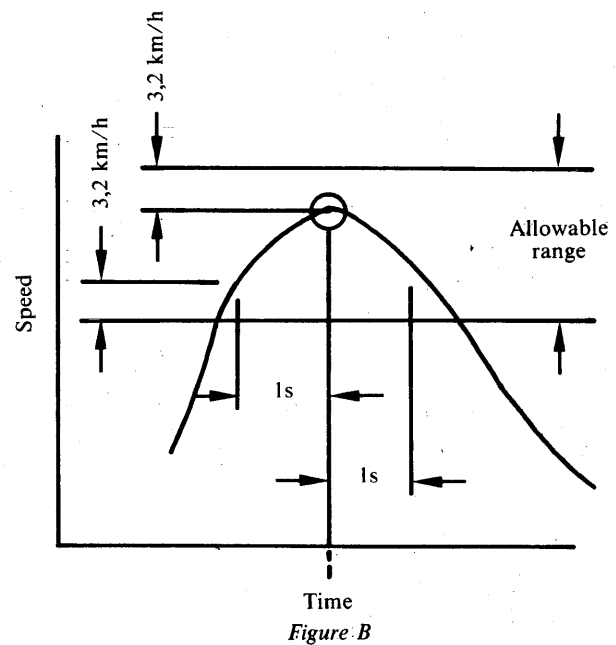
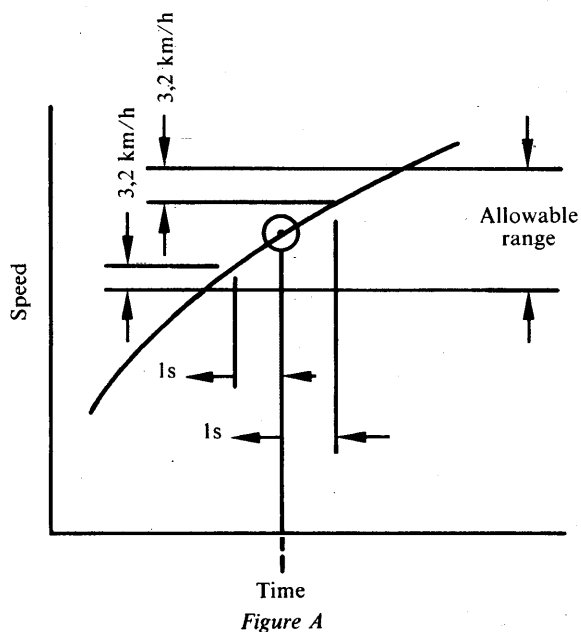
The vehicle must be driven with minimum accelerator pedal movement to maintain the desired speed.

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.



3. VEHICLE AND FUEL

3.1. Test vehicles

- 3.1.1.
 - 3.1.2.
 - 3.1.3.
 - 3.1.4.
 - 3.1.5.
 - 3.1.6.
- } *Idem* sections 3.1.1 to 3.1.6 of Annex III.

3.2. Fuel

The appropriate reference fuel as defined in Annex VI 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. *Idem* section 4.1.1 of Annex III but add the following subparagraph :

'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. } *Idem* sections 4.1.1, 4.1.2 and 4.1.3 of Annex III.
4.1.3. }

4.1.4. *Accuracy*

4.1.4.1. *Idem* 4.1.4.1 Annex III.

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 km/h, 60 and 40 km/h and 10 % at 20 km/h. Below this, dynamometer absorption must be positive.

4.1.4.3. } *Idem* sections 4.1.4.3 and 4.1.4.4 of Annex III.
4.1.4.4. }

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, section 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, point 3 and Appendix 3.

4.1.5.3. *Idem* section 4.1.5.3 of Annex III.

4.2. } *Idem* sections 4.2 to 4.7 of Annex III.
4.3. }
4.4. }
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 III.

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 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 III.

6. PROCEDURE FOR BENCH TESTS

6.1.
6.1.2.
6.1.3.
6.1.4. } *Idem* sections 6.1 to 6.1.4 of Annex III.

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 enable 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 190 °C ± 10 °C.

6.2.2.5. Adjust the sample flowrates to the desired flowrate (minimum of 0,28 m³/h) and set the gas flow measuring devices to zero.

Note :

CFV-CVS sample flowrate 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), turn the ignition key on 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' bags to the 'stabilized' bags, 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 (the diesel hydrocarbon integrator No 2 and mark the hydrocarbon recorder chart, if applicable) and position the sample selector valves to 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 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.
- 6.2.2.14. 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 sections 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. The key-on operation step described in section 6.2.2.7 begins 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 turn off gas flow measuring device No 1 (and diesel hydrocarbon integrator No 1, mark the diesel hydrocarbon recorder chart, if applicable) and position the sample selector valve to the 'standby' position (engine shutdown is not part of the hot start test sample 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 with 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* ⁽¹⁾
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.

7. PROCEDURE FOR ANALYSES

- 7.1. *Idem* section 7.2.2 of Annex III.
- 7.2. *Idem* section 7.2.3 of Annex III.
- 7.3. *Idem* section 7.2.4 of Annex III.
- 7.4. *Idem* section 7.2.5 of Annex III.
- 7.5. *Idem* section 7.2.6 of Annex III.
- 7.6. *Idem* section 7.2.7 of Annex III.
- 7.7. *Idem* section 7.2.8 of Annex III.

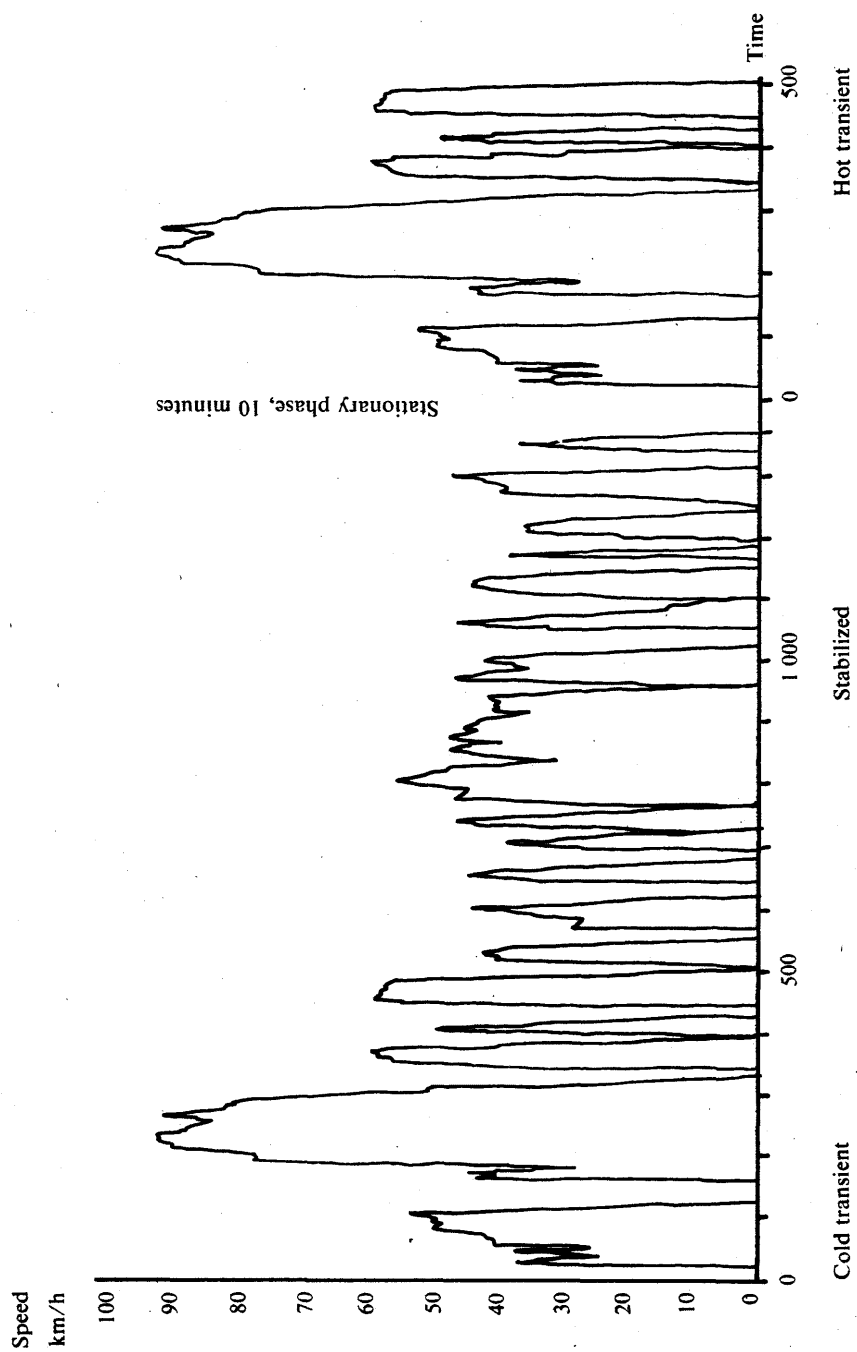
8. DETERMINATION OF THE QUANTITY OF GASEOUS POLLUTANTS

- 8.1. } *Idem* sections 8.1 and 8.2 of Annex III.
- 8.2. }

⁽¹⁾ 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.

Appendix 1

OPERATING CYCLE



t	v	t	v	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				
285	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	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	525	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	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	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	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	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						

Appendix 2

CHASSIS DYNAMOMETER

1. DEFINITION

- 1.1. *Idem* section 1.1 of Appendix 2 to Annex III, but replace '50 km/h' by '80,5 km/h'.

2. METHOD OF CALIBRATING THE DYNAMOMETER

- 2.1. *Idem* section 2.1 of Appendix 2 to Annex III.

- 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 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 section 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, a new calibration is required.

2.2.3. Calculations

The power actually absorbed by the dynamometer is calculated from the following equation :

$$P_a = W \frac{V_1^2 - V_2^2}{2000 t}$$

where :

P_a = 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.

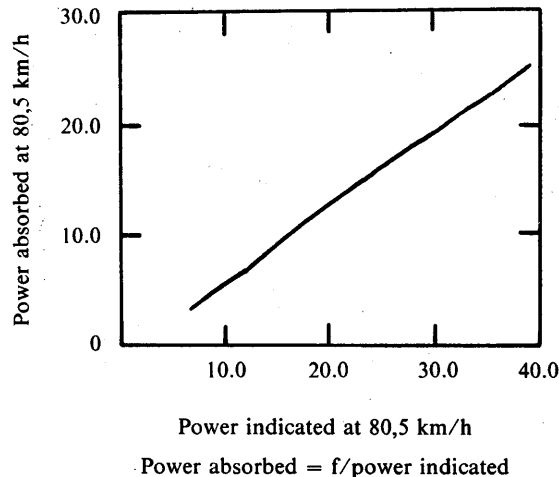


Figure A

2.3. *Idem* section 2.3 of Appendix 2 to Annex III.

2.4. Deleted.

3. SETTING OF THE DYNAMOMETER

3.1. Vacuum method

Idem section 3.1 of Appendix 2 to Annex III, but replace 'at the speed of 50 km/h' by 'at the speed of 80,5 km/h'.

3.2. Other setting method

Idem section 3.2 of Appendix 2 to Annex III, but replace 'at the speed of 50 km/h' by 'at the speed of 80,5 km/h'.

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 the dynamometer 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 (m²). 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; = $4,93 \times 10^{-4}$ for all other vehicles

A vehicle is considered to have a fastback shape if the rearward projection of that portion of the rear surface (A_2) 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.

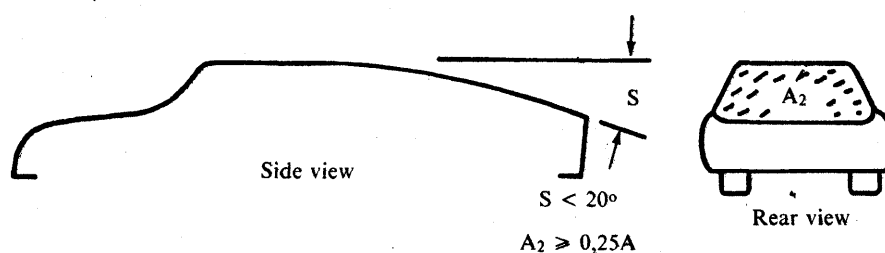


Figure 1

TABLE I

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, A_p , 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 m² 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 :

$$P_A = aA + P + (8,22 \times 10^{-4} + 0,33 t)w$$

All symbols in the above equation are defined in section 3.3.2.1.

*Appendix 3***RESISTANCE TO PROGRESS OF A VEHICLE —
MEASUREMENT METHOD ON THE ROAD AND ON A CHASSIS DYNAMOMETER**

(*Idem* Appendix 3 to Annex III)

*Appendix 4***VERIFICATION OF INERTIAS OTHER THAN MECHANICAL**

(*Idem* Appendix 4 of Annex III)

*Appendix 5***DEFINITION OF GAS SAMPLING SYSTEMS**

(*Idem* Appendix 5 of Annex III, but six bags (instead of two) are necessary on the CVS)

*Appendix 6***METHOD OF CALIBRATING THE EQUIPMENT**

(*Idem* Appendix 6 to Annex III)

*Appendix 7***TOTAL SYSTEM VERIFICATION**

(*Idem* Appendix 7 to Annex III)

Appendix 8

CALCULATION OF THE MASS EMISSIONS OF POLLUTANTS

The mass emissions of pollutants are calculated by the following equation :

$$M_i = 0,43 \frac{M_{icT} M_{is}}{S_{cT} + S_s} + 0,57 \frac{M_{iHT} + M_{is}}{S_{HT} + S_s}$$

where :

- M_i = 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

The mass emissions of pollutants are calculated by means of the following :

$$M_i = V_{mix} \times Q_i \times k_H \times C_i \times 10^{-6}$$

where :

- M_i = 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

ANNEX VI

The table in section 1 is replaced by the following table :

1. TECHNICAL DATA OF THE REFERENCE FUEL TO BE USED FOR TESTING VEHICLES EQUIPPED WITH POSITIVE-IGNITION ENGINES

CEC reference fuel RF-08-A-85

Type : Premium petrol, unleaded

	Limits and units		ASTM method
	minimum	maximum	
Research octane number	95,0		D 2699
Motor octane number	85,0		D 2700
Density at 15 °C	0,748	0,762	D 1298
Reid vapour pressure	0,56 bar	0,64 bar	D 323
Distillation :			
— initial boiling point	24 °C	40 °C	D 86
— 10 % vol point	42 °C	58 °C	D 86
— 50 % vol point	90 °C	110 °C	D 86
— 90 % vol point	155 °C	180 °C	D 86
— final boiling point	190 °C	215 °C	D 86
Residue		2 %	D 86
Hydrocarbon analysis :			
— olefins		20 % vol	D 1319
— aromatics	(Including max. 5 % vol benzene (1))		D 1319
— saturates		45 % vol balance	(1) D 3606/D 2267 D 1319
Carbon/hydrogen ratio		ratio	
Oxidation stability	480 min.		D 525
Existent gum		4 mg/100 ml	D 381
Sulphur content		0,04 % mass	D 1266/D 2622/ D 2785
Copper corrosion at 50 °C		1	D 130
Lead content		0,005 g/l	D 3237
Phosphorus content		0,0013 g/l	D 3231

(1) Addition of oxygenates prohibited.

Section 2 is replaced by the following :

2. TECHNICAL DATA OF THE REFERENCE FUEL TO BE USED FOR TESTING VEHICLES EQUIPPED WITH A DIESEL ENGINE

CEC reference fuel RF-03-A-84 (1) (3) (7)

Type : Diesel fuel

	Limits and units	ASTM Method
Cetane number (4)	min. 49 max. 53	D 613
Density 15 °C (kg/l)	min. 0,835 max. 0,845	D 1298
Distillation (2) :		
— 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	D 93

	Limits and units	ASTM Method
CFPP	min. — max. -5 °C	EN 116 (CEN)
Viscosity 40 °C	min. 2,5 mm ² /s max. 3,5 mm ² /s	D 445
Sulphur content	min. (to be reported) max. 0,3 % mass	D 1266/D 2622 D 2785
Copper corrosion	max. 1	D 130
Conradson carbon residue (10 % DR)	max. 0,2 % mass	D 189
Ash content	max. 0,01 % mass	D 482
Water content	max. 0,05 % mass	D 95/D 1744
Neutralization (strong acid) number	max. 0,20 mg KOH/g	
Oxidation stability ⁽⁶⁾	max. 2,5 mg/100 ml	D 2274
Additives ⁽⁵⁾		

(1) Equivalent ISO methods will be adopted when issued for all properties listed above.

(2) The figures quoted show the total evaporated quantities (% recovered + % loss).

(3) 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.

(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 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) 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.

(6) Even though oxidation stability is controlled it is likely that shelf life will be limited. Advice should be sought from the supplier as to storage conditions and life.

(7) If it is required to calculate the thermal efficiency of an engine or vehicle, the calorific value of the fuel can be calculated from:

$$\text{Specific energy (calorific value) (net) in MJ/kg} = (46,423 - 8,792d^2 + 3,170d) (1 - (x + y + s)) + 9,420s - 2,499x$$

where:

d = the density at 15 °C

x = the proportion by mass of water (% divided by 100)

y = the proportion by mass of ash (% divided by 100)

s = the proportion by mass of sulphur (% divided by 100).

Annex VII is replaced by the following :

ANNEX VII

MODEL

Maximum size : A 4 (210 × 297 mm)

Name of administration

ANNEX TO THE EEC VEHICLE TYPE-APPROVAL CERTIFICATE WITH REGARD TO THE EMISSION OF GASEOUS POLLUTANTS FROM THE ENGINE

(Articles 4 (2) and 10 of Council Directive 70/156/EEC of 6 February 1970 on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers)

In the light of the amendments made pursuant to Directive 83/351/EEC

EEC type-approval No :

1. Category of the vehicle type (M₁, N₁, etc.) :
2. Trademark or trade name of the vehicle :
3. Vehicle type : Engine type :
4. Manufacturer's name and address :
.....
5. If applicable, name and address of the manufacturer's authorized representative :
.....
6. Engine capacity (in cm³) :
7. Mass of vehicle in running order :
- 7.1. Reference mass of vehicle :
8. Technically permissible maximum mass of vehicle :
9. Gearbox :
- 9.1. Manual or automatic ⁽¹⁾ ⁽²⁾ :
- 9.2. Number of gear ratios :
- 9.3. Transmission ratios ⁽¹⁾ : 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 × 4 ⁽¹⁾

⁽¹⁾ Delete as inapplicable.

⁽²⁾ In the case of vehicles equipped with automatic-shift gearboxes, give all pertinent technical data.

- 9.4. Check of performance referred to in section 3.1.6 of Annex III to this Directive :
-
10. Date vehicle submitted for approval :
11. Technical service responsible for type-approval tests :
-
12. Date of test report issued by that service :
13. Number of test report issued by that service :
14. EEC type-approval granted/refused ⁽¹⁾
15. Results of approval tests carried out in accordance with Annex III/Annex III A ⁽¹⁾ :
- Inertia equivalent mass : kg
- Absorbed power P_a : kW at 50 km/h
- Method of setting :
- 15.1 Test type I carried out in accordance with Annex III :
- CO : g/test HC : g/test NO_x : g/test
- 15.2 Test type I carried out in accordance with Annex III A :
- CO : g/km HC : g/km NO_x : g/km
- 15.3. Test type II :
- CO : % vol at : idle rev./min
- 15.4. Test type III :
-
16. Gas sampling system used :
- 16.1. PDP/CVS ⁽¹⁾
- 16.2. CFV/CVS ⁽¹⁾
- 16.3. CFO/CVS ⁽¹⁾
17. Place :
18. Date :
19. Signature :
20. The following documents, bearing the EEC type-approval number shown above are attached to this Annex :
- one copy of Annex II to this Directive, duly completed and with the drawings and diagrams referred to attached,
 - one photograph of the engine and its compartment,
 -

⁽¹⁾ Delete as inapplicable.

COUNCIL DIRECTIVE**of 3 December 1987****on the approximation of the laws of the Member States relating to the measures to be taken against the emission of gaseous pollutants from diesel engines for use in vehicles**

(88/77/EEC)

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

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

Having regard to the proposal from the Commission ⁽¹⁾,

In cooperation with the European Parliament ⁽²⁾,

Having regard to the opinion of the Economic and Social Committee ⁽³⁾,

Whereas it is important to adopt measures with the aim of progressively establishing the internal market over a period expiring on 31 December 1992; whereas the internal market shall comprise an area without internal frontiers in which the free movement of goods, persons, services and capital is ensured;

Whereas the first programme of action of the European Communities on the protection of the environment, approved by the Council on 22 November 1973, called for account to be taken of the latest scientific advances in combating atmospheric pollution caused by gases emitted from motor vehicles and for Directives adopted previously to be amended accordingly; whereas the third programme of action provides for additional efforts to be made to reduce considerably the present level of emissions of pollutants from motor vehicles;

Whereas the technical requirements which motor vehicles must satisfy pursuant to national laws relate, *inter alia*, to the emission of gaseous pollutants from diesel engines for use in vehicles;

Whereas those requirements differ from one Member State to another; whereas these differences could restrict the free circulation of the products in question;

whereas it is therefore necessary that all the Member States adopt the same requirements either in addition to or in place of their existing rules, in order, in particular, to permit the implementation, for each vehicle type, of the EEC type-approval, which was the subject of Council Directive 70/156/EEC of 6 February 1970 on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers ⁽⁴⁾, as last amended by Directive 87/403/EEC ⁽⁵⁾;

Whereas it is desirable to follow the technical requirements adopted by the United Nations Economic Commission for Europe in its Regulation No 49 (uniform provisions concerning the approval of diesel engines with regard to the emission of gaseous pollutants), which is annexed to the Agreement of 20 March 1958 concerning the adoption of uniform conditions of approval and reciprocal recognition of approval for motor vehicle equipment and parts;

Whereas the Commission has undertaken to submit proposals to the Council, not later than the end of 1988, regarding a further reduction of the limit values for the three pollutants which are the subject of this Directive and the fixing of limit values for particulate emissions,

HAS ADOPTED THIS DIRECTIVE:

Article 1

For the purposes of this Directive:

- 'vehicle' means any vehicle propelled by a diesel engine, intended for use on the road, with or without bodywork, having at least four wheels and a maximum design speed exceeding 25 km/h, with the exception of vehicles of category M₁ as defined in section 0.4 of Annex I to Directive 70/156/EEC, having a total mass not exceeding 3,5 tonnes, and vehicles which run on rails, agri-

⁽¹⁾ OJ No C 193, 31. 7. 1986, p. 3.

⁽²⁾ Position of Parliament on 18 November 1987 (OJ No C 345, 21. 12. 1987, p. 61).

⁽³⁾ OJ No C 333, 29. 12. 1986, p. 17.

⁽⁴⁾ OJ No L 42, 23. 2. 1970, p. 1.

⁽⁵⁾ OJ No L 220, 8. 8. 1987, p. 44.

cultural tractors and machines and public works vehicles,

- 'diesel-engine type' means a diesel engine for which type-approval of a separate technical unit within the meaning of Article 9a of Directive 70/156/EEC may be granted.

Article 2

1. From 1 July 1988, no Member State may, on grounds relating to the gaseous pollutants emitted from an engine:

- refuse to grant EEC type-approval, or to issue the document provided for in the last indent of Article 10 (1) of Directive 70/156/EEC, or to grant national type-approval for a type of vehicle propelled by a diesel engine, or
- prohibit the registration, sale, entry into service or use of such new vehicles, or
- refuse to grant EEC type-approval, or to grant national type-approval for a type of diesel engine, or
- prohibit the sale or use of new diesel engines,

if the requirements of the Annexes to this Directive are satisfied.

2. From 1 July 1988, Member States may, on grounds relating to gaseous pollutants emitted from an engine:

- refuse to grant national type-approval for a type of vehicle propelled by a diesel engine,
- or
- refuse to grant national type-approval for a diesel-engine type,

if the requirements of the Annexes to this Directive are not satisfied.

3. Until 30 September 1990, paragraph 2 shall not apply to types of vehicles propelled by a diesel engine, and to diesel-engine types if the diesel engine is described in the Annex to a type approval certificate granted before that date in accordance with Directive 72/306/EEC.

4. From 1 October 1990 Member States may, on grounds relating to gaseous pollutants emitted from an engine:

- prohibit the registration, sale, entry into service and use of new vehicles, propelled by a diesel engine,
- or

- prohibit the sale and use of new diesel engines

if the requirements of the Annexes to this Directive are not satisfied.

Article 3

1. The Member State which has granted type-approval of a type of diesel engine shall take the necessary measures to ensure that it is informed of any modification of a part or characteristic referred to in section 2.3 of Annex I. The competent authorities of that Member State shall decide whether fresh tests should be carried out on the modified engine and a fresh report drawn up. Where the tests reveal failure to comply with this Directive, the modification shall not be approved.

2. The Member State which has granted type-approval of a vehicle type in respect of its diesel engine shall take the necessary measures to ensure that it is informed of any modification of such vehicle type as regards the engine installed. The competent authorities of that Member State shall decide whether after such a modification, measures in application of Directive 70/156/EEC, especially of Article 4 or of Article 6 thereof, must be taken.

Article 4

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

Article 5

1. Member States shall bring into force the laws, regulations, and administrative provisions necessary to comply with the Directive by 1 July 1988. They shall forthwith inform the Commission thereof.

2. As soon as this Directive has been notified, Member States shall also ensure that the Commission is informed, in sufficient time for it to submit its comments of any draft major laws, regulations or administrative provisions which they intend to adopt in the field covered by this Directive.

Article 6

Not later than the end of 1988, the Council will consider, on the basis of a proposal from the Commission, a further reduction of the limit values for the

three pollutants concerned by this Directive and the fixing of limit values for particulate emissions.

Done at Brussels, 3 December 1987.

Article 7

This Directive is addressed to the Member States.

For the Council
The President
Chr. CHRISTENSEN

ANNEX I

SCOPE, DEFINITIONS AND ABBREVIATIONS, APPLICATION FOR EEC TYPE-APPROVAL SPECIFICATIONS AND TESTS AND CONFORMITY OF PRODUCTION

1. SCOPE

This Directive applies to the gaseous pollutants from all motor vehicles equipped with compression-ignition engines and to compression-ignition engines as specified in Article 1 with the exception of those vehicles of category N₁, N₂ and M₂ for which type-approval has been granted under Directive 70/220/EEC ⁽¹⁾, as last amended by Directive 88/76/EEC ⁽²⁾.

2. DEFINITIONS AND ABBREVIATIONS

For the purposes of this Directive :

- 2.1. 'Approval of an engine' means the approval of an engine type with regard to the level of the emission of gaseous pollutants;
- 2.2. 'diesel engine' means an engine which works on the compression-ignition principle;
- 2.3. 'engine type' means a category of engines which do not differ in such essential respects as engine characteristics as defined in Annex II to this Directive;
- 2.4. 'gaseous pollutants' means carbon monoxide, hydrocarbons (assuming a ratio of C₁H_{1,85}) and oxides of nitrogen, the last-named being expressed in nitrogen dioxide (NO₂) equivalent;
- 2.5. 'net power' means the power in EEC kW obtained on the test bench at the end of the crankshaft, or its equivalent, measured in accordance with the EEC method of measuring power as set out in Directive 80/1269/EEC ⁽³⁾;
- 2.6. 'rated speed' means the maximum full load speed allowed by the governor as specified by the manufacturer in his sales and service literature;
- 2.7. 'per cent load' means the fraction of the maximum available torque at an engine speed;
- 2.8. 'intermediate speed' means the speed corresponding to the maximum torque value if such speed is within the range of 60 to 75 % of rated speed; in other cases it means a speed equal to 60 % of rated speed;

2.9. Abbreviations and units

P	kW	net power output non-corrected ⁽⁴⁾
CO	g/kWh	carbon monoxide emission
HC	g/kWh	hydrocarbon emission
NO _x	g/kWh	emission of oxides of nitrogen
conc	ppm	concentration (ppm by volume)
mass	g/h	pollutant mass flow
WF		weighting factor
G _{EXH}	kg/h	exhaust gas mass flow rate on wet basis
V' _{EXH}	m ³ /h	exhaust gas volume flow rate on dry basis
V [*] _{EXH}	m ³ /h	exhaust gas volume flow rate on wet basis
G _{AIR}	kg/h	intake air mass flow rate
V _{AIR}	m ³ /h	intake air volume flow rate (wet air at 0 °C and 101,3 kPa)
G _{FUEL}	kg/h	fuel mass flow rate
HFID		heated flame ionization detector
NDUVR		non-dispersive ultraviolet resonance absorption
NDIR		non-dispersive infra-red

⁽¹⁾ OJ No L 76, 6. 4. 1970, p. 1.

⁽²⁾ See page 1 of this Official Journal.

⁽³⁾ OJ No L 375, 31. 12. 1980, p. 46.

⁽⁴⁾ As described in Annex I to Directive 80/1269/EEC.

CLA	chemiluminescent analyser
HCLA	heated chemiluminescent analyser

3. APPLICATION FOR EEC TYPE-APPROVAL

3.1. Application for EEC type-approval for a type of engine as a separate technical unit

3.1.1. The application for approval of an engine type with regard to the level of the emission of gaseous pollutants shall be submitted by the engine manufacturer or by a duly accredited representative.

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

3.1.2.1. a description of the engine type comprising the particulars referred to in Annex II to this Directive which conform to the requirements of Article 9a of Directive 70/156/EEC.

3.1.3. An engine conforming to the 'engine type' characteristics described in Annex II shall be submitted to the technical service responsible for conducting the approval tests defined in section 6.

3.2. Application for EEC type-approval for a vehicle type in respect of its engine

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

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

3.2.2.1. a description of the vehicle type and of engine-related vehicle parts comprising the particulars referred to in Annex II, along with the documentation required in application of Article 3 of Directive 70/156/EEC,
or

3.2.2.2. a description of the vehicle type and of engine-related vehicle parts comprising the particulars referred to in Annex II, as applicable, and a copy of the EEC Type-Approval Certificate (Annex VIII) for the engine as a separate technical unit which is installed in the vehicle type, along with the documentation required in application of Article 3 of Directive 70/156/EEC.

4. EEC TYPE-APPROVAL

4.1. A certificate conforming to the model specified in Annex VIII shall be issued for approval referred to under sections 3.1 and 3.2.

5. ENGINE MARKINGS

5.1. The engine approved as a technical unit must bear :

5.1.1. the trademark or trade name of the manufacturer of the engine;

5.1.2. the manufacturer's commercial description;

5.1.3. the EEC type-approval number preceded by the distinctive letter(s) of the country granting EEC type-approval ⁽¹⁾.

5.2. These marks must be clearly legible and indelible.

6. SPECIFICATIONS AND TESTS

6.1. General

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

6.2. Specifications concerning the emission of gaseous pollutants

The emission of gaseous pollutants by the engine submitted for testing shall be measured by the method described in Annex III. Other methods may be approved if it is found that they yield equivalent results.

(1) B = Belgium, D = Federal Republic of Germany, DK = Denmark, E = Spain, F = France, GR = Greece, I = Italy, IRL = Ireland, L = Luxembourg, NL = Netherlands, P = Portugal, UK = United Kingdom.

- 6.2.1. The mass of the carbon monoxide, the mass of the hydrocarbons and the mass of the oxides of nitrogen obtained shall not exceed the amounts shown in the table below :

Mass of carbon monoxide (CO) grams per kWh	Mass of hydrocarbons (HC) grams per kWh	Mass of nitrogen oxides (NO _x) grams per kWh
11,2	2,4	14,4

7. INSTALLATION ON THE VEHICLE

- 7.1. The engine installation on the vehicle shall comply with the following characteristics in respect to the type-approval of the engine :
- 7.1.1. intake depression shall not exceed that specified for the type-approved engine in Annex VIII;
- 7.1.2. exhaust back pressure shall not exceed that specified for the type-approved engine in Annex VIII;
- 7.1.3. maximum power absorbed by the engine-driven equipment shall not exceed the maximum permissible power specified for the type-approved engine in Annex VIII.

8. CONFORMITY OF PRODUCTION

- 8.1. Every engine bearing an EEC type-approval number pursuant to this Directive shall conform to the engine-type approved.
- 8.2. In order to verify conformity as prescribed in section 8.1, an engine bearing an EEC type-approval number shall be taken from the series.
- 8.3. As a general rule, conformity of the engine with the approved type shall be verified on the basis of the description given in the type-approval certificate and its annexes and, if necessary, an engine shall be subjected to the test referred to in section 6.2.
- 8.3.1. For verifying the conformity of the engine in a test, the following procedure is adopted :
- 8.3.1.1. An engine is taken from the series and subjected to the test described in Annex III. The mass of the carbon monoxide, the mass of the hydrocarbons and the mass of the oxides of nitrogen obtained shall not exceed the amounts shown in the table below :

Mass of carbon monoxide (CO) grams per kWh	Mass of hydrocarbons (HC) grams per kWh	Mass of nitrogen oxides (NO _x) grams per kWh
12,3	2,6	15,8

- 8.3.1.2. If the engine taken from the series does not satisfy the requirements of section 8.3.1.1, the manufacturer may ask for measurements to be performed on a sample of engines taken from the series and including the engine originally taken. The manufacturer shall determine the size (n) of the sample, in agreement with the technical service. Engines other than the engine originally taken shall be subjected to a test. The arithmetical mean ($\bar{x}$) of the results obtained with the sample shall then be determined for each gaseous pollutant. The production of the series shall then be deemed to conform if the following condition is met :

$$\bar{x} + k \cdot S \leq L^{(1)}$$

where :

L is the limit value laid down in section 8.3.1.1 for each gaseous pollutant considered, and

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

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

n	2	3	4	5	6	7	8	9	10
k	0,973	0,613	0,489	0,421	0,376	0,342	0,317	0,296	0,279
n	11	12	13	14	15	16	17	18	19
k	0,265	0,253	0,242	0,233	0,224	0,216	0,210	0,203	0,198

$$\text{If } n \geq 20, \quad k = \frac{0,860}{\sqrt{n}}$$

8.3.2.

The technical service responsible for verifying the conformity of production shall carry out tests on engines which have been run-in partially or completely, according to the manufacturer's specifications.

ANNEX II**INFORMATION DOCUMENT No ...****PURSUANT TO ANNEX I OF DIRECTIVE 70/156/EEC**

relating to EEC partial type-approval or type-approval as a separate technical unit of gaseous pollutant emissions from diesel engines for use in vehicles (Directive 88/77/EEC)

Vehicle/engine type:

0. General

- 0.1. Make (name of undertaking):
- 0.2. Type and commercial description (mention any variants):
.....
- 0.3. Manufacturer's type coding as marked on the vehicle/separate technical unit/component:
- 0.4. Category of vehicle (if applicable):
- 0.5. Name and address of manufacturer:
.....
- 0.6. Name and address of manufacturer's authorized representative (if any):
.....

Attachments

- 1. Essential characteristics of the engine and information concerning the conduct of test.
- 2. Characteristics of the engine-related vehicle parts (if applicable).
- 3. Photographs of the engine and, if applicable, of the engine compartment.
- 4. List further attachments if any.

Date, File

Appendix I

**ESSENTIAL CHARACTERISTICS OF THE ENGINE AND INFORMATION
CONCERNING THE CONDUCT OF TEST ⁽¹⁾**

1. **Description of engine**
 - 1.1. Manufacturer :
 - 1.2. Manufacturer's engine code :
 - 1.3. Cycle : four stroke/two stroke ⁽²⁾
 - 1.4. Bore : mm
 - 1.5. Stroke : mm
 - 1.6. Number and layout of cylinders :
 - 1.7. Engine capacity : cm³
 - 1.8. Volumetric compression ratio ⁽³⁾ :
 - 1.9. Drawing(s) of combustion chamber and piston crown :
 - 1.10. Minimum cross-sectional area of inlet and outlet ports :
 - 1.11. *Cooling system*
 - 1.11.1. Liquid
 - 1.11.1.1. Nature of liquid :
 - 1.11.1.2. Circulating pump(s) : yes/no ⁽²⁾
 - 1.11.1.3. Characteristics or make(s) and type(s) (if applicable) :
 - 1.11.1.4. Drive ratio(s) (if applicable) :
 - 1.11.2. Air
 - 1.11.2.1. Blower : yes/no ⁽²⁾
 - 1.11.2.2. Characteristics or make(s) and type(s) (if applicable) :
 - 1.11.2.3. Drive ratio(s) (if applicable) :
 - 1.12. *Temperature permitted by the manufacturer*
 - 1.12.1. Liquid cooling : Maximum temperature at outlet : K
 - 1.12.2. Air cooling : Reference point :
Maximum temperature at reference point : K
 - 1.12.3. Maximum charge air outlet temperature of the inlet intercooler (if applicable) K
 - 1.12.4. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold(s) : K
 - 1.12.5. Fuel temperature : min. K, max. K
 - 1.12.6. Lubricant temperature : min. K, max. K
 - 1.13. *Pressure charger : yes/no ⁽²⁾*
 - 1.13.1. Make :
 - 1.13.2. Type :

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

⁽²⁾ Strike out what does not apply.

⁽³⁾ Specify the tolerance.

- 1.13.3. Description of the system (e.g. max. charge pressure, wastegate, if applicable):
- 1.13.4. Intercooler: yes/no ⁽¹⁾
- 1.14. *Intake system*
Minimum and/or maximum allowable intake depression (if applicable) at rated engine speed and at 100 % load: kPa
- 1.15. *Exhaust system*
Maximum allowable exhaust back pressure at rated engine speed and at 100 % load: kPa
2. **Additional anti-smoke devices** (If any, and if not covered by another heading)
Description and/or diagram(s):
3. **Fuel feed**
- 3.1. *Feed pump*
Pressure ⁽²⁾: kPa or characteristic diagram ⁽²⁾:
- 3.2. *Injection system*
- 3.2.1. Pump
- 3.2.1.1. Make(s):
- 3.2.1.2. Type(s):
- 3.2.1.3. Delivery: mm³ ⁽²⁾ per stroke or cycle at pump speed of rpm at full injection, or characteristic diagram ⁽¹⁾ ⁽²⁾:
Mention the method used: On engine/on pump bench ⁽¹⁾
- 3.2.1.4. Injection advance
- 3.2.1.4.1. Injection advance curve ⁽²⁾:
- 3.2.1.4.2. Timing ⁽²⁾:
- 3.2.2. Injection piping
- 3.2.2.1. Length: mm
- 3.2.2.2. Internal diameter: mm
- 3.2.3. Injector(s)
- 3.2.3.1. Make(s):
- 3.2.3.2. Type(s):
- 3.2.3.3. 'Opening pressure': kPa ⁽²⁾
or characteristic diagram ⁽¹⁾ ⁽²⁾:
- 3.2.4. Governor
- 3.2.4.1. Make(s):
- 3.2.4.2. Type(s):
- 3.2.4.3. Speed at which cut-off starts under full load: rpm
- 3.2.4.4. Maximum no-load speed: rpm
- 3.2.4.5. Idling speed: rpm
- 3.3. *Cold start system*
- 3.3.1. Make(s):
- 3.3.2. Type(s):
- 3.3.3. Description:
4. **Valve timing**
- 4.1. Maximum lift of valves and angles of opening and closing in relation to dead centres of equivalent data: ...
.....

⁽¹⁾ Strike out what does not apply.

⁽²⁾ Specify the tolerance.

(3) Specify the tolerance.

7.2. *Engine power* (measured in accordance with the provisions of Directive 80/1269/EEC)

	Engine speed		
	Idle	Intermediate	Rated
Maximum power measured on test (kW (a))			
Total power absorbed by engine-driven equipment as per section 6.2.2 (kW (b))			
Gross engine power (kW (c))			
Maximum permissible power absorbed as per section 5 (kW (d))			
Minimum net engine power (kW (e))			
$c = a + b; e = c - d$			

Appendix 2

CHARACTERISTICS OF THE ENGINE-RELATED VEHICLE PARTS

1. Intake system depression at rated engine rpm and at 100 % load : kPa
2. Exhaust system back pressure at rated engine rpm and at 100 % load : kPa
3. Power absorbed by the engine-driven equipment as specified in and under the operation conditions of Directive 80/1269/EEC, Annex I, section 5.1.1, at each engine speed as defined in section 4.1 of Annex III to this Directive.

Equipment	Power absorbed (kW) at various engine speeds		
	Idle	Intermediate	Rated
Total			

ANNEX III

TEST PROCEDURE

1. INTRODUCTION

1.1. This Annex describes the method of determining emissions of gaseous pollutants from the engines to be tested.

1.2. The test shall be carried out with the engine mounted on a test bench and connected to a dynamometer.

2. MEASUREMENT PRINCIPLE

The gaseous emissions from the exhaust of the engine include hydrocarbons, carbon monoxide and oxides of nitrogen. During a prescribed sequence of warmed-up-engine operating conditions the amounts of the above gases in the exhaust shall be examined continuously. The prescribed sequence of operations consists of a number of speed and power modes which span the typical operating range of diesel engines. During each mode the concentration of each pollutant, exhaust flow and power output shall be determined and the measured values weighted and used to calculate the grams of each pollutant emitted per kilowatt hour, as described in this Annex.

3. EQUIPMENT

3.1. Dynamometer and engine equipment

The following equipment shall be used for emission tests of engines on engine dynamometers:

3.1.1. an engine dynamometer with adequate characteristics to perform the test cycle described in section 4.1;

3.1.2. measuring instruments for speed, torque, fuel consumption, air consumption, temperature of coolant and lubricant, exhaust gas pressure and inlet manifold depression, exhaust gas temperature, air inlet temperature, atmospheric pressure, humidity and fuel temperature. The accuracy of these instruments shall satisfy the EEC method of measuring the power of the internal combustion engines of road vehicles;

3.1.3. an engine cooling system with sufficient capacity to maintain the engine at normal operating temperatures for the duration of the prescribed engine tests;

3.1.4. a non-insulated and uncooled exhaust system extending at least 0,5 metres past the point where the exhaust probe is located, and presenting an exhaust backpressure within ± 650 Pa (± 5 mm Hg) of the upper limit at the maximum rated power, as established by the engine manufacturer's sale and service literature for vehicle application;

3.1.5. an engine air inlet system presenting an air inlet restriction within ± 300 Pa (30 mm H₂O) of the upper limit for the engine operating condition which results in maximum air flow, as established by the engine manufacturer for an air cleaner, for the engine being tested.

3.2. Analytical and sampling equipment

The system shall comprise one HFID analyser for the measurement of the unburned hydrocarbons (HC), and NDIR analyser for measurement of carbon monoxide (CO) and a CLA, HCLA or equivalent analyser for measurement of oxides of nitrogen (NO_x). Due to the heavy hydrocarbons present in the diesel exhaust, the HFID system shall be heated and maintained at a temperature of 453 to 473 K (180 to 200 °C).

The accuracy of the analysers shall be $\pm 2,5$ % of full-scale deflection or better. The scale of measurement of the analysers shall be selected appropriately in relation to the values measured.

3.3. Gases

3.3.1. The system must be free of gas leaks. The design and materials used must be such that the system does not influence the pollutant concentration in the exhaust gas. The following gases may be used:

Analyser	Span gas	Zero gas
CO	CO in N ₂	nitrogen or dry purified air
HC	C ₃ H ₈ in air	dry purified air
NO _x	NO in N ₂ ⁽¹⁾	nitrogen or dry purified air

⁽¹⁾ The amount of NO₂ contained in this gas must not exceed 5 % of the NO content.

3.4. Support gases

3.4.1. The following gases must be available if necessary for operation :

3.4.2. Purified nitrogen (purity ≤ 1 ppm C, ≤ 1 ppm CO, ≤ 400 ppm CO₂, $\leq 0,1$ ppm NO);

3.4.3. Purified oxygen (purity $\geq 99,5$ % vol O₂);

3.4.4. Hydrogen mixture (40 $\pm$ 2 % hydrogen, balance nitrogen or helium) (purity ≤ 1 ppm C, ≤ 400 ppm CO₂);

3.4.5. Purified synthetic air (purity ≤ 1 ppm C, ≤ 1 ppm CO, ≤ 400 ppm CO₂, $\leq 0,1$ ppm NO) oxygen content between 18 and 21 % vol.

3.5. Calibration gases

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

3.5.2. The gases used for calibration may also be obtained by means of a gas divider, diluting with purified N₂ or with purified synthetic air. The accuracy of the mixing device must be such that the concentrations of the diluted calibration gases may be determined to within ± 2 %.

Annex V describes the analytical systems in current use. Other systems or analysers which have proved to give equivalent results may be used.

4. TEST PROCEDURE**4.1. Test cycle**

The following 13-mode cycle shall be followed in dynamometer operation on the test engine :

Mode No	Engine speed	Per cent load
1	idle	—
2	intermediate	10
3	intermediate	25
4	intermediate	50
5	intermediate	75
6	intermediate	100
7	idle	—
8	rated	100
9	rated	75
10	rated	50
11	rated	25
12	rated	10
13	idle	—

4.2. Measurement of exhaust gas flow

For calculation of the emission it is necessary to know the exhaust gas flow (see section 4.8.1.1). For determination of exhaust flow either of the following methods may be used :

(a) Direct measurement of the exhaust flow by flow nozzle or equivalent metering system;

(b) Measurement of the air flow and the fuel flow by suitable metering systems and calculation of the exhaust flow by the following equations :

$$G_{EXH} = G_{AIR} + G_{FUEL}$$

or

$$V'_{EXH} = V_{AIR} - 0,75 G_{FUEL} \text{ (dry exhaust volume)}$$

or

$$V''_{EXH} = V_{AIR} + 0,77 G_{FUEL} \text{ (wet exhaust volume)}$$

The accuracy of exhaust flow determination shall be $\pm 2,5$ % or better. The concentration of carbon monoxide and nitric oxide are measured in the dry exhaust. For this reason the CO and NO_x emissions shall be calculated using the dry exhaust gas volume V'_{EXH}. However in the case of an analytical system with heated sampling line, the NO_x emissions shall be calculated using the wet exhaust gas volume V''_{EXH}. If the exhaust mass flow rate (G_{EXH}) is used in the calculation the CO and NO_x concentrations shall be related to the wet exhaust. Calculation of the HC emission shall include G_{EXH} and V'_{EXH} according to the measuring method used.

4.3. Operating procedure for analysers and sampling system

The operating procedure for analysers shall follow the start-up and operating instructions of the instrument manufacturer. The following minimum requirements shall be included.

4.3.1. Calibration procedure

The calibration procedure shall be carried out within one month preceding the emission test. The instrument assembly shall be calibrated and calibration curves checked against standard gases. The same gas flow rates shall be used as when sampling exhaust.

4.3.1.1. A minimum of two hours shall be allowed for warming up the analysers.

4.3.1.2. A system leakage test shall be performed. The probe shall be disconnected from the exhaust system and the end plugged. The analyser pump shall be switched on. After an initial stabilization period all flow meters and pressure gauges should read zero. If not, the sampling line(s) shall be checked and the fault corrected.

4.3.1.3. The NDIR analyser shall be tuned, where appropriate, and the flame combustion of the HFID analyser optimized.

4.3.1.4. Using purified dry air (or nitrogen), the CO and NO_x analysers shall be set at zero; dry air shall be purified for the HC analyser. Using appropriate calibrating gases, the analysers shall be reset.

4.3.1.5. The zero setting shall be rechecked and the procedure described in section 4.3.1.4 above repeated, if necessary.

4.3.2. Establishment of the calibration curve

4.3.2.1. 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 must be not less than 80 % of the full scale.

4.3.2.2. The calibration curve is calculated by the least square 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.

4.3.2.3. The calibration curve must not differ by more than 2 %, from the nominal value of each calibration gas.

4.3.2.4. 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 must be indicated, particularly :

- the scale,
- the sensitivity,
- the zero point,
- the date of carrying out the calibration.

4.3.2.5. 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.

4.3.3. Efficiency test of the NO_x converter

4.3.3.1. The efficiency of the converter used for the conversion of NO_x into NO is tested as follows.

4.3.3.2. Using the test set up as shown at the end of this Annex and the procedure below, the efficiency of converters can be tested by means of an ozonator.

4.3.3.3. Calibrate the CLA in the most common operating range following the manufacturer's specifications using zero and span gas (the NO content of which must amount to about 80 % of the operating range and the NO₂ concentration of the gas mixture to less than 5 % of the NO concentration). The NO_x analyser must be in the NO mode so that the span gas does not pass through the converter. Record the indicated concentration.

4.3.3.4. Via a T-fitting, oxygen is added continuously to the gas flow until the concentration indicated is about 10 % less than the indicated calibration concentration given in section 4.3.3.3. Record the indicated concentration (c). The ozonator is kept deactivated throughout the process.

4.3.3.5. 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 4.3.3.3. Record the indicated concentration (d).

4.3.3.6. The NO analyser is then switched to the NO_x mode which means that the gas mixture (consisting of NO, NO₂, O₂ and N₂) now passes through the converter. Record the indicated concentration (a).

4.3.3.7. The ozonator is now deactivated. The mixture of gases described in section 4.3.3.4 passes through the converter into the detector. Record the indicated concentration (b).

4.3.3.8. With the ozonator deactivated, the flow of oxygen is also shut off. The NO reading of the analyser must then be no more than 5 % above the figure given in section 4.3.3.3.

4.3.3.9. The efficiency of the NO_x converter is calculated as follows :

$$\text{Efficiency (\%)} = \left(1 + \frac{a-b}{c-d} \right) \times 100$$

4.3.3.10. The efficiency of the converter must be tested prior to each calibration of the NO_x analyser.

4.3.3.11. The efficiency of the converter must not be less than 90 %.

NB :

If the analyser operating range is above the highest range that the NO_x generator can operate to give a reduction from 80 to 20 %, then the highest range the NO_x generator will operate on will be used.

4.3.4. *Pre-test checks*

A minimum of two hours shall be allowed for warming up the infra-red NDIR analysers, but it is preferable that power be left on continuously in the analysers. The chopper motors may be turned off when not in use.

4.3.4.1. The HC analyser shall be set at zero on dry air or nitrogen and a stable zero obtained on the amplifier meter and recorder.

4.3.4.2. Span gas shall be introduced and the gain set to match the calibration curve. The same flow rate shall be used for calibration, span and exhaust sampling to avoid correction for sample cell pressure. Span gas having a concentration of the constituent that will give a 75 to 95 % full-scale deflection shall be used. Concentration shall be obtained to $\pm 2,5$ %.

4.3.4.3. Zero shall be checked and the procedures described in sections 4.3.2.1 and 4.3.2.2 repeated, if required.

4.3.4.4. Flow rates shall be checked.

4.4. **Fuel**

The fuel shall be the reference fuel specified in Annex IV.

4.5. **Engine test conditions**

4.5.1. The absolute temperature (T) of the engine air inlet expressed in kelvins and the dry atmospheric pressure (ps) expressed in kilopascals shall be measured and the parameter F shall be determined by the formula :

$$F = \left(\frac{99}{ps} \right)^{0,65} \times \left(\frac{T}{298} \right)^{0,5}$$

4.5.2. For a test to be recognized as valid, the parameter F shall be such that :

$$0,96 \leq F \leq 1,06$$

4.6. **Test run**

During each mode of the test cycle the specified speed shall be held to within ± 50 rpm and the specified torque shall be held to within ± 2 % of the maximum torque at the test speed. The fuel temperature at the injection pump inlet shall be 306 to 316 K (33 to 43 °C). The governor and fuel system shall be adjusted as established by the manufacturer's sales and service literature. The following steps shall be taken for each test :

4.6.1. instrumentation and sample probes shall be installed as required;

4.6.2. the cooling system shall be started;

4.6.3. the engine shall be started and warmed up until all temperatures and pressures have reached equilibrium;

4.6.4. the torque curve at full load shall be determined by experimentation to calculate the torque values for the specified test modes; the maximum permissible power absorbed by engine-driven equipment, declared by the manufacturer to be applicable to the engine type, shall be taken into account. The dynamometer setting for each engine speed and load shall be calculated using the formula :

$$s = P_{\min} \times \frac{L}{100} + P_{\text{aux}}$$

where

s = dynamometer setting,

P_{min} = minimum net engine power as indicated in line (e) in the table of section 7.2 in Appendix 1 to Annex II,

L = per cent load as indicated in section 4.1 of this Annex,

P_{aux} = total permissible power absorbed by engine driven equipment minus the power of any such equipment actually driven by the engine: (d)–(b) of section 7.2 of Appendix 1 to Annex II;

4.6.5. the emission analysers shall be set at zero and spanned;

4.6.6. the test sequence shall be started (see section 4.1). The engine shall be operated for six minutes in each mode, completing engine speed and load changes in the first minute. The responses of the analysers shall be recorded on a strip chart recorder for the full six minutes with exhaust gas flowing through the analysers at least during the last three minutes. The engine speed and load, intake air temperature and depression exhaust temperature and back pressure, fuel flow and air of exhaust flow shall be recorded during the last five minutes of each mode, with the speed and load requirements being met during the last minute of each mode;

4.6.7. any additional data required for calculation shall be read and recorded (see section 4.7);

4.6.8. the zero and span settings of the emission analysers shall be checked and reset, as required, at least at the end of the test. The test shall be considered satisfactory if the adjustment necessary after the test does not exceed the accuracy of the analysers prescribed in section 3.2.

4.7. Chart reading

The last 60 seconds of each mode shall be located, and the average chart reading for HC, CO and NO_x over this period shall be determined. The concentration of HC, CO and NO_x during each mode shall be determined from the average chart readings and the corresponding calibration data. However a different type of registration can be used if it ensures an equivalent data acquisition.

4.8. Calculations

4.8.1. The final reported test results shall be derived through the following steps:

4.8.1.1. the exhaust gas mass flow rate G_{EXH} or V'_{EXH} and V''_{EXH} shall be determined (see section 4.2) for each mode;

4.8.1.2. when applying G_{EXH} the measured carbon monoxide and oxides of nitrogen concentration shall be converted to a wet basis according to Annex VI. However in the case of an analytical system with heated sampling line, the NO_x emissions shall not be converted according to Annex VI;

4.8.1.3. the NO_x concentration shall be corrected according to Annex VII;

4.8.1.4. the pollutant mass flow for each mode shall be calculated as follows:

$$(1) \text{ NO}_x \text{ mass} = 0,001587 \times \text{NO}_x \text{ conc} \times \text{G}_{\text{EXH}}$$

$$(2) \text{ CO}_{\text{mass}} = 0,000966 \times \text{CO}_{\text{conc}} \times \text{G}_{\text{EXH}}$$

$$(3) \text{ HC}_{\text{mass}} = 0,000478 \times \text{HC}_{\text{conc}} \times \text{G}_{\text{EXH}}$$

or

$$(1) \text{ NO}_x \text{ mass} = 0,00205 \times \text{NO}_x \text{ conc} \times \text{V}'_{\text{EXH}} \text{ (dry) for unheated systems}$$

$$(2) \text{ NO}_x \text{ mass} = 0,00205 \times \text{NO}_x \text{ conc} \times \text{V}''_{\text{EXH}} \text{ (wet) for heated systems}$$

$$(3) \text{ CO}_{\text{mass}} = 0,00125 \times \text{CO}_{\text{conc}} \times \text{V}'_{\text{EXH}} \text{ (dry)}$$

$$(4) \text{ HC}_{\text{mass}} = 0,000618 \times \text{HC}_{\text{conc}} \times \text{V}''_{\text{EXH}} \text{ (wet)}$$

4.8.2. The emissions shall be calculated in the following way:

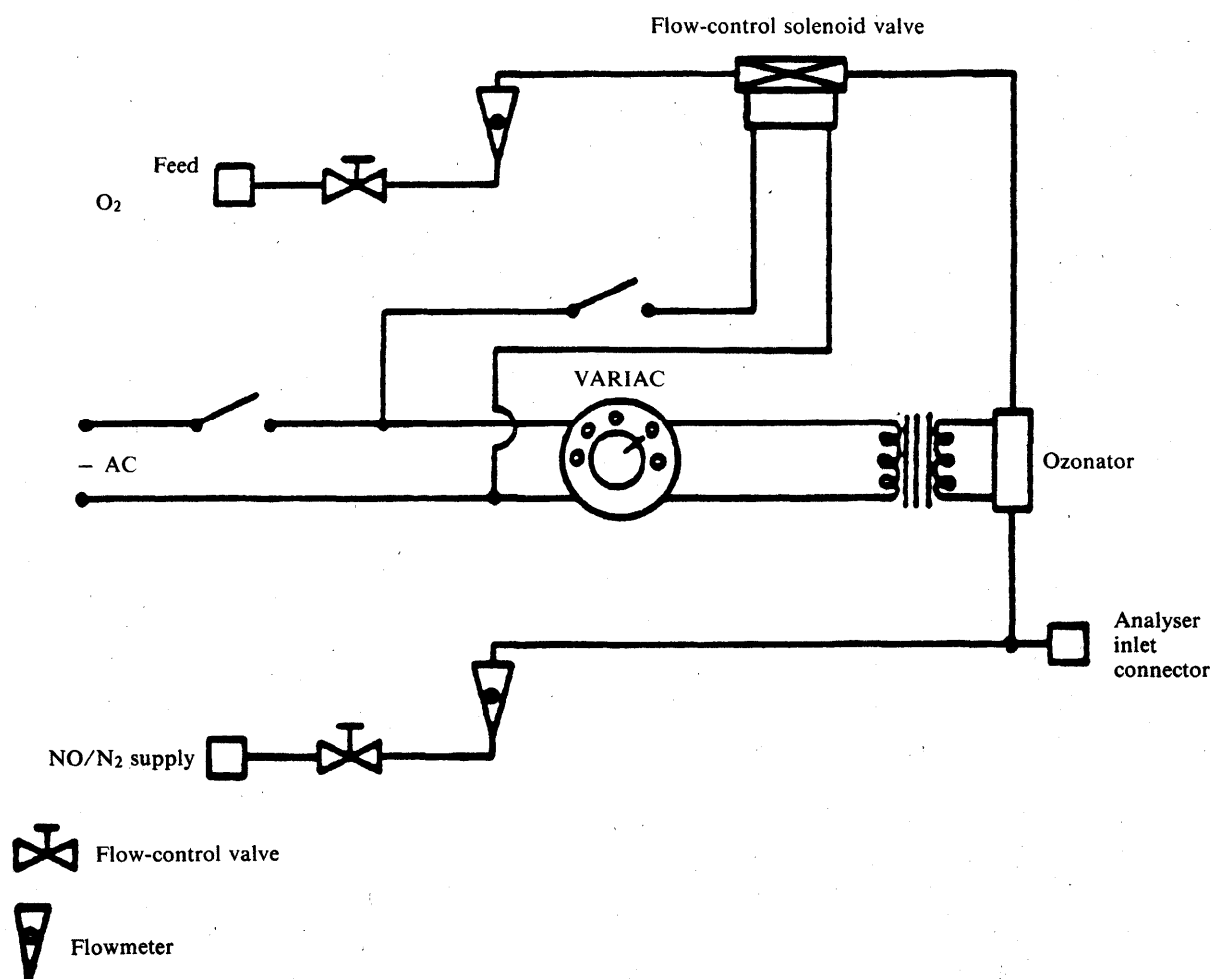
$$\text{NO}_x = \frac{\sum \text{NO}_x \text{ mass} \times \text{WF}}{\sum \text{P} \times \text{WF}}$$

$$\text{CO} = \frac{\sum \text{CO}_{\text{mass}} \times \text{WF}}{\sum \text{P} \times \text{WF}}$$

$$\text{HC} = \frac{\sum \text{HC}_{\text{mass}} \times \text{WF}}{\sum \text{P} \times \text{WF}}$$

The weighting factors used in the above calculation are according to the following table:

Mode No	WF
1	0,25/3
2	0,08
3	0,08
4	0,08
5	0,08
6	0,25
7	0,25/3
8	0,10
9	0,02
10	0,02
11	0,02
12	0,02
13	0,25/3



Schematic of NO_x converter efficiency device

ANNEX IV

**TECHNICAL CHARACTERISTICS OF REFERENCE FUEL PRESCRIBED FOR
APPROVAL TESTS AND TO VERIFY CONFORMITY OF PRODUCTION**

CEC reference fuel RF-03-A-84 (1) (3) (7)

Type : Diesel fuel

	Limits and units	ASTM Method
Cetane number (4)	min. 49 max. 53	D 613
Density 15 °C (kg/l)	min. 0,835 max. 0,845	D 1298
Distillation (2) :		
— 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	D 93
CFPP	min. — max. -5 °C	EN 116 (CEN)
Viscosity 40 °C	min. 2,5 mm ² /s max. 3,5 mm ² /s	D 445
Sulphur content	min. (to be reported) max. 0,3 % mass	D 1266/D 2622 D 2785
Copper corrosion	max. 1	D 130
Conradson carbon residue (10 % DR)	max. 0,2 % mass	D 189
Ash content	max. 0,01 % mass	D 482
Water content	max. 0,05 % mass	D 95/D 1744
Neutralization (strong acid) number	max. 0,20 mg KOH/g	
Oxidation stability (6)	max. 2,5 mg/100 ml	D 2274
Additives (5)		

(1) Equivalent ISO methods will be adopted when issued for all properties listed above.

(2) The figures quoted show the total evaporated quantities (% recovered + % loss).

(3) 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.

(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 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) 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.

(6) Even though oxidation stability is controlled it is likely that shelf life will be limited. Advice should be sought from the supplier as to storage conditions and life.

(7) If it is required to calculate the thermal efficiency of an engine or vehicle, the calorific value of the fuel can be calculated from :

$$\text{Specific energy (calorific value) (net) in MJ/kg} = (46,423 - 8,792d^2 + 3,170d) (1 - (x + y + s)) + 9,420s - 2,499x$$

where :

d = the density at 15 °C

x = the proportion by mass of water (% divided by 100)

y = the proportion by mass of ash (% divided by 100)

s = the proportion by mass of sulphur (% divided by 100).

ANNEX V

ANALYTICAL SYSTEMS

Three analytical systems are described based on the use of:

- HFID analyser for the measurement of hydrocarbons,
- NDIR analyser for the measurement of carbon monoxide,
- CLA, HCLA or equivalent analyser with or without heated sampling line for measurement of nitrogen oxides.

System 1

A schematic diagram of the analytical and sampling system using the chemiluminescent analyser for measuring NO_x is shown in Figure 1.

SP	Stainless-steel sample probe, to obtain samples from the exhaust system. A closed-end multihole static probe extending at least 80 % across the exhaust pipe is recommended. The exhaust gas temperature at the probe shall be not less than 343 K (70 °C).
HSL	Heated sampling line, temperature shall be kept at 453 to 473 K (180 to 200 °C); the line shall be made in stainless steel or PTFE.
F ₁	Heated pre-filter, if used; temperature shall be the same as HSL.
T ₁	Temperature read-out of sample stream entering oven compartment.
V ₁	Suitable valving for selecting sample, span gas or air gas flow to the system. The valve shall be in the oven compartment or heated to the temperature of the sampling line.
V ₂ , V ₃	Needle valves to regulate calibration gas and zero gas.
F ₂	Filter to remove particulates. A 70-mm-diameter glass-fibre-type filter disc is suitable. The filter shall be readily accessible and changed daily or more frequently, as needed.
P ₁	Heated sample pump.
G ₁	Pressure gauge to measure pressure in sample line.
V ₄	Pressure regulator valve to control pressure in sample line and flow to detector.
HFID	Heated flame ionization detector for hydrocarbons. Temperature of oven shall be kept at 453 to 473 K (180 to 200 °C).
FL ₁	Flowmeter to measure sample by-pass flow.
R ₁ , R ₂	Pressure regulators for air and fuel.
SL	Sample line. The line shall be made in PTFE or in stainless steel. It may be heated or unheated.
B	Bath to cool and condense water from exhaust sample. The bath shall be maintained at a temperature of 273 to 277 K (0 to 4 °C) by ice or refrigeration.
C	Cooling coil and trap sufficient to condense and collect water vapour.
T ₂	Temperature read-out of bath temperature.
V ₅ , V ₆	Toggle valves to drain condensate trap and bath.
V ₇	Three-way valve.
F ₃	Filter for removing particulate contaminants from sample prior to analysis. A glass-fibre type of at least 70 mm diameter is suitable.
P ₂	Sample pump.
V ₈	Pressure regulator to control sample flow.
V ₉ , V ₁₀ , V ₁₁ , V ₁₂	Three-way ball valves or solenoid valves to direct sample, zero gas or calibrating gas streams to the analysers.
V ₁₃ , V ₁₄	Needle valves to regulate flows to the analysers.
CO	NDIR analyser for carbon monoxide.
NO_x	CLA analyser for nitric oxides.
FL ₂ , FL ₃ , FL ₄	By-pass flowmeters.

System 2

A schematic diagram of the analytical and sampling system using the NDIR analyser for measuring NO_x is shown in Figure 2.

SP	Stainless-steel sample probe, to obtain samples from the exhaust system. A closed-end multihole static probe extending at least 80 % across the exhaust pipe is recommended; the temperature at the probe shall be at least 343 K (70 °C) (in accordance with Directive 72/306/EEC). The probe shall be located in the exhaust line at a distance of 1 to 5 metres from the exhaust manifold outlet flange of the outlet of the turbocharger.
HSL	Heated sampling line, temperature shall be kept at 453 to 473 K (180 to 200 °C); the line shall be made in stainless steel or PTFE.
F ₁	Heated pre-filter, if used; temperature shall be the same as the HSL.
T ₁	Temperature read-out of sample stream entering oven compartment.
V ₁	Suitable valving for selecting sample, span gas or air zero gas flow to the system. The valve shall be in the oven compartment or heated to the temperature of the sampling line.
V ₂ , V ₃	Needle valves to regulate calibration gas and zero gas.
F ₂	Filter to remove particulates. A 70-mm-diameter glass-fibre-type filter disc is suitable. The filter shall be readily accessible and changed daily or more frequently, as needed.
P ₁	Heated sample pump.
G ₁	Pressure gauge to measure pressure in sample line.
V ₄	Pressure regulator valve to control pressure in sample line and flow to detector.
HFID	Heated flame ionization detector for hydrocarbons. Temperature of oven shall be kept at 453 to 473 K (180 to 200 °C).
FL ₁	Flowmeter to measure sample by-pass flow.
R ₁ , R ₂	Pressure regulators for air and fuel.
SL	Sample line. The line shall be made in PTFE or in stainless steel.
B	Bath to cool and condense water from exhaust sample. The bath shall be maintained at a temperature of 273 to 277 K (0 to 4 °C) by ice or refrigeration.
C	Cooling coil and trap sufficient to condense and collect water vapour.
T ₂	Temperature read-out of bath temperature.
V ₅ , V ₆	Toggle valves to drain condensation trap and bath.
V ₇	Three-way valve.
F ₃	Filter for removing particulate contaminants from sample prior to analysis. A glass-fibre type of at least 70 mm diameter is suitable.
P ₂	Sample pump.
V ₈	Pressure regulator to control sample flow.
V ₉	Ball or solenoid valve to direct sample, zero gas or calibrating gas streams to the analysers.
V ₁₀ , V ₁₁	Three-way valves to by-pass drier.
D	Drier to remove moisture in the sample stream. If a drier is used before NO _x analyser it shall have minimum effect on NO _x concentration.
V ₁₂	Needle valve to regulate flow to the analysers.
G ₂	Gauge to indicate inlet pressure to the analysers.
CO	NDIR analyser for carbon monoxide.
NO _x	NDIR analyser for nitric oxides.
FL ₂ , FL ₃	By-pass flowmeters.

System 3

A schematic diagram of the analytical and sampling system using HCLA or equivalent systems for measuring NO_x is shown in Figure 3 to this Annex.

SP	Stainless-steel sample probe, to obtain samples from exhaust system. A closed-end multihole straight probe extending at least 80 % across the exhaust pipe is recommended. The exhaust gas temperature at the probe shall be not less than 343 K (70 °C).
HSL ₁	Heated sampling line, temperature shall be kept at 453 to 473 K (180 to 200 °C); the line shall be made in stainless steel or PTFE.
F ₁	Heated pre-filter, if used; temperature shall be the same as HSL ₁ .

T ₁	Temperature read-out of sample stream entering oven compartment.
V ₁	Suitable valving for selecting sample, span gas or air gas flow to the system. The valve shall be in the oven compartment or heated to the temperature of the sampling line HSL ₁ .
V ₂ , V ₃	Needle valves to regulate calibration gas and zero gas.
F ₂	Filter to remove particulates. A 70-mm-diameter glass-fibre-type filter disc is suitable. The filter shall be readily accessible and changed daily or more frequently, as needed.
P ₁	Heated sample pump.
G ₁	Pressure gauge to measure pressure in sample line HC-analyser.
R ₃	Pressure regulator valve to control pressure in sample line and flow to detector.
HFID	Heated flame ionization detector for hydrocarbons. Temperature of oven shall be kept at 453 to 473 K (180 to 200 °C).
FL ₁ , FL ₂ , FL ₃	Flowmeters to measure sample by-pass flow.
R ₁ , R ₂	Pressure regulators for air and fuel.
HSL ₂	Heated sampling line, temperature shall be kept between 368 and 473 K (95 and 200 °C); the line shall be made in stainless steel or PTFE.
T ₂	Temperature read-out of sample stream entering CL analyser.
T ₃	Temperature read-out of NO ₂ to NO converter.
V ₉ , V ₁₀	Three-way valve to by-pass NO ₂ to NO converter.
V ₁₁	Needle valve to balance flow through NO ₂ to NO converter and by-pass.
SL	Sample line. The line shall be made in PTFE or in stainless steel. It may be heated or unheated.
B	Bath to cool and condense water from exhaust sample. The bath shall be maintained at a temperature of 273 to 277 K (0 to 4 °C) by ice or refrigeration.
C	Cooling coil and trap sufficient to condense and collect water vapour.
T ₄	Temperature read-out of bath temperature.
V ₅ , V ₆	Toggle valves to drain condensate trap and bath.
R ₄ , R ₅	Pressure regulators to control sample flow.
V ₇ , V ₈	Ball valve or solenoid valves to direct sample, zero gas or calibrating gas streams to the analysers.
V ₁₂ , V ₁₃	Needle valves to regulate flows to the analysers.
CO	NDIR analyser for carbon monoxide.
NO _x	HCLA analyser for nitric oxides.
FL ₄ , FL ₅	By-pass flowmeters.
V ₄ , V ₁₄	Three-way ball or solenoid valves. The valves shall be in an oven compartment or heated to the temperature of the sampling line HSL ₁ .

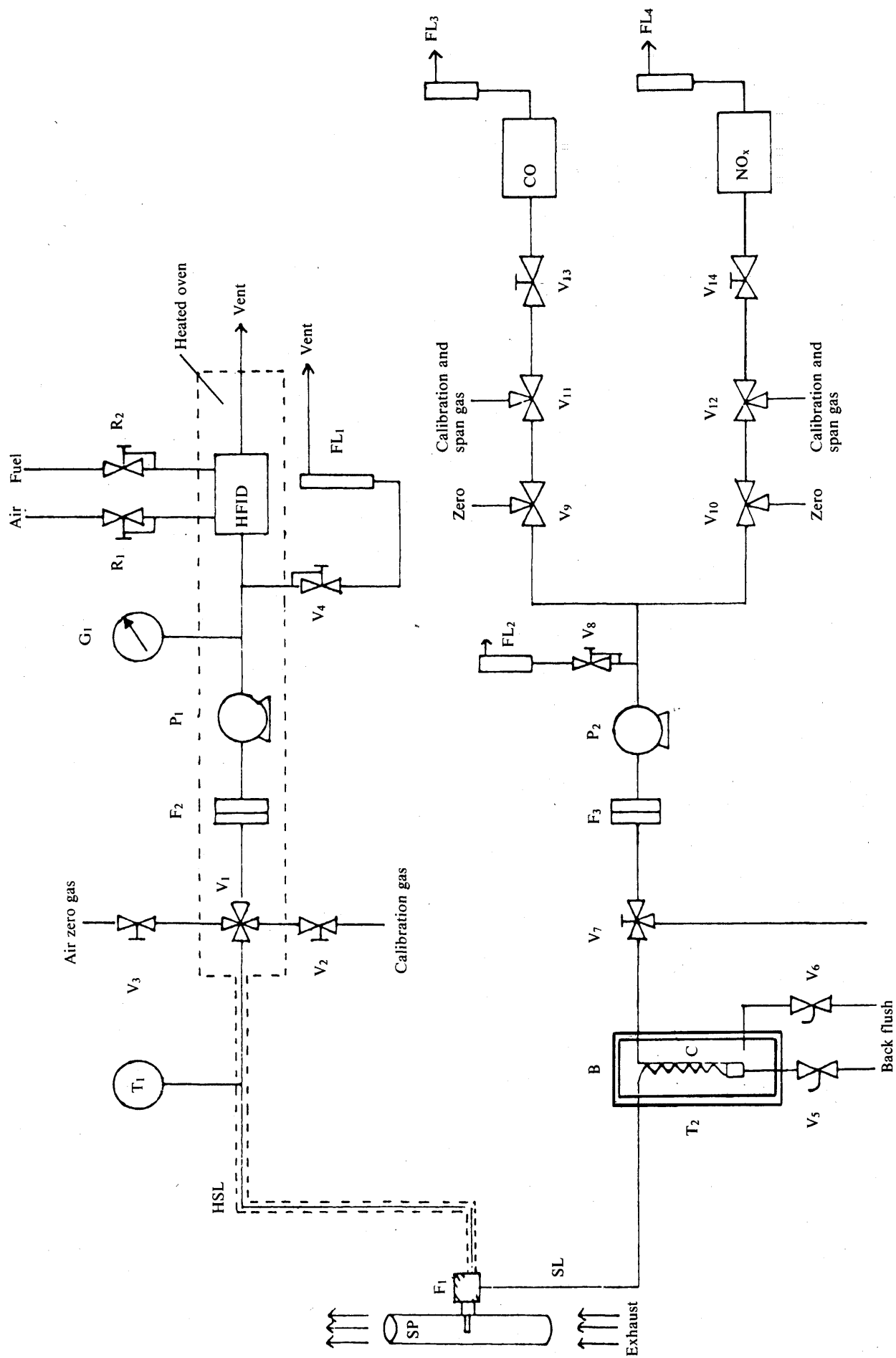


Figure 1

Flow diagram of exhaust gas analysis system for CO, NO_x, HC (NO_x analysis by CLA)

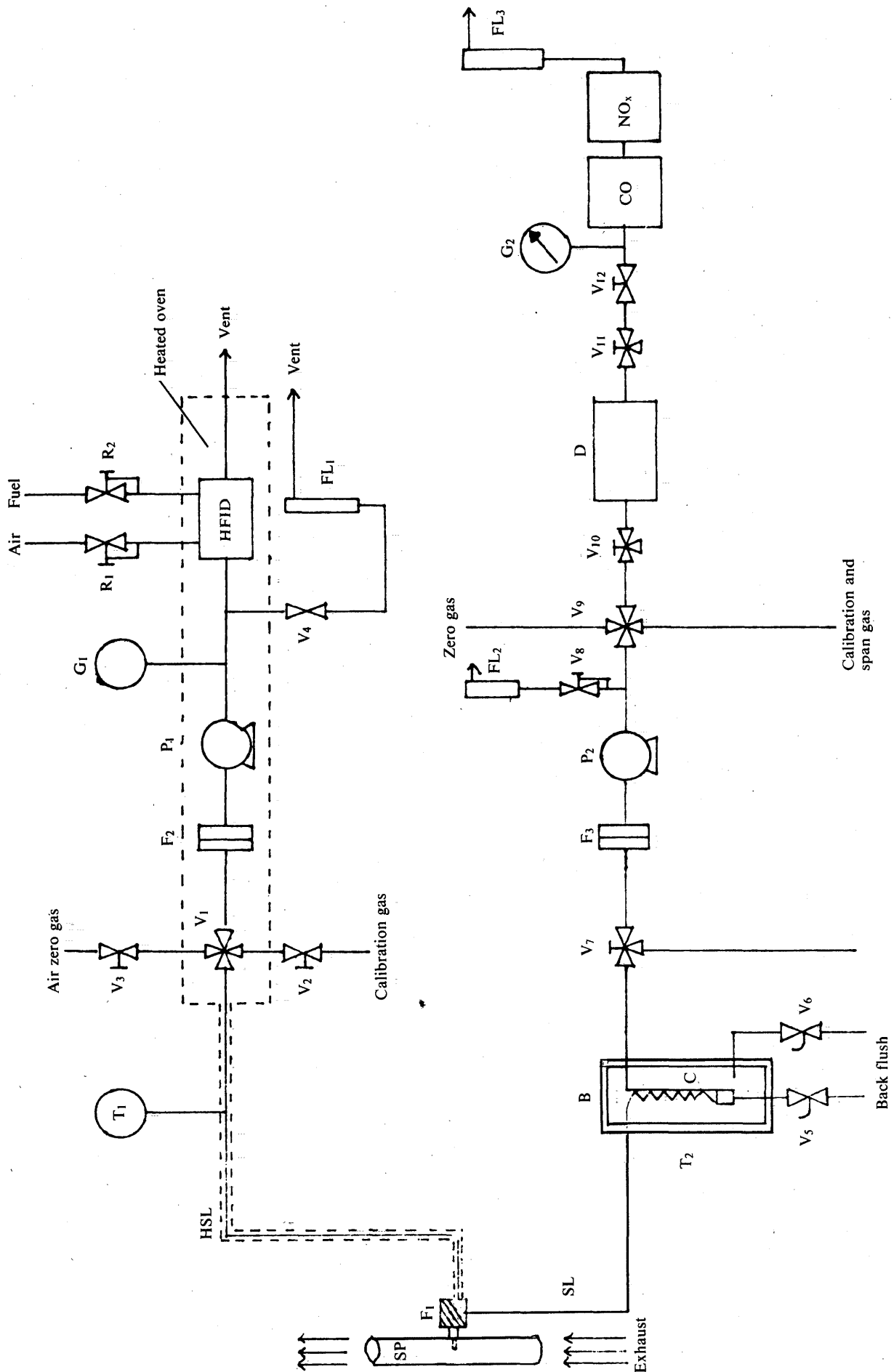


Figure 2

Flow diagram of exhaust gas analysis system for CO, NO_x, HC (NO_x analysis by NDIR)

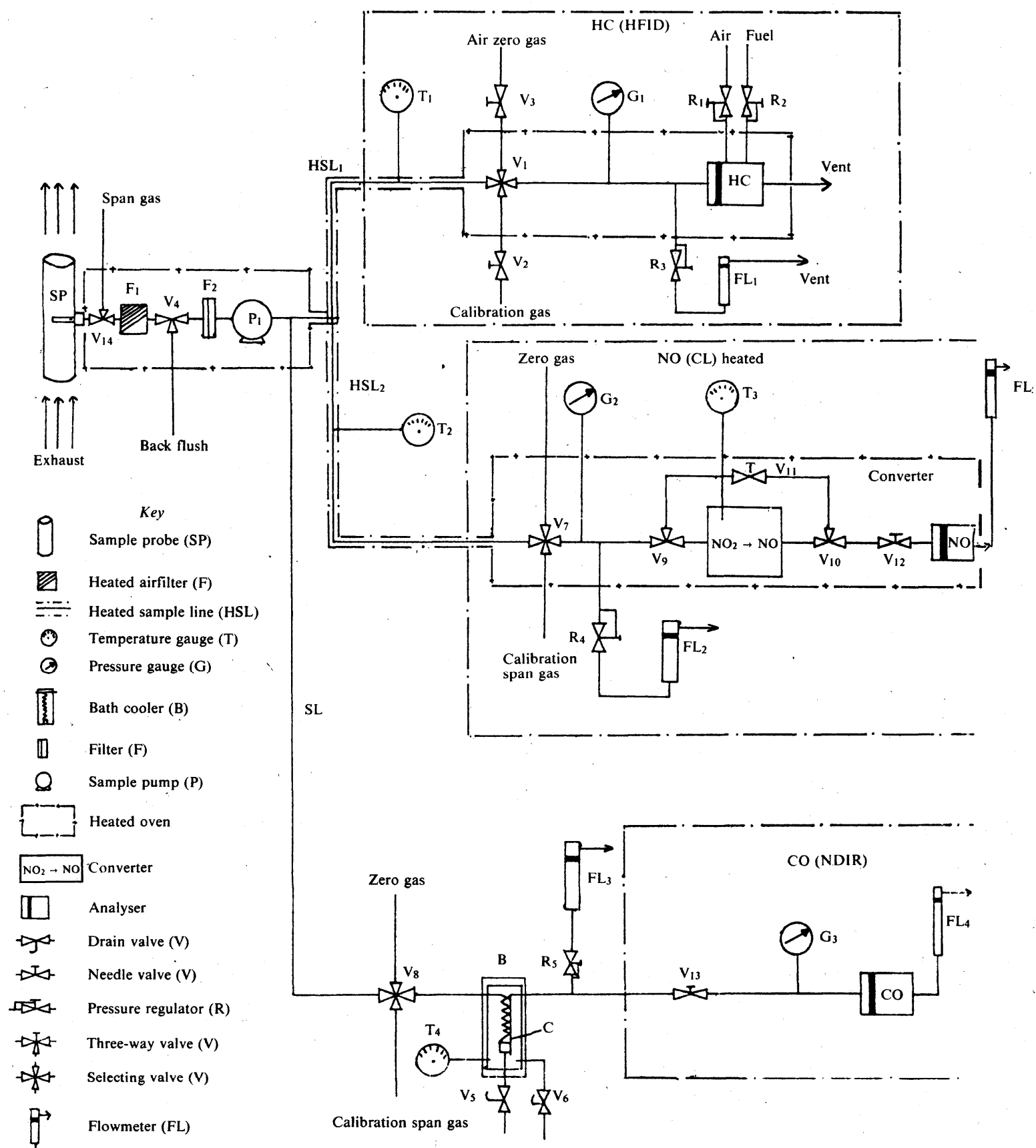


Figure 3

Flow diagram of exhaust gas analysis system for CO, NO_x and HC (analysis by HCLA and heated sample line)

ANNEX VI

CONVERSION OF CO AND NO_x CONCENTRATION TO A WET BASIS

The CO and NO_x exhaust gas concentrations as measured in this procedure are on a dry basis. To convert the measured values to the concentrations present in the exhaust (wet basis), the following relationship may be employed:

$$\text{ppm (wet basis)} = \text{ppm (dry basis)} \times \left[1 - 1,85 \left(\frac{G_{\text{FUEL}}}{G_{\text{AIR}}} \right) \right]$$

where:

G_{FUEL} = the fuel flow (kg/s) (kg/h)

G_{AIR} = the air flow (kg/s) (kg/h) (dry air).

ANNEX VII

HUMIDITY CORRECTION FACTOR FOR NITROGEN OXIDES

The values of the oxides of nitrogen shall be multiplied by the following humidity correction factor:

$$\frac{1}{1 + A(7m - 75) + B \times 1,8(T - 302)}$$

where:

$$A = 0,044 \frac{G_{\text{FUEL}}}{G_{\text{AIR}}} - 0,0038$$

$$B = 0,116 \frac{G_{\text{FUEL}}}{G_{\text{AIR}}} + 0,0053$$

m = humidity of the inlet air in grams of water per kilogram of dry air

T = temperature of the air in K

$\frac{G_{\text{FUEL}}}{G_{\text{AIR}}}$ = fuel air ratio (dry air basis).

ANNEX VIII

(MODEL)

EEC TYPE-APPROVAL CERTIFICATE

Stamp of administration

Communication concerning the :

— type-approval ⁽¹⁾— extension of type-approval ⁽¹⁾ of a type of a vehicle/separate technical unit/component ⁽¹⁾ with regard to Directive 88/77/EEC as last amended by Directive...

EEC type-approval No : Extension No :

SECTION I

0. General

0.1. Make of vehicle/separate technical unit/component ⁽¹⁾ :0.2. Manufacturer's designation of vehicle type/separate technical unit/component ⁽¹⁾ :0.3. Manufacturer's type coding as marked on the vehicle/separate technical unit/component ⁽¹⁾ :

0.4. Category of vehicle :

0.5. Name and address of manufacturers :

0.6. Name and address of manufacturer's authorized representative (if any) :

SECTION II

1. Brief description (where appropriate) : See Annex I.

2. Technical department responsible for carrying out the tests :

3. Date of test report :

4. Number of test report :

5. Ground(s) for extending type approval (where appropriate) :

6. Remarks (if any) : See Annex I.

7. Place :

8. Date :

9. Signature :

10. A list of documents making up the type-approval file lodged with the administrative department that has granted type approval, which may be obtained on request, is attached.

⁽¹⁾ Delete as appropriate.

Appendix

to EEC type-approval certificate No ... concerning the type approval of a vehicle/separate technical unit/component ⁽¹⁾ within the meaning of Directive 88/77/EEC

1. **Brief description**
 - 1.1. *Particulars to be completed in relation to the type-approval of a vehicle with an engine installed :*
 - 1.1.1. Make of engine (name of undertaking) :
 - 1.1.2. Type and commercial description (mention any variants) :
 - 1.1.3. Manufacturer's code as marked on the engine :
 - 1.1.4. Category of vehicle (if applicable) :
 - 1.1.5. Name and address of manufacturer :
 - 1.1.6. Name and address of manufacturer's authorized representative (if any) :
 - 1.2. *If the engine referred to in 1.1 has been type-approved as a separate technical unit :*
 - 1.2.1. Type-approval number of the engine :
 - 1.3. *Particulars to be completed in relation to the type-approval of an engine as a separate technical unit (conditions to be respected in the installation of the engine on a vehicle) :*
 - 1.3.1. Maximum and/or minimum intake depression kPa
 - 1.3.2. Maximum allowable back pressure kPa
 - 1.3.3. Maximum permissible power absorbed by the engine-driven equipment :
 - 1.3.3.1. Idle : kW; Intermediate : kW; Rated : kW
 - 1.3.4. Restrictions of use (if any) :
 - 1.4. *Emission levels*

CO		g/kWh
HC		g/kWh
NO _x		g/kWh
6. **Remarks (if any) :**

⁽¹⁾ Delete as appropriate.