CHAPTER 3 : TYPE I TEST ON SI ENGINES (VERIFYING THE AVERAGE EMISSIONS OF GASEOUS POLLUTANTS)

1. This chapter describes the procedure for the Type I test defined in paragraph 5.2.2 of Chapter 1 of this Part.

2. Operating Cycle on the Chassis Dynamometer :

2.1 Description of the Cycle : The operating cycle on the chassis dynamometer shall be that indicated in Table I and depicted in Figure 2. The breakdown by operations is given in Table II.

2.2 General Conditions under which the Cycle is carried out : preliminary testing cycles should be carried out if necessary to determine how best to actuate the accelerator and brake controls so as to achieve a cycle approximately to the theoretical cycle within the prescribed limits.

2.3 Use of the Gear Box : The use of the gear box shall be as specified by the manufacturer. However, in the absence of such instructions, the following points shall be taken into account.

2.3.1 Manual Change Gear Box :

2.3.1.1 During each phase at constant speed, the rotating speed of the engine shall be, if possible, between 50 and 90% of the speed corresponding to the maximum power of the engine. When this speed can be reached in two or more gears, the vehicle shall be tested with the higher gear engaged.

2.3.1.2 During acceleration, the vehicle shall be tested in whichever gear is appropriate to the acceleration imposed by the cycle. A higher gear shall be engaged at the latest when the rotating speed is equal to 110% of the speed corresponding to the maximum power of the engine.

2.3.1.3 During deceleration, a lower gear shall be engaged before the engine starts to idle roughly, at the latest when the engine revolutions are equal to 30% of the speed corresponding to the maximum power of the engine. No change down to first gear shall be effected during deceleration.

2.3.1.4 Vehicles equipped with an overdrive which the driver can actuate shall be tested with the overdrive out of action.

2.3.1.5 When it is not possible to adhere to the cycle, the operating cycle will be modified for gear change points, allowing 2 seconds time interval at constant speed for each gear change keeping the total time constant. Figure 1 shows the operating cycle with recommended gear positions.

2.3.2 Automatic Gear Box : Vehicles equipped with automatic shift gear boxes shall be tested with the highest gear (drive) engaged. The accelerator shall be used in such a way as to obtain the steadiest acceleration possible, enabling the various gears to be engaged in the normal order.

2.4 Tolerances

2.4.1 A tolerance of ± 1 km/h shall be allowed between the indicated speed and the theoretical speed during acceleration, during steady speed and during deceleration, when the vehicle's brakes are used. If the vehicle decelerates more rapidly without the use of the brakes, then the timing of the theoretical cycle shall be restored by constant speed or idling period merging into the following operation. Speed tolerances greater than those prescribed shall be accepted, during phase changes provided that the tolerances are never exceeded for more than 0.5 second on any one occasion.

2.4.2 Time tolerances of ± 0.5 second shall be allowed. The above tolerances shall apply equally at the beginning and at the end of each gear changing period.

2.4.3 The speed and time tolerances shall be combined as indicated in Figure 2.

3. Vehicle and Fuel

3.1 Test Vehicle :

3.1.1 The vehicle presented shall be checked that it is the same model as specified as per format of chapter 2 of this annexure. It shall have been run-in as per manufacturer's specification before the test.

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

3.1.3 The air intake system should be leak proof.

3.1.4 The settings of the engine and of the vehicle's controls shall be those prescribed by the manufacturer. This requirement also applies, in

particular, to the settings for idling and for the cold start device, automatic choke, and exhaust gas cleaning systems, etc.

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

The testing agency may verify that the vehicle conforms to the performance of power, acceleration, maximum speed etc., stated by the manufacturer and that it can be used for normal driving and more particularly that it is capable of starting when cold and when hot.

3.2 Fuel : The reference fuel as defined in Chapter 10 of this Part shall be used for testing. If the engine is lubricated by a mixture, the oil added to reference fuel shall comply as to grade and quality with the manufacturer's recommendation.

4. Test Equipment :

4.1 Chassis Dynamometer :

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

4.1.1.1 Dynamometer with fixed load curve, i.e., a dynamometer whose physical characteristics provide a fixed load curve shape. This is not a preferred type of dynamometer.

4.1.1.2 Dynamometer with adjustable load curve, i.e. a dynamometer with at least two road load parameters that can be adjusted to shape the load curve. This is a preferred type of dynamometer.

4.1.2 The chassis dynamometer may have one or two rollers. In the case of a single roller, the roller diameter shall not be less than 400 mm for 2-wheelers and 1200 mm for other vehicles.

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

4.1.4 It shall be equipped with means to simulate inertia and load. These simulators shall be connected to the front roller, in the case of a two roller dynamometer.

4.1.5 The roller shall be fitted with a revolution counter with reset facility to measure the distance actually covered.

4.1.6 Accuracy :

4.1.6.1 It shall be possible to measure and read the indicated load to an accuracy of ± 5 per cent.

4.1.6.2 In the case of dynamometer with a fixed load curve the accuracy of the load setting at 40 km/h shall be ± 5 per cent. In the case of a dynamometer with adjustable load curve, the accuracy of matching dynamometer load to road load shall be within 5 per cent at 30, 40 and 50 km/h and 10 per cent at 20 km/h. Below this, the dynamometer absorption must be positive.

4.1.6.3 The total equivalent inertia of the rotating parts (including the simulated inertia where applicable) must be known and within ± 20 kg of the inertia class for the test, in case of 4-wheeler vehicles; for 2-wheeler vehicles within ± 2 per cent.

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

4.1.7 Load and Inertia Setting :

4.1.7.1 Dynamometer with adjustable load curve: the load simulator shall be adjusted in order to absorb the power exerted on the driving wheels at various steady speeds.

4.17.2 Chassis Dynamometer with fixed load curve: the load simulator shall be adjusted to absorb the power exerted on the driving wheels at a steady speed of 40 km/h.

4.1.7.3 The means by which these loads are determined and set are described in Chapter 4 of this Part.

4.1.7.4 Chassis Dynamometers with electrical inertia simulation must be demonstrated to be equivalent to mechanical inertia systems.

The means by which equivalence is established is described in Chapter 5 of this Part.

4.1.8 Chassis Dynamometer Calibration :

4.1.8.1 The dynamometer should be calibrated at least once a month or performance verified at least once a week and then calibrated as required. The calibration shall consist of the manufacturers' recommended procedure and a determination of the dynamometer frictional power absorption at 40 km/h. One method for determining this is given in Chapter 7. Other methods may be used if they are proven to yield equivalent results.

4.1.8.2 The performance check consists of conducting dynamometer coast down time at one or more inertia power setting and comparing the coast down time to that recorded during the last calibration. If the coast down time differs by more than 1 second, a new calibration is required.

4.2 Exhaust Gas-sampling System :

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

4.2.1 The flow through the system shall be sufficient to eliminate water condensation at all conditions which may occur during a test, as defined in Chapter 6 of this Part.

4.2.2 Figure 6, 7 & 8 gives a schematic diagrams of the general concept. Examples of three types of Constant Volume Sampler systems which will meet the requirements are given in Chapter 6 of this Part.

4.2.3 The gas and air mixture shall be homogenous at point S2 of the sampling probe. (Figure 3)

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

4.2.5 The system should be free of gas leaks. The design and materials shall be such that the system does not influence the pollutant concentration in the diluted exhaust gas. Should any component (heat exchanger, blower, etc.) change the concentration of any

pollutant gas in the diluted gas, then the sampling for that pollutant shall be carried out before that component, if the problem cannot be corrected.

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

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

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

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

4.3 Analytical Equipment :

4.3.1 Pollutant gases shall be analysed with the following instruments :

4.3.1.1 Carbon monoxide (CO) and carbon dioxide (CO2) analysis. The carbon monoxide and carbon dioxide analysers shall be of the NON-DISPENSIVE INFRA RED (NDIR) absorption type.

4.3.1.2 Hydrocarbon (HC) analysis - GASOLINE VEHICLES. The hydrocarbons analyser shall be of the FLAME IONISATION (FID) type calibrated with propane gas expressed equivalent to carbon atoms.

4.3.1.3 Hydrocarbons (HC) analysis - DIESEL VEHICLES. The hydrocarbon analyser shall be of the Flame Ionisation type Detector with valves , pipe work etc. heated to 463K ± 10K (HFID). It shall be calibrated with propane gas expressed equivalent to carbon atoms (C_1).

4.3.1.4 Nitrogen oxide (NOx) analysis.

The nitrogen oxide analyser shall be of the CHEMILUMINESCENT (CLA) type with an NOx-NO converter.

4.3.1.5 Accuracy

The analysers shall have a measuring range compatible with the accuracy required to measure the concentrations of the exhaust gas sample pollutants: Measurement errors shall not exceed ± 3 per cent disregarding the true value of the calibration gases. For concentrations of less than 100 ppm the measurement error shall not exceed ± 3 ppm. The ambient air sample shall be measured on the same analyser and range as the corresponding diluted exhaust sample.

4.3.1.6 Ice-trap

No gas drying device shall be used before the analysis unless it is shown that it has no effect on the pollutant content of the gas stream.

4.3.2 Particular requirements for compression ignition engines :

4.3.2.1 A heated sample line for a continuous HC-analysis with the heated flame ionisation detector (HFID), including recorder (R) is to be used.

4.3.2.2 The average concentration of the measured hydrocarbons shall be determined by integration. Throughout the test, the temperature of the heated sample line shall be controlled at 463K ± 10K. The heated sampling line shall be fitted with a heated filter (F_H') (99% efficient with particle < 0.3 um) to extract any solid particles from the continuous flow of gas required for analysis.

4.3.2.3 The sampling system response time (from the probe to the analyser inlet) shall be no more than 4 s.

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

4.3.3 Calibration :

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

4.3.3.2 The calibration method that shall be used is described in Chapter 7 for the analysers indicated in para 4.3.1 above.

4.4 Volume measurement :

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

4.4.2 Constant Volume Sampler Calibration :

4.4.2.1 The Constant Volume Sampler system volume measurement device shall be calibrated by a suitable method to ensure the prescribed accuracy and at a frequency sufficient to maintain such accuracy.

4.4.2.2 An example of a calibration procedure which will give the required accuracy is given in Chapter 7 of this Part. The method shall utilise a flow metering device which is dynamic and suitable for the high flow rate encountered in Constant Volume Sampler testing. The devices shall be of certified accuracy traceable to an approved national or international standard.

4.5 Gases :

4.5.1 Pure Gases :
The following pure gases shall be available when necessary, for calibration and operation:

Purified nitrogen (purity < 1ppm C, < 1ppm CO, < 400 ppm CO_2,<0.5 ppm NO);

Purified synthetic air (purity < 3 ppm C, < 1ppm CO, < 400 ppmCO_2,< 0.5 ppm NO)

Oxygen content between 18 and 21 percent vol;

Purified oxygen (purity > 99.5 per cent Vol O_2);

Purified hydrogen (and mixture containing hydrogen)
(Purity < 1ppm C, < 400 ppm CO_2).

4.5.2 Calibration and span gases :

Gases having the following chemical compositions shall be available $C_3 H_8$ and purified synthetic air, as in para 4.5.1 above ;CO and purified nitrogen;CO_2 and purified nitrogen;NO and purified nitrogen (the amount of NO_2 contained in this calibration gas must not exceed 5 percent of the NO content)

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

4.5.4 The concentrations specified in Chapter 7 of this Part may also be obtained by means of a gas divider, diluting with purified nitrogen or with purified synthetic air. The accuracy of the mixing device shall be such that the concentrations of the diluted calibration gases may be determined within ± 2%.

4.6 Additional equipment :

4.6.1 Temperature : The temperature indicated in Chapter 8 of this Part shall be measured with an accuracy of ± 1.5K.

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

4.6.3 Absolute Humidity : The absolute humidity (H) shall be measurable to within ± 5 percent.

4.7 The exhaust gas-sampling system shall be verified by the method described in para 3 of Chapter 7 of this Part. The maximum permissible deviation between the quantity of gas introduced and the quantity of gas measured shall be 5 per cent.

5. Preparations for the test :

5.1 Adjustment of inertia simulators to the vehicle's translatory inertias : An inertia simulator shall be used enabling a total inertia of the rotating masses to be obtained proportional to the reference weight within the following limits given in Table III.

5.2.1 Setting of dynamometer :

5.2.2 The load shall be adjusted according to methods described in paragraph 4.1.7 above.

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

5.3 Four wheel drive vehicles will be tested in a two-wheel drive mode of operation. Full time four-wheel drive vehicles will have one set of drive wheels temporarily disengaged by the vehicle manufacturers. Four-wheel drive vehicles which can be manually shifted to a two-wheel drive mode will be tested in the normal on highway two-wheel drive mode of operation.

6. Procedure for Chassis Dynamometer Test :

6.1 Special conditions for carrying out the cycle :

6.1.1 During the test, the cell temperature shall be between 298K and 313K. The absolute humidity (H) of either the air in the test cell or the intake air of the engine shall be such that

$$5.5 <= H <= 18.0 \text{ g } H_2O/\text{kg dry air}$$

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

6.1.3 The tyre pressure shall be the same as that indicated by the manufacturer and used for the preliminary road test for data collection for adjustment of chassis Dynamometer. The tyre pressure may be increased by up to 50 per cent from the manufacturer's recommended setting in the case of a two roll dynamometer . The actual pressure used shall be recorded in the test report.

6.1.4 Cooling of the Vehicle :

6.1.4.1 For vehicles with liquid cooled engines the test shall be carried out with the bonnet raised unless this is technically impossible. An auxiliary ventilating device acting on the radiator (water cooling) or on the air intake (air cooling) may be used if necessary, to keep the engine temperature normal.

6.1.4.2 For vehicles with air cooled engines throughout the test, an auxiliary cooling blower shall be positioned in front of the vehicle, so as to direct cooling air to the engine. The blower speed shall be such that, within the operating range of 10 km/h to 50 km/h the linear velocity of the air at the blower outlet is within ± 5 km/h of the corresponding roller speed. At roller speeds of less than 10 km/h, air velocity may be zero, the blower outlet shall have a cross section area of at least 0.4 m^2 and the bottom of the blower outlet shall be between 15 and 20 cm above floor level. The blower outlet shall be perpendicular to the longitudinal axis of the vehicle between 30 and 45 cm in front of its front wheel.

6.1.4.3 As an alternative, an auxiliary cooling blower may be positioned in front of the vehicle. The blower outlet shall have a cross sectional area of at least 0.4 m^2 and shall be perpendicular to the longitudinal axis of the vehicle between 30 and 45 cm in front of its front wheel. The device used to measure the linear velocity of the air shall be located in the middle of the stream at 20 cm away from the air outlet. The air velocity shall be 25 km/h ± 5 km/h. This velocity shall be as nearly constant as possible across the whole of the blower outlet surface.

6.1.5 During the test, the speed shall be recorded with respect to time so that the correctness of the cycles performed can be assured.

6.2 Starting up the engine :

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

6.2.2 Warming up of the vehicle will be done on the chassis dynamometer as per manufacturer's instructions by using the operating test cycles. The test cycle shall begin at the end of this warming up period.

6.2.3 If the maximum speed of the vehicle is less than the maximum speed of the driving cycle, that part of the driving cycle, where speed is exceeding the vehicle's maximum speed, the vehicle will be driven with the throttle fully open.

6.3 Idling :

6.3.1 Manual-shift or semi-automatic gear-box :

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

6.3.1.2 To enable the accelerations to be performed according to normal cycle the vehicle shall be placed in first gear, with clutch disengaged, 5 seconds before the acceleration following the idling period considered.

6.3.1.3 The first idling period at the beginning of the cycle shall consist of 11 seconds of idling in neutral with the clutch engaged and 5 seconds in first gear with the clutch disengaged.

6.3.2 Automatic-shift gear-box : After initial engagement, the selector shall not be operated at any time during the test except in accordance with paragraph 6.4.2 below.

6.4 Accelerations :

6.4.1. Manual Shift Gear Box :

6.4.1.1 Accelerations shall be so performed that the rate of acceleration is as constant as possible through the phase.

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

6.4.2 Automatic-shift gear-boxes : If an acceleration cannot be carried out in the prescribed time the gear selector shall be operated in accordance with requirements for manual-shift gear-boxes.

6.5 Decelerations :

6.5.1 All decelerations shall be effected by closing the throttle completely. The clutch shall be disengaged, at around a speed of 10 km/h.

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

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

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

6.6 Steady Speeds :

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

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

7. Procedure for Sampling and Analysis :

7.1 Sampling : Sampling shall begin at the beginning of the test cycle as defined in para 6.2.2 above and end at the end of the sixth cycle.

7.2 Analysis :

7.2.1 The exhaust gases contained in the bag shall be analysed as soon as possible and in any event not later than 20 minutes after the end of the test cycle.

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

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

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

7.2.5 The samples shall then be analysed.

7.2.6 After the analysis zero and span points shall be re-checked using the same gases. If these re-checks are within 2 percent of those in paragraph 7.2.3, then the analysis shall be considered acceptable.

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

7.2.8 The figure adopted for the content of the gases in each of the pollutants measured shall be that read off after stabilisation of the measuring device. Diesel hydrocarbon mass emissions shall be calculated from the integrated HFID reading corrected for varying flow, if necessary as shown in Chapter 6 of this Part.

8. Determination of the Quantity of Gaseous Pollutants Emitted :

8.1 The volume Considered : The volume to be considered shall be corrected to conform to the conditions of 101.3 kPa and 293 K.

8.2 Total Mass of Gaseous Pollutants Emitted : The mass, M, of each pollutant emitted by the vehicle during the test shall be determined by obtaining the product of the voluminal concentration and the volume of the gas in question, with due regard for the following densities at the above mentioned reference condition. In the case of carbon monoxide (CO)d = 1.164 kg/m^3 In the case of hydrocarbons ($CH_{1.85}$)d = 0.5768 Kg/m^3 In the case of nitrogen oxides (NO_2)d = 1.913 kg/m^3.

8.3 Chapter 8 of this Part describes the calculations for the various methods to determine the quantity of gaseous pollutants emitted.

TABLE 1

OPERATING CYCLE ON THE CHASSIS DYNAMOMETER

(Please ref. Para. 2.1chapter 3 ,Part 3)

No. of operation		Acceleration (m/sec^2)	Speed (Km/h)	Duration of each operation (S)	Cumulative time(s)
01.	Idling	--	---	16	16
02.	Acceleration	0.65	0-14	6	22
03.	Acceleration	0.56	14-22	4	26
04.	Deceleration	-0.63	22-13	4	30
05.	Steady speed	--	13	2	32
06.	Acceleration	0.56	13-23	5	37
07.	Acceleration	0.44	23-31	5	42
08.	Deceleration	-0.56	31-25	3	45
09.	Steady speed	--	25	4	49
10.	Deceleration	-0.56	25-21	2	51
11.	Acceleration	0.45	21-34	8	59
12.	Acceleration	0.32	34-42	7	66
13.	Deceleration	-0.46	42-37	3	69
14.	Steady speed	--	37	7	76
15.	Deceleration	- 0.42	37-34	2	78
16.	Acceleration	0.32	34-42	7	85
17.	Deceleration	-0.46	42-27	9	94
18.	Deceleration	-0.52	27-14	7	101
19.	Deceleration	-0.56	14-00	7	108

TABLE II

BREAK DOWN OF THE OPERATING CYCLE USED FOR THE TYPE 1 TEST
(Please ref. para. 2.1 chapter 3, Part 3)

A: BREAK DOWN BY PHASES

Sr. No.	Particulars	Time(s)	Percentage
1	Idling	16	14.81
2	Steady speed periods	13	12.04
3	Accelerations	42	38.89
4	Deceleration's	37	34.26
		108	100

A: AVERAGE SPEED DURING TEST : 21.93 Km/h

C: THEORETICAL DISTANCE COVERED PER CYCLE : 0.658 Km.

D: EQUIVALENT DISTANCE FOR THE TEST (6 cycles) : 3.948 Km.

TABLE III
(Please refer para. 5.1 Chapter 3 ,Part 3)

REFERENCE MASS OF VEHICLE R(kg) MORE THAN	REFERENCE MASS OF VEHICLE R(kg) UPTO AND INCLUDING	Equivalent inertia 1 Kg
----	105	100
105	115	110
115	125	120
125	135	130
135	145	140
145	165	150
165	185	170
185	205	190
205	225	210
225	245	230
245	270	260
270	300	280
300	330	310
330	360	340
360	395	380
395	435	410
435	475	450
475	515	490
515	555	530
555	595	570

595	635	610
635	675	650
675	715	690
715	750	730
750	850	800
850	1020	910
1020	1250	1130
1250	1470	1360
1470	1700	1590
1700	1930	1810
1930	2150	2040
2150	--	2270

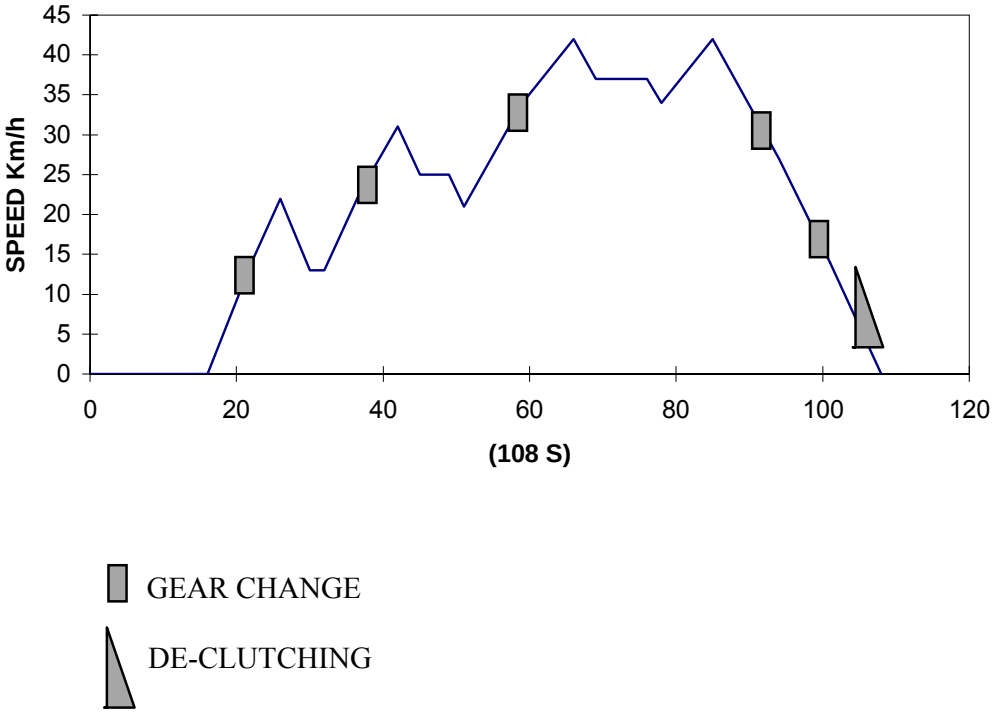
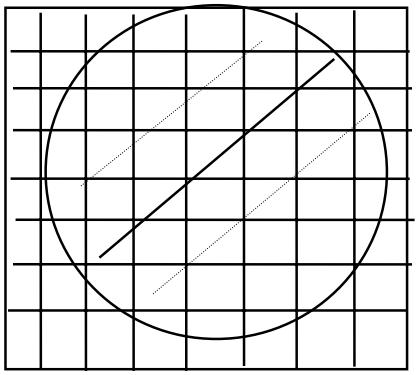


Fig 1 : OPERATING CYCLE WITH RECOMMENDED GEAR POSITION
(Pl. ref. para 2.3.1.5 of chapter 3 ,Part 3)



SPEED AND TIME TOLERANCES

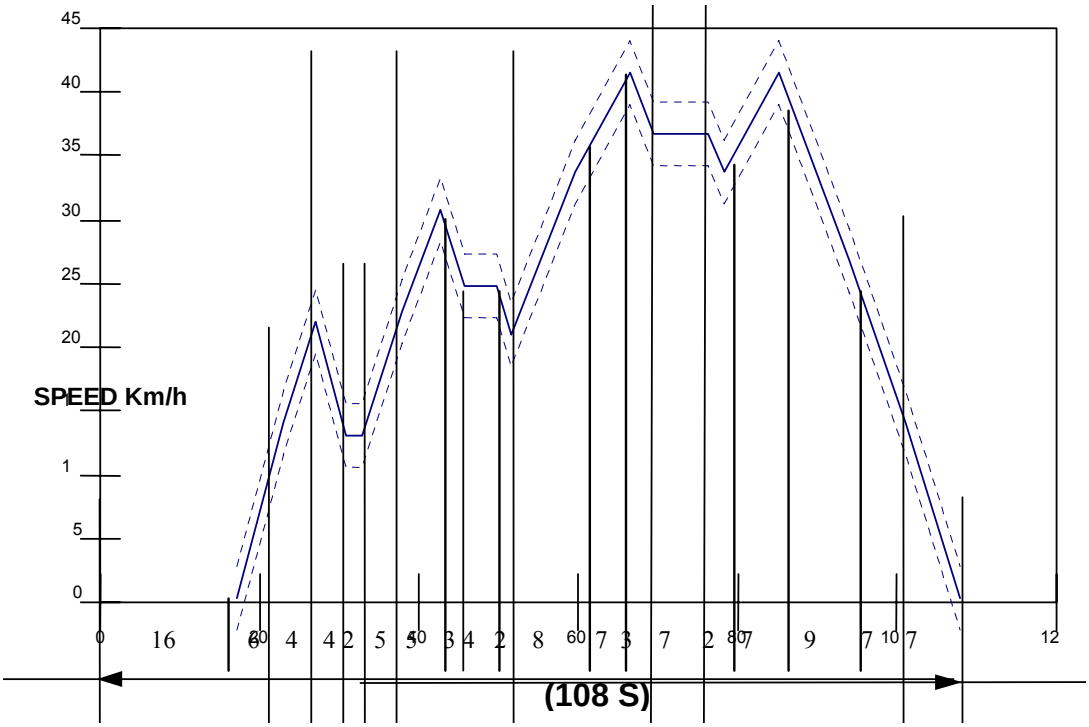
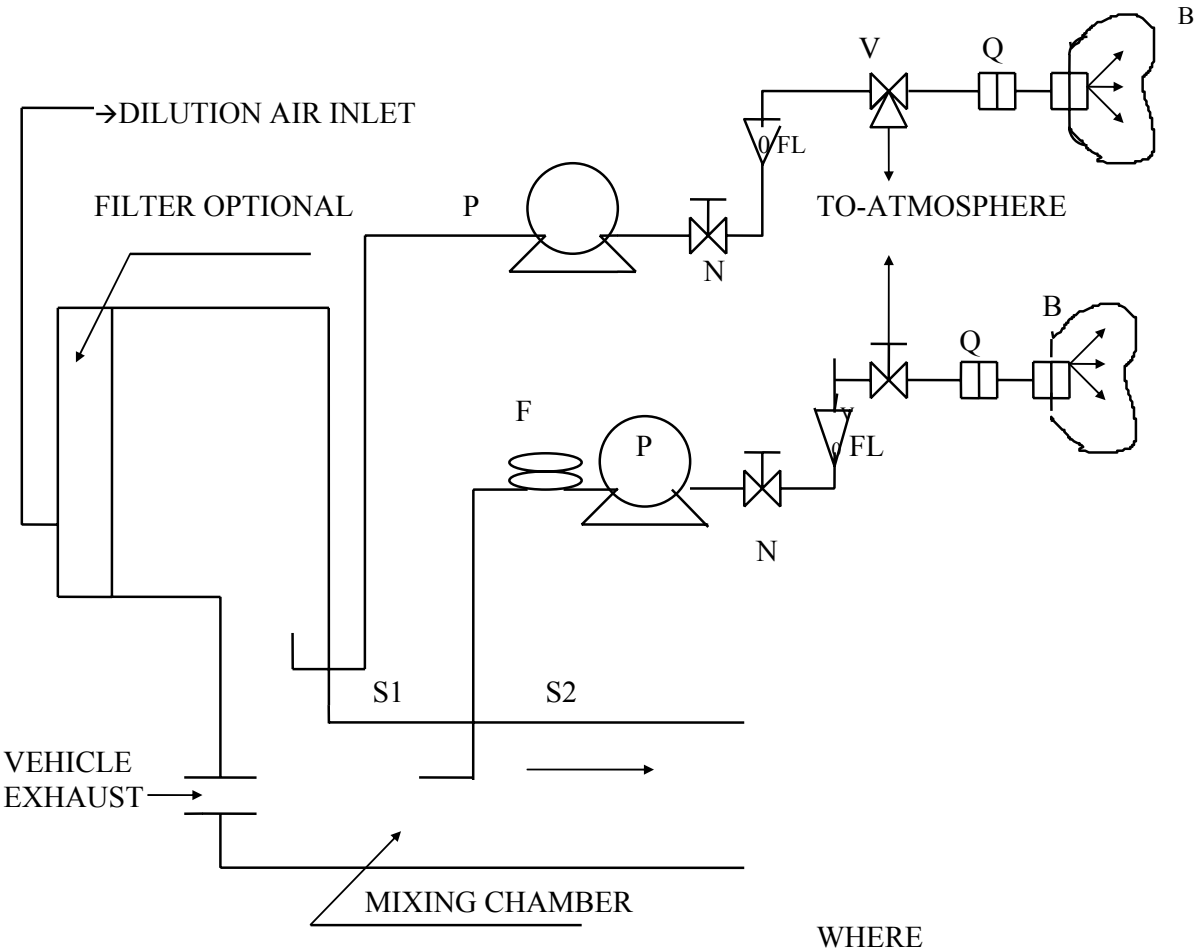


Fig 2: Operating cycle with speed and time tolerances
(Pl. ref. para 2.1 & 2.4.3 of chapter 3 ,Part 3)

FIGURE 3 : SCHEMATIC OF EMISSION MEASUREMENT SET-UP

(PL. REF. PARA. 4.2.3. OF CHAPTER 3 ,Part 3)



WHERE

S1,S2 -- SAMPLING PROCESS
P -- SUCTION PUMPS
F -- FILTERS
FL -- FLOW METERS
N -- FLOW CONTROLLERS
V -- QUICK CHANGING SOLENOID VALVES TO DIVERT FLOW INTO BAGS /VENTS
Q --QUICK ACTING COPLERS
B --BAGS FOR COLLECTING SAMPLES