



COMMONWEALTH OF AUSTRALIA

AUSTRALIAN DESIGN RULE 27

FOR

VEHICLE ENGINE EMISSION CONTROL

As Endorsed by the

Australian Transport Advisory Council

The intention of this Australian Design Rule is to define the limits of engine emissions from motor vehicles in order to reduce air pollution.

The Australian Transport Advisory Council has recommended to Commonwealth, State and Territory Governments that all motor vehicles specified below shall comply with Australian Design Rule 27 - Vehicle Engine Emission Control.

VEHICLE CATEGORY	RULE AMENDMENT		
	MANUFACTURED ON OR AFTER		
	27		
Passenger Cars			
Forward Control Passenger Vehicles up to 8 seats	N/A		
9 seats	N/A		
Other Passenger Cars	1 Jan 1974		
Passenger Car Derivatives	N/A		
Multi-Purpose Passenger Cars	N/A		
Omnibuses up to 3.5 tonnes GVM			
up to 12 seats	N/A		
over 12 seats	N/A		
up to 4.5 tonnes GVM	N/A		
over 4.5 tonnes GVM	N/A		
Motorcycles	N/A		
Mopeds	N/A		
Specially Constructed Vehicles	N/A		
Other Vehicles not listed above			
up to 4.5 tonnes GVM	N/A		
over 4.5 tonnes GVM	N/A		

N/A - Not Applicable

GROSS VEHICLE MASS - Abbreviated to 'GVM'

The Australian Transport Advisory Council has also recommended to Commonwealth, State and Territory Governments that motor vehicles which comply with the requirements of ADR 27A, 27B, or 27C - Vehicle Emission Control need not comply with the requirements of ADR 27.

The Australian Transport Advisory Council has also recommended to Commonwealth, State and Territory Governments that motor vehicles manufactured after 1 July 1985 which comply with the requirements of ADR 37 need not comply with the requirements of ADR 27.

The Australian Transport Advisory Council has also recommended to Commonwealth, State and Territory Governments that the option available in ADR 27 - Vehicle Engine Emission Control, for motor vehicles which use unleaded petrol exclusively, shall only apply to motor vehicles manufactured on or after 1 July 1985.

Issued By: Department of Transport
PO Box 594
CIVIC SQUARE ACT 2608
AUSTRALIA

Issued: February 1984

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27.1 Implementation

27.1.1 Implementation of this Rule shall be by vehicle type approval in accordance with the specifications contained in this Rule.

(See footnote) *

27.1.2 Only vehicle types representing the basic combinations of engine, transmissions, rear axles and vehicle weights shall require certification.

27.2 Definitions

27.2.1 'Reference weight' - means the weight of the vehicle in running order, increased by a uniform figure of 120 kg. The weight of the vehicle in running order is its total unladen weight with all tanks except the fuel tank full, the fuel tank only half full, and the set of tools and the spare wheel on board.

27.2.2 'Engine crank-case' - means the spaces in or external to an engine which are connected to the oil sump by internal or external ducts through which gases and vapours can escape.

27.2.3 'Gaseous pollutants' - means carbon monoxide and hydrocarbons.

27.2.4 'Maximum weight' - means the technically permissible maximum weight declared by the vehicle manufacturer.

27.2.5 'Approval of a vehicle' - means the approval of a vehicle type with regard to the limitation of the emission of gaseous pollutants from the engine.

27.2.6 'Vehicle type' - means a category of power-driven vehicles which do not differ in such essential respects as:

the equivalent inertia determined in relation to the reference weight as prescribed in Clause 27.8.5 to this Rule, and the engine and vehicle characteristics as defined in Appendix 2 to this Rule.

FOOTNOTE

For information purposes and whilst not part of implementation procedures, vehicles from the production line, if tested in accordance with this Rule, may exceed the specified mass emission limits in Clause 27.3.3 by up to 20 percent for carbon monoxide and 30 percent for hydrocarbons.

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- 27.2.7 'Vehicle type approval' - means that a vehicle representative of the type to be approved shall be subject to tests. The specification of this vehicle and results of the tests shall form the basis of the certification.
- 27.2.8 'Basic Combination' means the combination of each unique engine, transmission and vehicle reference weight as described in Appendix 2 to this Rule, coupled with the manufacturer's recommended or major volume axle ratio. Optional axle ratios or other minor volume options such as airconditioning shall not be included in basic combinations.
- 27.2.9 'Unleaded Petrol' means petrol (or motor spirit) containing not more than 0.013 gram of lead per litre and not more than 0.0013 gram of phosphorus per litre.
- 27.2.10 'Unleaded Petrol-engined Vehicle' means a vehicle coming within the definition of this Rule and which has been designed, constructed and is recommended by the vehicle manufacturer to be operated using unleaded petrol exclusively.
- 27.2.11 'Other Vehicle' means a vehicle coming within the definition of this Rule, other than an unleaded petrol-engined vehicle (refer Definitions Clause 27.2.10). *
- 27.2.12 'Leaded Petrol' means petrol (or motor spirit) which is produced with the use of any lead additive or which contains more than 0.013 gram of lead per litre or more than 0.0013 gram of phosphorus per litre.
- 27.2.13 'Lead Additive' means any substance containing lead or lead compounds.
- 27.3 Requirements of Specifications and Tests *
- 27.3.1 General
- 27.3.1.1 The components liable to affect emissions shall be so designed, constructed and assembled as to enable the vehicle, in normal use, despite the vibration to which it may be subjected, to comply with the provisions of this Rule.
- 27.3.1.2 Every modification affecting emissions within the definition of this Rule shall require the vehicle to be re-certified. *
- 27.3.2 Requirements for Exhaust Gas Measurement
- The vehicle shall be subjected, according to its category, to tests of two types, 1 and 2, as specified below.

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- 27.3.3 Test 1 (measuring the average emission of pollutants in a congested urban area after a cold start). *
- 27.3.3.1 This test shall be carried out on all vehicle types referred to in Clause 27.1.1. The vehicle shall be placed on a dynamometer bench equipped with a brake and a fly wheel. A test lasting a total of 13 minutes and comprising 4 cycles shall be carried out without interruption. Each cycle shall comprise 15 phases (idling, acceleration, steady speed, deceleration, etc.). During the test the exhaust gases shall be collected in one or more bags. The gases shall be analysed and their volume measured at the end of the filling period.
- 27.3.3.2 The test shall be carried out by the procedure described in Clause 27.5 of this Rule. The methods used to collect and analyse the gases shall be those prescribed. Other methods may be approved if it is found that they yield equivalent results.
- 27.3.3.3 The mass of the carbon monoxide and the mass of the hydrocarbons obtained in the test shall be less, for a vehicle of given reference weight, than the amounts shown in the Table below:

Reference Weight (rw) kg	Mass of hydrocarbons (a) grams per test	Mass of carbon monoxide; grams per test
rw 750	8.0	100
750 rw 850	8.4	109
850 rw 1020	8.7	117
1020 rw 1250	9.4	134
1250 rw 1470	10.1	152
1470 rw 1700	10.8	169
1700 rw 1930	11.4	186
1930 rw 2150	12.1	203
2150 rw	12.8	220

(a) Determined as n-hexane equivalent

- 27.3.4 Test 2 (measuring carbon monoxide emissions at idle speed). *
- 27.3.4.1 This test shall be carried out on the vehicle types referred to in Clause 27.1.1.
- 27.3.4.2 The carbon monoxide content by volume of the exhaust gases with the engine idling must not exceed 4.5 percent.

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27.3.4.3 Conformity with the last preceding requirement shall be checked by a test carried out by the procedure described in Clause 27.12.

27.4.1 Requirements for fuel label

Every unleaded petrol-engined vehicle (refer Definitions Clause 27.2.10) shall have the words "UNLEADED PETROL ONLY" or "UNLEADED FUEL ONLY" on a durable label or by other durable means permanently affixed to the area immediately adjacent to the petrol filler inlet(s), on the door to the filler inlet compartment, or within 150 mm of the door to the filler inlet compartment, or on or within 150 mm of the filler inlet cap, readily visible to any person intending to refuel the vehicle. The lettering shall be legible and in capital letters no smaller than 6.0 mm high.

Alternative wording or location may be used, if approved.

27.4.2 Requirements for petrol filler inlet

The following requirements shall apply to every unleaded petrol-engined vehicle:

- (a) Unleaded petrol-engined vehicles (refer Definitions Clause 27.2.10) shall be equipped with a petrol tank filler inlet assembly which prevents the insertion of a * nozzle having a spout with an external diameter of 23.6 mm or greater (leaded petrol nozzle) and allows the insertion of a nozzle having a spout with an external diameter of 21.34 mm or less (unleaded petrol nozzle).

For details of nozzles, refer Appendix 4.

- (b) The design and construction of the filler inlet assembly shall be such that it is not possible for it to be readily altered to allow the insertion of a leaded petrol nozzle having a spout with an external diameter of 23.6 mm or greater, without causing such damage as would require its replacement or major repair to enable it to be restored to the design condition.
- (c) The filler inlet assembly shall be designed to pass not more than 700 ml of petrol into the tank when the introduction of petrol into such filler inlet assembly is attempted from a leaded petrol nozzle complying with the characteristics specified in Appendix 4.

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- (d) A test shall be conducted to establish compliance with Clause 27.4.2(c), using a test fixture which positions the filler inlet assembly in the same position as it is installed in the vehicle. For the purpose of this test, an attempted introduction shall be conducted by inserting a leaded petrol nozzle such that its automatic shutoff * vacuum port is at various depths within the filler inlet, except those locations which cause spillage (not including splash back) outside the filler inlet assembly shall not be used. The nozzle valve shall be fully and rapidly opened to a 30 ± 4 litres/minute flow setting.

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- 27.5 Description of Test 1 (measuring the average emission of pollutants in a congested urban area after a cold start). *
- 27.5.1 Description of the cycle
- The operating cycle on the dynamometer bench shall be that indicated in the following Table and Graph. The breakdown by operations is also given in the Table in Appendix 1.
- 27.5.2 Use of the gear box
- If the maximum speed which can be attained in the first gear is below 15 km/h the second, third and fourth gears shall be used.
- 27.5.3 Vehicles equipped with the semi-automatic-shift gear boxes shall be tested by using the gears normally employed for driving, and the gear shift shall be used in accordance with the manufacturer's instructions.
- 27.5.4 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. Furthermore, the gear change points shown in the foregoing graph shall not apply; acceleration shall 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 tolerances given below shall apply.
- 27.5.5 Vehicles equipped with an overdrive which the driver can actuate shall be tested with the overdrive out of action.
- 27.5.6 Tolerances
- A tolerance of one km/h above or below the theoretical speed shall be allowed 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 provisions of Clause 27.9.23 shall apply. Speed tolerances greater than those prescribed shall be accepted during phase change provided that the tolerances are never exceeded for more than 0.5 second on any one occasion.
- 27.5.7 Time tolerances of ± 0.5 second.

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OPERATING CYCLE ON THE DYNAMOMETER BENCH

27.5.1 (Cont'd)

Operation	Phase	Accel'n m/s ²	Speed km/h	Duration of each		Cumulative time sec.	Gear to be used in the case of a manual shift
				Operation	Phase		
1. Idling	1			11	11	11	6 sec. PM + 5 sec. K1 (#)
2. Acceleration	2	1.04	0-15	4	4	15	1
3. Steady speed	3		15	8	8	23	1
4. Deceleration		-0.69	15-10	2)		25	1
5. Deceleration, clutch disengaged	4)	5		
6. Idling	5	-0.92	10-0	3)		28	K1
7. Acceleration		0.83	0-15	21	21	49	16 sec. PM + 5 sec. K1
8. Shifting of gears	6			5)		54	1
9. Acceleration		0.94	15-32	2)	12	56	
10. Steady speed	7		32	5)	24	61	2
11. Deceleration		-0.75	32-10	24		85	2
12. Deceleration	8			8)	11	93	2
13. Idling		-0.92	10-0)		96	K2
14. Acceleration	9	0.83	0-15	3)		117	16 sec. PM + 5 sec. K1
15. Shifting of gears				21	21	122	1
16. Acceleration	10	0.62	15-35	5)		124	
17. Shifting of gears				2)	26	133	2
18. Acceleration		0.52	35-50	9)		135	
19. Steady speed	11		50	2)		143	3
20. Deceleration		-0.52	50-35	8)	12	155	3
21. Steady speed	12		35	12	8	163	3
22. Shifting of gears				8	13	176	3
23. Deceleration	13			13		178	2
24. Deceleration	14	-0.86	32-10	2)	12	185	
25. Idling		-0.92	10-0	7)		188	K2
	15			3)	7	195	7 sec. PM

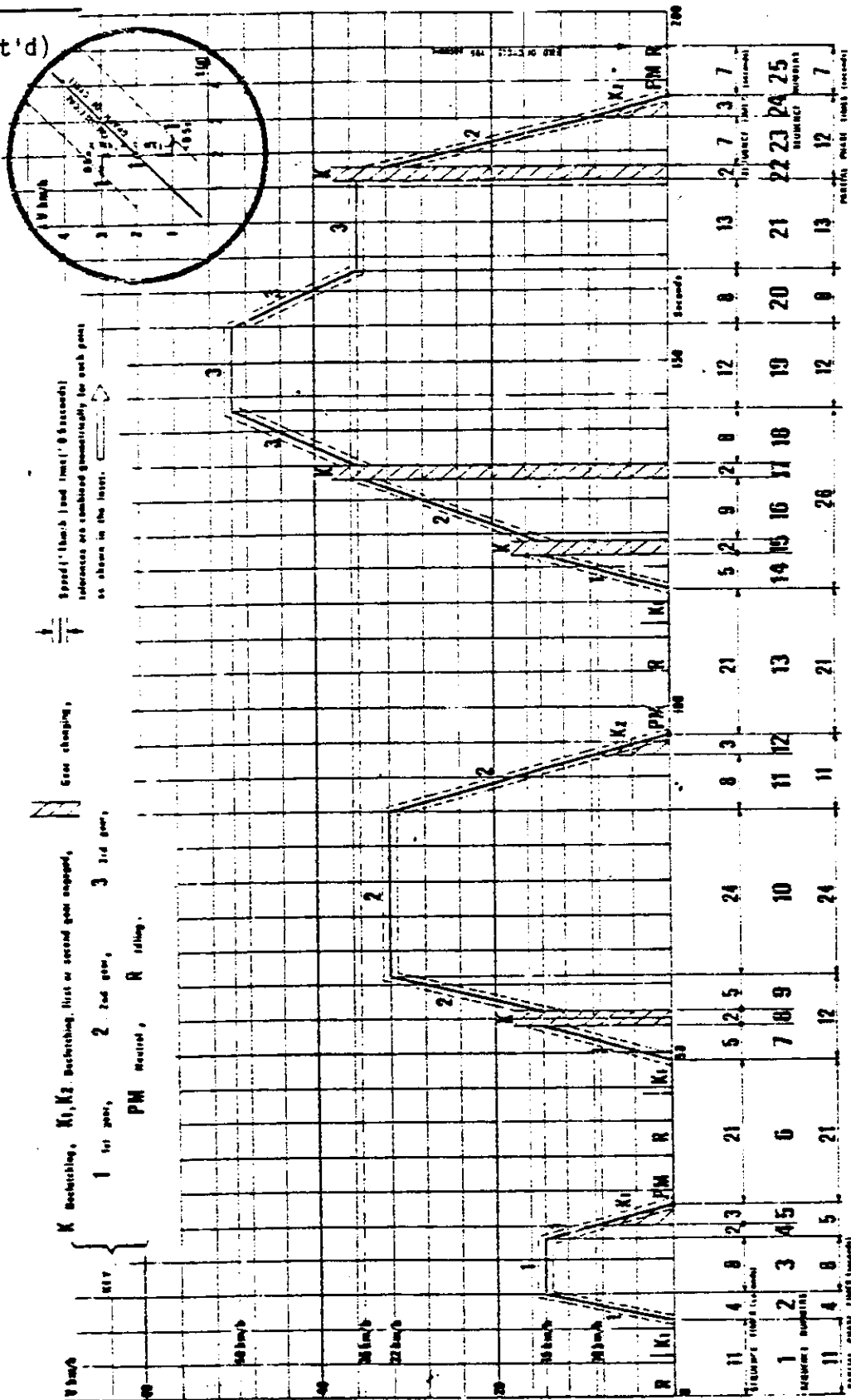
(#) PM = Gears in neutral, clutch engaged.
K1, K2 = First or second gear engaged, clutch disengaged.

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27.5.1 (Cont'd)

OPERATING CYCLE OF PETROL ENGINES FOR THE TYPE 1 TEST

Figure 1



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- 27.5.8 The above tolerances shall apply equally at the beginning and at the end of each gear changing period.

(It should be noted that the time of 2 seconds allowed includes the time for changing the combination and, if necessary, a certain amount of latitude to catch up with the cycle).

- 27.5.9 The speed and time tolerances shall be combined as indicated in the foregoing graph.

27.6 VEHICLE AND FUEL

27.6.1 Test vehicle

The vehicle shall be presented in good mechanical condition. It shall have been run in and have been driven at least 3 000 km before the test. The fuel used in distance accumulation shall be

- (a) for unleaded petrol-engined vehicles (refer Definitions clause 27.2.10) either unleaded test fuel whose specifications are given in clause 27.6.7.1 or unleaded petrol (refer Definitions clause 27.2.12) representative of commercial unleaded petrol; *
- (b) for other vehicles (refer Definitions clause 27.2.11) either leaded test fuel whose specifications are given in clause 27.6.7.2 or leaded petrol (refer Definitions clause 27.2.12) representative of commercial leaded petrol.

- 27.6.2 The exhaust device shall not exhibit any leak likely to reduce the quantity of gas collected, which quantity shall be that emerging from the engine.

- 27.6.3 The tightness of the induction system may be checked to ensure that carburation is not affected by an accidental intake of air.

- 27.6.4 The settings of the engine and of the vehicle's controls shall be of those prescribed by the manufacturer.

- 27.6.5 A vacuum gauge shall be installed in the intake circuit near the carburettor, beyond the throttle.

- 27.6.6 The laboratory may verify that the vehicle conforms to the performances stated by the manufacturer, that it can be used for normal driving, and more particularly that it is capable of starting when cold and when hot.

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27.6.7 Test Fuels

- 27.6.7.1 For unleaded petrol-engined vehicles (refer Definitions clause 27.2.10) unless otherwise approved the test fuel shall be the unleaded test fuel whose specifications are given in Appendix 5.
- 27.6.7.2 For other vehicles (refer Definitions clause 27.2.11), unless otherwise approved the test fuel shall be either of the leaded reference fuels whose specifications are given in Appendix 3. *
- 27.6.7.3 If the engine is lubricated by mixture, the oil added to the fuel shall comply as to grade and quantity with the manufacturer's recommendations.

27.7 Test Equipment27.7.1 Dynamometer brake

No particular model is prescribed. However, its adjustment shall not be affected by the lapse of time. It shall not produce any vibrations perceptible in the vehicle and likely to impair the latter's normal operation. It shall be equipped with an inertia adapter enabling the vehicle's operation on the road to be reproduced (equivalent inertias).

27.7.2 Gas-collection equipment

The connecting tubes shall be made of steel and shall, as far as possible, be provided with rigid connections. However, a completely gas-tight flexible ring element shall be used to isolate the device from the vehicle's vibrations. Other materials may be used if they do not affect the composition of the gases.

- 27.7.3 If the vehicle being tested is equipped with an exhaust pipe comprising several branches, the branches shall be connected as near as possible to the vehicle.
- 27.7.4 The temperature of the gases in the collecting system shall be compatible with correct operation of the engine; with maintenance of the sampling bags in good condition; with the hydrocarbon absorption level prescribed in Clause 27.8.10; and with reduction to a minimum of condensation on the sides of the sampling bag or bags.
- 27.7.5 The various valves used to direct the exhaust gases either to the atmosphere or to the sampling device shall be of a quick-adjustment, quick-acting type.

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- 27.7.6 The collecting device shall comprise one or more bags of adequate capacity. The bags shall be made of such materials as will not adversely affect either the accuracy of the measurements or the conservation of the gases.
- 27.7.7 Analytical equipment
- The sampling probe may consist of the sampling tube leading into the collecting device or of the bag-emptying tube. It may also be independent, but in no case shall its opening be at the bottom of the bag.
- 27.7.8 Analysers shall be of the non-dispersive type with absorption in the infra-red. The hydrocarbons analyser shall be sensitized for n-hexane or propane. The n-hexane equivalent of propane when used as the normalising gas for calibration non-dispersive infra-red analysers is prescribed to be 0.52 (Propane molar concentration \times 0.52 = n-hexane equivalent molar concentration).
- 27.7.9 Volume-measuring equipment
- A volumetric gauge shall be used.
- 27.7.10 Pressure and temperature measurements enabling the volume to be referred to standard conditions shall be carried out at points selected in the light of the type of gauge used. The laboratory shall specify their positions.
- 27.7.11 The gas-bleeding device may consist of a pump or of any other system which keeps the pressure measured at the gauge constant.
- 27.7.12 Accuracy of instruments
- As the brake is calibrated in a separate test, the accuracy of the dynamometer is not indicated. The total inertia of the rotating masses, including that of the rollers and the rotating part of the brake (see Clause 27.8.5) shall be given to within ± 20 kg.
- 27.7.13 The speed of the vehicle shall be measured by the speed of rotation of the rollers connected to the brake fly wheel. It shall be measurable to within ± 2 km/h in the speed range from 0 to 10 km/h and to within ± 1 km/h at speeds above 10 km/h.
- 27.7.14 The temperatures considered in Clauses 27.9.1 and 27.10.11 shall be measurable to within $\pm 2^{\circ}\text{C}$.
- 27.7.15 The atmospheric pressure shall be measurable to within ± 1 mm of mercury.

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- 27.7.16 The vacuum in the vehicle's intake manifold shall be measured to within ± 5 mm (mercury gauge) and the other pressures (back-pressure in the sampling device; pressure for correction of volume; etc.) to within ± 5 mm (water gauge).
- 27.7.17 The size and accuracy of the meter shall be appropriate to the volume of gas to be measured, so that the measurement of volume is accurate to within ± 2 percent.
- 27.7.18 The analysers shall have a measuring range compatible with the accuracy required to measure the content of the various constituents to within ± 3 percent, disregarding the accuracy of the standard (calibration) gases. The overall response time of the analysing circuit shall be less than one minute.
- 27.7.19 The content of the standard gases shall not differ by more than ± 2 percent from the reference value of each gas. The diluent shall be nitrogen.

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27.8 PREPARING THE TEST27.8.1 Setting of brake

The brake shall be so adjusted as to reproduce the operations of the vehicle on the level at a steady speed of 50 km/h.

27.8.2 For this purpose the vacuum shall be measured at the engine intake during a road test carried out at 50 km/h in third gear, or by using the gears specified in Clause 27.5.2, the vehicle being loaded to its reference weight and the tyre pressure being that indicated by the manufacturer. The vacuum shall be measured when a steady speed on the level has been maintained for at least 15 seconds. To take account of the influence of the wind, the average of the results of measurements made twice in each direction shall be taken.

27.8.3 The vehicle shall then be placed on the dynamometer bench and the brake so adjusted as to obtain the same vacuum at the intake as that recorded in the road test referred to in Clause 27.8.2 above. This brake setting shall be maintained throughout the test.

27.8.4 This setting is appropriate for brakes of hydraulic type. For other types it may be necessary to make sure that the setting so obtained is appropriate for other intermediate states between idling and the maximum speed in the cycle. If necessary, an intermediate setting shall be adopted.

27.8.5 Adjustment of equivalent inertias to the vehicle's translatory inertias

A fly wheel shall be used enabling a total inertia of the rotating masses to be obtained proportional to the reference weight within the following limits:

Reference weight of vehicle (rw) kg			Equivalent inertias kg
	rw	750	680
750	rw	850	800
850	rw	1020	910
1020	rw	1250	1130
1250	rw	1470	1360
1470	rw	1700	1590
1700	rw	1930	1810
1930	rw	2150	2040
2150	rw		2270

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27.8.6 Conditioning of vehicle

Before the test the vehicle shall be kept at a temperature between 20°C and 30°C for at least 6 hours. The cooling water and engine oil temperature shall be measured before the test to make sure that they are between 20°C and 30°C (68°F and 86°F).

27.8.7 The tyre pressure shall be the same as that indicated by the manufacturer for the preliminary road test for brake adjustment. However, if the diameter of the rollers is less than 500 mm, the pressure in the tyres shall be increased by 30 to 50 percent to prevent damage to them.

27.8.8 Check of back pressure

During the preliminary tests a check shall be made to ensure that the back pressure set up by the sampling device does not exceed 75 mm (water gauge), measurement being performed at the various steady speeds prescribed in the cycle.

27.8.9 Conditioning of bags

The bags shall be so conditioned, particularly with regard to hydrocarbons, that hydrocarbon losses over a period of 20 minutes do not exceed 2 percent of the initial content. This conditioning shall be carried out during preliminary tests conducted at temperatures close to the extreme temperatures encountered during the various tests.

27.8.10 Losses shall be measured as follows. When the engine is running at a constant r.p.m. speed the hydrocarbons content of the gases entering the bag shall be measured continuously until the bag has been filled. The content when filling is completed shall be the average of the contents recorded during filling. The bag shall be emptied by the analyser pumps and the content recorded continuously or at fixed intervals. If after 20 minutes the content has varied by more than 2 percent, the bag shall be emptied and then refilled for a second measurement. This cycle shall be repeated as many times as is necessary to saturate the walls.

27.8.11 Calibration of analytical apparatus

27.8.12 Calibration of analysers.

The quantity of gas at the indicated pressure compatible with the correct functioning of the equipment shall be injected into the analyser by means of the discharge gauge and the pressure reducing valve mounted on each gas cylinder.

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- 27.8.13 The apparatus shall be adjusted to indicate as a stabilised value, the value shown on the standard gas cylinder. Starting from the setting obtained with the maximum content cylinder the curve of the analyser's deviations shall be drawn as a function of the content of the various standard gas cylinders used. Standard gases containing carbon dioxide in addition to carbon monoxide in nitrogen may be employed provided that the instrumentation used to measure carbon monoxide concentration has a cross-response to carbon dioxide not exceeding 10 parts per million of carbon monoxide per one percent carbon dioxide. This cross-response may be determined by passing known mixtures of carbon dioxide and nitrogen through the instrumentation.
- 27.8.14 Overall response time of the apparatus.
- The gas from the maximum content cylinder shall be injected into the end of the sampling probe. A check shall be made to ensure that the indicated value corresponding to the maximum deviation is attained in less than one minute. If this value is not attained, the analysing circuit shall be inspected from end to end for leaks.
- 27.8.15 Adjustment of volume measuring device
- The bag shall be filled during the preliminary tests and a check made to ensure that the volume can be measured with the desired accuracy. If necessary, a suitable meter will be selected in each specific case.

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27.9 PROCEDURE FOR BENCH TESTS

- 27.9.1 The temperature in the room accommodating the roller bed shall be between 20°C and 30°C throughout the test and approximate as closely as possible that of the room in which the vehicle was conditioned for the test.
- 27.9.2 The vehicle shall be approximately horizontal during the test so as to avoid any abnormal distribution of the fuel.
- 27.9.3 The test shall be carried out with the bonnet raised. 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.
- 27.9.4 When the cycle is carried out the speed considered shall be that of the rollers connected to the brake fly wheel. During the test the speed shall be plotted against time so that the correctness of the cycles performed can be assessed.
- 27.9.5 Recording of the vacuum shall be optional; however if it is recorded at the same time as the speed it will be possible to judge whether the accelerations have been made correctly.
- 27.9.6 The temperature of the cooling water and of the crank-case oil may also be recorded if desired.
- 27.9.7 Starting up the engine
The engine shall be started up by means of the devices provided for this purpose, such as the choke, the starting valve, etc., according to the manufacturer's instructions.
- 27.9.8 The engine shall be kept idling on the choke for a period of 40 seconds.
- 27.9.9 The first cycle shall begin when the valve of the effluent recovery device is operated, which shall be done at the end of the aforesaid period of 40 seconds.
- 27.9.10 Use of the manual choke
The choke shall be cut out as soon as possible, and in principle before acceleration from zero to 50 km/h. If this principle cannot be abided by, the amount of effective cut-out shall be stated. The method used to adjust the choke shall be that indicated in the manufacturer's specifications.
- 27.9.11 Idling
Manual shift gear box.

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- 27.9.12 During period of idling the clutch shall be engaged and the gears in neutral.
- 27.9.13 To enable the accelerations to be performed according to the normal cycle the vehicle shall be placed in first gear, with the clutch disengaged, 5 seconds before the acceleration following the idling period considered.
- 27.9.14 The first idling period at the beginning of the cycle shall consist of 6 seconds of idling in neutral with the clutch engaged and 5 seconds in first gear with the clutch disengaged.
- 27.9.15 For the idling periods during each cycle the corresponding times shall be 16 seconds in neutral and 5 seconds in first gear with the clutch disengaged.
- 27.9.16 The idling period between two successive cycles shall comprise 13 seconds in neutral with the clutch engaged.
- 27.9.17 Semi-automatic-shift gear boxes.
- 27.9.18 Automatic-shift gear boxes.

The selector shall not be operated at any time during the test unless the manufacturer specifies otherwise. In the latter case the procedure for manual shift gear boxes shall be applied.

27.9.19 Accelerations

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

- 27.9.20 If 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 period.

27.9.21 Decelerations

All decelerations shall be affected by removing the foot completely from the accelerator, the clutch remaining engaged. The clutch shall be disengaged, without the use of the gear lever, at a speed of 10 km/h.

- 27.9.22 If the period of deceleration is longer than prescribed for the corresponding phase, the vehicle's brakes shall be used to enable the timing of the cycle to be abided by.
- 27.9.23 If the period of deceleration is shorter than that prescribed for the corresponding phase, the timing of the theoretical cycle shall be restored by an idling period merging into the following idling operation.

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- 27.9.24 At the end of the deceleration period (half of vehicle on the rollers) the gears shall be placed in neutral and the clutch engaged.
- 27.9.25 Steady speeds
'Pumping' or the closing of the throttle shall be avoided when passing from acceleration to the following steady speed.
- 27.9.26 Periods of constant speed shall be achieved by keeping the accelerator position fixed.

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27.10 PROCEDURE FOR SAMPLING AND ANALYSIS

- 27.10.1 Sampling shall begin as soon as the valve has been opened as indicated in Clause 27.9.9.
- 27.10.2 If several bags are used the bag shall be changed at the beginning of the first idling period of a cycle.
- 27.10.3 The bag shall be hermetically closed as soon as it is full.
- 27.10.4 At the end of the last cycle the valve shall be operated to divert the gases produced by the engine to the atmosphere.
- 27.10.5 Analysis
- The gases contained in each bag shall be analysed as soon as possible and in any event not later than 20 minutes after filling of the bag considered began.
- 27.10.6 If the sampling probe is not left permanently in the bag, the entry of air into the latter during insertion of the probe and the escape of gases from the bag during extraction of the probe shall be avoided.
- 27.10.7 The analyser shall be in a stabilised condition within one minute after the operation of placing it in communication with the bag.
- 27.10.8 The figure adopted as the content of the gases in each of the effluents measured shall be that read off after stabilisation of the measuring device.
- 27.10.9 Measurement of volume
- To avoid wide temperature variations, the volume of the bag or bags shall be measured as soon as the temperature has reached room temperature.
- 27.10.10 The bags shall be emptied through the gas gauge.
- 27.10.11 The temperature (t_m) used for calculations shall be the arithmetical mean of the temperatures at the beginning and at the end of emptying, the maximum permissible difference between these 2 temperatures being below 5°C.
- 27.10.12 The pressure (P_m) used for the calculations shall be the arithmetical mean of the absolute pressures recorded at the beginning and at the end of emptying; the maximum permissible difference between these two pressures being below 4 mm (mercury gauge).

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- 27.10.13 The volume of gas drawn off for analysis shall be added to the volume measured by the meter if the first mentioned volume is equivalent to more than one per cent of the said volume measured. The result obtained shall be designated by the symbol V_m .

27.11 Determination of the Quantity of Gaseous Pollutants Emitted

27.11.1 Correction of the measured volume

The volume of the gases contained in each bag shall be referred to normal temperature and pressure by means of the formula:

$$V = V_m \cdot \frac{273}{273 + t_m} \cdot \frac{P_m - P_H}{760}$$

where:

V_m is the volume measured expressed in litres, as indicated in Clause 27.10.13;

t_m is the arithmetical mean of the extreme temperatures recorded as indicated in Clause 27.10.11, expressed in degrees Celsius.

P_m is the arithmetical mean of the extreme absolute pressures recorded as indicated in Clause 27.10.12, expressed in millimetres (mercury gauge); and

P_H is the saturated water vapour pressure, expressed in millimetres (mercury gauge), at the temperature.

27.11.2 Mass of the gaseous pollutants contained in each bag

The mass of the gaseous pollutants contained in each bag shall be determined by the product of dCV, where C is the content by volume and d the volume mass of the gaseous pollutant considered:

in the case of carbon monoxide, $d = 1.250$

in the case of hydrocarbons, $d = 3.844$ hexane

27.11.3 Total mass of gaseous pollutants emitted

The mass M of each gaseous pollutant emitted by the vehicle during the test shall be determined by adding the masses of the gaseous pollutants contained in each bag and calculated as indicated in Clause 27.11.2.

NOTE : Laboratories are recommended to check the analyses by also measuring the quantity of carbon dioxide produced.

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APPENDIX 1 - Page 1 of 1

BREAKDOWN OF THE OPERATING CYCLE

	<u>Time</u>	<u>Percentage</u>	
(1) <u>Breakdown by Phases</u>			
Idling	60 sec.	30.8	} 35.4
Idling, vehicle moving, clutch engaged on one combination	9 sec.	4.6	
Gear Shift	8 sec.		4.1
Accelerations	36 sec.		18.5
Steady speed periods	57 sec.		29.2
Decelerations	25 sec.		12.8
	<u>195 sec.</u>		<u>100%</u>
(2) <u>Breakdown by use of gears</u>			
Idling	60 sec.	30.8	} 35.4
Idling, vehicle moving, clutch engaged in one combination	9 sec.	4.6	
Gear Shift	8 sec.		4.1
first gear	24 sec.		12.3
second gear	53 sec.		27.2
third gear	41 sec.		21
	<u>195 seconds</u>		<u>100%</u>
Average speed during test:	19 km/h		
Effective Running Time:	195 seconds		
Theoretical distance covered per cycle:	1.013 km		
Equivalent distance for the test (4 cycles):	4.052 km		

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APPENDIX 2 - Page 1 of 4

VEHICLE SPECIFICATIONS

The following specifications are required for certification purposes. (a)

Description of Engine

Make

Type

Cycle: four stroke/two stroke (b)

Number of Cylinders

Bore

Stroke

Cylinder capacity

Maximum cubic capacity of each combustion chamber
(rotary engines)

Number of rotors

Number of lobes per rotor

Compression ratio

System of cooling

Supercharge with/without (b) description of system

Device for recycling crank-case gases (description and
diagrams)

Catalytic converter characteristics

*

Thermal reactor characteristics

Air filters: drawings, or makes and types

Additional anti-pollution devices (if any, and not covered by another heading)

Description and diagrams

* Amended July 1983

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APPENDIX 2 - Page 2 of 4

Air intake and fuel feed

Description and diagrams of air intakes and their accessories (dashpot, heating device, additional air intakes, etc)

Fuel Feed
by carburettor(s) (b) (number)

Make

Type

Adjustments

Jets

Venturis

Float chamber level

Float needle

Choke: Manual/automatic b

(Curve of fuel
{ delivery plotted
{ against air flow (bc)

or

Closure setting (c)

Feed Pump

Pressure (c) or characteristic diagram
(c) by injector (b)

Pump

Make

Type

Deliverymm (c) per stroke at pump
speed of ... r.p.m.
(bc); or

characteristic diagram (bc)

Injector(s)

Make

Type

Calibration kPa

or characteristic diagram (bc)

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APPENDIX 2 - Page 3 of 4

Valve Timing

Maximum lift of valves and angles of opening and closing
in relation to dead centres

Reference and/or setting ranges (b)

Ignition

Distributor(s)

Make

Type

Ignition advance curve (c)

Ignition timing (c)

Contact point gap (c)

Exhaust system

Description and diagram

Additional information on test conditionsLubricant used

Make

Type

(State percentage of oil mixture if lubricant and fuel mixed)

Sparking plugs

Make

Type

Spark gap setting

Ignition coil

Make

Type

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Ignition condenser

Make

Type

Engine Performances

Idle speed r.p.m. (c)

Idling mixture adjustment

Engine speed at maximum power r.p.m. (c)

Maximum power kW (ISQ : BSI : CUNA : DIN : IGM : SAE, etc. (b))

Miscellaneous

Trade name or mark of the vehicle

Vehicle type

Manufacturer's name and address

If applicable name and address of manufacturer's representative

Reference weight of vehicle

Transmission: Manual/Automatic (b)

Number of gear ratios

Speed of vehicle for each gear ratio at engine speed of 1,000 r.p.m. (b)

(first)

(second)

(third)

Check of performances referred to in clause 27.6.6 of this Rule.

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FOOTNOTES

- a In the case of engines and systems differing from conventional engines and systems, particulars equivalent to those referred to here shall be supplied.
- b Strike out what does not apply.
- c Specify the tolerance.

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APPENDIX 3 - Page 1 of 2
SPECIFICATIONS OF LEADED REFERENCE FUEL

* I

<u>Property</u>	<u>Limits and Units</u>	<u>ASTM Test Method #</u>
Octane Number, Research	99 ± 1	D 908 -67
Specific gravity 15/40°C	0.742 ± 0.007	D 1298 -67
Antioxidant	min. 50 ppm	
Sulphur content	0.03 ± 0.015 percent by weight	D 1266 -64
Lead content	(0.57 ± 0.03) grams/litre	D 526 -66
Nature of scavenger	Motor Mix	
Nature of lead alkyl	Not specified	
<u>Distillation Range</u>		D 86 -67
Initial boiling point		
10 percent vol.	$50 \pm 50^\circ\text{C}$	
50 percent vol.	$100 \pm 100^\circ\text{C}$	
90 percent vol.	$160 \pm 100^\circ\text{C}$	
Final boiling point	$195 \pm 100^\circ\text{C}$	
- residue (percent vol.)	max. 2	
- loss "	max. 1	
<u>Hydrocarbon analysis</u>		D 1319 -66 T
- olefins	18 ± 4 percent by volume	
- aromatics	35 ± 5 percent by volume	
- saturates	Balance	
Oxidation stability	min. 480 minutes	D 525 -55
Existent gum	max. 4mg/100ml.	D 381 -64
Other additives	Nil	
<u>Reid Vapour Pressure</u>	(60 ± 4) kPa	D 323 -58

FOOTNOTE

Initials of the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103, U.S.A. The figures after the dash denote the year when a standard was adopted or revised.

Should any ASTM standards be amended, the standards adopted in the years quoted above will remain applicable until this Rule is amended.

* Amended July 1983

AUSTRALIAN DESIGN RULE NO. 27 - VEHICLE ENGINE EMISSION CONTROL

APPENDIX 3 - Page 2 of 2

Alternative Specification for Leaded Reference Fuel

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<u>PROPERTY</u>		<u>TEST METHOD</u>		<u>SPECIFICATION</u>
		<u>ASTM #</u>	<u>IP</u>	
Octane Number, Research	or	D 1656)		98 minimum
Lead (organic) gram/litre		D 2699)	237	
		D 526	96	0.82-0.84
Sulphur, weight per cent		D 1266	107	0.10 maximum
Phosphorus, theory				0.0
<u>Distillation Range (°C)</u>		D 86	123	
Initial Boiling Point				24- 35
10 percent point				49- 57
50 percent point				93-110
90 percent point				149-163
End Point				213 maximum
<u>Hydrocarbon Composition</u>		D 1319		
Olefins, percent				10 maximum
Aromatics, percent				35 maximum
Saturates				Remainder
<u>Reid Vapour Pressure (kPa)</u>		D 323	69	55.2-63.4

FOOTNOTE

Initials of the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania, 19103, U.S.A. The figures after the dash denote the year when a standard was adopted or revised.

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* Amended July 1983

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APPENDIX 4

PETROL NOZZLE CHARACTERISTICS

(This Appendix is to be read in conjunction with Clause 27.4.2 - Requirements for Petrol Filler Inlet).

Filler pipes and openings of motor vehicle fuel tanks may be as described in Society of Automotive Engineers, Incorporated "Recommended Practice" J1140, entitled "Filler Pipes and Openings of Fuel Tanks", to accommodate petrol dispenser nozzle spouts as described in Society of Automotive Engineers, Incorporated "Recommended Practice" J285a entitled "Gasoline Dispenser Nozzle Spouts".

Leaded Petrol Nozzle - a nozzle used for demonstrating compliance with paragraph 27.4.2 having a spout with an external diameter of 23.6 mm or more.

This leaded petrol nozzle shall have an automatic shut off vacuum port, the * centre of which shall be located within 22.1 mm of the tip of the terminal end.

This leaded petrol nozzle shall pass less than 120 ml of petrol when fully and rapidly activated with the automatic shutoff vacuum port plugged.

Unleaded Petrol Nozzle - a nozzle having:

- (i) a spout with an external diameter of 21.34 mm or less
- (ii) the terminal end of the spout shall have a straight section of at least 63 mm in length
- (iii) any retaining spring fitted to the nozzle shall terminate 76 mm from the terminal end.

* Amended July 1983

AUSTRALIAN DESIGN RULE NO. 27 - VEHICLE ENGINE EMISSION CONTROL

APPENDIX 5

UNLEADED TEST FUEL SPECIFICATIONS

(Refer Appendix 3 for SPECIFICATIONS OF LEADED REFERENCE FUEL)

<u>PROPERTY</u>	<u>ASTM TEST METHOD</u>	<u>SPECIFICATION</u>
Octane Number, Research	D 2699	91 min, 93 max
Octane Number, Motor	D 2700	82 min
Lead (Organic), gram/litre	D 3237	0.013 max
Sulphur, per cent by weight	D 1266 or D 2785	0.10 max
Phosphorus, gram/litre	D 3231	0.0013 max
<u>Distillation Range (°C):</u>	D 86	
Initial Boiling Point		24-35
10 percent Point		49-57
50 percent Point		93-110
90 percent Point		149-163
End Point		213 max
<u>Hydrocarbon Composition:</u>	D 1319	
Olefins, percent by volume		10 max
Aromatics, percent by volume		35 max
Saturates		remainder
<u>Reid Vapour Pressure (kPa):</u>	D 323 or D 2551	55.0 - 63.4 (8.0 - 9.2 psi)

* Amended July 1983