Chapter 3

TYPE I TEST ON S.I. ENGINES, CNG, LPG AND DIESEL ENGINE VEHICLES (VERIFYING THE AVERAGE TAILPIPE EMISSION) OF GASEOUS AND PARTICULATE POLLUTANTS

1. This chapter describes the procedure for the Type I test defined in paragraph 5.2.2 of Chapter 1 of this Part. This chapter should be read in conjunction with the applicable Gazette notification for which the test is to be carried out.

2. **Operating Cycle on the Chassis Dynamometer**:

2.1. Description of the Cycle: The operating cycle on the chassis dynamometer shall be as given in 2.1.1.

2.1.1. The operating cycle on the chassis dynamometer for four wheelers shall be as per modified Indian Driving Cycle i.e. Urban Driving Cycle (Table II) and Extra Urban Driving Cycle (Table III) and as depicted in the Figure 1 and Figure 2 of this Chapter respectively. The break down by operations is given in Table II-A for Urban Driving Cycle (Part One) and in Table III-A for Extra Urban Driving Cycle (Part Two) of this chapter.

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:

2.3.1. The use of gears shall be as shown in Table II and Table III for the elementary urban cycles (Part One) and the extra urban cycle (Part Two) respectively.

2.3.1.1. However, if the maximum speed which can be attained in first gear is below 15 km/h, the second, the third and fourth gears are used for the elementary urban cycles (Part One) and the second, third, fourth and fifth gears for the extra urban cycle (Part Two). Second, third and fourth gears may also be used for the urban cycles (Part One) and the second, third, fourth and fifth gears for the extra urban cycle (Part Two) when the driving instructions recommended starting in second gear on level ground, or when first gear is therein defined as a gear reserved for cross country driving, crawling or towing.

Alternatively, if technical justification given by vehicle manufacturer is acceptable to the certifying agency to use first gear for elementary urban cycles (Part One) and extra urban cycle (Part Two) based on vehicle driving characteristics then such cases the first gear can be used.

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

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

2.3.3. Vehicles equipped with automatic gearboxes shall be tested with the highest gear (drive) engaged. The accelerator shall be used in such a way as to obtain the steadiest acceleration possible, enabling the various gears to be engaged in the normal order. Furthermore the gear change points given in Table II and Table III of this Chapter do not apply: acceleration must continue throughout the period represented by the straight line connecting the end of each period of idling with the beginning of the next following period of steady speed. The tolerance given in 2.4 shall apply.

2.3.4. Vehicles equipped with an overdrive, which the driver can activate are tested with the overdrive out of action for the urban cycle (Part One) and with the overdrive in action for the extra urban cycle (Part Two).

2.3.5. At the request of the manufacturer, for a vehicle type where the idle speed of the engine is higher than the engine speed that would occur during operations 5, 12 and 24 of the elementary urban cycle (Part One), the clutch may be disengaged during the previous operation

2.4. Tolerances

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

2.4.2. Time tolerances of ± 1 second shall be allowed. The above tolerances shall apply equally at the beginning and at the end of each gear changing period for the urban cycle (Part One) and for the operations Nos 3, 5 and 7 of the extra-urban cycle (Part Two).

2.4.3. The speed and time tolerances shall be combined as indicated in Figure 1 of this chapter.

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 Part. It shall have been run-in either as per manufacturer's specification or at least 3000 km 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, 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.

3.1.6. The testing agency may verify that the vehicle performance conforms to that 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 prescribed in the applicable Gazette notification shall be used. If the engine is lubricated by a fuel oil mixture, the oil added to reference fuel shall comply as to grade and quantity with the manufacturer's recommendation.

3.2.1. Reference Fuel shall be used for Type Approval and Conformity of Production one year after the same is available to the test agencies. Till then, Commercial CNG/LPG fuel shall be used as per applicable Gazette Notification under CMVR.

4. **Test Equipment:**

4.1. Chassis Dynamometer:

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

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

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

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

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. Accuracy:

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

4.1.5.2. In the case of a dynamometer with a fixed load curve the accuracy of the load setting at 80 km/h shall be ± 5 percent. In the case of a dynamometer with an adjustable load curve, the accuracy of matching dynamometer load to road load shall be within 5 per cent at 90, 80, 60, 50, 40, 30 km/h and 10 per cent at 20 km/h. Below this, the dynamometer absorption must be positive.

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

4.1.5.4. 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.

4.1.6. Load and Inertia Setting:

4.1.6.1. Dynamometer with fixed load curve: the load simulator shall be adjusted to absorb the power exerted on the driving wheels at a steady speed of 80 km/h and the absorbed power at 50 km/h shall be noted. The means by which this load is determined and set are described in Chapter 4 of this part.

4.1.6.2. 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 of 90, 80, 60, 50, 40, 30 and 20 km/h. The means

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

4.1.6.3. Chassis Dynamometers with electrical inertia simulation shall be demonstrated to be equivalent to mechanical inertia systems. The means by which equivalence is established is described in Chapter 5 of this Part.

4.1.7. Chassis Dynamometer Calibration:

4.1.7.1. The dynamometer should be calibrated periodically as recommended by the manufacturer of the chassis dynamometer and then calibrated as required. The calibration shall consist of the manufacturers' recommended procedure and a determination of the dynamometer frictional power absorption at 80 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.

4.1.7.2. 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:

4.2.1. The exhaust gas sampling shall be designed to enable the measurement of the true mass emissions of vehicle exhaust. A Constant Volume Sampler System (CVS) 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 shall be measured and a continuously proportional sample of the volume shall 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. The particulate pollutant emission level is determined by using suitable filters to collect the particulates from a proportional part flow throughout the test and determining the quantity thereof gravimetrically in accordance with 4.3.2.

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

4.2.3. Figure 9, 10, 11 of Chapter 6 of this Part gives a schematic diagram 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.

4.2.4. The gas and air mixture shall be homogenous at point S_2 of the sampling probe.

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

4.2.6. 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.

4.2.7. 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 but in such a manner so as not to effect the functioning of the vehicle.

4.2.8. 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 backpressure shall be measured in the exhaust pipe as near as possible to its end or in an extension having the same diameter.

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

4.2.10. 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 (CO_2) analysis. The carbon monoxide and carbon dioxide analysers shall be of the Non-Dispersive Infra Red (NDIR) absorption type.

4.3.1.2. Hydrocarbon (HC) analysis - Spark ignition Vehicles. The hydrocarbons analyzer shall be of the Flame Ionisation (FID) type calibrated with propane gas expressed equivalent to carbon atoms (C_1).

4.3.1.3.Hydrocarbons (HC) analysis - Compression Ignition Vehicles. The hydrocarbon analyzer shall be of the Flame Ionisation type Detector with valves, pipe work etc. heated to 463 K ± 10 K (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 or by NDUVR (non-dispersive ultraviolet resonance absorption) type analyzer, both with an NO_X – NO converter.

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

- V_{ep}: Flow through filters.
- V_{mix}: Flow through tunnel.
- M: Particulate mass (g/km)
- M_{limit}: Limit mass of particulates (limit mass in force, g/km)
- m: Mass of particulates collected by filters (g)
- d: Actual distance corresponding to the operating cycle (km)

$$M = \frac{(V_{mix} * m)}{(V_{ep} * d)} \qquad \text{or}$$

$$m = \frac{(M * d * V_{ep})}{V_{mix}}$$

- The particulate sample rate (V_{ep} / V_{mix}) will be adjusted so that for $M = M_{limit}$ $1 \leq m \leq 5$ mg (when 47mm diameter filters are used).
- The filter surface consists of a material that is hydrophobic and inert towards the components of exhaust gas (fluorocarbon coated glass fibre filters or equivalent).

4.3.1.6.Accuracy: The analysers must have a measuring range compatible with the accuracy required to measure the concentrations of the exhaust gas sample pollutants. Measurements error must not exceed ± 2% (intrinsic error of analyser) disregarding the true value for the calibration gases. For concentration of less than 100 ppm the measurement error must not exceed ± 2 ppm. The ambient air sample must be measured on the same analyser with an appropriate range. The microgram balance used to determine the weight of all filters must have an accuracy of 5 µg and readability of 1 µg.

4.3.1.7.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 463 K (190°C) ±10 K. The heated sampling line shall be fitted with a heated filter (F_h) 99% efficient with particle ≥ 0.3 μm 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.

4.3.2.5. The particulate sampling unit consists of a dilution tunnel, a sampling probe, a filter unit, a partial flow pump, and a flow rate regulator and measuring unit. The particulate sampling part flow is drawn through two series mounted filters. The sampling probe for the test gas flow for particulates shall be so arranged within the dilution tract that a representative sample gas flow can be taken from the homogenous air / exhaust mixture and an air / exhaust gas mixture temperature of 325 K (52 °C) shall not exceed immediately before the particulate filter. The temperature of the gas flow in the flow meter shall not fluctuate more than ± 3K, nor the mass flow rate shall fluctuate more than ± 5%. If the volume of flow changes unexpectedly as a result of excessive filter loading, the test should be stopped. When it is repeated, the rate of flow shall be decreased and / or larger filter shall be used. The filters shall be removed from the chamber not earlier than an hour before the test begins.

4.3.2.6. The necessary particulate filters should be conditioned (as regards temperature and humidity) in an open dish which shall be protected against dust ingress for at least 8 and not more than 56 hours before the test in an air-conditioned chamber. After this conditioning, the uncontaminated filters shall be weighed and stored until they are used. The temperature of the chamber (or room) in which particulate filters are conditioned and weighed shall be maintained to within 295 +/- 3 K (22°C +/-3°C) during all filters conditioning and weighing. The humidity shall be maintained to a dew point of 282.5 K +/- 3 K (9.5°C +/- 3°C) and a relative humidity of 45% +/- 8%.

4.3.2.7. If the filters are not used within 1 hour of their removal from the weighing chamber then they shall be re-weighed. The one hour limit shall be replaced by an eight hour limit if one or both of the following conditions are met:

- A stabilised filter is placed and kept in a sealed filter holder assembly with the ends plugged, or
- A stabilised filter is placed in a sealed filter holder assembly which is then immediately placed in a sample line through which there is no flow.

4.3.3. Calibration

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 of this part 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 ≤ 1 ppm C, ≤ 1ppm CO, ≤ 400 ppm CO_2, ≤ 0.1 ppm NO);

- Purified synthetic air (purity ≤ 1 ppm C, ≤ 1ppm CO, ≤ 400 ppm CO_2, ≤ 0.1 ppm NO); oxygen content between 18% & 21% 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 of:

- C_3 H_8 and purified synthetic air, as in Para 4.5.1 above
- CO and purified nitrogen, as in para 4.5.1 above
- CO_2 and purified nitrogen, as in para 4.5.1 above.
- NO and purified nitrogen, as in para 4.5.1 above (The amount of NO_2 contained in this calibration gas shall 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. Temperatures: The temperature indicated in Chapter 8 of this part shall be measured with an accuracy of ± 1.5 K.

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

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

4.7. The exhaust gas-sampling system shall be verified by the method described in Para 4 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 %.

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 I. If the corresponding equivalent inertia is not available on the dynamometer, the large value closest to the vehicle reference mass will be used.

5.2. Setting of dynamometer:

5.2.1. 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.

5.2.3. 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.

TABLE I

For 4 Wheeler vehicles		
Reference Mass of Vehicle RW (kg)		Equivalent Inertia (kg)
Exceeding	Upto	
----	480	455
480	540	510
540	595	570
595	650	625
650	710	680
710	765	740
765	850	800
850	965	910
965	1080	1020
1080	1190	1130
1190	1305	1250
1305	1420	1360
1420	1530	1470
1530	1640	1590
1640	1760	1700
1760	1870	1810
1870	1980	1930
1980	2100	2040
2100	2210	2150
2210	2380	2270
2380	2610	2270
2610	----	2270

5.3. Preconditioning of the vehicle:

5.3.1. For the compression ignition engine vehicles for the purpose of measuring particulates at most 36 hours and at least 6 hours before testing, the Part II cycle described in Table III shall be used. Three consecutive cycles shall be driven. The dynamometer setting shall be as per 5.1 and 5.2 above.

5.3.2. At the request of the manufacturers, vehicles with positive ignition engines may be pre-conditioned with one Part-I and two Part-II driving cycles.

5.3.3. After this preconditioning specific for compression ignition engines and before testing, compression ignition and positive ignition engine vehicles shall be kept in a room in which a temperature remains relatively constant between 293 K and 303 K (20 and 30 °C). The vehicle soaking shall be carried out for at least 6 hours and continue until the engine oil temperature and coolant, if any, are within ± 2 K of the temperature of the room.

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

5.3.5. For positive-ignition engine vehicles fuelled with LPG or CNG or so equipped that they can be fuelled with either petrol or LPG or CNG, between the tests on the first gaseous reference fuel and the second gaseous reference fuel, the vehicle shall be preconditioned before the test on the second reference fuel. This preconditioning is done on the second reference fuel by driving a preconditioning cycle consisting of one part one (urban part) and two times part two (extra urban part) of the test cycle, if reference fuel is available. On the manufacturer's request and with the agreement of the test agency this preconditioning cycle may be extended. The dynamometer setting shall be the one indicated in points 5.1 and 5.2 of this Chapter.

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

6. Procedure for Chassis Dynamometer Test:

6.1. Special conditions for carrying out the cycle:

6.1.1. During the test, the test cell temperature shall be between 293 K and 303 K (20 and 30 °C). The absolute humidity (H) of either the air in the test cell or the intake air of the engine shall be such that: $5.5 \leq H \leq 12.2$ g H_2O/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. During the test, the speed can be recorded against time so that the correctness of the cycle performed can be assessed.

6.1.4. Cooling of the Vehicle:

6.1.4.1. The blower speed shall be such that, within the operating range of 10 km/h to at least up to 50 km/h the linear velocity of the air at the blower outlet is within ± 5 km/h of the corresponding roller speed.~~,~~ the blower outlet shall have a cross section area of at least 0.2 m^2, height of the lower edge above ground approximately 20 cm. The distance from front end of the vehicle is approx. 30 cm.

6.1.4.2. As an alternative the blower speed shall be at least 6 m/s (21.6 km/h). At the request of the manufacturer for special vehicles (e.g. vans, off-road) the height of the cooling fan can be modified.

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. The first cycle starts on the initiation of the engine start-up procedure.

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 accelerator control fully actuated.

6.2.4. In the case of the use of LPG or CNG as a fuel, it is permissible that the engine is started on petrol and switched to LPG or CNG after a predetermined period of time which cannot be changed by the driver.

6.3. Idling:

6.3.1. Manual-shift or semi-automatic gearbox:

6.3.1.1. During periods of idling, the clutch shall be engaged and 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 of the elementary urban cycle (Part One).

6.3.1.3. The first idling period at the beginning of the urban cycle (Part One) shall consist of 6 seconds of idling in neutral with the clutch engaged and 5 seconds in first gear with the clutch disengaged. The two idling periods referred to above shall be consecutive The idling period at the beginning of extra-urban cycle (Part Two) consist of 20 seconds of idling in first gear with the clutch disengaged.

6.3.1.4. For the idling periods during each urban cycle (Part One) the corresponding times are 16 seconds in neutral and 5 seconds in first gear with the clutch disengaged.

6.3.1.5. The idle period between two successive elementary cycles (Part One) comprises 13 seconds in neutral with the clutch engaged.

6.3.1.6. At the end of the deceleration period that of the vehicle on the roller of the extra urban cycle (Part Two), the idling period consist of 20 seconds in neutral with the clutch engaged.

Note: Wherever first gear is mentioned above, second gear is to be used subject to 2.3.1 to 2.3.4

6.3.2. Automatic-shift gearbox: After initial engagement, the selector shall not be operated at any time during the test except in accordance with paragraph 6.4.3 below or if the selector can actuate the overdrive, if any.

6.4. Accelerations:

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

6.4.2. If an acceleration cannot be carried out in the prescribed time, the extra time required is, if possible, deducted from the time allowed for changing gear, but otherwise from the subsequent steady speed period.

6.4.3. Automatic-shift gear-boxes: If 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 of the elementary urban cycle (Part One) shall be effected by closing the throttle completely. The clutch shall be disengaged, at around a speed of 10 km/h. All the deceleration of the extra urban cycle

(Part Two) shall be effected by closing the throttle completely. The clutch shall be disengaged, at around a speed of 50 km/h for the last deceleration.

6.5.2. If the period of deceleration is longer than that prescribed for the corresponding phase, the vehicle's brakes shall be used to enable the timing of the cycle to be 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) of the elementary urban cycle (Part One) the gears shall be placed in neutral and the clutch engaged.

6.6. Steady Speeds:

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

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

7. Procedure for Sampling and Analysis:

7.1. Sampling:

7.1.1. Sampling begins (BS) before or at the initiation of the engine start up procedure and ends on conclusion of the final idling period in the extra urban cycle (Part Two).

7.2. Analysis

7.2.1. The exhaust gases contained in the bag shall be analysed as soon as possible and in any event not later than 20 minutes after the end of the test cycle. The spent particulate filters must be taken to the chamber no later than 1 hour after conclusion of the test on the exhaust gases and must be conditioned for between 2 & 36 hours and then be weighed.

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

7.2.3. The analysers shall then be set to the calibration curves by means of span gases of nominal concentrations of 70 to 100 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 ($CH_{1.85}$):
  - for petrol ($CH_{1.85}$) d = 0.5768 kg/ m^3
  - for diesel ($CH_{1.86}$) d = 0.5768 kg/ m^3
  - for LPG ($CH_{2.525}$) d = 0.6047 kg/ m^3
  - for CNG (CH_4) d = 0.665 kg/ m^3
- In the case of nitrogen oxides (NO_x): d = 1.913 kg/ m^3.
- In case of carbon dioxide(CO_2): d=1.830 kg/m^3
- The mass ‘m’ of particulate pollutant emissions from the vehicle during the test is defined by weighing the mass of particulates collected by two filters, ‘m_1’ by the first filter, ‘m_2’ by the second filter.
  - if 0.95 ($m_1 + m_2$) ≤ m_1, m = m_1

- if 0.95 ($m_1 + m_2$) > m_1, m = $m_1 + m_2$
- if $m_2 > m_1$, the test shall be cancelled.

8.3. Chapter 8 of this Part describes the calculations, followed by examples, used in determining the mass emissions of gaseous and particulates.

Figure 1: Elementary – Urban cycle for type I test

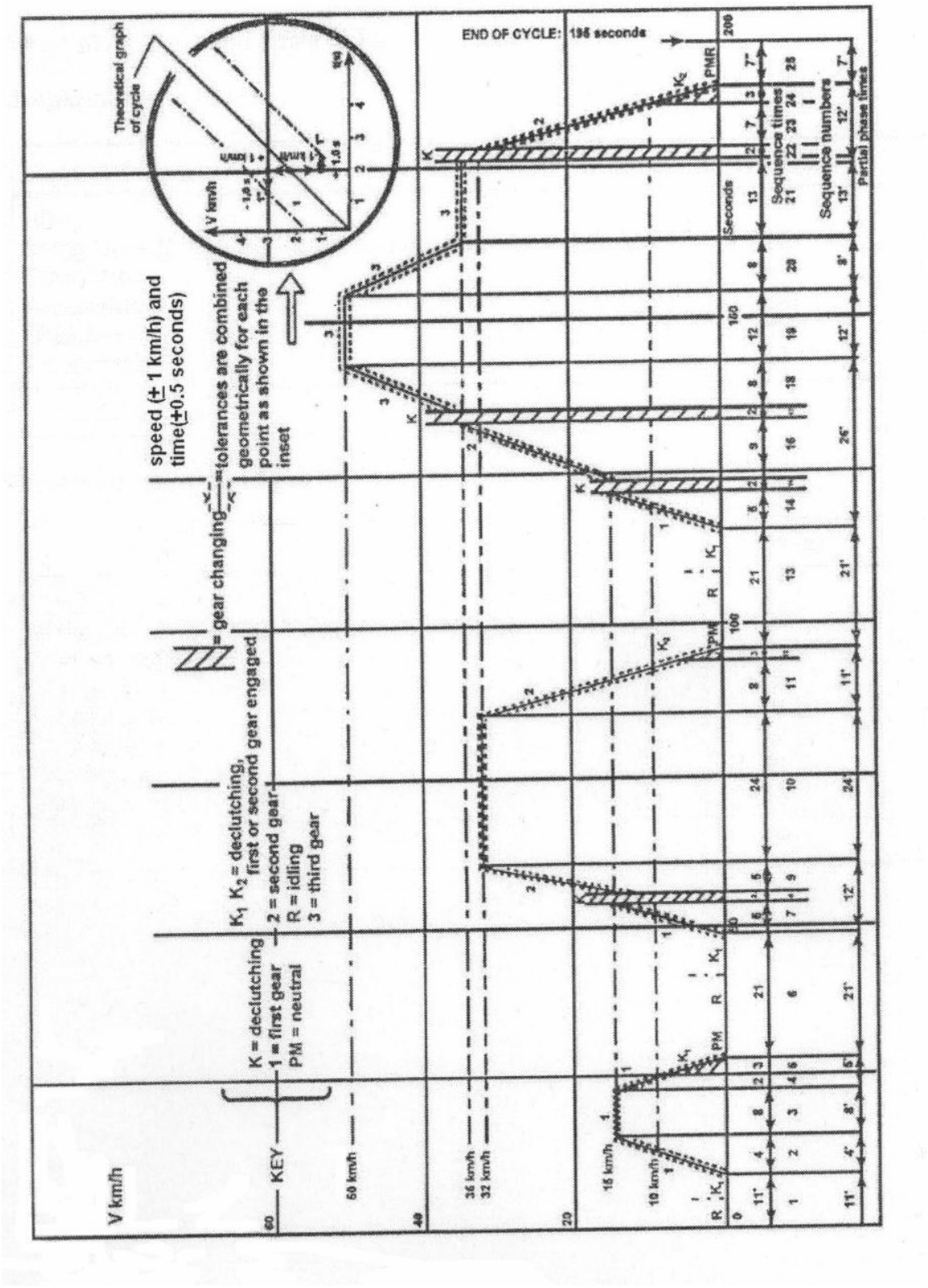

Figure 2: Extra – Urban cycle (Part two) for type I test

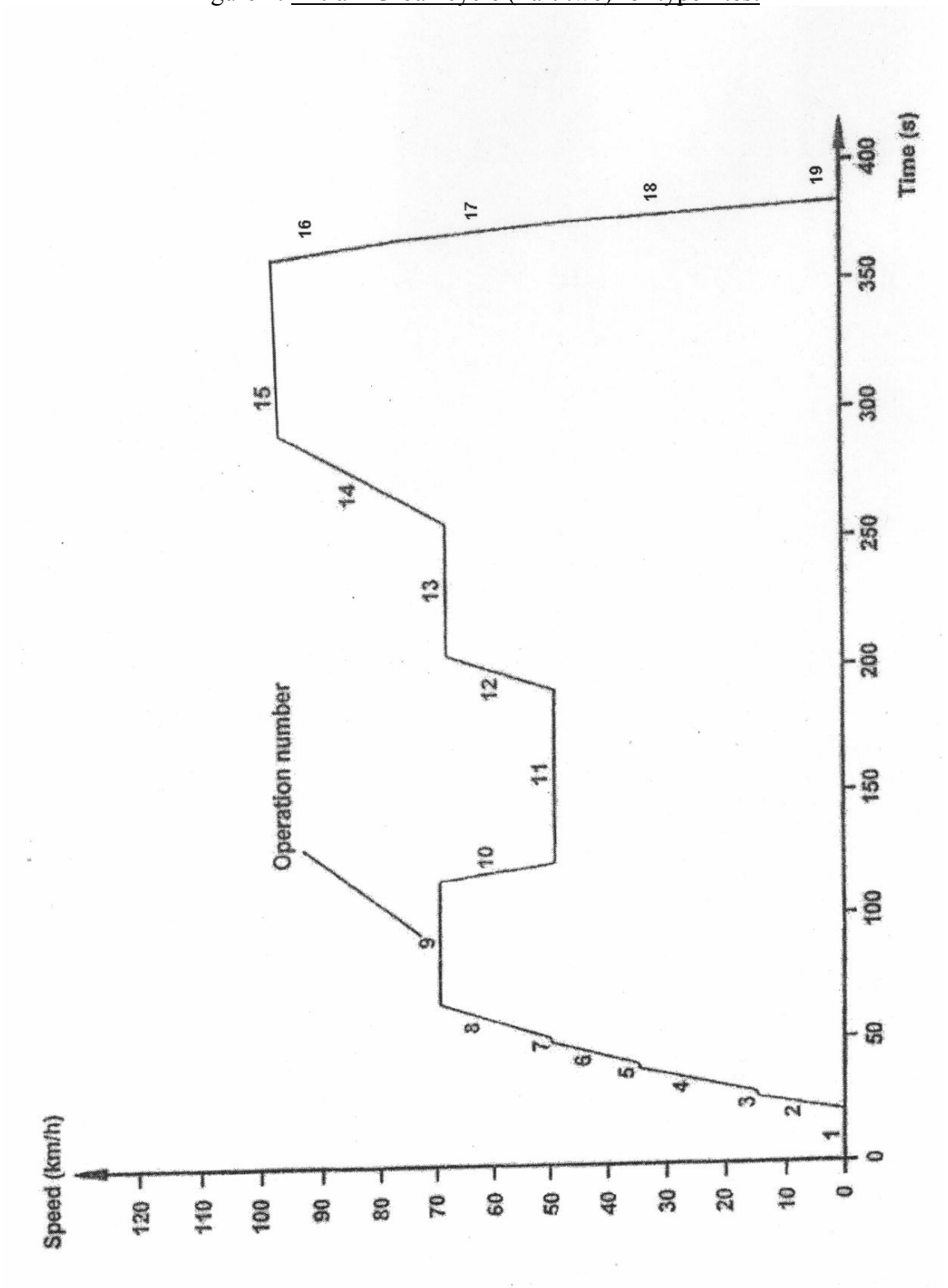

Figure 3: Operating Cycle for the type I Test

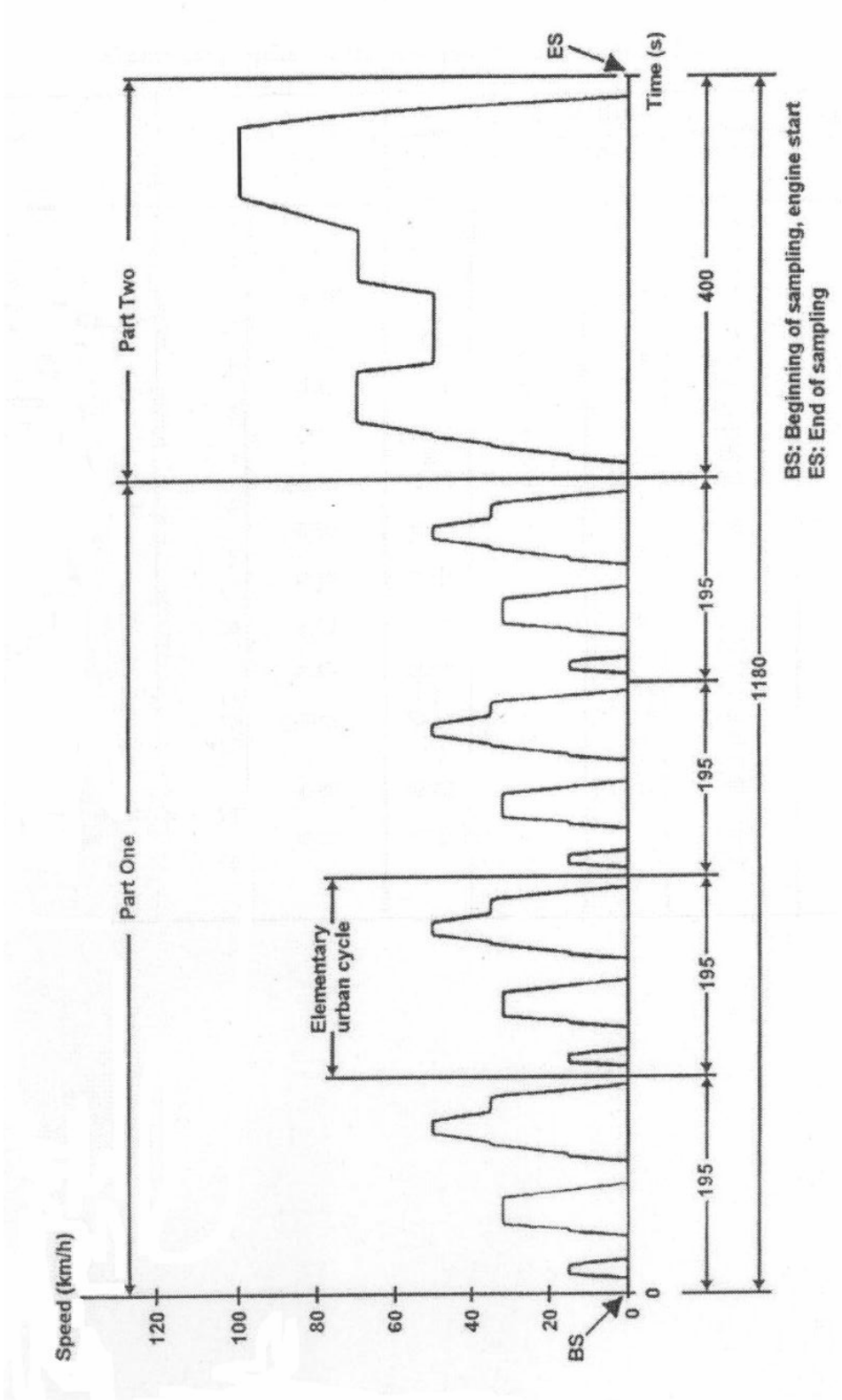

Table II: Modified Indian Driving Cycle Operating Cycle on the Chassis Dynamometer (Part One)

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

(*) [ ] - gearbox in neutral, clutch engaged
K_1 K_2 - first or second gear engaged , clutch disengaged

Table II A - Breakdown of the Part – One of Modified Indian Driving Cycle

(ELEMENTARY URBAN CYCLE)

Breakdown by phases

	Time (s)	**%**
Idling	60	30.8
Idling, Vehicle moving, clutch engaged on one combination	9	4.6 } 35.4
Gear Changing	8	4.1
Accelerations	36	18.5
Steady-speed periods	57	29.2
Decelerations	25	12.8
	195	**100**

Breakdown by use of gears

	Time (s)	**%**
Idling	60	30.8
Idling, Vehicle moving, clutch engaged on one combination	9	4.6 } 35.4
Gear Changing	8	4.1
First Gear	24	12.3
Second Gear	53	27.2
Third Gear	41	21
	195	**100**

General Information

Average speed during test	:	19 km/h
Effective running time	:	195 seconds
Theoretical distance covered per cycle	:	1.013 km
Equivalent distance for the four cycles	:	4.053 km

Table III: Modified Indian Driving Cycle Extra-urban cycle (Part Two) for the type I Test

No of Operation	Operation	Phase	Acceleration time ( )	Speed (km)	Duration of each		Cumulative ( )	Gear to be used in case of manual gearbox
					Operation	Phase		
1	Idling	1			20	20	20	K_1 (*)
2	Acceleration	2	0.83	0-15	5	41	25	1
3	Gear change				2		27	----
4	Acceleration		0.62	15-35	9		36	2
5	Gear change				2		38	----
6	Acceleration		0.52	35-50	8		46	3
7	Gear change				2		48	----
8	Acceleration		0.43	50-70	13		61	4
9	Steady Speed	3		70	50	50	111	5
10	Deceleration	4	-0.69	70-50	8	8	119	4 s 5 + 4 s 4
11	Steady Speed	5		50	69	69	188	4
12	Acceleration	6	0.43	50-70	13	13	201	4
13	Steady Speed	7		70	50	50	251	5
14	Acceleration	8	0.24	70-90	24	24	275	5
15	Steady Speed	9		90	83	83	358	5
16	Deceleration	10	-0.69	90-80	4	22	362	5
17	Deceleration		-1.04	80-50	8		370	5
18	Deceleration		-1.39	50-00	10		380	K_5 (*)
19	Idle	11			20	20	400	PM (*)

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

Table III A - Breakdown of the Part – Two of Modified Indian Driving Cycle

(EXTRA –URBAN CYCLE)

Breakdown by phases

	Time (s)	%
Idling	20	5.0
Idling, Vehicle moving, clutch engaged on one combination	20	5.0
Gear Changing	6	1.5
Accelerations	72	18.0
Steady-speed periods	252	63.0
Decelerations	30	7.5
	400	**100**

Breakdown by use of gears

	Time (s)	%
Idling	20	5.0
Idling, Vehicle moving, clutch engaged on one combination	20	5.0
Gear Changing	6	1.5
First Gear	5	1.3
Second Gear	9	2.2
Third Gear	8	2.0
Fourth Gear	99	24.8
Fifth Gear	233	58.2
	400	**100**

General Information

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