

Vehicle Standards Bulletin 14

**NATIONAL CODE OF PRACTICE
for
LIGHT VEHICLE CONSTRUCTION
and
MODIFICATION**

**SECTION LG
BRAKES**

VERSION 2.0 JANUARY 2011

Vehicle Standards Bulletin 14

National Code of Practice for Light Vehicle Construction and Modification (VSB 14)

Important Information for Users

Users of VSB 14 need to be aware that this document needs to be used in conjunction with the appropriate administrative requirements of the jurisdiction in which they wish to either register a vehicle or to obtain approval for a modification for an already registered vehicle. *Administrative requirements* include, amongst other things, processes for vehicle registration, obtaining exemptions, obtaining modification approvals, vehicle inspections, preparation and submission of reports and the payment of appropriate fees and charges.

If unsure of any of the requirements specified in VSB 14, or if more information is needed for any other issues concerning the administrative requirements, users should contact their relevant Registration Authority **prior** to commencing any work.

While VSB 14 provides advice on the construction of Individually Constructed Vehicles (ICVs) and the execution of modifications, it is not to be taken to be a design manual. Determination of component strength, performance, suitability and functionality must be either calculated or determined on a case by case basis by suitably qualified personnel experienced in each matter under consideration.

Users of VSB 14 also need to ensure that they refer to the most recent version of the relevant Section/s when working on a project. The version is identified by the version number and date on the face page of each Section. The version and date is also located in the footer of each page in each Section. On the website the version number is specified in the Section file name for easy identification.

If a project is taking a long time to complete, check the currency of the version you are using.

Users must be familiar with the provisions stated in the Preface and Introduction. These two Sections provide the necessary background information to assist users in understanding how VSB 14 is administered by Registration Authorities across Australia, on how it is structured, and the meaning of the types of modification codes specified in VSB 14. If not already done so, users should download them for study and reference.

Understanding these requirements is important to ensure that the correct processes are followed thereby reducing the likelihood of having work rejected by Registration Authorities.

Many of the Sections refer to other Sections within VSB 14 for further information or additional requirements. Users must read and apply all relevant Sections.

If in doubt about any issue concerning or contained in VSB 14, users should seek clarification from the appropriate State or Territory Registration Authority.

Please do not contact Vehicle Safety Standards (VSS) of the Australian Government Department of Infrastructure and Transport in Canberra about VSB 14. VSS provides the website as a service only.

Document Amendments by Version

Version

Version 2

Published 1 January 2011

Amendments

Sub-section 2 of Code LG1 and Table LG5 have been amended to include an alternative brake test that better represents the requirements of ADR 31/01.

This document has also a number of editorial amendments that have had no affect on its technical content.

CONTENTS

	Page
1 Scope	5
1.1 Modifications Not Requiring Certification	5
1.2 Modifications Requiring Certification Under LG Codes	5
2 General Requirements	5
2.1 Design	5
2.2 Braking Performance	6
2.3 Master Cylinder Substitution	7
2.4 Component Standards	8
2.5 Modification of Components	8
2.6 Fabrication	8
2.7 Installation	9
3 Australian Design Rules	10
4 Modifications without Certification	10
4.1 Optional Disc Brakes	10
4.2 Power Brakes	11
5 Certified Modifications (LG Codes)	11
LG1 Brake System Conversion (Design)	12
Checklist	18
LG2 Brake System Conversion	20
Checklist	22

1 SCOPE

Section LG provides for the minimum design, installation and fabrication requirements for light vehicle modifications involving braking systems.

This Section does not apply to ADR category L-group vehicles and motor cycles.

1.1 MODIFICATIONS NOT REQUIRING CERTIFICATION

The following modifications may be performed without certification:

- Fitting a manufacturer's optional braking system for the particular make/model; and
- Fitting of additional or substitute in-line brake boosters to pre-ADR 31/35 vehicles.

1.2 MODIFICATIONS REQUIRING CERTIFICATION UNDER LG CODES

The following modifications may be performed under LG Codes:

- Fitting disc or drum brakes that are not a manufacturer's option;
- Substituting brake master cylinders, wheel cylinders or calipers;
- Fitting or modifying brake balance and pressure limiting devices; and
- Relocating the brake pedal position for left hand or right hand drive.

The principal design installation and fabrication requirements for all of the above modifications are contained in sub-section 2 *General Requirements*.

2 GENERAL REQUIREMENTS

This sub-section applies to all light vehicles and must be read and applied in conjunction with all the LG Codes applicable to the proposed modifications.

Modified vehicles must continue to comply with the Australian Design Rules (ADRs) to which they were originally constructed, except as allowed for in the Australian Vehicle Standards Rules (AVSR). These modified vehicles must also comply with the applicable in-service requirements of the AVSR.

Modified pre-ADR vehicles must continue to comply with the AVSR.

Compliance with the AVSR also means compliance with the equivalent regulations of a State or Territory of Australia.

2.1 DESIGN

It is recommended that braking modifications be carried out using production components which themselves do not require modification.

The size and performance of the brake equipment must be suitably matched to the vehicle's weight and performance. The specifications of similar production vehicles can be used as a

basis for comparison with the brake system of a modified vehicle. Such comparisons should include the following:

- Construction and dimensions of brakes; if disc, whether solid or vented, effective diameter, caliper piston area, pad area, or if drum, diameter, brake shoe width, brake lining area, slave cylinder piston area etc.; and
- Comparisons of vehicle weights and performance capabilities, e.g. - power to weight ratio.

The aim of all brake system *up-grades* in early model passenger vehicles should be to at least meet the deceleration and brake fade standards specified in ADR 31, particularly if an engine modification results in increased vehicle performance.

When the brake system of an early model vehicle is modified, a dual or split circuit brake system should be fitted. Disc brakes are highly recommended on the front and generally should be power assisted.

2.2 BRAKING PERFORMANCE

The brake system selected must provide the correct balance between front and rear. Proportioning valves such as the *Holden* unit or some after-market valves can be used to correct a small imbalance. Load sensing proportioning valves should be fitted at the rear on utilities and light commercial vehicles. The brake balance between wheels must not result in premature lock-up of front or rear wheels under braking (in particular, premature lock-up of the rear wheels must be avoided).

A comfortable and easily accessible range of positions of the brake pedal from the *off* position to the fully depressed position (i.e. normal working travel) must be provided. Foot clearance around the brake pedal comparable with similar contemporary vehicles must also be provided.

For highly modified engines (e.g. high lift camshafts) which require a more open throttle position to maintain idle speed, it is recommended that a vacuum pump or vacuum reserve tank be fitted together with a vacuum check valve to assist in maintaining the required low pressure in the brake booster.

Any alteration to a vehicle must not result in a reduction of service or emergency brake performance and must not impair the correct functioning of the secondary braking system and the original equipment failure warning systems.

2.2.1 Drum or Disc Brake Substitution

The following sub-section applies where the original drum or disc brakes are replaced or substituted with non-original components.

2.2.2 Steering Knuckles/Uprights/Struts

Steering knuckles, suspension uprights or McPherson struts with integral stub axles must not be modified to enable the fitting of hubs, disc rotors or caliper brackets.

2.2.3 Caliper Brackets

Caliper brackets must be designed to take into account all of the forces that occur during braking, including the bending stresses resulting from the offset between the centreline of the disc and the plane of the caliper bracket.

Existing caliper bracket mounting holes must not be modified.

Caliper brackets must be mounted using all of the original disc brake caliper bracket mounting points or at least three of the original drum brake backing plate mounting points.

Tapped holes must have a depth at least equal to the diameter of the screw thread.

2.2.4 Wheel Rim Stud/Bolt Pattern

The number and size of fasteners, their pitch circle diameter and any nut/bolt taper angles must be the same for the attachment of all wheels on an axle. The wheel stud or bolt threads may be opposite handed on opposite ends of an axle. Where the rim attachment detail is different between axles, the design must prevent wheels from one axle being incorrectly fitted to the other axle.

2.2.5 Wheel Track

Brake conversions must not cause front or rear suspension track changes beyond specified limits. The allowable track change (if any) is outlined in Section LS *Tyres, Rims, Suspension and Steering*.

2.3 MASTER CYLINDER SUBSTITUTION

Master cylinders must be sized to provide the correct braking effect to the front and rear wheels without excessive pedal travel.

If other components of the braking system are modified, the replacement master cylinder must be selected to ensure continued compliance with the requirements of the applicable ADR, including reservoir capacity and minimum pedal effort.

2.3.1 Piston Diameter

If all other components in the braking system are unmodified, a replacement master cylinder must have a piston diameter as near as possible to that of the original master cylinder.

2.3.2 Stroke

If all other components in the braking system are unmodified, a replacement master cylinder must have an effective stroke that enables an equivalent displacement of fluid in one stroke to that of the original master cylinder.

If all other components in the braking system are unmodified, a replacement master cylinder must have a stroke that gives full travel of the master cylinder piston(s) on full application of the brake pedal.

2.3.3 Reservoir Capacity

Master cylinder reservoirs must have sufficient capacity, adequate for the total displacement volume of all wheel (slave) cylinders and calipers. Total displacement volume includes the volume of brake fluid necessary to accommodate the variation in volume from new to fully worn brake pads or shoes.

2.3.4 Mounting

The firewall/master cylinder mounting must be adequately reinforced to achieve adequate mounting stiffness whenever replacement master cylinder/boosters are fitted. The strength of

the mounting and of the brake pedal mechanism must be capable of withstanding a load of 1800 N applied to the brake pedal.

2.3.5 Pedals

If a brake pedal is modified, the strength and detail of any welding must be checked to ensure that the pedal can withstand the maximum forces applied to the pedal.

2.4 COMPONENT STANDARDS

All components and devices in the *Brake System* must meet or exceed at least one appropriate recognised international, national or association standard, where such standards exist, or the relevant parts thereof. (*Recognised* can be taken as meaning AS, SAA, SAE, BS, JIS, ISO or DIN standards).

Hydraulic pipes must be made from steel Bundy tube complying with SAE J1047 or equivalent.

All hydraulic pipes must be double flared in accordance with SAE J5336 or equivalent and appropriate flare connections must be used.

Hydraulic pipes must not be welded, brazed or silver soldered.

Hydraulic brake hoses must comply with SAE J1401 or equivalent. Flexible hoses complying with ADR 7/... or ADR 42/ 04, including braided brake hoses, are also acceptable.

2.5 MODIFICATION OF COMPONENTS

Where modification of components cannot be avoided, the following guidelines must be followed:

- Stub axles must not be machined to reduce the diameter of the spindle in order to fit the bearings of a replacement disc rotor. Rather, the disc rotor should be machined to accept suitable bearings providing such machining does not reduce the strength of the disc rotor;
- Brake components, adaptors or brackets to steering knuckles, suspension uprights or struts must not be welded. These components must be attached using suitable fasteners together with appropriate adapters where necessary. Such modifications must not affect the structural integrity of the original components;
- Brake drums and disc rotors must not be machined beyond the limits recommended by the manufacturer for that application; and
- The re-drilling of drums or rotors to suit different stud patterns must not be undertaken unless in accordance with the manufacturers' specifications.

2.6 FABRICATION

All work must be performed in accordance with recognised engineering standards. Cutting, heating, welding or bending of components should be avoided by choosing unmodified production components wherever possible.

2.6.1 Welding, Fasteners and Electroplating

Mandatory requirements and guidance on the above items are contained in Section LZ *Appendices*.

- For the use of fasteners refer to Appendix A *Fasteners*;
- For welding techniques and procedures refer to Appendix C *Heating and Welding of Steering Components*; and
- For electroplating refer to Appendix D *Electroplating*.

2.7 INSTALLATION

2.7.1 Clearance

All brake components must clear other vehicle components such as wheels, suspension members and chassis members over the full range of steering and suspension travel. It is recommended that a clearance of at least 10mm be provided at all such locations.

2.7.2 Protection

Hydraulic brake pipes, hoses and cables must be mounted in protected areas where they are not likely to be struck or snagged by objects thrown up from the road or onto other vehicle components. They must be protected from excessive heat and abrasion.

Hoses and pipes must be adequately supported. They must allow the full range of suspension and steering travel without being stretched or bent through a tight radius.

Brake hoses must not touch wheels or tyres and must not be located such that they are likely to be snagged by adjacent suspension or steering components. Brake hoses must be sufficiently clear of and/or shielded from hot exhaust components.

The vacuum pipe between the brake booster and engine must be routed to allow for engine movement and must be securely fastened at each end.

Power brake boosters must be securely mounted and where fitted under the floor must be adequately protected from road debris by a shield or chassis cross member.

Caliper pistons must be fitted with dust seals.

2.7.3 Parkbrake/Handbrake

Parkbrake/handbrake cables must not rub on the drive shaft under any condition of vehicle suspension movement.

Parkbrake/handbrake lever assemblies must not be mounted on un-reinforced wooden or particleboard floors.

In the applied position, retention of the parkbrake system must be by mechanical means.

2.7.4 Hydraulic Pipes

Copper tubing must not be used for hydraulic brakes.

Hydraulic brake pipes must not be joined by brazing or silver soldering. They must be joined by appropriate flaring of the tube and associated fittings.

Threaded bosses used for braking component mounting must have full depth thread engagement of at least the bolt diameter.

2.7.5 Sealed Openings

Any opening in the firewall (e.g. due to brake booster/master cylinder modifications) must be sealed to prevent entry of engine fumes into the vehicle cabin.

3 AUSTRALIAN DESIGN RULES

A modified vehicle must continue to comply with the ADRs to which it was originally constructed, except as allowed for in the AVSR.

Outlined in Table LG1 below are requirements and/or components of the vehicle that may be affected by the modifications and that may require re-certification, testing and/or data to show continuing compliance for the modified vehicle. This is not an exhaustive list and other modifications may also affect ADR compliance.

For example, certain brake modifications can affect compliance with other ADRs such as tyre and rim selection.

Table LG1 Summary of items that if modified, may detrimentally affect compliance with applicable ADRs

ADRS	DETAILS
7, 7/..., 42/...	Brake Hoses
13/...	Installation of lighting and light signalling devices (brake lights)
24x, 24/...	Tyre and Rim Selection (speed rating)
31, 31/...	Hydraulic brake systems for passenger cars
35x, 35/...	Commercial vehicle brake systems

The applicable ADRs are individually listed on the Identification (Compliance) Plate of Second Edition ADR vehicles. For Third Edition ADR vehicles, the Identification Plate contains the vehicle category and the date of manufacture, from which the applicable ADRs can be determined (refer to the applicability tables in Section LO *Vehicle Standards Compliance*).

Alternatively, ADR applicability tables for individual vehicle categories may be referenced on the Department of Infrastructure and Transport RVCS website at the following address and under the section titled ADR *Applicability Tables*:

<http://rvcs.dotars.gov.au/>

4 MODIFICATIONS WITHOUT CERTIFICATION

The following modifications may be carried out without certification under an LG Code, provided that the vehicle continues to comply with relevant ADRs and AVSRs and provided that the vehicle meets the following general safety requirements.

4.1 OPTIONAL DISC BRAKES

Drum brakes may be replaced with a disc brake system where the replacement system was originally available as an option for the vehicle model, provided that:

- all associated equipment that was part of the manufacturer's disc brake *package* (which may include a different master cylinder, different rear wheel cylinders and proportioning valve) is fitted;
- the installation is in accordance with the manufacturer's specifications;
- all components used are unmodified;
- the wheel track is not reduced; and
- the wheel track is not increased by more than 25mm (For for four wheel drive vehicles see Section LS *Tyres, Rims, Suspension and Steering*).

4.2 POWER BRAKES

Additional or substitute in-line brake boosters to pre-ADR 31 and pre-ADR 35 vehicles may be used provided that they are installed in accordance with the requirements of the manufacturer of the replacement brake booster.

Power brake installations in ADR 31 and ADR 35 vehicles require certification under LG Codes.

5 CERTIFIED MODIFICATIONS (LG CODES)

This section specifies particular requirements and covers limitations on modifications that can be carried out under individual LG Codes.

Each Code is supplemented with a checklist (refer to Table LG2).

Table LG2 LG Code Directory

LG Codes		Page
LG1	Brake System Conversion (Design)	12
	Checklist	18
LG2	Brake System Conversion	20
	Checklist	22

BRAKE SYSTEM CONVERSION (DESIGN)

CODE LG1

SCOPE

This code covers the design of brake assembly substitutions, the fitting of balance or pressure limiting devices and for transferring brake pedals from one side of a vehicle to the other.

Code LG1 does not apply to ADR category L-group vehicles and motor cycles.

MODIFICATIONS COVERED BY CODE LG1

The following is a summary of the designs that are covered by Code LG1:

- Fitting substitute disc brake or drum brake assemblies;
- Fitting substitute brake master cylinders;
- Fitting substitute or additional brake boosters;
- Fitting brake balance or pressure limiting devices; and
- Transferring the position of the brake pedal for left hand or right hand drive.

MODIFICATIONS NOT COVERED BY CODE LG1

The following designs are not covered by Code LG1:

- The actual physical modification of the vehicle (this is covered by Code LG2); and
- Design of suspension modifications including substitute suspension uprights, struts and axles (this is covered by Codes LS3 and LS5).

COMPLIANCE WITH APPLICABLE VEHICLE STANDARDS

Modified vehicles must continue to comply with the ADRs to which they were originally constructed, except as allowed for in the AVSR. These modified vehicles must also comply with the applicable in-service requirements of the AVSR.

Modified pre-ADR vehicles must continue to comply with the AVSR.

Compliance with the AVSR also means compliance with the equivalent regulations of a State or Territory of Australia.

Outlined below in Table LG3 are areas of the vehicle that may be affected by the modifications and that may require re-certification, testing and/or data to show compliance for the modified vehicle. This is not an exhaustive list and other modifications may also affect ADR compliance.

Table LG3 Summary of items that if modified, may detrimentally affect compliance with applicable ADRs

DETAIL	REQUIREMENTS
Brake Hoses	ADR 7, 42/...
Brake Lights	ADR 13/..., 60/...
Hydraulic Brake Systems	ADR 31, 31/..., 35x, 35/...
Brake Performance	Regulations

To determine the ADRs that apply to the vehicle in question, refer to the applicability tables in Section LO. Vehicles manufactured on or after 1 January 1969 and prior to 1 July 1988 need to comply with the Second Edition ADRs whilst vehicles manufactured after this date need to comply with the Third Edition ADRs. Section LO has separate applicability tables for each edition.

The ADRs apply according to the vehicle's category and date of manufacture. It is the responsibility of the signatory to refer to the appropriate ADR applicable to the vehicle

Alternatively, ADR applicability tables for individual vehicle categories may be referenced on the Department of Infrastructure and Transport RVCS website at the following address and under the section titled *ADR Applicability Tables*:

<http://rvcs.dotars.gov.au/>

SPECIFIC REQUIREMENTS

The following are specific requirements to enable design approvals to be issued for brake system conversions under Code LG1.

The designs must also comply with the general guidelines contained in sub-section 2 *General Requirements*.

The completed vehicle must be evaluated under a range of operating conditions to establish that braking performance progresses appropriately with the application of pedal force. Tests should examine the ability of the vehicle to meet the requirements of the relevant Regulations and applicable ADRs.

1 COMPLIANCE OF PRE-ADR (POST 1930) VEHICLES

Tests should be conducted on fully laden vehicles and they should meet the following stopping distances and decelerations outlined in Table LG4. The tests and performance levels specified in Table LG4 are contained in the AVSR.

The tests should be conducted on a smooth dry level road surface free from loose material.

The vehicle must not move outside a 3.7 metre wide straight path centred on the longitudinal axis of the vehicle when the brakes are initially applied.

Table LG4 Minimum Braking Performance Requirements for Pre ADR Vehicles

Brake Type	Gross Vehicle Mass (GVM)	Stopping Distance from 35 km/hr has to be within	Min. Average Deceleration from any speed	Min. Peak Deceleration from any speed
Service Brakes	Under 2.5 tonnes GVM	12.5 metres	3.8 m/sec/sec	5.8 m/sec/sec
	2.5 tonnes GVM and over	16.5 metres	2.8 m/sec/sec	4.4 m/sec/sec
Emergency Brakes	Under 2.5 tonnes GVM	30 metres	1.6 m/sec/sec	1.9 m/sec/sec
	2.5 tonnes GVM and over	40.5 metres	1.1 m/sec/sec	1.5 m/sec/sec

The service brakes and emergency brakes must be capable of stopping the vehicle with one sustained application from a speed of 35 km/hr in no more than the respective distances listed in Table LG4.

The service brakes and emergency brakes must also be capable of stopping the vehicle with one sustained application from any speed at which the vehicle can travel, at no more than the respective average and peak deceleration rates listed in Table LG4.

The parking brake must be capable of holding the vehicle on a 12% gradient.

2 COMPLIANCE OF ADR VEHICLES

Vehicles originally manufactured to comply with ADR requirements must continue to comply with those requirements.

2.1 Simplified ADR Test Procedure

A simplified brake test procedure has been developed for demonstrating compliance with the brake performance requirements of ADR 31/01 to enable the certification of the brake system and brake modifications under Code LG1. This test procedure (refer Table LG5) may be used as an alternative, to demonstrate compliance with Parts 1 & 2 of Annex 3 to Appendix A of ADR 31/01 and does not exempt the vehicle from any other requirements of the design rule.

The simplified test is only intended for MA, MB or MC ADR category motor vehicles that are equipped with an internal combustion or electric engine and that are either an:

- (a) ICV; or
- (b) a production motor vehicle that has undergone major modifications that have a serious affect on its braking system performance, such as changes to suspension and/or engine.

2.1.1 Definitions

For the purposes of this Section the following definitions apply:

Laden Mass - the mass of the vehicle when loaded to its manufacturer's maximum mass.

Note: This mass may include that of the driver and of one extra person (if it is necessary for that extra person to be on board to record test results).

Unladen Mass - the mass of the vehicle unladen except for the driver and with all standard equipment fitted and all fluid reservoirs filled to nominal capacity including fuel.

Note: The included mass of one extra person shall be ignored for testing purposes, if it is necessary for that person to be on board to record test results.

Engine Disconnected - an engine that is running with the transmission in neutral.

Engine Connected - an engine that is running with the transmission in gear.

Cold Test - Tests in which the brake components are at any temperature between 65°C and 100°C.

Hot Test - Tests in which the brake components are at a temperature greater than 100°C.

2.1.2 Test Conditions

The following test conditions apply:

- All tests must be conducted on a dry and level road which has a sealed surface or which has another surface affording good adhesion, i.e. with a coefficient of friction of 0.8 or higher for a dry surface;
- All tests, other than the parkbrake test, must successfully bring the vehicle to a standstill;
- The tyres must be cold (i.e. at ambient temperature) and inflated to the recommended pressure required for the vehicle to operate safely at its design load/speed;
- Unless otherwise specified, the vehicle must be at its *Laden Mass* for each test and the even distribution of its mass among the axles shall be as specified by the vehicle's manufacturer;
- The vehicle's transmission must be disconnected for each test unless otherwise specified;
- In braking tests, particularly those at high speed, the general behaviour of the vehicle during braking must be checked and unless otherwise specified each test result must be obtained without abnormal vibrations and without the vehicle:
 - locking its wheels at speeds exceeding 15km/h;
 - deviating from a 3.5m wide lane; and
 - exceeding a yaw angle of 15 degrees;

- If the maximum design speed of the vehicle is lower than the speed prescribed for a particular test, the test must be performed at the vehicle's maximum speed;
- No adjustments must be made to the braking system and no braking system components may be replaced after the commencement of the tests other than those permitted by the ADR; and
- The test sequences and conditions as specified in Table LG5 apply.

2.1.3 Explanatory Notes for Table LG5

The following details apply to the tests detailed in Table LG5:

- Two tests are required for test 8, *Parking Brake*. One with the test vehicle facing downwards and the other with the test vehicle facing in the opposite direction. During the tests the longitudinal axis of the test vehicle must be positioned in line with the 20 degree slope of the test surface;
- *Minimum average deceleration* is the average deceleration achieved between $0.8V_o$ and $0.1V_o$, where V_o is the initial test speed, refer column 4 of Table LG5;
- V_{max} is the maximum speed of the vehicle;
- For all vehicles, other than certain ICVs, test speed is either 100 km/h or $0.8 V_{max}$, whichever is the greater. The maximum test speed is limited to 160 km/h for all vehicles including those vehicles that have a V_{max} in excess of 160 km/h. This is described in the Table LG5 as *Test Speed = 80% $V_{max} \leq 160$; and*
- For tests 2, 4 and 5 ICVs may be tested at 100 km/hr if the mass of the vehicle to be tested is less than the mass of the vehicle from which its brake system was sourced (e.g. Clubman type vehicles).

Table LG5 Test Sequence and Conditions for ADR 31/01 Abridged Brake Test

Tests and Procedures		Test Speed V_i (km/h)	Max. Pedal Effort (N)	Minimum Average Decel. (m/s ²)	Stopping Dist. (m)
Check pedal/mountings – apply 1kN pedal force – there must be no damage or permanent deformation to the pedal system.					
Pre-condition brakes & check instrumentation		100	670	N/A	N/A
For mechanically operated brake proportioning valves, disconnect valve linkage to verify operation.					
	Check Brake Proportioning Valve operation if applicable	100	500	3.86	≤ 110
	Repeat this check with vehicle at Unladen Mass if applicable	100	500	3.86	≤ 110
Immediately thereafter, reconnect linkage to brake proportioning valve.					
Allow brake components to cool to ambient temperature (i.e. between 65°C and 100°C) for each run.					
1	1 st Cold test – service brakes	100	500	6.43	≤ 70
2	2 nd Cold test – service brakes, engine connected *	100 or 80% V_{max} ≤ 160	500	5.76 or peak 7.76	≤ 188
3	Repeat 1 st Cold test with vehicle at Unladen Mass	100	500	6.43 or peak 8.43	≤ 70
4	Repeat 2 nd Cold test with vehicle at Unladen Mass *	100 or 80% V_{max} ≤ 160	500	5.76 or peak 7.76	≤ 188
To establish required pedal force F for fade tests - slow vehicle from 120km/h to 60km/h & record average pedal force F- then adapt that force F to attain a mean deceleration rate of 3.00m/s ² for each test.					
5	15 fade test runs @ max 45 second intervals – slowing vehicle from 100 km/h to 0 km/h or to 50% of test speed if the higher test speed is used *	100 or 80% V_{max} ≤ 120	F	3.00	
6	1 st Hot test – service brakes	100	500	4.82	≤ 90
Recovery Procedure - undertake 4 Recovery runs operating vehicle at 50km/h, stopping every 1.5 km using a deceleration rate not exceeding 3.00 m/s ² .					
7	1 st Recovery test – service brakes	100	500	4.5 or peak 9.6	50 - 105
8	Parking Brake * Note: If a hand control is used to apply the park brake, the application effort must not exceed 400N.	Stationary	500	Hold vehicle stationary on 20% gradient - up & down	

* Refer to sub-section 2.1.3 for additional information.

CHECKLIST LG1
BRAKE SYSTEM CONVERSION (DESIGN)
CODE LG1

(N/A=Not Applicable, Y=Yes, N=No)

1	COMPONENTS			
1.1	Are all components and equipment in the brake system specified to comply with relevant Standards outlined in sub-section 2 <i>General Requirements</i> ?		Y	N
2	CALIPER BRACKETS			
2.1	Have the caliper brackets and mountings been designed to adequately cope with the forces generated during severe braking?	N/A	Y	N
3	MASTER CYLINDER			
3.1	Has the master cylinder and its mounting been correctly selected and specified?	N/A	Y	N
4	WORKMANSHIP			
4.1	Has all work, that has been specified in the certification of the LG1 brake system conversion, been determined in accordance with recognised engineering standards and the relevant Appendices of Section LZ <i>Appendices</i> ?		Y	N
5	COMPLIANCE WITH ADRS			
5.1	Does the design ensure the completed vehicle will continue to comply with the applicable ADRs?	N/A	Y	N
6	TESTING			
6.1	Has all required testing been completed and results recorded?	N/A	Y	N

Note: If the answer to any question is **N (No)**, the design cannot be certified under Code LG1.

[Continued Overleaf]

CERTIFICATION DETAILS																	
Make						Model						Year of Manufacture					
VIN																	
Chassis Number (If applicable)																	
Brief Description of Modification/s																	
Vehicle Modified By																	
Certificate Number (If applicable)																	
Vehicle Certified By (<i>Print</i>)																	
Signatory's Employer (If applicable)																	
Signatory's Signature											Date						

BRAKE SYSTEM CONVERSION

CODE LG2

SCOPE

This code covers the installation of brake assembly substitutions, the fitting of balance or pressure limiting devices and for transferring brake pedals from one side of a vehicle to the other.

Code LG2 does not apply to ADR category L-group vehicles and motor cycles.

MODIFICATIONS COVERED BY CODE LG2

The following is a summary of the modifications that are covered by Code LG2:

- Fitting substitute disc brake or drum brake assemblies;
- Fitting substitute brake master cylinders;
- Fitting substitute or additional brake boosters;
- Fitting brake balance or pressure limiting devices; and
- Transferring the position of the brake pedal for left hand or right hand drive.

MODIFICATIONS NOT COVERED BY CODE LG2

The following modifications are not covered by Code LG2:

- Design of suspension modifications including substitute suspension uprights, struts and axles (this is covered by Codes LS3 and LS5).

COMPLIANCE WITH APPLICABLE VEHICLE STANDARDS

Modified vehicles must continue to comply with the ADRs to which they were originally constructed, except as allowed for in the AVSR. These modified vehicles must also comply with the applicable in-service requirements of the AVSR.

Modified pre-ADR vehicles must continue to comply with the AVSR.

Compliance with the AVSR also means compliance with the equivalent regulations of a State or Territory of Australia.

Outlined below in Table LG6 are areas of the vehicle that may be affected by the modifications and that may require re-certification, testing and/or data to show compliance for the modified vehicle. This is not an exhaustive list and other modifications may also affect ADR compliance.

Table LG6: Summary of items that if modified, may detrimentally affect compliance with applicable ADRs

DETAIL	REQUIREMENTS
Brake Hoses	ADR 7, 42/...
Brake Lights	ADR 13/..., 60/...
Hydraulic Brake Systems	ADR 31, 31/..., 35x, 35/...
Brake Performance	Regulations

To determine the ADRs that apply to the vehicle in question, refer to the applicability tables in Section LO. Vehicles manufactured on or after 1 January 1969 and prior to 1 July 1988 need to comply with the Second Edition ADRs whilst vehicles manufactured after this date need to comply with the Third Edition ADRs. Section LO has separate applicability tables for each edition.

The ADRs apply according to the vehicle's category and date of manufacture. It is the responsibility of the signatory to refer to the appropriate ADR applicable to the vehicle

Alternatively, ADR applicability tables for individual vehicle categories may be referenced on the Department of Infrastructure and Transport RVCS website at the following address and under the section titled *ADR Applicability Tables*:

<http://rvcs.dotars.gov.au/>

CHECKLIST LG2
BRAKE SYSTEM CONVERSION
CODE LG2

(N/A=Not Applicable, Y=Yes, N=No)

1.	DESIGN			
1.1	Has the vehicle been modified in accordance with the plans and specifications issued under: Design Approval No.....	N/A	Y	N
2.	WORKMANSHIP			
2.1	Is all work, including welding, of satisfactory quality and has all work been performed in accordance with recognised engineering standards?		Y	N
3.	FASTENERS AND WELDING			
3.1	Do all fasteners comply with the applicable requirements of Section LZ <i>Appendices - Appendix A Fasteners</i> ?	N/A	Y	N
3.2	Does the quality of welding comply with the applicable requirements of Section LZ <i>Appendices, Appendix C Heating and Welding of Steering Components</i> ?	N/A	Y	N
4	INSPECTION and TESTING			
4.1	Has an inspection been carried out on the installation and all modified components and found to be satisfactory?		Y	N
4.2	Has the vehicle been road tested and the braking system found to operate satisfactorily?		Y	N

NOTE: If the answer to any question is **N (No)**, the modification cannot be certified under Code LG2.

[Continued overleaf]

CERTIFICATION DETAILS																		
Make						Model						Year of Manufacture						
VIN																		
Chassis Number (If applicable)																		
Brief Description of Modification/s																		
Vehicle Modified By																		
Certificate Number (If applicable)																		
Vehicle Certified By (<i>Print</i>)																		
Signatory's Employer (If applicable)																		
Signatory's Signature												Date						