CHAPTER I: OVERALL REQUIREMENTS

1. SCOPE

This part applies to the gaseous and particulate pollutant from all motor vehicles equipped with compression ignition engines and to the gaseous pollutant from all motor vehicles equipped with positive ignition engines fuelled with natural gas or LPG, with the exception of those vehicles of category M1, with a technically permissible maximum laden mass less than or equal to 3,500 kg and the vehicles of category N_1, N_2 and M_2 for which type-approval has been granted under Part XI – of MoRTH / CMVR / TAP 115-116 under CMVR Rules,115-14C.

2. DEFINITIONS AND ABBREVIATIONS

For the purposes of this Document:

2.1 "**Test Cycle**" means a sequence of test points each with a defined speed and torque to be followed by the engine under steady state (ESC test) or transient operating conditions (ETC, ELR test);

2.2. "**Approval of an engine**" means the approval of an engine type with regard to the level of the emission of gaseous and particulate pollutants;

2.3. "**Diesel engine**" means an engine which works on the compression-ignition principle;

"**Gas engine**" means an engine which is fuelled with natural gas (NG) or liquid petroleum gas (LPG);

2.4. "**Engine type**" means a category of engines which do not differ in such essential respects as engine characteristics as defined in Chapter 2 to this Document;

2.5. "**Gaseous pollutants**" means carbon monoxide, hydrocarbons (assuming a ratio of $CH_{1.85}$ for diesel, $CH_{2.525}$ for LPG and $CH_{2.93}$ for NG (NMHC)), methane (assuming a ratio of CH4 for NG) and oxides of nitrogen, the last-named being expressed in nitrogen dioxide (NO_2) equivalent;

"**Particulate pollutants**" means any material collected on a specified filter medium after diluting the exhaust with clean filtered air so that the temperature does not exceed 325 K (52 °C);

2.6. "**Smoke**" means particles suspended in the exhaust stream of a diesel engine which absorb, reflect, or refract light;

2.7. "**Net power**" means the power in kW obtained on the test bench at the end of the crankshaft, or its equivalent, measured in accordance with the method of measuring power as set out in part IV of MoRTH /CMVR/TAP-115/116;

2.8. "**Declared maximum power (P_{max})**" means the maximum power in kW (net power) as declared by the manufacturer in his application for type-approval;

2.9. "**Per cent load**" means the fraction of the maximum available torque at an engine speed;

2.10. "**ESC test**" means a test cycle consisting of 13 steady state modes to be applied in accordance with section 6.2 of this Chapter;

2.11 "**ELR test**" means a test cycle consisting of a sequence of load steps at constant engine speeds to be applied in accordance with section 6.2 of this Chapter

2.12. "**ETC test**" means a test cycle consisting of 1800 second-by-second transient modes to be applied in accordance with section 6.2 of this Chapter.;

2.13. "**Engine operating speed range**" means the engine speed range, most frequently used during engine field operation, which lies between the low and high speeds, as set out in Chapter 3 to this Document;

2.14. "**Low speed** (n_{lo})" means the lowest engine speed where 50 % of the declared maximum power occurs;

2.15. "**High speed** (n_{hi})" means the highest engine speed where 70 % of the declared maximum power occurs in case of diesel engines and in case of gas engines if the engine speed wherever highest 70% of the declared max. Power occurs, is not possible to measure then high speed is taken as rated speed as declared by the manufacturer or max. Power speed whichever is higher.

2.16. "**Engine speeds A, B and C**" means the test speeds within the engine operating speed range to be used for the ESC test and the ELR test, as set out in Chapter 3, Appendix 1 to this Document;

2.17. "**Control area**" means the area between the engine speeds A and C and between 25 to 100 per cent load;

2.18. "**Reference speed** (n_{ref})" means the 100 per cent speed value to be used for denormalising the relative speed values of the ETC test, as set out in Chapter 3, Appendix 2 to this Document;

2.19. "**Opacimeter**" means an instrument designed to measure the opacity of smoke particles by means of the light extinction principle;

2.20. "**NC gas range**" means one of the H or L range as defined in European Standard EN 437, dated November 1993;

2.21. "**Self adaptability**" means any engine device allowing the air/fuel ratio to be kept constant;

2.22. "**Recalibration**" means a fine tuning of an NG engine in order to provide the same performance (power, fuel consumption) in a different range of natural gas;

2.23 "**Wobbe Index** (lower WI; or upper Wu)" means the ratio of the corresponding calorific value of a gas per unit volume and the square root of its relative density under the same reference conditions:

$$W = H_{Gas} \, X(\rho_{air}/\rho_{Gas})^{0.5}$$

2.24 "**λ shift factor** (Sλ) means an expression that describes the required flexibility of the engine management system regarding a change of the excess-air ratio if the engine is fuelled with a gas composition different from pure methane (see Chapter VI for the calculation of Sλ).

2.25. "**Defeat Device**" means any element of engine or vehicle design which measures or senses vehicle speed, engine speed, gear used, temperature, intake pressure or any other parameter, with a view to activating, modulating delaying or deactivating the operation of any component of the emission control system so that the effectiveness of the emission control system is reduced under conditions encountered in normal vehicle use.

Such a device will not be regarded as a defeat device if:

- the need for the device is justified temporarily to protect the engine against intermittent operating conditions that could lead to damage or failure and no other measures are applicable for the same purpose which do not reduce the effectiveness of the emission control system;

- the device operates only when needed during engine starting and/or warming-up and no other measures are applicable for the same purpose which do not reduce the effectiveness of the emission control system.

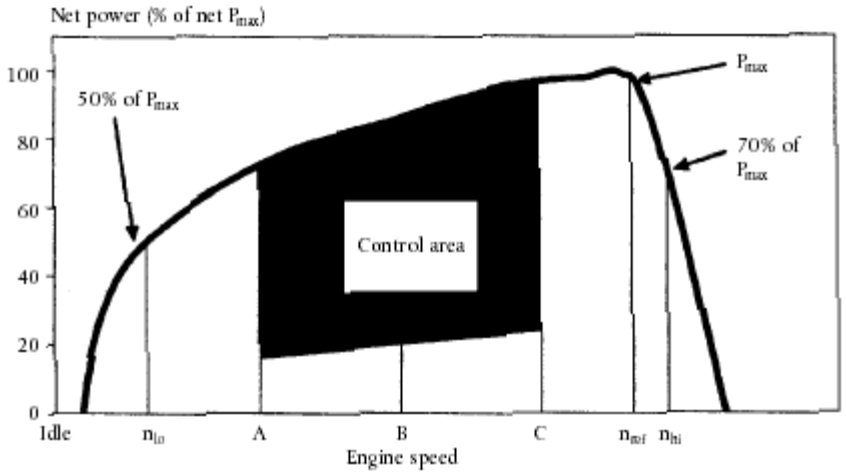

Figure 1
Specific definitions of the test cycles

2.29. Symbols and abbreviations

2.29.1. *Symbols for test parameters*

Symbol	Unit	Term
A_p	m^2	Cross-section area of the isokinetic sampling probe
A_T	m^2	Cross-section area of the exhaust pipe
CE_E	--	Ethane efficiency
CE_M	--	Methane efficiency
C1	--	Carbon 1 equivalent hydrocarbon
conc	ppm/Vol%	Subscript denoting concentration
D_0	m^3/s	Intercept of PDP calibration function
DF	--	Dilution factor
D	--	Bessel function constant
E	--	Bessel function constant
E_z	g/kWh	Interpolated Nox emission of the control point
Fa	--	Laboratory atmospheric factor
Fc	s^{-1}	Bessel filter cut-off frequency
F_{FH}	--	Fuel specific factor for the calculation of wet concentration from dry concentration
Fs	--	Stoichiometric factor
G_{AIRW}	kg/h	Intake air mass flow rate on wet basis
G_{AIRD}	kg/h	Intake air mass flow rate on dry basis
G_{DILW}	kg/h	Dilution air mass flow rate on wet basis
G_{EDFW}	kg/h	Equivalent diluted exhaust gas mass flow rate on wet basis
G_{EXHW}	Kg/h	Exhaust gas mass flow rate on wet basis
G_{FUEL}	kg/h	Fuel mass flow rate
G_{TOTW}	kg/h	Diluted exhaust gas mass flow rate on wet basis
H	MJ/m^3	Calorific value
H_{REF}	g/kg	Reference value of absolute humidity (10.71 g/kg)
H_a	g/kg	Absolute humidity of the intake air
H_d	g/kg	Absolute humidity of the dilute air
HTCRAT	mol/mol	Hydrogen-to-carbon ratio
i	--	Subscript denoting an individual mode
K	--	Bessel constant
k	m^{-1}	Light absorption coefficient
$K_{H,D}$	--	Humidity correction factor for Nox, for diesel engines
$K_{H,G}$	--	Humidity correction factor of Nox, for gas engines
K_v	--	CFV calibration function
$K_{w,a}$	--	Dry to wet correction factor for the intake air
$K_{w,d}$	--	Dry to wet correction factor for the dilution air
$K_{w,e}$		Dry to wet correction factor for the diluted exhaust gas

Symbol	Unit	Term
Kw,r	--	Dry to wet correction factor for the raw exhaust gas
L	%	Percent torque related to the maximum torque for the test engine
L_a	m	Effective optical path length
m		Slope of PDP calibration function
mass	g/h or g	Subscript denoting emissions mass flow (rate)
M_{DIL}	kg	Mass of the dilution air sample passed through the particulates sampling filters
M_d	mg	Particulate sample mass of the dilution air collected
M_f	mg	Particulate sample mass collected
$M_{f,p}$	mg	Particulate sample mass collected on primary filter
$M_{f,b}$	mg	Particulate sample mass collected on back-up filter
M_{SAM}		Mass of the diluted exhaust sample passed through the particulate sampling filters
M_{SEC}	kg	Mass of secondary dilution air
M_{TOTW}	kg	Total CVS mass over the cycle on wet basis
$M_{TOTW,i}$	kg	Instantaneous CVS mass on wet basis
N	%	Opacity
Np,i	--	Total revolutions of PDP over the cycle
Np_s	--	Revolutions of PDP during a time interval
n	min^{-1}	Engine speed
np	s-1	PDP speed
n_{hi}	min^{-1}	High engine speed
n_{lo}	min^{-1}	Low engine speed
nref	min^{-1}	Reference engine speed for ETC test
P_a	kPa	Saturation vapour pressure of the engine intake air
P_A	kPa	Absolute pressure
p_B	kPa	Total atmospheric pressure
p_d	kPa	Saturation vapour pressure of the dilution air
ps	kPa	Dry atmospheric pressure
p_1	kPa	Pressure depression at pump inlet
P(a)	kW	Power absorbed by auxiliaries to be fitted for test
P(b)	kW	Power absorbed by auxiliaries to be removed for test
P(n)	kW	Net power non-corrected
P(m)	kW	Power measured on test bed
Ω	--	Bessel constant
Q_s	m^3/s	CVS volume flow rate
q	--	Dilution ratio
r	--	Ratio of cross sectional areas of isokinetic probe and exhaust pipe

Symbol	Unit	Term
R_a	%	Relative humidity of the intake air
R_d	%	Relative humidity of the dilution air
R_r	--	FID response factor
ρ	kg/m^3	Density
S	kW	Dynamometer setting
Si	m-1	Instantaneous smoke value
Sλ	--	λ Shift factor
T	K	Absolute temperature
T_a	K	Absolute temperature of the intake air
t	s	Measuring time
t_e	s	Electrical response time
t_f	s	Filter response time for Bessel function
t_p	s	Physical response time
Δt	s	Time interval between successive smoke data (=1/sampling rate)
Δt_i	s	Time interval for instantaneous CFV flow
ζ	%	Smoke transmittance
	M^3/rev	PDP volume flow rate at actual conditions
V_0	--	Wobbe index
W	kWh	Actual cycle work of ETC
W_{act}	kWh	Reference cycle work of ETC
W_{ref}	--	Weighting factor
WF	--	Effective weighting factor
WF_E	m^3/rev	Calibration function of PDP volume flow rate
X_0	m^{-1}	1 s Bessel averaged smoke value
Y_i		

2.29.2 *Symbols for the Chemical Components*

CH_4	Methane
C_2H_6	Ethane
C_3H_8	Propane
CO	Carbon monoxide
DOP	Di-octylphtalate
CO_2	Carbon dioxide
HC	Hydrocarbons
NMHC	Non-methane hydrocarbons
NO_x	Oxides of nitrogen
NO	Nitric oxide
NO_2	Nitrogen dioxide
PT	Particulates

2.29.3. *Abbreviations*

CFV	Critical Flow Venturi
CLD	Chemi-Luminescent detector
ELR	Engine Load Response Test

ESC	Engine Steady-state Cycle
ETC	Engine Transient Cycle
FID	Flame Ionization Detector
GC	Gas Chromatograph
HCLD	Heated Chemi-Luminescent Detector
HFID	Heated Flame-Ionization Detector
LPG	Liquified Petroleum Gas
NDIR	Non-Dispersive Infrared Analyser
NG	Natural Gas
NMC	Non-Methane Cutter

3. APPLICATION FOR TYPE-APPROVAL

3.1. As per AIS 007 Revision-02 to be submitted to Test Agencies.

4. TYPE-APPROVAL

4.1. Granting of a universal fuel type-approval

A universal fuel type-approval is granted subject to the following requirements:

4.1.1 In the case of diesel fuel, the parent engine meets the requirements of part or the reference fuel specified in Annexure IV-F of CMVR rule.

4.1.2. In the case of natural gas, the parent engine demonstrates its capability to adapt to any fuel composition that may occur across the market. In the case of natural gas there are generally two types of fuel, high calorific fuel (H-gas) and low calorific fuel (L-gas), but with a significant spread within both ranges; they differ significantly in their energy content expressed by the Wobbe Index and in their shift factor ($S\lambda$). The composition of the reference fuels reflects the variations of those parameters

The parent engine shall meet the requirements of the part of the reference fuels G20 and G25 as specified in Annexure IV-I of CMVR rule, without any readjustment to the fuelling between the two tests.

4.1.3. In the case of an engine fuelled with natural gas which is self-adaptive for the range of H-gases on the one hand and the range of L-gases on the other hand, and which switches between the H-range and the L-range by means of a switch, the parent engine shall be tested on the two relevant reference fuels as specified in Annex IV for each range, at each position of the switch. The fuels are G20 (fuel 1) and G23 (fuel 2) for the H-range of gases, G23 (fuel 1) and G25 (fuel 2) for the L-range of gases. The parent engine shall meet the requirements of this Directive at both positions of the switch without any readjustment to the fuelling between the two tests at each position of the switch. However, one adaptation run over one ESC cycle without measurement is permitted after the change of the fuel.

4.1.3.1. On the manufacturer's request the engine may be tested on a third fuel (fuel 3) if the shift factor ($S\lambda$) lies between those of the fuels G20 and G25, e.g. when fuel

3 is a market fuel. The results of this test may be used as a basis for the evaluation of the conformity of the production.

4.1.3.2. The ratio of emission results "r" shall be determined for each pollutant as follows:

$$r = \frac{\text{emission result on reference fuel 2}}{\text{emission result on reference fuel 1}}$$

or,

$$ra = \frac{\text{emission result on reference fuel 2}}{\text{emission result on reference fuel 3}}$$

and,

$$rb = \frac{\text{emission result on reference fuel 1}}{\text{emission result on reference fuel 3}}$$

4.1.4. In the case of LPG the parent engine should demonstrate its capability to adapt to any fuel composition that may occur across the market. In the case of LPG there are variations in C3/C4 composition. These variations are reflected in the reference fuels. The parent engine should meet the emission requirements on the reference fuels A and B as specified in Annex IV-H of CMVR rules without any readjustment to the fuelling between the two tests. However, one adaptation run over one ESC cycle without measurement is permitted after the change of the fuel.

4.1.4.1. The ratio of emission results "r" shall be determined for each pollutant as follows:

$$r = \frac{\text{emission result on reference fuel 2}}{\text{emission result on reference fuel 1}}$$

4.2. Granting of a fuel range restricted type-approval

At the present state of technology it is not yet possible to make leanburn natural gas engines self-adaptive. Yet these engines offer an advantage in efficiency and CO_2 emission. If a user has the guarantee of a supply of fuel of uniform composition, he may opt for a lean burn engine. Such an engine could be given a fuel restricted approval. In the interest of international harmonisation it is regarded desirable that a specimen of such an engine is granted international approval. Fuel restricted variants would then need to be identical except for the contents of the database of the ECU of the fuelling system, and such parts of the fuelling system (such as injector nozzles) that need to be adapted to the different fuel flow.

Fuel range restricted type-approval is granted subject to the following requirements:

4.2.1. Exhaust emissions approval of an engine running on natural gas and laid out for operation on either the range of H-gases or on the range of L-gases

The parent engine shall be tested on the two relevant reference fuels as specified in Annex IV-I of CMVR rules for the relevant range. The fuels are G20 (fuel 1) and G23 (fuel 2) for the H-range of gases, G23 (fuel 1) and G25 (fuel 2) for the L-range of gases. The parent engine shall meet the emission requirements without any readjustment to the fuelling between the two tests. However, one adaptation run over one ESC cycle without measurement is permitted after the change of the fuel.

4.2.1.1. On the manufacturer's request it may be tested on a third fuel (fuel 3) of the ($S\lambda$) shift factor lies between those of the fuels G20 and G23, or G23 and G25 respectively, e.g. when fuel 3 is a market fuel. The results of this test may be used as a basis for the evaluation of the conformity of the production.

4.2.1.2. The ratio of emission results "r" shall be determined for each pollutant as follows:

$$r = \frac{\text{emission result on reference fuel 2}}{\text{emission result on reference fuel 1}}$$

or,

$$ra = \frac{\text{emission result on reference fuel 2}}{\text{emission result on reference fuel 3}}$$

and,

$$rb = \frac{\text{emission result on reference fuel 1}}{\text{emission result on reference fuel 3}}$$

4.2.1.3. Upon delivery to the customer the engine shall bear a label (see paragraph 5.1.5) stating for which range of gases the engine is approved.

4.2.2. *Exhaust emissions approval of an engine running on natural gas or LPG and laid out for operation on one specific fuel composition*

4.2.2.1. The parent engine shall meet the emission requirements on the reference fuels G20 and G25 in the case of natural gas, or the reference fuels A and B in the case of LPG, as specified in Annex IV-H of CMVR rules. Between the tests fine-tuning of the fuelling system is allowed. This fine-tuning will consist of a recalibration of the fuelling database, without any alteration to either the basic control strategy or the basic structure of the database. If necessary the exchange of parts that are directly related to the amount of fuel flow (such as

injector nozzles) is allowed.

4.2.2.2. If the manufacturer so desires the engine may be tested on the reference fuels G20 and G23, or G23 and G25, in which case the type approval is only valid for the H-range or the L-range of gases respectively.

4.2.2.3. Upon delivery to the customer the engine shall bear a label (see paragraph 5.1.5) stating for which fuel composition the engine has been calibrated.

4.2.3 **Until availability of reference LPG (fuel A & Fuel B), CNG (G20, G23, G25) as per notification, CNG/LPG engines will be tested as per commercially available CNG or LPG fuels as per guidelines given by GOI.**

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. Declared maximum power

5.1.4. In case of an NG engine one of the following markings to be placed after the type approval number:

- H in case of the engine being approved and calibrated for the H-range of gases;
- L in case of the engine being approved and calibrated for the L-range of gases;
- HL in case of the engine being approved and calibrated for both the H-range and L-range of gases;
- Ht in case of the engine being approved and calibrated for a specific gas composition in the H-range of gases and transformable to another specific gas in the H-range of gases by fine tuning of the engine fuelling;
- Lt in case of the engine being approved and calibrated for a specific gas composition in the L-range of gases and transformable to another specific gas in the L-range of gases after fine tuning of the engine fuelling;
- HLt in the case of the engine being approved and calibrated for a specific gas composition in either the H-range or the L-range of gases and transformable to another specific gas in either the H-range or the L-range of gases by fine tuning of the engine fuelling.

5.1.5. *Labels*

In the case of NG and LPG fuelled engines with a fuel range restricted type approval, the following labels are applicable:

5.1.5.1. Content

The following information must be given:

In the case of paragraph 4.2.1.3, the label shall state "ONLY FOR USE WITH NATURAL GAS RANGE H". If applicable, "H" is replaced by "L".

In the case of paragraph 4.2.2.3, the label shall state "ONLY FOR USE WITH NATURAL GAS SPECIFICATION ..." or "ONLY FOR USE WITH LIQUEFIED PETROLEUM GAS SPECIFICATION ...", as applicable. All the information in the appropriate table(s) in Chapter IV of CMVR rules shall be given with the individual constituents and limits specified by the engine manufacturer.

The letters and figures must be at least 4 mm in height.

Note:

If lack of space prevents such labelling, a simplified code may be used. In this event, explanatory notes containing all the above information must be easily accessible to any person filling the fuel tank or performing maintenance or repair on the engine and its accessories, as well as to the authorities concerned. The site and content of these explanatory notes will be determined by agreement between the manufacturer and the approval authority.

5.1.5.2. Properties

Labels must be durable for the useful life of the engine. Labels must be clearly legible and their letters and figures must be indelible. Additionally, labels must be attached in such a manner that their fixing is durable for the useful life of the engine, and the labels cannot be removed without destroying or defacing them.

5.1.5.3. Placing

Labels must be secured to an engine part necessary for normal engine operation and not normally requiring replacement during engine life. Additionally, these labels must be located so as to be readily visible to the average person after the engine has been completed with all the auxiliaries necessary for engine operation.

5.2. In case of an application for type-approval for a vehicle type in respect of its engine, the marking specified in section 5.1.5 shall also be placed close to fuel filling aperture.

5.3. In case of an application for type-approval for a vehicle type with an approved engine, the marking specified in section 5.1.5 shall also be placed close to the fuel filling aperture.

6. SPECIFICATIONS AND TESTS

6.1. General

The components liable to affect the emission of gaseous and particulate pollutants from diesel engines and the emission of gaseous pollutants from gas engines shall be so designed, constructed and assembled as to enable the engine, in normal use, to comply with the provisions of this Document.

6.1.1. The use of a defeat device and/or irrational emissions control strategy is forbidden. If the type-approval authority suspects that a vehicle type utilises defeat device(s) and/or any irrational emission control strategy under certain operating conditions, upon request the manufacturer has to provide information on the operation and effect on emissions of the use of such devices and/or control strategy. Such information shall include a description of all emission control components, fuel control system logic including timing strategies and switch points during all modes of operation. These informations should remain strictly confidential and not be attached to the documentation required in Chapter I, section 3.

6.2. Specifications Concerning the Emission of Gaseous and Particulate Pollutants and Smoke

For type approval to B.S. III, the emission shall be determined on the ESC and ELR tests with conventional diesel engines including those fitted with electronic fuel injection equipment, exhaust gas re-circulation (EGR), and/or oxidation catalysts. Diesel engines fitted with advanced exhaust after treatment systems including the NOx catalysts and/or particulate traps, shall additionally be tested on the ETC test.

For gas engines, the gaseous emission shall be determined only on ESC test.

The ESC & ELR test procedures are described in Chapter III, Appendix 1. The ETC test procedure in Chapter III, Appendix 2 & 3.

The emissions of gaseous pollutants and particulate pollutants, if applicable, and smoke, if applicable, by the engine submitted for testing shall be measured by the methods described in Chapter III, Appendix 4. Chapter V describes the recommended analytical systems for the gaseous pollutants, the recommended particulate sampling systems, and the recommended smoke measurement system.

Other systems or analysers may be approved by the Technical Service if it is found that they yield equivalent results on the respective test cycle. For particulate emissions only the full flow dilution system is recognised as the reference system. "Results" refer to the specific cycle emissions value. The correlation testing shall be performed at the same laboratory, test cell, and on

the same engine, and is preferred to be run concurrently. The equivalency criterion is defined as a ± 5 % agreement of the sample pair averages. For introduction of a new system into the Document the determination of equivalency shall be based upon the calculation of repeatability and reproducibility, as described in ISO 5725.

6.2.1. Limit Values

The specific mass of the carbon monoxide, of the total hydrocarbons, of the oxides of nitrogen and of the particulates, as determined on the ESC test, and of the smoke opacity, as determined on the ELR test, shall not exceed the amounts shown in Notification 115 –14D.

Table 1

Limit values - ESC and ELR tests (TA = COP)

Year	Mass of carbon monoxide (CO) g/kWh	Mass of hydrocarbons (HC) g/kWh	Mass of oxides of Nitrogen (NO_x) g/kWh	Mass of Particulate (PT) [2] g/kWh	Smoke m^{-1} [2]
1.4.2005	2,1	0,66	5,0	0,10 0,13 [1]	0,8

[1] For engines having swept volume of less than 0,75 dm^3 per cylinder and a rated power speed of more than 3000 min^{-1}

[2] Applicable to Diesel Engines only.

For diesel engines that are additionally tested on the ETC test, the specific masses of the carbon monoxide, of the non-methane hydrocarbons, of the oxides of nitrogen and of the particulates shall not exceed the amounts shown in Table 2.

Table 2

Limit values - ETC tests [1] (TA = COP)

Year	Mass of carbon monoxide (CO) g/kWh	Mass of hydrocarbons (HC) g/kWh	Mass of oxides of Nitrogen (NOx) g/kWh	Mass of Particulate (PT) [3] g/kWh
1.4.2005	5,45	0,78	5,0	0,16 0,21 [2]

(1) The conditions for verifying the acceptability of the ETC tests (see Chapter III, Appendix 2, section 3.9)

(2) For engines having a swept volume of less than 0.75 dm^3 per cylinder and a rated power speed of more than 3000 min^{-1}

(3) Applicable to Diesel Engines only.

6.2.2. Hydrocarbon measurement for diesel fuelled engines

6.2.2.1. A manufacturer may choose to measure the mass of total hydrocarbons (THC) on the ETC test instead of measuring the mass of non-methane hydrocarbons. In this case, the limit for the mass of total hydrocarbons is the same as shown in table 2 for the mass of non-methane hydrocarbons.

6.2.3. *Specific requirements for diesel engines*

6.2.3.1. The specific mass of the oxides of nitrogen measured at the random check points within the control area of the ESC test must not exceed by more than 10 per cent the values interpolated from the adjacent test modes (reference Chapter III, Appendix 1 sections 4.6.2 and 4.6.3).

6.2.3.2. The smoke value on the random test speed of the ELR must not exceed the highest smoke value of the two adjacent test speeds by more than 20 per cent, or by more than 5 per cent of the limit value, whichever is greater.

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.

7.1.2. Exhaust back pressure shall not exceed that specified for the type-approved engine.

7.1.3. Power absorbed by the auxiliaries needed for operating the engine shall not exceed that specified for the type-approved engine.

7.1.4 Exhaust system value shall not differ by more than 40% of that specified for the type-approved engine

9. PRODUCTION CONFORMITY

9.1. Measures to ensure production conformity must be taken in accordance with the provisions as per Part VI of MoRTH /CMVR/TAP115/116.

9.1.1. If emissions of pollutants are to be measured and an engine type-approval has had one or several extensions, the tests will be carried out on the engine(s) described in the information package relating to the relevant extension.

9.1.1.1. Conformity of the engine subjected to a pollutant test:

After submission of the engine to the authorities, the manufacturer shall not carry out any adjustment to the engines selected.

9.1.1.1.1. Three engines are randomly taken in the series. Engines that are subject to testing only on the ESC and ELR tests (for Diesel Engines) or only on the ESC test (for Gaseous Engines) for the checking of production conformity. The limit values are given in section 6.2.1 of this Chapter.

9.1.1.1.2. The tests are carried out according to Appendix 1 to this Chapter.

OR

At the manufacturer's request, the tests may be carried out in accordance with Appendix 2 to this Chapter.

9.1.1.1.3. On the basis of a test of the engine by sampling, the production of a series is regarded as conforming where a pass decision is reached for all the pollutants and non conforming where a fail decision is reached for one pollutant, in accordance with the test criteria applied in the Appendix.

When a pass decision has been reached for one pollutant, this decision may not be changed by any additional tests made in order to reach a decision for the other pollutants.

If no pass decision is reached for all the pollutants and if no fail decision is reached for one pollutant, a test is carried out on another engine (see Figure 2).

If no decision is reached, the manufacturer may at any time decide to stop testing. In that case a fail decision is recorded.

9.1.1.2. The tests will be carried out on newly manufactured engines.

9.1.1.2.1. However, at the request of the manufacturer, the tests may be carried out on diesel or gas engines, which have been run-in, up to a maximum of 100 hours. In

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

9.1.1.2.2. When the manufacturer asks to conduct a running-in procedure in accordance with section 9.1.1.2.1, it may be carried out on:

- all the engines that are tested,

or,

- the first engine tested, with the determination of an evolution coefficient as follows:

  - the pollutant emissions will be measured at zero and at "x" hours on the first engine tested,
  - the evolution coefficient of the emissions between zero and "x" hours will be calculated for each pollutant:

$$\frac{Emissions'x'hours}{Emissionszerohours}$$

  It may be less than one.

  The subsequent test engines will not be subjected to the running-in procedure, but their zero hour emissions will be modified by the evolution coefficient.

  In this case, the values to be taken will be:
  - the values at "x" hours for the first engine,
  - the values at zero hour multiplied by the evolution coefficient for the other engines.

9.1.1.2.3. For diesel and LPG fuelled engines, all these tests may be conducted with commercial fuel. However, at the manufacturer's request, the reference fuels described in Annexure IV(F&H) of CMVR rules respectively may be used. This implies tests, as described in section 4 of this Chapter, with at least two of the reference fuels for each gas engine.

9.1.1.2.4. For NG fuelled engines, all these tests may be conducted with commercial fuel in the following way:
- for H marked engines with a commercial fuel within the H range;
- for L marked engines with a commercial fuel within the L range;
- for HL marked engines with a commercial fuel within the H or the L range.

However, at the manufacturer's request, the reference fuels described in Annexure IV-I of CMVR rules may be used. This implies tests, as described in section 4 of this Chapter, with at least two of the reference fuels for each gas engine.

9.1.1.2.5. In the case of dispute caused by the non-compliance of gas fuelled engines when using a commercial fuel, the tests shall be performed with a reference fuel on which the parent engine has been tested, or with the possible additional fuel 3

as referred to in paragraphs 4.1.3.1 and 4.2.1.1 on which the parent engine may have been tested. Then, the result has to be converted by a calculation applying the relevant factor(s) "r", "ra" or "rb" as described in paragraphs 4.1.3.2, 4.1.4.1 and 4.2.1.2. If r, ra or rb are less than one no correction shall take place. The measured results and the calculated results must demonstrate that the engine meets the limit values with all relevant fuels (fuels 1, 2 and, if applicable, fuel 3).

9.1.1.2.6. Tests for conformity of production of a gas fuelled engine laid out for operation on one specific fuel composition shall be performed on the fuel for which the engine has been calibrated.

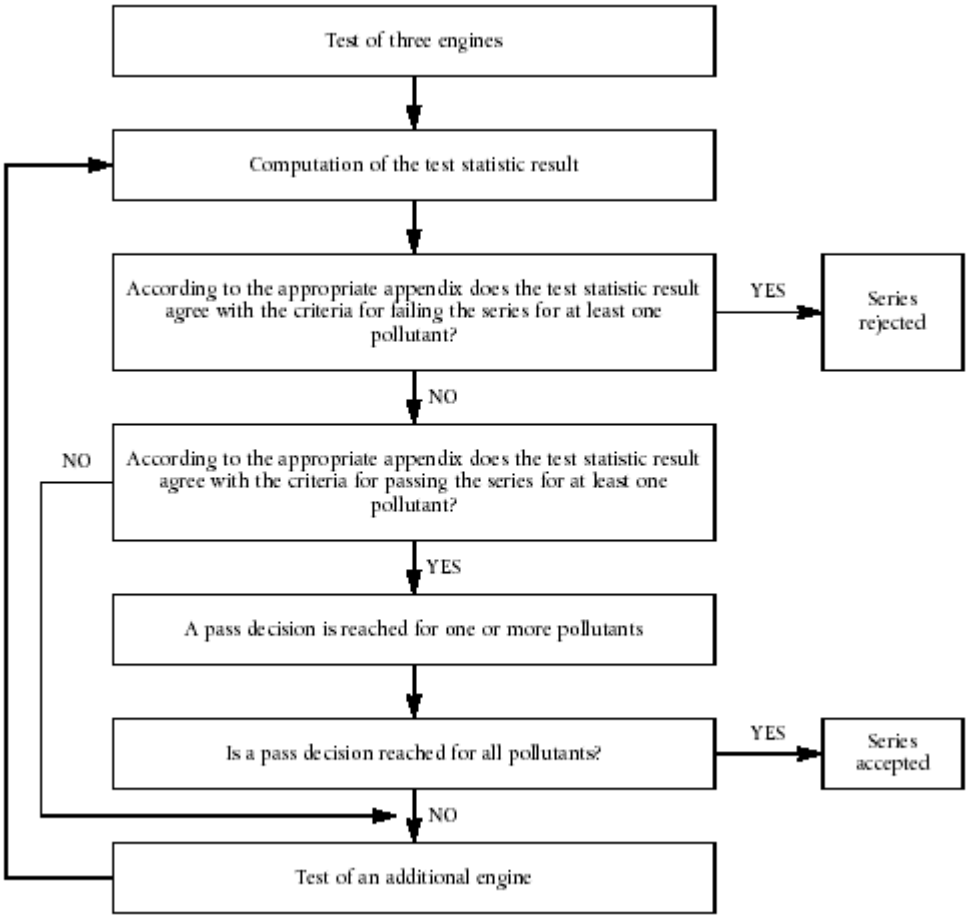

Figure 2
Schematic of production conformity testing

Appendix 1

PROCEDURE FOR PRODUCTION CONFORMITY TESTING

1. This Appendix describes the procedure to be used to verify production conformity for the emissions of pollutants.

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

3. The values of the pollutants given in section 6.2.1 of Chapter I are considered to be log normally distributed and should be transformed by taking their natural logarithms. Let m_0 and m denote the minimum and maximum sample size respectively (m_0 = 3 and m = 32) and let n denote the current sample number.

4. If the natural logarithms of the values measured in the series are $x_1, x_2 \ldots x_3$, and L is the natural logarithm of the limit value for the pollutant, then, define

$d_i = x_i - L$

and,

$$\overline{d_n} = \frac{1}{n}\sum_{i=1}^{n} d_i$$

$$V_n^2 = \frac{1}{n}\sum_{i=1}^{n} (d_i - \overline{d_n})^2$$

5. Table 3 shows values of the pass (An) and fail (Bn) decision numbers against current sample number. The test statistic result is the ratio $\overline{d_n}$ / V_n and shall be used to determine whether the series has passed or failed as follows:

For $m_0 <= n <= m$:

- pass the series if $\frac{\overline{d_n}}{V_n} \leq A_n$

- fail the series if $\frac{\overline{d_n}}{V_n} \geq B_n$

- take another measurement if $A_n \leq \frac{\overline{d_n}}{V_n} \leq B_n$

6. **Remarks**

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

$$\overline{d_n} = (1-\frac{1}{n})\overline{d_n - 1} + \frac{1}{n} d_n$$

$$V^2_n = (1-\frac{1}{n})V^2{}_{n-1} + \frac{(\overline{d_n} - d_n)^2}{n-1}$$ (n = 2, 3,…..; $\overline{d_1}$ = d_1; V1 = 0)

Table 3

Pass and Fail Decision Numbers of Appendix 1 Sampling Plan

Minimum Sample Size: 3

Cumulative number of engines tested (sample size)	Pass decision number A_n	Fail decision number B_n
3	-0,80381	16,64743
4	-0,76339	7,68627
5	-0,72982	4,67136
6	-0,69962	3,25573
7	-0,67129	2,45431
8	-0,64406	1,94369
9	-0,61750	1,59105
10	-0,59135	1,33295
11	-0,56542	1,13566
12	-0,53960	0,97970
13	-0,51379	0,85307
14	-0,48791	0,74801
15	-0,46191	0,65928
16	-0,43573	0,58321
17	-0,40933	0,51718
18	-0,38266	0,45922
19	-0,35570	0,40788
20	-0,32840	0,36203
21	-0,30072	0,32078
22	-0,27263	0,28343
23	-0,24410	0,24943
24	-0,21509	0,21831
25	-0,18557	0,18970
26	-0,15550	0,16328
27	-0,12483	0,13880
28	-0,09354	0,11603
29	-0,06159	0,09480
30	-0,02892	0,07493
31	-0,00449	0,05629
32	0,03876	0,03876

Appendix 2

PROCEDURE FOR PRODUCTION CONFORMITY TESTING AT MANUFACTURER'S REQUEST

1. This Appendix describes the procedure to be used to verify, at the manufacturer's request, production conformity for the emissions of pollutants.

2. With a minimum sample size of three engines the sampling procedure is set so that the probability of a lot passing a test with 30 % of the engines defective is 0,90 (producer's risk = 10 %) while the probability of a lot being accepted with 65 % of the engines defective is 0,10 (consumer's risk = 10 %).

3. The following procedure is used for each of the pollutants given in Section 6.2.1 of Chapter I (see Figure 2):

   Let:

   L = the limit value for the pollutant,

   x_i = the value of the measurement for the i-th engine of the sample,

   n= the current sample number.

4. Calculate for the sample the test statistic quantifying the number of non-conforming engines, i.e. xi $\geq$ L:

5. Then:

   - if the test statistic is less than or equal to the pass decision number for the sample size given in Table 4, a pass decision is reached for the pollutant;

   - if the test statistic is greater than or equal to the fail decision number for the sample size given in Table 4, a fail decision is reached for the pollutant;

   - otherwise, an additional engine is tested according to Section 9.1.1.1 of Chapter I and the calculation procedure is applied to the sample increased by one more unit.

   In Table 5 the pass and fail decision numbers are calculated by means of the International Standard ISO 8422/1991.

Table 4

Pass and Fail Decision Numbers of Appendix 2 Sampling Plan

Minimum sample Size : 3

Cumulative number of engines tested (sample size)	Pass decision number	Fail decision number
3	--	3
4	0	4
5	0	4
6	1	5
7	1	5
8	2	6
9	2	6
10	3	7
11	3	7
12	4	8
13	4	8
14	5	9
15	5	9
16	6	10
17	6	10
18	7	11
19	8	9