

## CHAPTER 1 : OVERALL REQUIREMENTS

### 1 Scope :

This Part applies to the emission of gaseous pollutants and particulates from Compression Ignition (C.I.) engined vehicles, Natural Gas (NG) engined vehicles and Liquefied Petroleum Gas (LPG) vehicles. However, the vehicles whose GVW equal to or less than 3500 kg, may be approved on the basis of test procedure of Part IX as opted by the manufacturer.

The main Part X is applicable to automotive application heavy duty engines, however, the sub-part A of Part X for the applications other than automotive is as given below :

Sub-Part A : Details of standards of gaseous and particulate pollutants from diesel engined Agricultural Tractors and Construction Equipment Vehicles (CEV) .

### 2. Definitions :

2.1 Compression Ignition Engine : Means an internal combustion engine which operates on compression ignition principle (Diesel Engines).

2.2 CNG Engines : CNG Engine means an internal combustion engine which is fuelled with natural gas (NG).

2.3 Gaseous pollutants : Means carbon monoxide, hydro carbons (assuming a ratio of  $C_1H_{1.85}$  for CI engines,  $C_1H_{3.76}$  for NG engines and  $C_1H_{2.61}$  for LPG engines) and oxides of nitrogen (expressed in nitrogen dioxide  $NO_2$  equivalent).

2.4 Particulate pollutants : Means any material collected on a specified filter medium after diluting C.I. engine exhaust gas with clean filtered air so that the temperature of the diluted exhaust gas does not exceed 325K (52°C).

2.5 Maximum Rated Speed : Means the maximum speed permitted by governor at full load or if such governor is not present then the speed at which the maximum power is obtained from the engine.

2.6 Minimum Rated Speed : Means either the highest of the following three engine speeds -  
45% of maximum net power speed,  
1000 rev/min,  
minimum speed permitted by the idling control or  
such lower speed as the manufacturer may request.

### 2.7 Intermediate Speed :

- 2.7.1 Intermediate Speed for automotive engines : 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.
- 2.7.2 Intermediate Speed for Agricultural Tractor Engines : 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 if it is below 60% take intermediate speed as 60% of the rated speed; if it is above 75% take the intermediate speed as 75% of the rated speed.
- 2.8 Percent Load : Means the fraction of the maximum available torque at an engine speed.
- 2.9 Net Power : Means the power of a C.I. engine as defined in Chapter 6 of Part IV of this rule.
- 2.10 Unladen Mass : Means the mass of the vehicle in running order without crew, passengers or load, but with the fuel tank 90% full and the usual set of tools and spare wheel on board where applicable.
- 2.11 Gross Vehicle Weight (GVW) : Means the technically permissible maximum weight declared by the vehicle manufacturer.
- 2.12 Cold Start Device : Means a device which enriches the airfuel mixture of the engine temporarily and thus to assist engine start up.
- 2.13 Starting Aid : Means a device which assists the engine start up without enrichment of the fuel mixture, e.g. glow plug, change of injection timing, etc.
- 2.14 Type Approval of a Vehicle : Means the type approval of a vehicle model with regard to the limitation of the emission of gaseous pollutants from the engine.
- 2.15 Vehicle Model : Means a category of power driven vehicles which do not differ in such essential respects of the vehicle characteristics which affects the vehicular emission and listed in Chapter 2 of this Part.
- 2.16 Vehicle for Type Approval Test : Means the fully built vehicle incorporating all design features for the model submitted by the vehicle manufacturer.
- 2.17 Vehicle for Conformity of Production : Means a vehicle selected at random from a production series of vehicle model which has already been type approved.
- 2.18 Abbreviations and Units

P	kW	net power output non-corrected
CO	g/kWh	Carbon Monoxide emission
HC	g/kWh	Hydrocarbon emission
NO <sub>x</sub>	g/kWh	emission of oxides of nitrogen
PT	g/kWh	particulate emissions
conc	ppm	concentration (ppm by volume)
conc <sub>w</sub>	ppm	concentration (ppm by volume) wet
conc <sub>d</sub>	ppm	concentration (ppm by volume) dry
mass	g/h	pollutant mass flow rate
WF		weighting factor
WF <sub>E</sub>		Effective weighting factor
G <sub>EXH</sub>	kg/h	exhaust gas mass flow rate on wet basis
V' <sub>EXH</sub>	m <sup>3</sup> /h	exhaust gas volume flow rate on dry basis
V'' <sub>EXH</sub>	m <sup>3</sup> /h	exhaust gas volume flow rate on wet basis
G <sub>AIR</sub>	kg/h	intake air mass flow rate
V' <sub>AIR</sub>	m <sup>3</sup> /h	intake air volume flow rate on dry basis
V'' <sub>AIR</sub>	m <sup>3</sup> /h	intake air volume flow rate on wet basis
G <sub>FUEL</sub>	kg/h	fuel mass flow rate
FID		flame ionization detector
G <sub>DIL</sub>	kg/h	dilution air mass flow rate
V'' <sub>DIL</sub>	m <sup>3</sup> /h	dilution air volume flow rate on wet basis
M <sub>SAM</sub>	kg	mass of sample through particulate sampling filters.
V <sub>SAM</sub>	m <sup>3</sup> /h	volume of sample through particulate sampling filters on

wet basis.

$G_{EDF}$	kg/hr	equivalent diluted mass flow rate
$V''_{EDF}$	$m^3/h$	equivalent diluted volume flow rate on wet basis
$i$		subscript denoting an individual mode
$P_f$	mg	particulate sample mass
$G_{TOT}$	kg/hr	Diluted exhaust gas mass flow rate.
$V''_{TOT}$	$m^3/h$	diluted exhaust gas volume flow rate on wet basis
$q$		dilution ratio
$r$		ratio of cross sectional area of sample probe and the exhaust pipe
$A_P$	$m^2$	cross sectional area of the isokinetic sample probe
$A_T$	$m^2$	cross sectional area of the exhaust pipe
HFID		Heated Flame Ionisation Detector
NDUVR		Non-dispersive ultra violet resonance absorption
NDIR		Non-Dispersive Infra-Red
HCLA		Heated Chemiluminescent Analyser
CLA		Chemiluminescent Analyser

### 3 Application for Type Approval :

3.1 The application for type approval of a vehicle model with regard to limitations of the emission of gaseous and particulate pollutants from its engine shall be submitted by the vehicle manufacturer with a description of the engine and vehicle model comprising all the particulars referred to in Chapter 2 of this Part.

3.2 A vehicle representative of the vehicle model to be type approved shall be submitted to the testing agency responsible for conducting tests referred in para 5 below.

### 4 Type Approval :

If the vehicle submitted for approval pursuant to these rules, meets the requirements of para 5.0 below, approval of vehicle model shall be granted. The approval of the vehicle model pursuant to this part shall be communicated to the Vehicle Manufacturer & Nodal Agency by the testing agency in the form of Certificate of Compliance to CMVR, as envisaged in Rule-126 of CMVR.

## 5 Specifications and Tests :

5.1 General : The components liable to affect the emission of gaseous and particulate 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 Rule.

### 5.2 Specifications Concerning the Emission of Gaseous and Particulate Pollutants

5.2.1 The emission of gaseous and particulate pollutants by the engine submitted for testing shall be measured by the method described in Chapter 3 of this Part. Other methods may be approved if it is found that they yield equivalent results.

5.2.2 Testing of the engine for gaseous and particulate pollutants shall be done by recommended analytical and particulate sampling system. Other systems or analysers may be approved by the test agency if it is found that they yield equivalent results. For particulate emissions, only the full flow dilution system is recognised as the reference system. For introduction of a new system into this regulation, the determination of equivalency shall be based upon the calculation of repeatability and reproducibility by an inter laboratory test, as defined in ISO 5725.

5.2.2.1 Mass emission standards for the four wheeled diesel transport vehicles (other than passenger cars) manufactured on and after 1<sup>st</sup> April 2000 (India Stage-I) including two and three-wheelers shall be as per details given in Central Motor Vehicles Rule 1989, Rule No.115, Sub-Rule (10)(B) as amended from time to time. This has come into force for all parts of the country w.e.f. 1<sup>st</sup> April 2000. For CNG vehicles and LPG vehicles shall be as per details given in Central Motor Vehicles Rule 1989, Rule No.115-B and 115-C as amended from time to time.

5.2.2.2 Mass Emission Standards (Bharat Stage – II) for the four wheeled diesel transport vehicles (other than passenger cars) are as per details given in Central Motor Vehicle Rules 1989. Rule No.115, Sub-Rule (11)(C) as amended from time to time for various regions / cities. For CNG and LPG vehicles shall be as per details given in Central Motor Vehicle Rule 1989, Rule No.115-B and 115-C as amended from time to time for various regions / cities.

## 6 Modifications of the vehicle Model :

6.1 Every modification in the essential characteristics of the Vehicle shall be intimated by the Vehicle Manufacturer to the test agency which Type approved the Vehicle model. The test agency may either :

6.1.1 Consider that the Vehicle with the modifications made may still comply with the requirement, or

6.1.2 Require a further test to ensure compliance.

6.2 In case of 6.1.1 above, the testing agency shall extend the type approval covering the modified specification.

In case of 6.1.2 above, the vehicle model shall be subjected to necessary test. In case the vehicle complies with the requirements, the test agency shall extend the type approval.

6.3 Any changes to the procedure of PDI and running in concerning emission shall also be intimated to the test agency by the vehicle manufacturer, whenever such changes are carried out.

## 7 Conformity of Production :

7.1 Every produced vehicle of the model approved under this rule shall conform, with regard to components affecting the emission of gaseous and particulate pollutants by the engine to the vehicle model type approved. The administrative procedure for carrying out conformity of production is given in Part VI of this Document.

7.2 For verifying the conformity of the engine in a test, the following procedure is adopted:-

7.2.1 For compliance of India Stage I norms :

An engine is taken from the series and subjected to the test described in Chapter 3 of this Part.

7.2.1.1 If the engine taken from the series does not satisfy the requirements of applicable limits, 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 specify the size  $n$  of the sample subject to  $n$  being minimum 2 and maximum 10, including the engine originally taken. The engines other than originally tested shall be subjected to a test. The arithmetical mean ( $\bar{x}$ ) of the results obtained from the sample shall be determined for each pollutant. The production of the series shall then be deemed to conform if the following condition is met :-

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

where :-

$$S^2 = \frac{\sum (x_i - \bar{x})^2}{(n-1)}$$

$x_i$  = the individual results obtained with the sample n.

L = the limit value laid down in Paragraph 5.2.2.1 or 5.2.2.2 for each pollutant considered; and

k = 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

S = Standard Deviation ( rounded off to second decimal point).

7.2.1.2 The testing agency 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.

7.2.2 Conformity of Production procedure for Bharat Stage-II engines (vehicles);

7.2.2.1 Minimum of three engines shall be selected randomly from the series with a sample lot size (Refer Part VI).

7.2.2.2 After selection by the authority, the manufacturer must not undertake any adjustments to the engines (vehicles) selected, except those permitted in Part VI.

7.2.2.3 First engine/vehicle out of three randomly selected engines/vehicles shall be tested for mass emission test as described in the. Part X.

7.2.2.4 If one or more than one of the pollutant exceeds limits prescribed in 5.2.2.2, the test shall be continued on samples 2 & 3

7.2.2.5 If the natural Logarithms of the value measured in the series are  $X_1, X_2, X_3, \dots, X_j$  and L is the natural logarithm of the limit value for the pollutant, then define :

$$d_j = X_j - L$$

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

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

Table I of Chapter 1 of this part shows values of the pass ( $A_n$ ) and fail ( $B_n$ ) decision numbers against current sample number. The test statistic result is the ratio  $\bar{d}_n / V_n$  and shall be used to determine whether the series has passed or failed as follows :

For  $m_0 \leq n < m$

(Minimum sample size  $m_0=3$  and maximum sample size  $m=32$ )

- pass the series if  $\bar{d}_n / V_n \leq A_n$
  - fail the series if  $\bar{d}_n / V_n \geq B_n$
- take another measurement if  $A_n < \bar{d}_n / V_n < B_n$

Remarks :

The following consecutive formulae are useful for calculating successive values of the test statistics:

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

$$V_n^2 = \left(1 - \frac{1}{n}\right) V_{n-1}^2 + \frac{(\bar{d}_n - d_n)^2}{n-1}$$

$$(n = 2, 3, \dots; \bar{d}_1 = d_1; V_1 = 0)$$



**Table I : Applicable for COP Procedure as per Bharat Stage II**

Sample size (n)	Pass decision threshold (A <sub>n</sub> )	Fail decision threshold (B <sub>n</sub> )
3 (including first sample)	-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