Brake Assessment Manual

Assessing and certifying brakes for modified vehicles and individually constructed vehicles.

Developed in association with the NSW Vehicle Standards Working Group

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DATE:	April 2021
VERSION:	3.0
REFERENCE:	
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Preface

This Manual was developed by an ad hoc focus group convened under the NSW Vehicle Standards Working Group, which was established in 2012 by the NSW Minister for Roads and Ports to ensure industry and stakeholders are represented in developing vehicle standards and policies in NSW. The Vehicle Standards Working Group is co-chaired by Transport for NSW and the Australian Confederation of Motor Clubs. The members are:

- Australian Automotive Aftermarket Association
- Australian Confederation of Motor Clubs
- Australian Street Rod Federation
- Four Wheel Drive NSW & ACT Inc.
- Institute of Automotive Mechanical Engineers
- Motorcycle Council of NSW Inc.
- Motorsport Australia
- Motor Traders' Association of New South Wales
- National Roads and Motorists' Association
- NSW Motorcycle Alliance
- NSW Police Force
- Transport for NSW
- Vehicle Safety Compliance Certification Scheme - Licensed Certifiers

This Manual was first published in October 2013, and gazetted as an Authority standard compliance specification in May 2017. It has now been updated and revised based on practical feedback. The major changes in this version are:

- A new section about maintaining safety features which includes additional requirements for vehicles fitted with electronic stability control
- Certain technical features being excluded for ICVs
- An amended Brake System Installation Checklist
- The section on use of aftermarket components has been amended to refer to a new document about manufacturer approved components
- Test H now includes options such as in fatigue analysis

Note: The document will be updated regularly and is subject to change as necessary.

1. General

1.1 Scope

This ‘Brake assessment manual’ (the Manual) applies to all types of light motor vehicles, except motorcycles and mopeds. It is intended to be used to assess the brake systems in modified vehicles and individually constructed vehicles (ICVs), including replica street rods, as part of the process for certifying the vehicle for registration in accordance with the Road Transport (Vehicle Registration) Regulation 2017 and the Vehicle Safety Compliance Certification Scheme (VSCCS). This Manual does not cover the design of brake systems.

The Manual serves as an alternate pathway to compliance in respect of brake testing of these vehicles. Vehicles certified to comply with specified requirements of the Manual are exempted from the related requirements of the applicable vehicle standards. The Exemption notice is included as Appendix H of the Manual.

Notes:

1. The term ‘vehicle’ used in this Manual refers to light vehicles, being vehicles with a *gross vehicle mass* of 4.5 tonnes or less.
2. From hereon, the term ‘modified vehicle’ also applies to ICVs except where stated otherwise.
3. Terms that are *italicised* are defined in Appendix A.
4. Appendix B contains a checklist to guide *modifiers* and assist licensed certifiers in certifying the vehicle.

1.2 Introduction

The Road Transport (Vehicle Registration) Regulation 2017 (the Regulation) requires that all registrable vehicles comply with the applicable vehicle standards, and modified vehicles continue to comply with those standards. It also specifies that the vehicle, its parts and equipment are suitable for safe use and are in a thoroughly serviceable condition.

To assist vehicle owners in meeting these obligations, Transport for NSW (TfNSW) manages a modification scheme under the Regulation, the VSCCS. This authorises individual people with appropriate technical qualifications, training and experience as ‘licensed certifiers’ to inspect a modified vehicle and where it complies with the applicable vehicle standards, issue a compliance certificate.

Except for purposes relating to compliance certification, a vehicle that has undergone a significant modification (i.e. one that requires a compliance certificate) must not be used on a road or road related area unless a compliance certificate has been issued for the vehicle. For more information, refer to clauses 60, 64, 84, 85 and 87 of the Regulation.

Vehicle braking systems are critical to crash avoidance. Modifications made to vehicle *brakes* or to the vehicle that affects the braking system necessitate that the effectiveness of the *brakes* are verified before the vehicle is registered. Similarly, the *brakes* fitted to an ICV must be assessed to ensure they meet minimum safety standards, regardless of where the *brakes* were sourced. This Manual identifies the types of modifications that affect vehicle braking systems which require assessment and certification, refer to Section 2.2 Table 1.

Standards for a *brake system* and components are complex and requires extensive and often expensive testing. It may be necessary to test at high speed to verify compliance with requirements. This Manual has been gazetted as an Authority standard compliance specification in accordance with Clause 64 of the Regulation, as such it may be utilised to demonstrate that a modified light vehicle complies with the applicable vehicle standards.

Note: Other standards that may be used in assessing a modified vehicle or ICV include the applicable ADRs and National Vehicle Standards Bulletin 14 *National Code of Practice for Light Vehicle Construction and Modification* (VSB 14).

The level of assessment a vehicle must undergo to obtain a compliance certificate is based on the extent of the modification and the risk posed to the vehicle occupants and road users. The options for obtaining a compliance certificate for the modified vehicle are:

1. Inspection of approved aftermarket components
2. Assessment based on tests previously done on a similar vehicle
3. Application of a series of road tests.

With respect to brake systems, adherence with this manual is the pathway to consideration for exemption from the standards. An exemption must be issued by TfNSW before the vehicle can be certified; the certificate then must refer to the specific exemption granted.

1.3 Limits of assessments

Assessments detailed in this Manual apply to vehicles intended to be registered for use on the road, under normal driving operations within posted speed limits. If the vehicle is to be use for specialised activities such as motorsports then more rigorous assessment and testing may be required to ensure the braking system is adequate.

1.4 Maintaining vehicle safety features

In addition to the provisions for registered vehicles to comply with safety standards, the Regulation requires vehicles to be maintained in a manner that will not cause a danger to any person. Safety features including those not covered by an ADR (or other applicable standard) must remain functional after the modification. With the introduction of complex and sensitive safety features in modern vehicles, such as electronic stability control (ESC) and autonomous emergency braking, particular care must be taken to ensure the systems are not affected negatively by modifications.

After *significant modification* a vehicle may not be issued with a compliance certificate where changes adversely affect the performance of a safety feature. For vehicles equipped with ESC the on-road effect must be scrutinised as part of the licensed certifier assessment. A compliance certificate may only be issued where ESC is shown to be operational without adversely affecting vehicle performance. Where necessary, the ESC may be reprogrammed to maintain expected performance. Video evidence of vehicle stability performance post-modification is expected in the documentation presented with the request for exemption.

1.5 Competence of licensed certifiers

TfNSW has assessed the competencies of persons registered as licensed certifiers. The areas of competence for every licensed certifier are published on the TfNSW website. Only licensed certifiers identified as competent in *brakes* who have the necessary equipment to do the applicable tests may be engaged in assessing and certifying vehicles with modifications to, or that affect their *brakes*.

1.6 Evidence of compliance

Licensed certifiers must maintain evidence and make it available to support every statement of compliance with this Manual as part of the VSCCS certification process. Evidence may include:

- statements, certificates and test reports from the component manufacturer
- equipment calibration details
- data readouts
- calculations
- video
- detailed photographs that clearly and unambiguously show the modification

2. Types of modifications

2.1 Changes that do not require assessment or certification

The following are not considered to be modifications that require assessment or certification:

1. Replacement of parts or components by identical or equivalent parts or components.
2. Replacement of parts or components with equivalent functional performance.
3. Optional parts or components as prescribed by the vehicle *manufacturer*.

2.2 Modifications that do require assessment

Table 1 sets out significant modifications that require the vehicle's *brake system* to be assessed. The vehicle may be subject to a single modification or a combination of modifications. If the vehicle has been subject to a number of modifications then the assessment must ensure that all the modifications are considered.

Table 1: Modifications that require brake system assessment

Mod.	Description
1	Relocation of brake pedal/master cylinder. Typical example being from the engine bay to the passenger compartment or the underside of the vehicle and no other brake modifications.
2	Single-circuit master cylinder replaced with dual-circuit master cylinder with the same bore diameter and no other brake modifications.
3	Conversion from left-hand drive to right-hand drive by re-fitting original brake master cylinder/booster to right-hand side of vehicle or by cross-shafting the original brake master cylinder/booster and no other brake modifications.
4	Fitting an 'inline vacuum assisted' brake booster or fitting a full power brake unit to an unmodified braking system or to a modified braking system which has been previously tested. Typical examples: vacuum assist - PBR VH40/VH44, full power -Chevrolet/GMC unit.
5	Fitting a twin diaphragm, direct-acting brake booster in place of the original single diaphragm, direct-acting brake booster.
6.	Fitting dual or multi-piston brake callipers to original front disc rotors in place of original single or multi-piston brake callipers The new dual or multi-piston brake calipers are fitted with or without adapting brackets.
7	Fitting disc *brakes* to the front of a vehicle without using brake caliper adapting brackets. Fitting larger-diameter drum *brakes* to the front of a vehicle.
8	Fitting disc *brakes* to the front of a vehicle with brake caliper adapting brackets.
9	Fitting disc *brakes* to the rear of a vehicle without using brake caliper adapting brackets. Fitting larger-diameter drum *brakes* to the rear of a vehicle.
10	Fitting disc *brakes* to the rear of a vehicle with brake caliper adapting brackets.
11	Fitting larger-diameter brake discs to the front of a vehicle with existing or replacement brake callipers to suit the larger disc diameter.
12	Fitting larger-diameter brake discs to the rear of the vehicle with existing or replacement brake callipers to suit the larger disc diameter.
13	Fitting replacement front suspension and *brakes* from a vehicle of a different make and model with or without modification to the replacement suspension. Significant modification to original suspension or original suspension mountings. Note: Refer to allowable 'Minor modifications' as set out in the Road and Maritime 'Light vehicle modifications manual: Suspension and ride height' 2016 TP16/03352.

Mod.	Description
14	Fitting replacement rear suspension and *brakes* from a vehicle of a different make and model with or without modification to the replacement suspension. Significant modification to original suspension or original suspension mountings. Note: Refer to allowable 'Minor modifications' as set out in the Road and Maritime 'Light vehicle modifications manual: Suspension and ride height' 2016 TP16/03352.
15	Replacement of the original vehicle rear *axle* assembly and *brakes* with a different rear *axle* assembly and *brakes* or with *brakes* from a different make and model and/or aftermarket brake components. If original vehicle *brakes* are retained then utilise the spike stop procedure only. Typical example: Ford 9” differential
16	Replacing the entire braking system with a combination of components either from a production vehicle or an aftermarket brake component manufacturer.
17	ICV with a combination of production car brake components and/or after-market brake components.
18	ICV with *brake system* components from a 31/01 complying vehicle having less mass than the donor vehicle. The components shall comprise at least, rotors, calipers, master cylinder, booster and park brake mechanism. Retention of the donor vehicle hand brake lever is not mandatory. Additional components such as a proportioning valve may be fitted to obtain balanced brake performance. ABS and/or EBS from the donor vehicle shall not be used.
19	Fitting hydraulic *brakes* to a vehicle that originally had an un-braked *axle* or cable-operated *brakes* (with no other modification to the original vehicle present). Future modifications are subjected to test item 16.
20	Change in the mass on the *axles* by 10% or more with *brakes* unchanged from those fitted and tested prior to the mass change. Note: A change in engine with up to 10% greater mass does not require testing.
21	Engine having a power increase over 20% of that offered: - by the vehicle *manufacturer* (for that model), or - from a previously certified modification, or - where the maximum speed of the original vehicle was less than 200 km/h (and the *brakes* are unchanged from those fitted and tested prior to the power increase).
22	Wheels and tyres - A change in the rolling diameter of the wheel and tyre combination in excess of +/- 7% which has not been previously tested.
23	Removal of any form of power assist or full power unit (whether by vacuum, air, or hydraulic means) from an existing *brake system* that results in the driver supplying all the energy to apply the *brakes*.
24	Removal or alteration to a motion sensitive *brake system* pressure differential valve.
25	Removal or alteration to a *brake system* load sensing or pressure regulating valve (brake proportioning valve).
26	Alteration or modification to a diagonally split braking system using like parts designed for a diagonally split braking system and remaining a diagonally split system. Typical vehicles that featured such a setup are Volvo, Lancia, and Ferrari.
27	Alteration or modification to a diagonally split braking system not using like parts designed for a diagonally split braking system and converting it to a conventional front/rear dual circuit braking system in the process.
28	Removal of a *brake system* pressure differential valve from a *manufacturer’s* standard and unmodified braking system. This modification can only be done if the vehicle is also modified to address the risk introduced. It must not be done if a vehicle is otherwise unmodified.
29	Modification to the *brake power unit* of a hydraulic *brake system* which has been previously tested and which incorporates pumps and accumulators also known as a full power braking system.

Mod.	Description
	Typical examples: Chevrolet/GMC and the like.
30	Modification or alteration to electro-hydraulic full power braking system.
31	Modification or alteration to regenerative *brake systems*.

The modification categories listed above are not exhaustive. Further categories may be added over time.

2.3 Modifications not permitted

A vehicle hydraulic *brake system* that incorporates pumps and accumulators (also known as ‘full power braking systems’) must not be modified.

3. Method

3.1 Method 1 – Approved aftermarket components

The requirements for using aftermarket components in modifying or building a vehicle are specified in the document *Using manufacturers approved aftermarket components in modified light vehicles*, which can be accessed on the NSW TfNSW website.

Verification that the component(s) meet the conditions specified in this document and have been manufactured to a suitable standard being compatible with the host vehicle. This may be demonstrated by certification from a company accredited to the National Association of Testing Authorities or another body registered with the International Laboratory Accreditation Cooperation accredited body.

3.2 Method 2 – Tests to similar vehicles

If a vehicle has been modified using a braking system or components identical to those from a similar vehicle (that are within the tolerances listed in Table 2) and it has already been assessed and certified, then a licensed certifier may issue a certificate of compliance without the need for testing provided the following conditions are satisfied:

- the engines are mounted in equivalent locations
- the components are identical to those used in the certified vehicle
- the components are examined to establish that they are in good condition
- a detailed examination of the vehicle is made to confirm suitability for properly accommodating the components, such as load-bearing members that display no evidence of structural degradation
- a detailed examination of the vehicle is made to ensure that the components have been correctly installed
- results of the assessment, including test results made on the similar vehicle with reference in the test report.

The licensed certifier must do the examinations listed above. A record of the examination and the evidence used to determine that the two vehicles are similar must be retained.

The results only apply for vehicles that are similar to the tested vehicle and must not be used for a vehicle once-removed, as follows:

If *Vehicle X* is tested and *Vehicle Y* is similar to *Vehicle X*, then tests obtained for *Vehicle X* can be applied to *Vehicle Y*.
If *Vehicle Z* is similar to *Vehicle Y* but not similar to *Vehicle X* (i.e. it is outside the parameters), then test results cannot be applied to *Vehicle Z*.

NB: This method also applies to standard vehicles manufactured to the ADRs and supplied to the market in accordance with standard Compliance Plate Approval Scheme administered by the Department of Infrastructure, Transport, Regional Development and Communications or any of its predecessors and successors.

Table 2: tolerances for determining a similar vehicle

Parameter	**Tolerance**
Individual unladen *axle* mass	+ 10%
Wheel base	± 20%
Centre of gravity Note: The following external website may provide a useful reference on determining the centre of gravity: http://brakepower.com/help_abc_07_YCG_t.htm.	± 50 mm in height
Power	+ 20% if this results in an increased rate of acceleration or maximum speed where the maximum speed of the original vehicle was less than 200 km/h
Tyre size	± 7% in rolling diameter

For particular requirements of handbrakes, refer to Appendix C.

3.3 Method 3 – Installation checklist, static brake test and assessment

3.3.1 General

Assessment by a licensed certifier

Licensed certifiers must assess the modified vehicle to determine that it:

- Does not present a safety risk
- Would comply with the applicable vehicle standards should it be subjected to the full range of tests specified by the standards.

The initial assessment shall comprise of a detailed inspection of the vehicle taking account of the installation checklist provided by the modifier, the condition of the vehicle, and the condition of the components. This should include a review of the data produced by the static brake test machine.

The following stages of assessment apply:

1. The modifier checks the brake components using the checklist in Appendix B.
2. The modifier presents the modified vehicle to a licensed certifier or a facility approved by Transport for NSW for brake tests using a static brake test machine. Note:
   - Authorised Inspection Stations that do safety checks (i.e. ‘Pink slip’ tests) are ‘approved facilities’ and many have appropriate static brake test machines.
   - Verify that the test machine has a current certification certificate before testing
3. The modifier takes the modified vehicle, the completed installation checklist, and the data read-outs from the static brake tests to a licensed certifier for assessment.
4. The vehicle and associated information is assessed by the licensed certifier.
   The certifier determines whether sufficient information exists to warrant issuing a compliance certificate, or whether ‘Additional tests’ are required (as set out following).

   Note: A static test machine may not provide the licensed certifier with sufficient information to form an opinion as to whether the vehicle complies with these standards, especially for vehicles that comply with ADR 31/--, that is vehicles manufactured after 1 January 1977.

3.3.2 Additional tests

General

Based on the results obtained from the static brake test machine and the type of modification being assessed, the licensed certifier may require the modified vehicle to undertake additional tests. Table 3 outlines the range of tests which can be used to verify the modifications listed in Table 1.

Non-road tests

A number of the tests listed in Table 3 can be done on a static brake test machine. Tests on static machine must be performed by a person trained and competent in its use. The licensed certifier must be satisfied the tests were performed correctly and relate to the vehicle being assessed. It is recommended that the certifier observe the tests performed.

Appendix D (Using a plate-type test machine) provides an example of how a plate-type brake test machine can be used to do the basic and additional tests. At the time of writing, data was only available for this type of brake test machine. Additional appendices will be developed when data from other machines types become available. A manufacturer or supplier that would like a particular type of machine can make a submission to roadsafety@transport.nsw.gov.au.

Other tests may be done statically. The licensed certifier must supervise these tests, namely:

- Test A: Reservoir volume
- Test C: Park brake

Road tests

If the tests required by the licensed certifier need to be done on a road or a road-type test facility then the conditions specified under ‘Method 4 – Road tests’ apply.

3.4 Method 4 – Road/track tests

3.4.1 General

There are few details available of the *brake* standards that were used before the introduction of ADR 31 ‘Brake systems for passenger cars’ in 1977. For this reason, the tests specified in Appendix E are derived from ADR 31/00 and ADR 31/01 which contain the least onerous tests.

The tests have been modified considerably so that they can be applied to all vehicles regardless of the date of manufacture, and to make the tests affordable and practicable while retaining safety considerations. For more information about the rationale used to develop the test schedule, refer to Appendix F.

The key elements of the test schedule relative to those specified in the ADRs:

- Typically, fewer repeat runs required
- Lower speeds permissible where appropriate justification is given, for example with the unavailability of a test track or a suitable high-speed road.

The applicable tests for the different modifications are given in Table 3 and described in Appendix E. Appendix G has variations that apply to *N Category* and certain *M Category vehicles*. Where a vehicle has been subjected to a combination of modifications, some test

items may happen to be duplicated. In such circumstances it is not necessary to duplicate a test item, although the combination of test items are required to be completed.

The Regulation allows an unregistered vehicle to be driven for testing on NSW roads for the purpose of determining whether the vehicle complies with the applicable vehicle standards. The reduction in test speed and number of test runs make it possible to test some modified vehicles on public roads under controlled conditions. Refer to 3.4.4 ‘Test conditions’.

3.4.2 Competence of drivers

The vehicle should be driven by a *competent person* capable of efficiently achieving the specified test operations.

Note: The successful execution of the tests in Appendix E may depend on competence of the person driving the vehicle. If the specified test conditions are not met there may be excessive tyre wear or other maintenance outcomes.

3.4.3 Test equipment

It is important that appropriate equipment is used to measure and record test-critical data. The following types of equipment must be used as a minimum:

- an inertial-type direct reading deceleration meter (that is capable of reading the *MFDD).* An exception to this is for modifications 6-10, see Table 1.

  Note: Alternatively, a device capable of measuring the average deceleration may be used, in which case the average deceleration reading must be at least equal to the *MFDD* specified.
- a pedal force gauge
- a device such as a fifth wheel or GPS (Global Positioning System) unit for measuring speed
- data logging equipment (mandatory) for all tests specified in Appendix E
- a GPS device may be used for measuring and recording distance and time (and therefore average deceleration).

  Note: The vehicle speedometer should not be used as test reference.

The equipment used must function correctly and accurately. Equipment requiring calibration must be within certification for testing and records retained to verify. The equipment must be capable of recording the relevant test data to facilitate verification and audit. Tolerance on test speeds shall be +/- 3 km/h, and instrumentation accuracy shall be +/- 3 %.

Note: Tolerances are not cumulative.

3.4.4 Test conditions

The following test conditions apply:

- Location:
  - For tests that cannot legally be performed on a public road (such as those requiring high speeds) an appropriate venue must be used (like a dedicated test track, race circuit, or aerodrome)
  - Where tests can be safely conducted on a public road, the necessary approval must be granted prior by the applicable road authority. For local roads this is the local council, for State and Federal roads in NSW the authority is TfNSW.
    A location specific risk assessment must accompany the application regarding suitability. All stipulated controls must be complied with, for example the use of accredited traffic controllers with a traffic control plan in place.
  - Dynamic tests must be conducted on a dry road that is either level or inclined slightly downhill, and which has a sealed surface or another surface affording good adhesion. (With exception of Test I).

  - The road must be sufficiently long and straight to enable the full range of tests to be carried out safely, with sufficient run-off in case of brake failure.
- Inspection - The certifier must inspect the vehicle prior, ensuring that it can be driven safely. Pre-test controls must be implemented before commencement. Refer to section 3.4.5 ‘Pre-test check’.
- Vehicle:

  The certifier must inspect the vehicle prior to driving it to the place of testing, to ensure that it can be driven safely.

  – The tyres are to be ‘cold’ (i.e. at ambient temperature) and inflated to an appropriate pressure for the vehicle to operate safely at its design load/speed.
  - The vehicle must be at maximum loaded test mass (unless otherwise specified). The loaded mass must be evenly distributed among the axles as specified by the vehicle manufacturer.
  - The transmission must be disconnected for each test (unless otherwise specified)
- Testing:
  - General behaviour of the vehicle during braking must be observed. Test results (unless otherwise specified) must be achieved without severe or abnormal vibrations and without the vehicle:
    - locking wheels at speeds exceeding 15 km/h
    - departing from a 3.5 m wide lane
    - exceeding a yaw angle of 15 degrees
  - If the maximum speed of the vehicle is lower than the speed prescribed for a particular test then the test shall be performed at the Maximum Vehicle Speed.

3.4.5 Pre-test check

In the interests of road safety before doing any of the tests outlined in Appendix E, the vehicle should be thoroughly examined to ensure it is in a roadworthy condition. The competent person testing *brakes* should check prior to the test that:

- the vehicle is in good order and the brake lights are all functioning correctly
- the vehicle *modifier* has affirmed that the type of brake fluid used is appropriate for the braking system and in good condition
- the correct fluid identification symbols are used and affixed in a visible position in indelible form within 150 mm of the filling ports of the fluid reservoirs
- modification to the *brake system* is complete and free of known and obvious defects
- the wheels and tyres are appropriately inflated, and inflation pressures recorded
- for modified vehicles, the wheel alignment is within specified safety limits
- the vehicle is structurally sound and will withstand the likely stresses induced in the tests
- the vehicle passes a rudimentary brake test as follows
  - with the vehicle in the *unladen* state, accelerate to over 35 km/h
  - put the transmission into neutral and coast down to 30 km/h
  - with both hands on the steering wheel, bring the vehicle to a stop as quickly as possible with one sustained and smooth braking action using the service brake control
  - that the vehicle does not pull to one side
  - that the brake pedal pressure must not exceed 885 N for full braking
  - average deceleration rate for the service brake must be at least 2.9 m/s^2
  - peak deceleration rate for the service brake must be at least 3.4 m/s^2.

If the vehicle does not meet the preceding listed requirements then it is not eligible for testing outlined in Appendix E.

Ensure that the test instrumentation is functioning correctly by performing (no more than 20) decelerations. For vehicles subject to Modification 19, the deceleration shall be done from a speed of 40 km/h; for all other vehicles conducted decelerations from a speed no more than 65 km/h. In all cases, the actual deceleration must not exceed 3.5 m/s^2.

3.4.6 Notes in relation to testing

1. When doing the series of tests they must be done as specified. This is both a safety matter and avoids unnecessary damage to the vehicle, including brake components and tyres. Ensure the vehicle is driven at the specified speeds with the specified maximum force to apply the *brakes*.
2. The licensed certifier must be satisfied that that the tests specified in Table 3 are sufficient to certify the subject vehicle. Test speeds may be increased should the test speeds in Table 3 be deemed insufficient to properly assess vehicle braking performance based on dynamic capabilities. The test speeds may not be decreased.
3. The test schedule is not necessarily exhaustive and further testing may be necessary at the discretion of those carrying out the brake testing.
4. It is not necessary to do a test as specified for one modification if the test has been done for another modification.
5. Tests done on public roads must comply with the conditions specified by the applicable road authority; and not interfere with or disrupt traffic; pose a risk to the persons doing the tests and other road users; or cause damage to the road and roadside infrastructure.
6. Testing that can be achieved at a single test mass deem it not necessary to carry out both tests (i.e. for both laden and unladen conditions). In such circumstances, the more onerous test conditions apply.

Table 3: Test Schedule – see the following page for notes

Test → / Modification ↓	A * Reservoir volume	B + Mounting structure	C * Park Brake	D + Partial failure front rear	E + Booster failure	F + Proportion valve failure	G + ABS Failure	H Spike stops	I + Wheel lock	J1 Type-0 Engine Disconnected/	K Type-I Heating procedure	L Type-I Hot performance	M Type-I Recovery procedure	N Type-I Recovery performance
1		T												
2	T			T										
3		T												
4					T				T					
5	T								T					
6	T	T		T	T	T	T	T	T	T				
7	T	T		T	T	T	T	T	T	T				
8	T	T		T	T	T	T	T	T	T				
9	T	T		T	T	T	T	T	T	T				
10	T	T	T	T	T	T	T	T	T	T				
11	T	T		T	T	T	T	T	T	T	T	T	T	T
12	T	T	T	T	T	T	T	T	T	T	T	T	T	T
13	T	T		T	T	T	T	T	T	T	T	T	T	T
14	T	T	T	T	T	T	T	T	T	T	T	T	T	T
15	T	T	T	T	T	T	T		T	T				
16	T	T	T	T	T	T	T	T	T	T	T	T	T	T
17 ICV	T	T	T	T	T	T		T	T	T	T	T	T	T
18 ICV Donor		T	T			T		T	T					
19	T	T	T	T	T			T	T					
20								T		T	T	T	T	T
21											T	T	T	T
22a										T				
22b										T	T	T	T	T
22c							T			T	T	T	T	T
23	Full test to applicable ADRs													
24									T					
25									T					
26	T	T	T	T	T	T	T	T	T	T	T	T	T	T
27	T	T	T	T	T	T	T	T	T	T	T	T	T	T
28									T					
29					T				T					
31	Full test to applicable ADRs													

Key to Table 3:

Reference	Description
*	The test does not need to be done on a road or road-type test facility
+	A static brake test machine may be appropriate for this test
T	Testing is required for the modification. Refer to Appendix E for details of the tests.
22a	Vehicles with a change in tyre/wheel diameter less than 26 mm
22b	Vehicles not fitted with ABS with a change in tyre/wheel diameter greater than 26 mm
22c	Vehicles fitted with ABS with a change in tyre/wheel diameter greater than 26 mm

Appendix A: Glossary

The terms below are used in this Manual. Except for those marked with an asterisk (*), they have been taken from 'Australian Design Rules - Definitions and Vehicle Categories'; and those marked (†) have been amended specifically for this Manual. To identify where they are used, they are *italicised* in the text.

ADR vehicle - a vehicle that was manufactured after to the introduction of ADR 31 on 1 January 1977.

Antilock System - a portion of a service *brake system* that automatically controls the degree of rotational wheel slip relative to the road at one or more road wheels of the vehicle during braking

Average Deceleration - the number determined by dividing the square of the initial vehicle speed by twice the stopping distance expressed in compatible units.

Axle - one or more shafts positioned in a line across a vehicle, on which one or more wheels intended to support the vehicle turn.

Axle Load - total load transmitted to the road by all the tyres of all the wheels whose centres may be included between two transverse parallel vertical planes less than one metre apart.

Brake Power Assist Unit - a device installed in a hydraulic *brake system* that reduces the operator effort required to actuate the system and that if inoperative does not prevent the operator from braking the vehicle by a continued application of muscular force on the service brake *Control*.

Brake Power Unit - a device installed in a *Brake System* that provides the energy required to actuate the *Brakes,* either directly or indirectly through an auxiliary device, with the operator action consisting only of modulating the energy application level.

Brake System - all those systems and devices attached to the vehicle whose primary function is to translate energy and/or muscular effort of the driver, or in the case of trailers, energy and/or information supplied by the towing vehicle into a force that restrains vehicle movement.

Brakes - those *Friction Elements* that are forced together by the influence of the remainder of the *brake system* so as to apply a restraining torque to the vehicle wheels.

* *Cold brakes* - *brakes* that have disc temperatures below 100ºC.

Competent person - a person who has acquired through a combination of training, qualification and experience the knowledge and skills necessary to carry out a specified task.

Control - a component actuated directly by the operator to transmit the force required to activate the *brake system*.

* *Fade* - reduction in braking effectiveness caused by excessive heat that can occur after repeated or sustained application of the *brakes*.

Friction Element - a part of the system designed for replacement and which contacts another part of the system in such a way that either vehicle kinetic energy is dissipated or the vehicle is restrained from moving.

Gross Vehicle Mass - the maximum laden mass of a motor vehicle as specified by the *Manufacturer*.

Laden Mass - the mass of a vehicle and its load borne on the surface on which it is standing or running.

Lightly Loaded Test Mass (LLTM) - the mass of the *Unladen* vehicle with a full capacity of lubricating oil and coolant and not less than 75% of full fuel capacity but without goods, occupants or options except those options which are essential for the test procedures specified, plus additional loading distributed in the seating position adjacent to the driver's

seating position so that the mass of such loading plus the mass of the driver and instrumentation mounted in the vehicle is 155 ± 30 kg.

M Category Vehicles

MA Passenger Car - a passenger vehicle, not being an off-road passenger vehicle or a forward-control passenger vehicle, having up to 9 seating positions, including that of the driver.

MB Forward-Control Passenger Vehicle - a passenger vehicle, not being an off-road passenger vehicle, having up to 9 seating positions, including that of the driver, and in which the centre of the steering wheel is in the forward quarter of the vehicle's total length.

MC Off-Road Passenger Vehicle - a passenger vehicle having up to 9 seating positions, including that of the driver and being designed with special features for off-road operation.

MD Light Omnibus - a passenger vehicle having more than 9 seating positions, including that of the driver and with a *Gross Vehicle Mass* not exceeding 5.0 tonnes.

Manufacturer - the name of the person or company who accepts responsibility for compliance with the Australian Design Rules and to whom the 'Compliance Plate' approval certificate is issued, or, for an individually constructed vehicle, the person in whose name the vehicle is registered.

† *Maximum Loaded Test Mass* (MLTM) - the mass of the *Unladen* vehicle together with a full capacity of lubricating oil and coolant and at least 75% capacity of fuel plus additional mass equivalent to 68 kg located in each unoccupied seating position.

† *Maximum Vehicle Speed* - the speed attainable, established by calculation or on the basis of a test, under maximum vehicle acceleration from a standing start for 1.6 km.

Modifier - the owner or the registered operator of a vehicle as used in the Regulation, whether or not the person actually does the modifications themselves.

MFDD – the mean fully developed deceleration. An explanation for how to calculate this is included in aDR31/04.

N Category Vehicles

NA Light Goods Vehicle - a goods vehicle with a *Gross Vehicle Mass* not exceeding 3.5 tonnes.

NB1 Medium Goods Vehicle - a goods vehicle with a *Gross Vehicle Mass* between 3.5 tonnes and 4.5 tonnes.

Goods Vehicle - a motor vehicle constructed primarily for the carriage of goods and having at least 4 wheels; or 3 wheels and a *Gross Vehicle Mass* exceeding 1.0 tonne.

* *OEM* - Original Equipment Manufacturer

Parking Mechanism - a component or sub-system of the drive train that locks the drive train when the transmission control is placed in the 'park' position or other gear position and the ignition key is removed.

Pedal Effort - the force applied to the service brake *Control*. The force may be measured by a force transducer located centrally on the brake pedal pad.

Pre-ADR vehicle – a vehicle that was manufactured prior the introduction of ADR 31 on 1 January 1977, or a vehicle that meets the requirements of the *National Guidelines for the Construction and Modification of Street Rods in Australia*.

* *Restored vehicle* - a vehicle that is being or has been restored to its *manufacturer's* specifications, so far as it is *reasonably practicable* to meet those specifications.

Note: This definition is from the Road Transport (Vehicle Registration) Regulation 2017.

Split Service Brake System - a *brake system* consisting of two or more sub-systems actuated by a single *Control* and so designed so that a leakage-type failure of a pressure component in a single sub-system (except structural failure of a housing that is common to all sub-systems) shall not impair the operation of any other sub-systems.

Stored Energy - energy stored in a device such as a pressure vessel, vacuum chamber, spring or battery.

† *Unladen Mass* - the mass of the vehicle in its operational configuration, unoccupied and unladen with all fluid reservoirs filled to nominal capacity including fuel.

Variable Proportioning Brake System - system that automatically adjusts the braking force at the *Axles* to compensate for vehicle static *Axle Load* and/or dynamic weight transfer between *Axles* during deceleration.

V_{max} – the *Maximum Vehicle Speed.*

In addition, the definitions below apply for the purposes of the tests. These are not italicised in the text.

May indicates an option that is permissible and which does not affect compliance with a test whether or not it is used.

Must indicates that something is an essential part of, or essential to, the test.

Shall indicates something that is a mandatory part of a test procedure.

Should indicates something that is recommended, but is not necessary to ensure compliance with a test.

Appendix B: Brake system installation checklist

This checklist may not necessarily cover all braking items in the modified vehicle or ICV. The checklist is to be used by the vehicle modifier, in the first instance, to gauge whether all aspects of the modification have been considered in detail. The checklist should be presented to the licensed certifier to aid with initial assessment. The licensed certifier should not rely on details in the checklist provided and should prepare a separate checklist for the assessment.

From Item 2 onward, where 'N' is selected this indicates that the vehicle does not presently meet the requirements of this Manual and that changes will be necessary before certification may proceed.

Details	
Owner name	
Modifier name	
Vehicle make and model	
Vehicle identification	
Date checklist completed	

Brake system installation checklist				
1	**Source of brakes**			
	Each component of the:	**Y**	**N**	**N/A**
	(a) service brake system is sourced from a single vehicle	**Y**	**N**	**N/A**
	(b) park brake system is sourced from a single vehicle.	**Y**	**N**	**N/A**
2	**Service braking system**			
	(a) The braking system does not leak fluid under any condition.	**Y**	**N**	**N/A**
	(b) The service *brake system* operates on all wheels.	**Y**	**N**	**N/A**
	(c) All service brake system components are in a safe and serviceable condition.	**Y**	**N**	**N/A**
	(d) If a dual circuit service *brake system* is fitted then the pressure variation between each circuit is balanced and/or adjusted automatically by the system.	**Y**	**N**	**N/A**
	(e) The brake proportioning valve or load sensing valve is connected and in good working condition	**Y**	**N**	**N/A**
	(f) When the service *brakes* are applied, the *brakes* on all wheels apply immediately and simultaneously.	**Y**	**N**	**N/A**
	(g) When the service *brakes* are released, the *brakes* on all wheels release immediately and simultaneously.	**Y**	**N**	**N/A**
	(h) Where fitted, all pumps, vacuum boosters, servos and accumulators are connected and in good working condition.	**Y**	**N**	**N/A**

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Brake system installation checklist				
	(i) With the ignition switch in the 'on' position and the engine is not running, each brake fail audible/visual warning device is connected and functional	**Y**	**N**	**N/A**
3	**Service brake control**			
	(a) There is sufficient clearance around the service brake control such that it may be operated without interference from the vehicle interior or another driving control.	**Y**	**N**	**N/A**
	(b) Test results show that the service brake control mounting surface withstands repetitive application loads without damage.	**Y**	**N**	**N/A**
	(c) Test results show that each non-OEM or modified-OEM component of the service brake control assembly withstands the specified application load without fatigue or damage.	**Y**	**N**	**N/A**
	(d) The service brake control features a non-slip surface.	**Y**	**N**	**N/A**
	(e) The service brake control can be operated by the driver from the normal driving position.	**Y**	**N**	**N/A**
	(f) The service brake control has sufficient travel to ensure that the full stroke of the master cylinder(s) is applied without the pedal bottoming-out.	**Y**	**N**	**N/A**
4	**Park/emergency brake system**			
	(a) The park brake is retained by direct mechanical means.	**Y**	**N**	**N/A**
	(b) The park brake operates on all wheels of at least one axle (e.g. both rear wheels of a passenger car).	**Y**	**N**	**N/A**
	(c) When the park brake is applied, the *brakes* on all of the relevant wheels apply immediately, simultaneously and equally.	**Y**	**N**	**N/A**
	(d) When the park brake is released, the brakes on all of the relevant wheels release immediately and simultaneously.	**Y**	**N**	**N/A**
	(e) Each component of the park *brake system* is in a safe and serviceable condition.	**Y**	**N**	**N/A**
	(f) With the park brake applied and the ignition switch in the 'on' position, the park brake warning device operates.	**Y**	**N**	**N/A**
5	**Park/emergency brake control**			
	(a) There is sufficient clearance around the park brake control to ensure that it can be operated without interference from the vehicle interior or another driving control.	**Y**	**N**	**N/A**
	(b) Test results show that the park brake control mounting surface withstands repetitive brake control application loads without damage.	**Y**	**N**	**N/A**
	(c) Test results show that each fabricated or modified component of the park brake control assembly withstands the specified application load without fatigue or damage.	**Y**	**N**	**N/A**
	(d) The park brake control can be operated by the driver from the normal driving position.	**Y**	**N**	**N/A**

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Brake system installation checklist				
	(e) The park brake control can be locked in the applied position.	**Y**	**N**	**N/A**
	(f) The park brake control requires two separate and distinct release operations or movements.	**Y**	**N**	**N/A**
	(g) The park brake control is adjustable for wear.	**Y**	**N**	**N/A**
6	**Master cylinder(s)**			
	(a) Test results show that the mounting surface for each master cylinder withstands repetitive brake control application loads without fatigue or damage.	**Y**	**N**	**N/A**
	(b) Test results show that the mounting surface for each cross shaft used to actuate a master cylinder withstands repetitive brake control application loads without fatigue or damage.	**Y**	**N**	**N/A**
	(c) The stroke of all master cylinder piston(s) is sufficient to cause a full application of the service *brakes* with a single movement of the service brake control without the pedal 'bottoming-out'.	**Y**	**N**	**N/A**
	(d) Master cylinder reservoirs have sufficient capacity 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. ***Fully-worn*** brake pads/linings necessitates the pad/lining surface to be: **i.** level with rivet or bolt heads on riveted or bolted linings; or **ii.** within 0.8 mm of pad backing plate or shoe for bonded linings; or **iii.** below the limit recommended by the *manufacturer*.	**Y**	**N**	**N/A**
	(e) A fabricated master cylinder push rod should be the minimum size in the following table: **Push rod length** / **Push rod diameter** Up to 250 mm / 10 mm 250 to 400 mm / 12 mm 400 to 600 mm / 14 mm 600 to 800 mm / 16 mm	**Y**	**N**	**N/A**
	(f) If the master cylinder push rod is more than 400 mm in length then it is provided with a support bearing along its length to prevent distortion.	**Y**	**N**	**N/A**
	(g) Each master cylinder push rod dust boot is new or in good condition.	**Y**	**N**	**N/A**
7	**Brake booster**			
	(a) The brake booster incorporated into the original braking system of the vehicle is retained.	**Y**	**N**	**N/A**
	(b) A non-standard replacement brake booster is fitted.	**Y**	**N**	**N/A**

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Brake system installation checklist				
	(c) The brake booster is deleted and the pedal effort required to apply the service brakes is either unchanged or is reduced.	**Y**	**N**	**N/A**
	(d) Each vacuum booster and vacuum tank is provided with a check valve that prevents loss of vacuum.	**Y**	**N**	**N/A**
	(e) A vacuum pump and vacuum reserve tank to maintain the vacuum supply for the brake booster is provided where an electric motor, diesel or petrol engine with a 'high-lift' camshaft is fitted.	**Y**	**N**	**N/A**
	(d) The vacuum hose used in the system is made of suitable material, in good condition, and of sufficient length to allow for free engine movement.	**Y**	**N**	**N/A**
	(e) The vacuum hose to each brake booster is secured at each end to prevent it from being inadvertently disconnected.	**Y**	**N**	**N/A**
8	**Brake fluid reservoir(s)**			
	(a) Each master cylinder is provided with brake fluid from a reservoir.	**Y**	**N**	**N/A**
	(b) Each brake fluid reservoir is easily accessible and refillable.	**Y**	**N**	**N/A**
	(c) For a vehicle built on or after 1 January 2002, the brake fluid level in each reservoir can be checked without removing the cap.	**Y**	**N**	**N/A**
	(d) The fluid capacity of each reservoir exceeds the volume of fluid displaced by a full stroke of the related master cylinder piston(s). Alternatively, the driver is provided with a visible or audible warning when the brake fluid level in a reservoir falls below the recommended fluid level.	**Y**	**N**	**N/A**
	(e) Each reservoir is marked to indicate the recommended fluid level.	**Y**	**N**	**N/A**
	(f) There is a warning marking 'WARNING - Clean filler cap before removing' on each reservoir or adjacent to each filler cap.	**Y**	**N**	**N/A**
	(g) There is a warning marking on each reservoir or adjacent to each filler cap advising the brake fluid type to be used.	**Y**	**N**	**N/A**
	(h) All warning markings are indelibly stamped, engraved, embossed or permanently marked in contrasting letters at least 3 mm high.	**Y**	**N**	**N/A**
9	**Brake fluid**			
	(a) After the brake work was completed, all brake fluid in the system was flushed out and replaced by new brake fluid.	**Y**	**N**	**N/A**
	(b) The brake fluid used is suitable for all *brake system* components such as the brake hoses, piston seals, dust boots and other parts.	**Y**	**N**	**N/A**
	(c) Before any braking system test was conducted, the brake fluid in the system was 'bled' of air bubble to result in a firm pedal.	**Y**	**N**	**N/A**
10	**Brake callipers and wheel cylinders**			
	(a) If original single piston calipers are replaced with calipers featuring larger diameter pistons or multi-piston calipers, then the brake balance (or modulation) between front and rear *axles* has been checked to be suitable for the increased brake application pressures.	**Y**	**N**	**N/A**

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Brake system installation checklist				
	(b) Any calliper/cylinder dust boot is new or in good condition.	**Y**	**N**	**N/A**
11	**Discs and drums**			
	Unless specifically approved by their manufacturers, brake discs and drums must not be re-drilled to suit different stud patterns or machined to fit larger hub centres or wheel bearings.			
	(a) Each disc/drum was fitted without being drilled to suit a different stud pattern.	**Y**	**N**	**N/A**
	(b) Each disc/drum was fitted without having its locating centre being machined.	**Y**	**N**	**N/A**
	(c) Each calliper is suitable for its respective brake rotor assembly.	**Y**	**N**	**N/A**
	(d) The thickness of the wear surface of each disc/drum fitted is within the wear limit specified by the component manufacturer.	**Y**	**N**	**N/A**
12	**Brake pads, shoes and linings**			
	(a) The thickness of each brake pad or shoe/lining fitted is within the wear limit specified by the component manufacturer.	**Y**	**N**	**N/A**
	(b) Each locating pin, guide pin, retaining pin, clip, or part provided for the brake pad or shoe/lining is in good condition and securely fitted.	**Y**	**N**	**N/A**
	For disk *brakes*			
	(c) Each brake pad fitted is suitable for the brake caliper assembly.	**Y**	**N**	**N/A**
	(d) Each brake pad guide, 'anti-rattle' shim, or backing plate is fitted.	**Y**	**N**	**N/A**
	For drum *brakes*			
	(e) Each brake shoe/lining is suitable for the brake drum assembly.	**Y**	**N**	**N/A**
	(f) The radius of each brake shoe/lining is matched or 'sized' to the relevant brake drum.	**Y**	**N**	**N/A**
	(g) Each brake return spring is either new or in good condition.	**Y**	**N**	**N/A**
13	**Brake lines, hoses and cables**			
	Rigid brake lines must not be welded, brazed or soldered - they must be double flared in accordance with SAE J5336 or its equivalent. Copper brake lines must not be used - copper-nickel alloy (Cunifer) tubing is acceptable.			
	Each:	**Y**	**N**	**N/A**
	(a) rigid brake line is made from material suitable for use in automotive braking systems.			
	(b) flexible brake hose is made from material suitable for use in automotive braking systems.	**Y**	**N**	**N/A**
	(c) flexible brake hose assembly is marked with the component manufacturer name/trademark stating compliance with SAE J1401 or equivalent.	**Y**	**N**	**N/A**
	(d) flexible brake hose is of sufficient length to allow full steering and suspension travel.	**Y**	**N**	**N/A**

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Brake system installation checklist				
	(e) rigid brake line is supported (and secured) at least every 600 mm.	**Y**	**N**	**N/A**
	(f) brake line passing through a panel, firewall, bulkhead or structural member is insulated from wear and/or abrasion.	**Y**	**N**	**N/A**
	(g) brake line is either routed away from areas of excessive heat or it is protected by a suitable heat shield.	**Y**	**N**	**N/A**
	(h) brake line is either routed away from areas of potential wear, impact, or mechanical damage - or is protected by a suitable guard.	**Y**	**N**	**N/A**
	(i) brake line is located at least 10 mm from a wheel or tyre	**Y**	**N**	**N/A**
	For park/emergency brake cables or actuator rods			**N/A**
	(j) Each park brake cable or actuator rod is supported and secured.	**Y**	**N**	**N/A**
	(k) The park brake cable or actuator rod assembly is adjustable.	**Y**	**N**	**N/A**
	(l) There is sufficient clearance around each park brake cable or rod to ensure it does not rub against the exhaust or any moving component.	**Y**	**N**	**N/A**
14	**Fasteners**			
	(a) Each fastener (i.e. stud, bolt, screw, or nut) is of a size and strength suitable for its allocated task.	**Y**	**N**	**N/A**
	(b) Each brake control, master cylinder, reservoir, booster and wheel cylinder/calliper is secured with high tensile fasteners marked by the component manufacturer as at least ISO Class 8.8 or SAE Grade 5.	**Y**	**N**	**N/A**
	(c) Each stud and bolt is long enough that at least **one clear turn** of thread is visible when secured.	**Y**	**N**	**N/A**
	(d) A suitable locking device is fitted to each fastener. ***Suitable locking device*** being: **i.** a spring washer or shake proof washer; or **ii.** a locking tab; or **iii.** suitable lock wire (with appropriate bolts/nuts); or **iv.** a deformed thread locknut; or **v.** a castellated nut with split pins. *Nyloc™ type (nylon-insert lock) nuts are not suitable for use where subject to heat as they become heat affected. In addition they are single use items.*	**Y**	**N**	**N/A**
15	**Brake system performance**			
	(a) When the *brakes* are applied at any speed, the vehicle remains within a 3.5 m wide lane.	**Y**	**N**	**N/A**
	(b) Under heavy braking, the front wheels lock up before the rear wheels.	**Y**	**N**	**N/A**
	(c) When the service *brakes* are applied, the vehicle is capable of stopping from an initial speed of 35 km/h in 12.5 m.	**Y**	**N**	**N/A**

Where 'N/A' is nominated to an item in the checklist, details shall be provided to explain why the item is not applicable.

For use by licensed certifier:

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Appendix C: Requirements when using a handbrake from a similar vehicle

When assessing a handbrake mechanism involving similar vehicle criteria, the following additional points must be taken into account.

1. For *ADR vehicles*, the category of the similar vehicles is the same.
   For example, a handbrake from a vehicle that complies with ADR 35/-- vehicle may not be used on a vehicle that complies with ADR 31/--. This is because a vehicle manufactured to ADR/35 has approximately 50% higher effort allowance than a vehicle manufactured to ADR 31/-- (590 N force compared to a 400 N force).
2. Item 1 above does not apply if the tested vehicle has been modified and the handbrake has been tested in accordance with the applicable vehicle standards (be it ADR or other), and those standards apply to the untested vehicle. For example, if the tested vehicle is a *pre-ADR vehicle* and the untested vehicle an *ADR vehicle*, the handbrake assembly is only eligible for the similar vehicle allowance where it has been tested in accordance with the same ADR that applied to the untested vehicle.
3. For *pre-ADR vehicles*, the following applies:
   a) Passenger car derivative commercial vehicle components may be used on passenger cars.
   b) Passenger car components may be used on any commercial vehicle.
   c) Ordinary commercial vehicle components that are not passenger car derivatives may not be used on passenger cars.
4. If the handbrake assembly is taken from a tested vehicle and the handbrake lever is not from the same donor vehicle as the tested vehicle, then the mechanical advantage or lever ratio of the untested vehicle must be numerically the same or higher than the tested vehicle. For example, where the tested vehicle's mechanical advantage is 6.0:1, then 6.1:1 is a higher ratio; and 5.9:1 is a lower ratio.

Notes: 1. ADR 31/-- and ADR 35/-- means any versions of ADR 31 or ADR 35 respectively.

4. The term 'handbrake' is equally applicable to 'park brake'.

For vehicles fitted with an equaliser system to equalise the tension in the cables, the handbrake cable equaliser system from the donor vehicle must be retained in the same form and function including, any ratio change which is incorporated into the equaliser system.

If a vehicle is modified so that an electrically applied handbrake replaces a hand operated handbrake, all mechanical components of the donor parts should be used.

Appendix D: Using a Plate-Type Test Machine

A plate-type brake test machine may be used to determine performance of the brakes, and some of the tests specified in Table 3. Tests are listed below, with applicable pass criteria. Examples of data and read-outs obtained from a plate-type brake test machine are provided.

For all tests the vehicle must be:

- In neutral gear
- Tested in the unladen condition with just the driver.

Test D - Basic performance (Table D1)

An assessment of brake performance for:

- Left to right brake imbalance – both front and rear brakes
- Front to rear brake imbalance
- Brake pedal force applied
- Peak deceleration rate
- Average deceleration rate
- Handbrake/park brake imbalance
- Peak handbrake/park brake deceleration rate
- Wheel alignment.

Test D – Test with front brakes disconnected (Table D2)

The read-out should indicate that the brakes exert sufficient force to bring the vehicle to a stop. To pass this test, the peak deceleration must have a minimum rate of 20%.

Test D – Test with rear brakes disconnected (Table D3)

The read-out should indicate the brakes exert sufficient force to bring the vehicle to a stop. To pass this test, the peak deceleration must have a minimum rate of 50%.
This corresponds to Test D in Table 3.

Test E - Test with booster disconnected (Table D4)

The read-out should indicate the brakes exert sufficient force to bring the vehicle to a stop. To pass this test, the peak deceleration must have a minimum rate of 50% applied with a pedal force pressure of 500 N.

Test B The mounting structure must remain rigid when the following loads are applied:

- 500 N for vehicles in Modification Category 19
- 885 N for vehicles manufactured prior to the introduction of ADR 31 on 1 January *1977*
- 1000 N for vehicles manufactured after the introduction of ADR 31 on 1 January *1977*.

Test F The *axle* brake force must be between:

- Front axle: 55% minimum and 90% maximum
- Rear axle: 10% minimum and 45% maximum.

Test G With ABS disconnected, the *axle* brake force must be between:

- Front axle: 55% minimum and 90% maximum
- Rear axle: 10% minimum and 45% maximum.

Test I The front wheels must lock before the rear wheels (determine from Test 4.1 graph), and the *axle* brake force must be between:

- Front axle: 55% minimum and 90% maximum
- Rear axle: 10% minimum and 45% maximum.

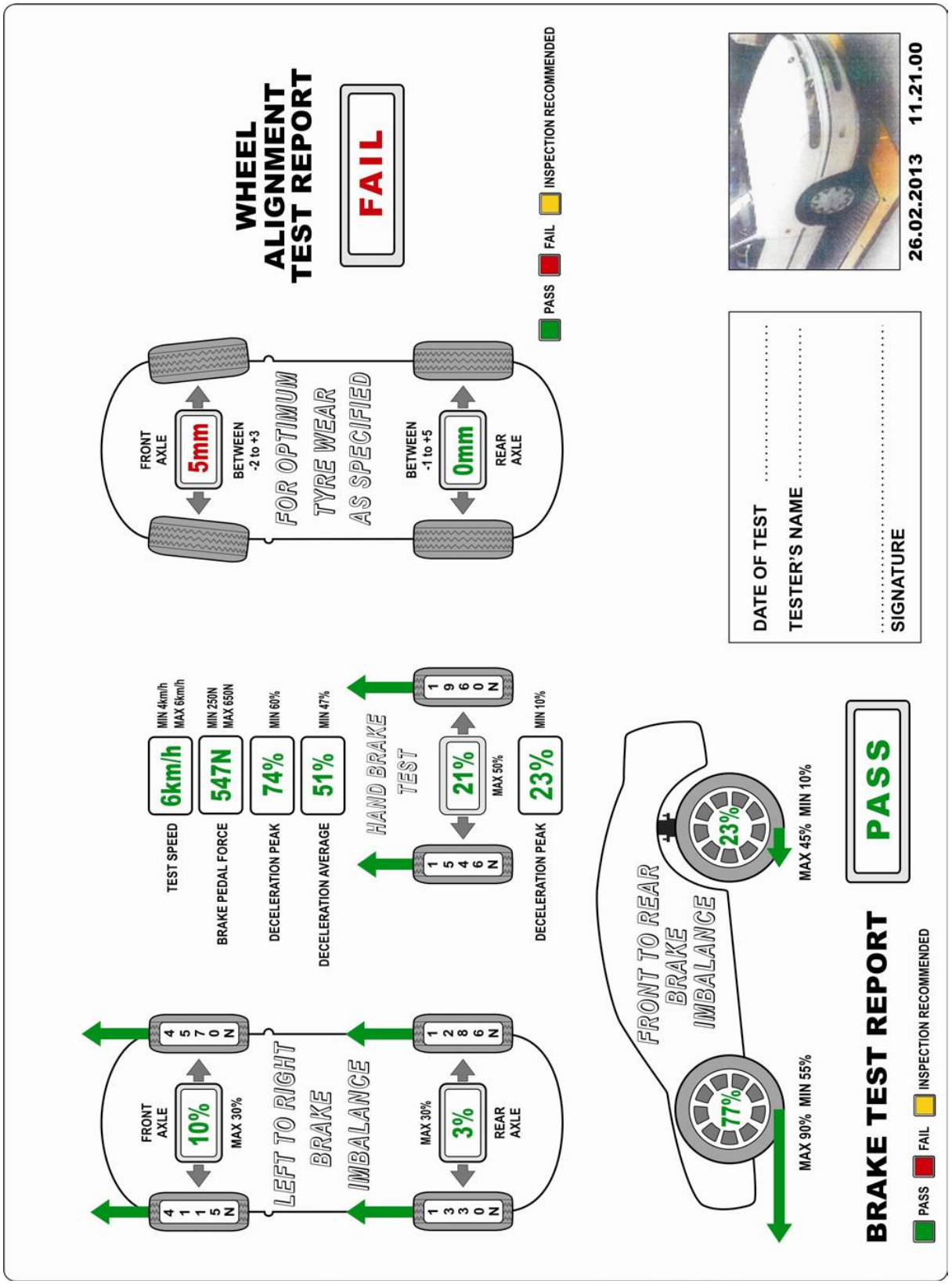
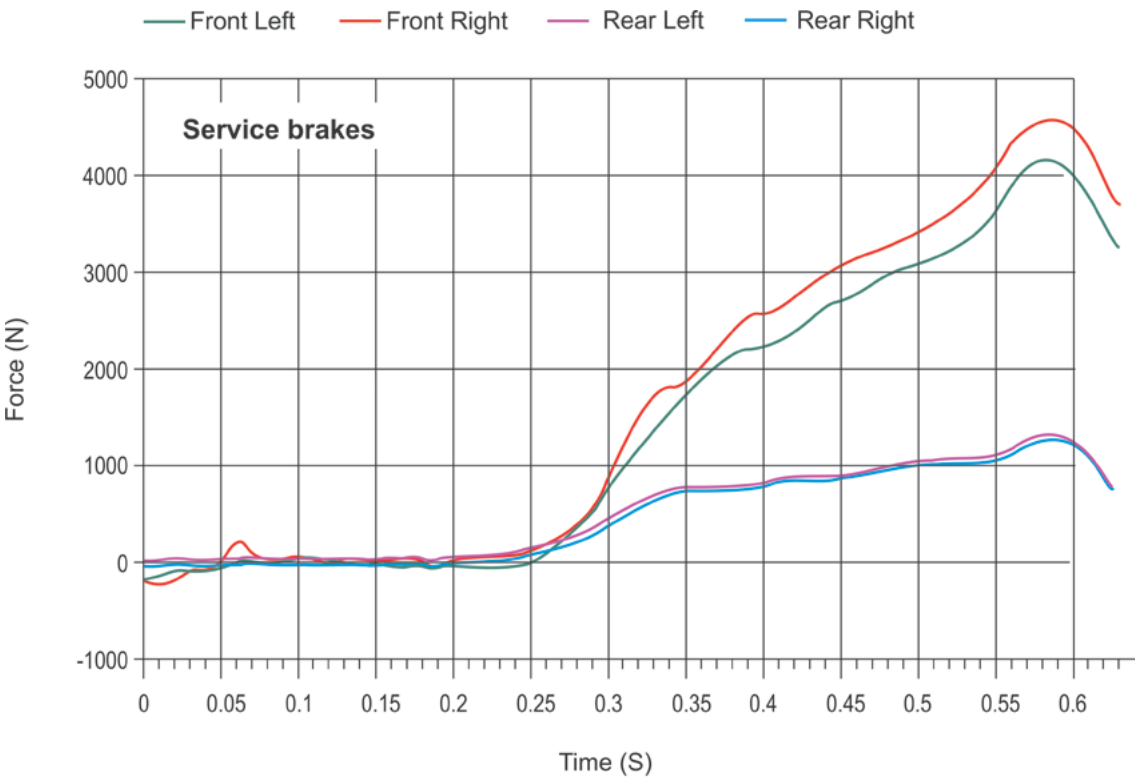


Figure D.1.1: Example of data from a plate brake test machine – Basic test



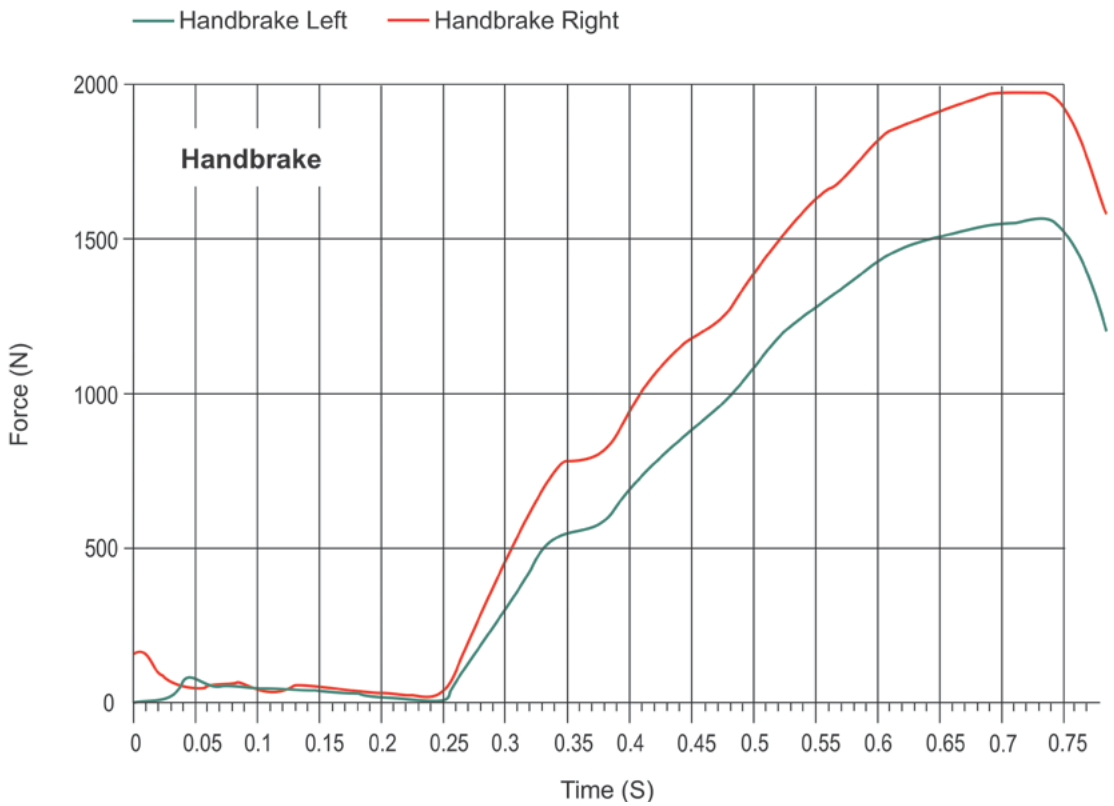


Figure D.1.2: Example of read out using a plate brake test machine – Basic test

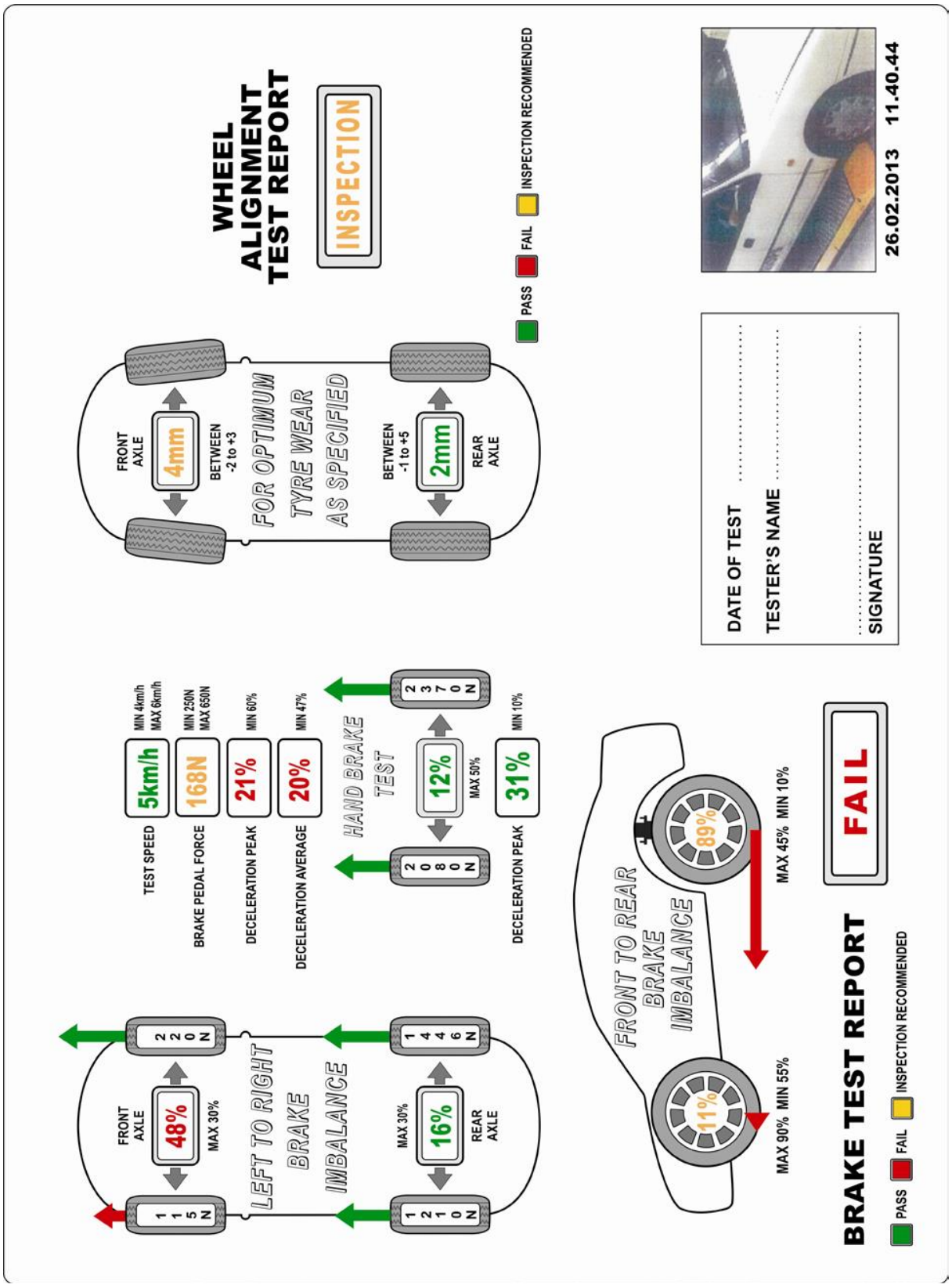
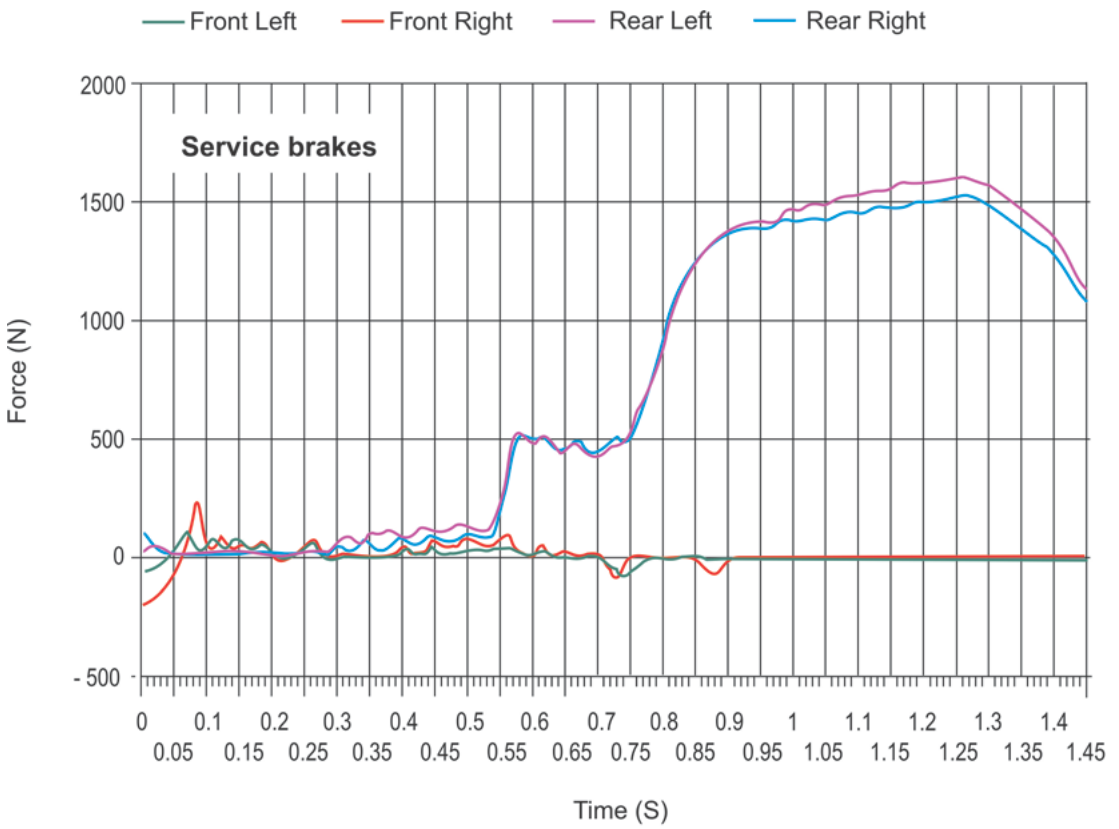


Figure D.2.1: Example of data using a plate brake test machine test – Test D Front *brakes* disconnected



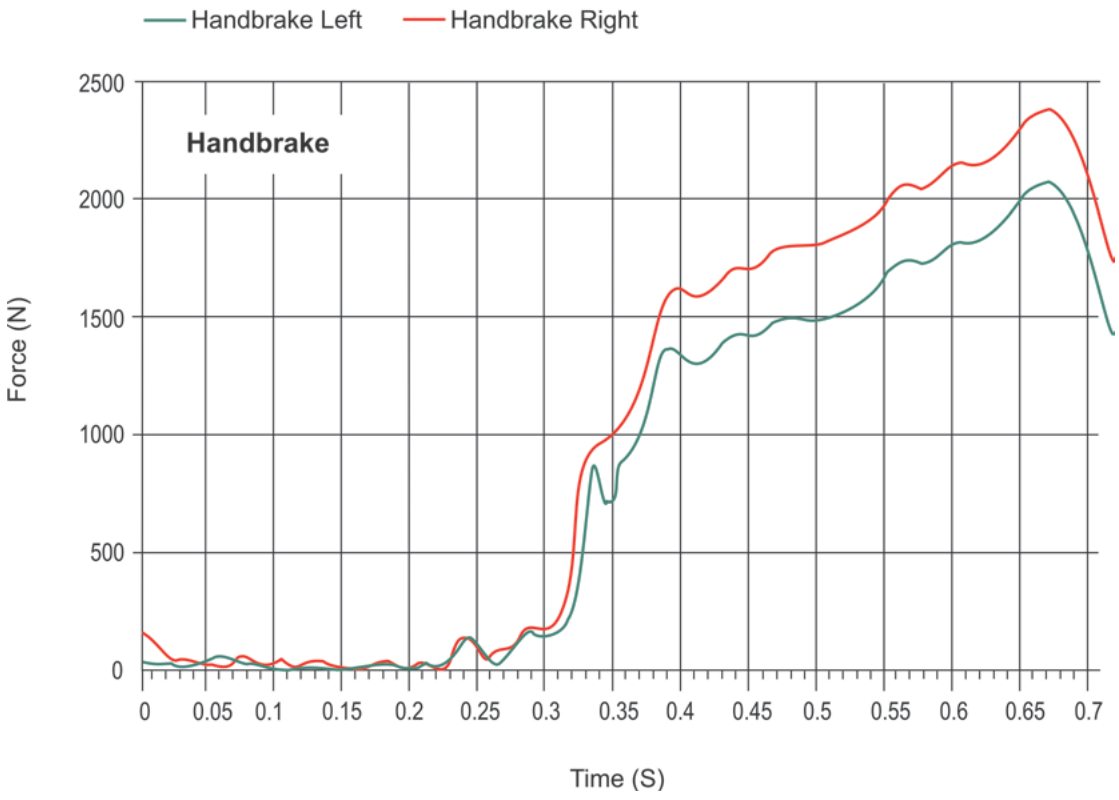


Figure D.2.2: Example of read out using a plate brake test machine test – Test D Front *brakes* disconnected

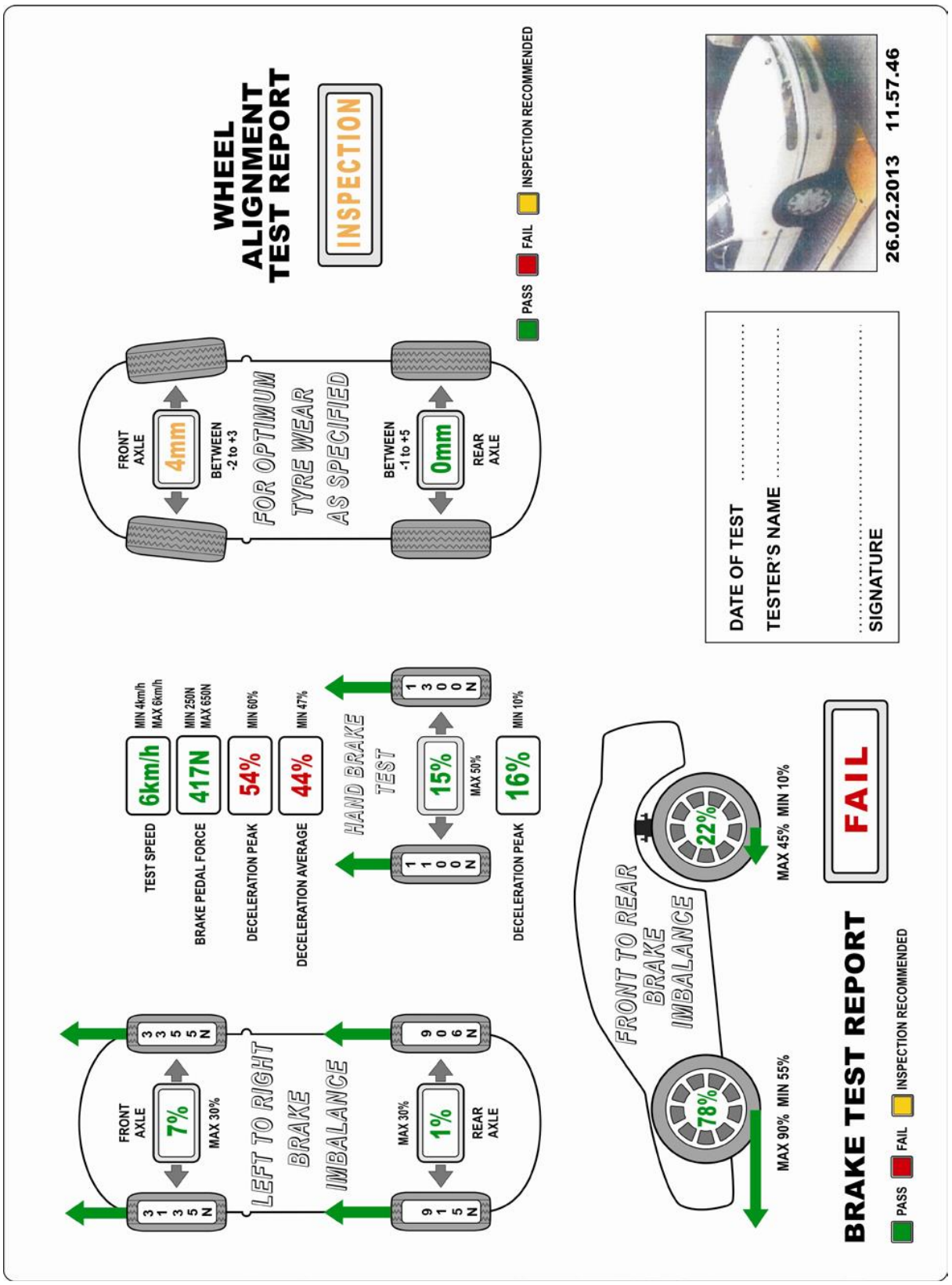


Figure D.3.1: Example of data using a plate brake test machine test – Test D Rear *brakes* disconnected

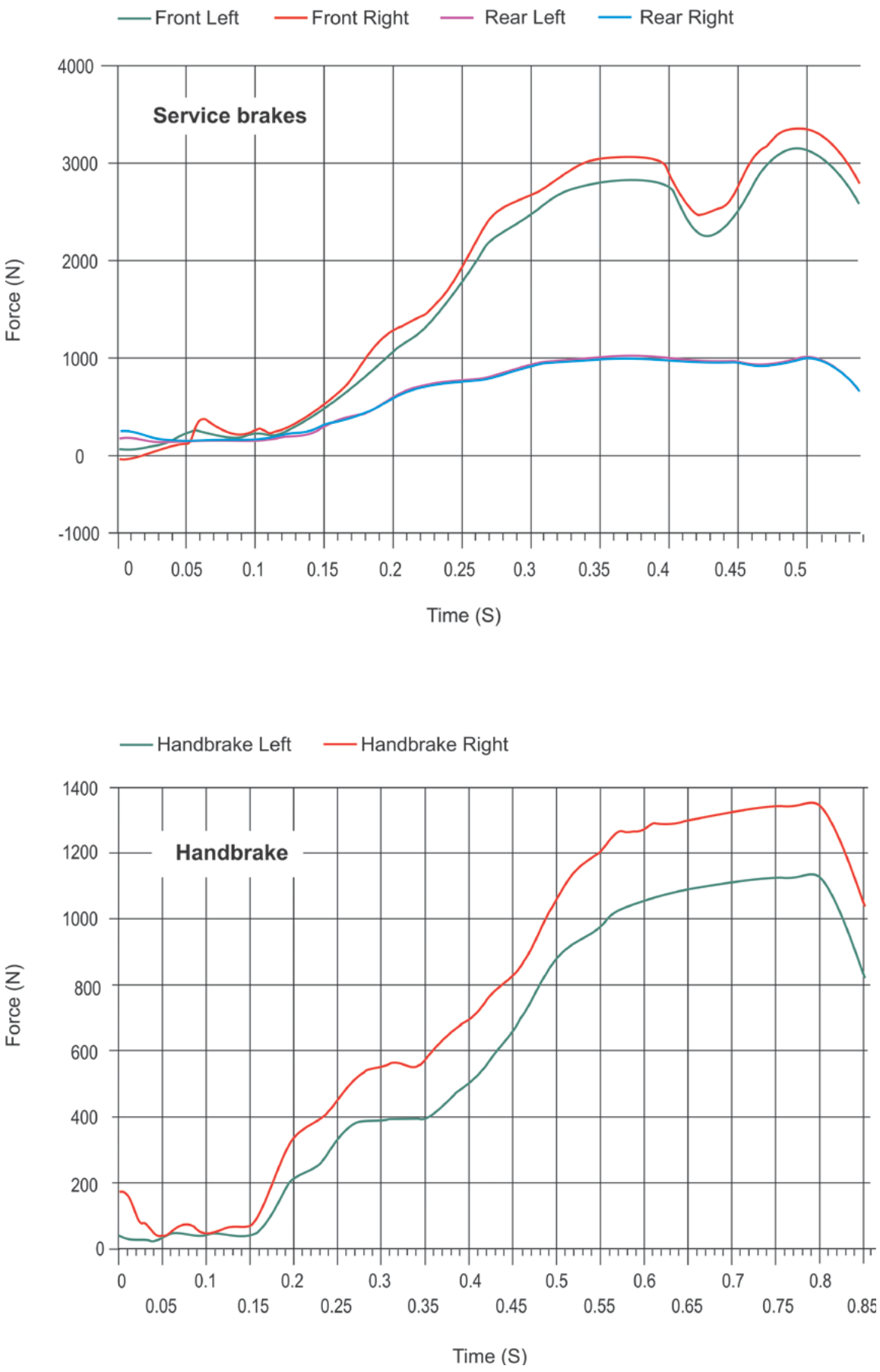


Figure D.3.2: Example rear out from a plate brake test machine test – Test D Rear *brakes* disconnected

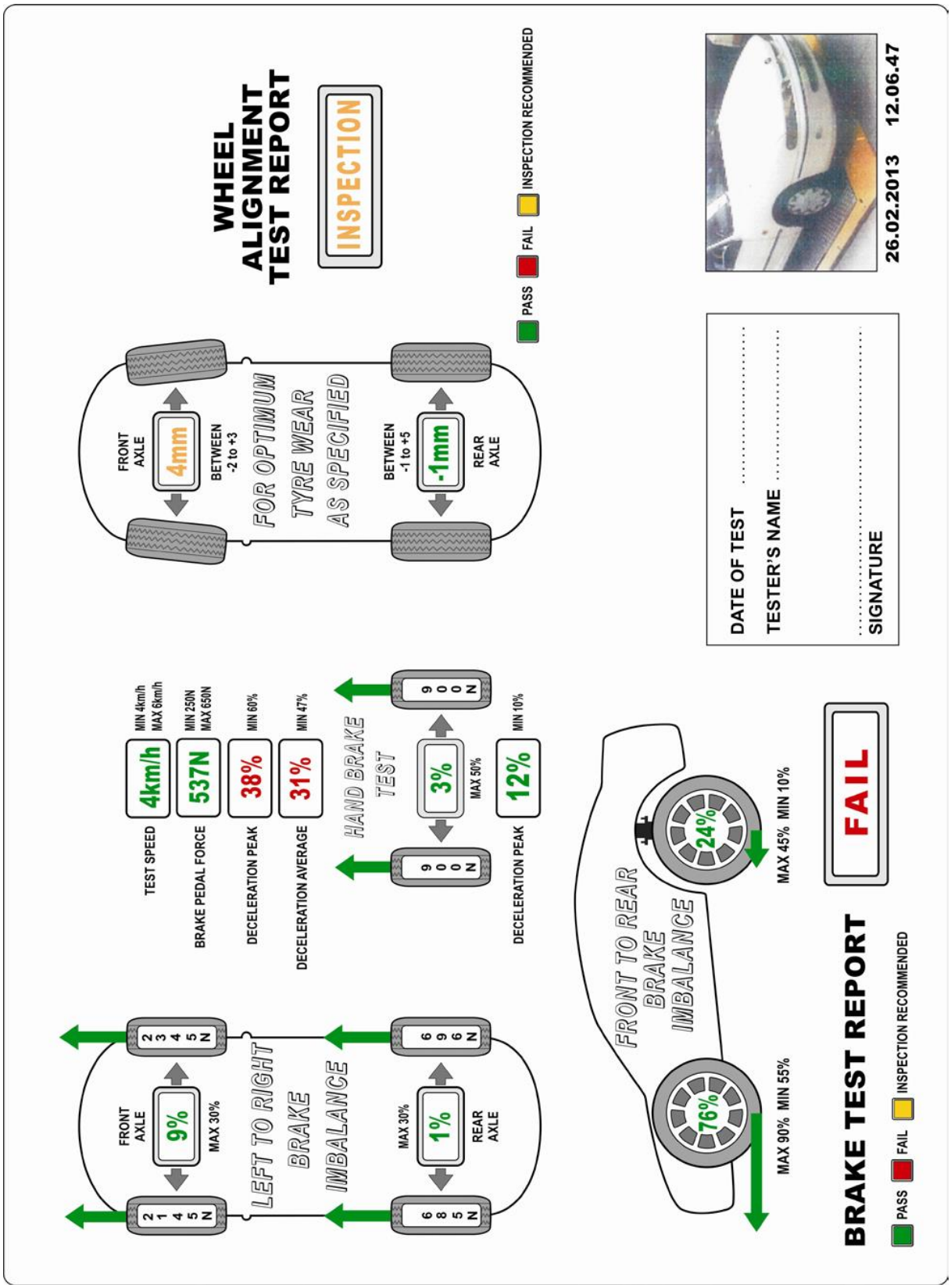


Figure D.4.1: Example of data using a plate brake test machine test – Test E Booster disconnected

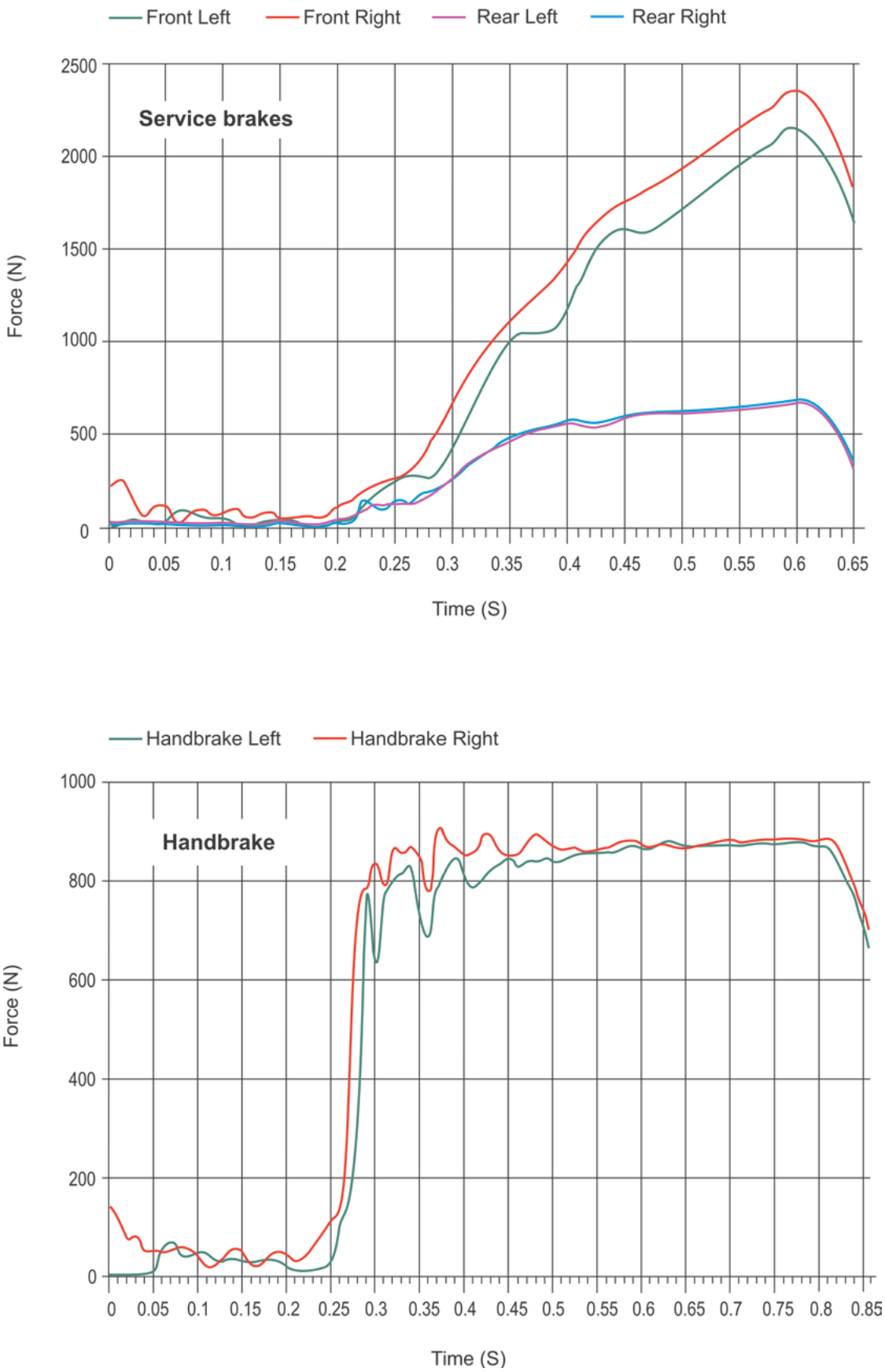


Figure D.3.2: Example of read out from a plate brake test machine test – Test E Booster disconnected

Appendix E: Description of tests

Order of tests

The tests should be done in the order presented.
Tests C, E, & F and Test D should be done as early as possible as these indicate the likelihood of the vehicle passing the other tests.

Test speed

The test speed shall be the vehicle speed registered on the test instrumentation, not on the vehicle speedometer.

Test A: Reservoir volume

The vehicle shall either be fitted with a red warning signal as specified in Clause 5.2.21.1.1 of ADR31/01, or the brake system shall pass the following test.

[Based on: ADR 31/00, Clause 31.2.5.]

Where the service *brake system* incorporates a master cylinder, all service brake subsystems serviced by the master cylinder must have either:

- a reservoir which contains fluid exclusively for the use of that service brake sub-system; or
- a reservoir which contains fluid for the use of two or more service brake sub-systems in which case that part of the reservoir capacity provided exclusively for the use of each service brake sub-system must be not less than the volume displaced by the master cylinder piston servicing the sub-system, during a full stroke of the piston.

The capacity of each reservoir must be not less than the fluid displacement resulting when all the wheel cylinders or calliper pistons serviced by the reservoir move from a new-lining, fully-retracted position, as adjusted according to the *Manufacturer's* recommendations to a fully-worn, fully applied position. For the purposes of this test, 'fully-worn' means that the lining is worn to whichever of the following conditions allows the greatest shoe or pad movement:

1. level with rivet or bolt heads on riveted or bolted linings;
2. within 0.8 mm of shoe or pad mounting surface on bonded linings or pads; or
3. the limit recommended by the *Manufacturer.*

Each *Brake Power Unit* must have a device for storing energy of capacity not less than the total capacity of the reservoirs required above plus the fluid displacement necessary to charge the piston(s) or accumulator(s) provided for the purpose of storing energy.

A statement specifying the type of fluid to be used in the *brake system* and displaying at least the words in letters not less than 3 mm high 'WARNING - Clean filler cap before removing' must be permanently affixed either on, or partially within 150 mm of, one brake fluid reservoir filler plug or cap, and totally within 300 mm of all reservoir filler plugs or caps. The statement must either be stamped, engraved or embossed, or comprise lettering of a contrasting colour to that of the background.

Test B: Mounting structure

This test is required to ensure that the firewall and mounting brackets for the brake pedal, master cylinder and/or booster are structurally adequate.

A load shall be applied to the brake pedal with the vehicle stationary and the engine off. An observation of the mounting structure shall be made for local deformation. The mounting structure shall be rigid.

Loading shall be:

- 500 N for vehicles in Modification Category 19;
- 885 N for vehicles manufactured prior to the introduction of ADR 31 on 1 January *1977*;
- 1000 N for vehicles manufactured after the introduction of ADR 31 on 1 January *1977*.

The mounting structure shall be deemed to have passed the test if there is no damage or permanent deformation after the load is removed.

Test C: Park brake

The park brake efficiency shall be tested as follows:

(a) with the vehicle stationary, apply the park brake;

(b) start the engine and engage low gear;

(c) attempt to move the vehicle forward under light throttle;

(d) engage reverse gear;

(e) attempt to move the vehicle backward.

The park brake shall be deemed to have passed the test if the vehicle remains stationary. When doing this test on a transmission handbrake, the throttle should be applied smoothly and gradually to prevent damage to the transmission.

This function test should only apply to a modified vehicle if the donor vehicle park *brake system* components are from a vehicle that has been tested and known to comply with the ADR or other applicable standard, and the modified vehicle is of a lesser mass than the donor vehicle.

The components comprise the foundation park brake assemblies, equalisers, cables and the like. The park brake lever may be either from the donor vehicle or one of the same ratio equivalent.

Note: In certain circumstances, the park brake forms an emergency brake and is subject to a dynamic test. This may dictate the choice of components.

Cables manufactured by a recognised park brake cable manufacturer, either the original component manufacturer or aftermarket, may be used as an alternative to an OEM cable.

If the components do not meet the above criteria, the modified vehicle must be tested in accordance with the ADR that applies to the modified vehicle, or a later version of the ADR. For *pre-ADR vehicles*, the vehicle must be tested in accordance with any version of ADR 31 or ADR 35 as applicable. Alternatively, the vehicle must be tested in accordance with the parking brake test specified in Table LG5 of VSB14 for *pre-ADR vehicles.*

For more information, see Appendix C.

Tests D, F & G: Partial failure test front and rear; proportional valve failure; and ABS failure

[Based on: ADR 31/00, Clause 31.3.2, Item 8 and Clause 31.5.8.]

SPLIT SERVICE BRAKE SYSTEMS

These tests apply to *Split Service Brake Systems*. They do not apply to single circuit brake systems fitted to pre-ADR vehicles; Single circuit brake systems fitted to pre-ADR vehicles must have an emergency brake fitted meeting the performance requirements specified in clause 2.3.6 to Annex 3, Appendix A of ADR 31/01.

These tests should not be carried out on public roads.

Test D checks the master cylinder in a *Split Service Brake System* has enough displacement to operate an individual circuit in the event of one of the circuits failing. Clamping off a brake hose does not simulate a failure in one circuit. Instead, one of the following two procedures should be used. Option 2 may not be suitable for vehicles fitted with vacuum brakes.

Option 1

1. Attach a container via a hose to the brake bleeder nipple
2. The bleeder hose must be such that it will be above any fluid level.
3. Open the brake bleeder nipple by **one full turn**.
4. Apply the service brake pedal one complete application
5. The fluid level MUST be below the end of the bleeder hose
6. Conduct the particular test.
7. Replenish the brake fluid – bleed the brakes for the failed circuit.; check bleed and the circuit that was tested
8. Repeat for the other circuit in the dual circuit system

Option 2

1. Set up vehicle on test lane, apply park brake.
2. Attach a container via a hose to the brake bleeder nipple.
3. The bleeder hose must be such that it will be above any fluid level.
4. Open the brake bleeder nipple by **one full turn**.
5. Conduct the test.
6. The test driver is to bring the vehicle to a complete stop and remain with the pedal depressed. Maintaining high pressure is not required, apply sufficient pressure so that the master cylinders do not return from the applied position.
7. The test driver is to then turn off the vehicle engine.
8. The assistant is then to tighten the bleed nipple to prevent any air from entering the system.
9. Replenish the brake fluid - bleed the brakes for the failed circuit; check and bleed the circuit that was tested.
10. Repeat for the other circuit in the dual circuit system.

Tests F and G ensure that the vehicle can be safely brought to rest in the event that the ABS or that the brake proportioning unit fails.

For vehicles subject to Modification 19, the vehicle shall be tested in both the *MLTM* and *LLTM* condition at a test speed of 55 km/h with the gear selected in the 'Drive' position. The minimum *Average Deceleration* shall be 2.55 m/s^2.

In the case of a vehicle with a *Split Service Brake System*, the vehicle shall be tested in the *MLTM* condition with the gear selected in the 'Drive' position at a test speed of either between 95 - 105 km/h or 80 km/h; the reason for using the lower test speed shall be provided as part of the certification process.

The minimum *Average Deceleration* shall be 2.55 m/s^2 for the 95 - 105 km/h speed, and 3.2 m/s^2 for 80 km/h. For *pre-ADR vehicles*, if the vehicle cannot reach the 3.2 m/s^2 at 80km/h, a minimum Average Deceleration of 2.7 m/s^2 would be accepted if accompanied by an explanation. These must be obtained by operation of the service brake *Control* on at least one deceleration mode and up to but not exceeding four (deceleration modes) for each single type of potential failure, including:

- failure of each sub-system of the split system
- inoperative *Antilock System;* and
- inoperative *Variable Proportioning Brake System* if fitted*.*

In addition, one single failure must be induced prior to each set of deceleration modes and the vehicle restored at the completion of the set.

SINGLE CIRCUIT BRAKE SYSTEMS

Single circuit brake systems must have an emergency brake fitted meeting the performance requirements specified in clause 2.3.6 to Annex 3, Appendix A of ADR 31/01. The use of the emergency handbrake to assist in this partial failure test is acceptable to achieve the required performance.

In the case of a vehicle not having a *Split Service Brake System*, the vehicle shall be tested in both the *MLTM* and *LLTM* condition with the gear selected in the 'Drive' position at a test speed of either between 95 - 105km/h or 80km/h. The rationale for using the lower test speed shall be provided as part of the certification process.
The minimum *Average Deceleration* shall be 2.55 m/s^2 for the 95 - 105 km/h speed, and 3.2 m/s^2 for 80 km/h.
These must be obtained by operation of the service brake *Control* on each of 10 consecutive stops for each single type of potential failure, including:

- rupture or leakage of any component of the *brake system* other than a structural failure of a housing that is common to two or more sub-systems
- inoperative *Antilock System; and*
- inoperative *Variable Proportioning Brake System.*

In addition, one single failure shall be induced prior to each set of deceleration modes and the vehicle restored at the completion of the set.

Single circuit brake systems fitted to pre-ADR vehicles need not comply with the above, they must however have an emergency brake fitted meeting the performance requirements specified in clause 2.3.6 to Annex 3, Appendix of ADR 31/01.

For vehicles not having a *Split Service Brake System* but having a service *brake system* using *Stored Energy* - the pressure and volume of the working fluid in the *brake system* (including any energy storage devices) shall not exceed the minimum levels specified by the vehicle *Manufacture* or achievable by adjustment of *Control* s accessible to the driver for initiation of the failure mode prior to the commencement of any partial failure test sequence.
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Test E: Booster failure

[Based on: ADR 31/00, Clause 31.3.2, Item 9 and Clause 31.5.9.]

Test E ensures the vehicle can be safely brought to rest in the event that the booster fails.

For vehicles subject to Modification 19, this test must be done at 55 km/h; for all other vehicles, the test must be done at 80 km/h. In all cases the vehicle must be in the *MLTM* condition and the gears in the 'drive' position. The vehicle must meet one of the following:

Condition D1 Attain a minimum *Average Deceleration* of 2.55 m/s^2 for one deceleration mode within a maximum of four deceleration modes when any one *Brake Power Assist Unit* or *Brake Power Unit* is inoperative and depleted of all reserve capability. One single failure must be induced prior to each set of deceleration modes and the vehicle restored at the completion of the set.

Condition D2 Where fitted with one or more *Brake Power Assist Units* - with any one *Brake Power Assist Unit* inoperative, the *Average Decelerations* set out in Table D must be attained on the first six consecutive stops (with the inoperative unit not initially depleted of reserve capability), and the *Average Deceleration* specified for the final seventh stop is attained with the inoperative unit depleted of reserve capability.

Condition D3 Where fitted with a *Brake Power Unit* incorporating an accumulator-type reserve system - with any one *Brake Power Unit* inoperative, the *Average Decelerations* set out in Table D must be attained on the first ten consecutive stops (with the inoperative unit not initially depleted of reserve capability), and the *Average Deceleration* specified for the final eleventh stop is attained with the inoperative unit depleted of reserve capability.

Condition D4 Where fitted with a *Brake Power Unit* incorporating a backup type system, with any one *Brake Power Unit* inoperative the *Average Deceleration* set out in Table D must be attained for each of the 15 consecutive stops.

Table D: Average decelerations for vehicles in m/s^2

Number	Condition		
	D2	D3	D4
1	4.85	4.85	Not less than 3.65
2	3.65	3.95	
3	3.00	3.65	
4	2.70	3.35	
5	2.40	3.00	
6	2.25	2.85	
7	2.00	2.70	
8		2.55	
9		2.40	
10		2.25	
11		2.10	
12			
13			
14			
15			

Test H: Spike stops and/or Fatigue assessment

General

The abridged spike stop test is both a brake system component and hydraulic durability test intended to show up any immediate flexing, permanent distortion, failures and/or brake imbalance in the brake system components and the vehicle suspension. The spike stop test is not an indication of the life expectancy of the brake system or the suspension system; a fatigue and structural analysis may be used for this purpose.

A hydraulic system shock test is also required for vehicles that do not generate sufficient pedal force in the spike stop test or where the fatigue and structural analysis is used instead of the spike stop tests.

Alternatively, a fatigue and structural analysis may be carried out instead of the spike stop test. This can also be used to determine the life expectancy of the brake system and consequent vehicle safety.

Spike stops

[Based on: ADR 31/00, Clause 31.3.2, Item 25 and Clause 31.5.25.]

Particular care is required in doing this test as it can result in unnecessary wear on the tyres. It is important that both the licensed certifier, or other person overseeing the test, and the person driving the vehicle are competent. Appropriate equipment is used to measure and record the data. Brake temperature can be recorded by thermocouple, laser temperature gauge or similar. This need not be a logging device. Either of the two methods may be used.

Method 1: This test sequence constitutes a series of tests to highlight issues with structural and hydraulic elements of the modifications by applying a sudden and instantaneous braking load to the vehicle, and then continuing on to stop with a lesser braking effort that allow the wheels commence rotating after the initial wheel lock. A modification that increases vehicle braking performance places additional stress on both original and custom components that may not have been designed suitably for the increased loadings.

For the applicable modifications, the following conditions apply:

- The vehicle is at MLTM
- The brake temperatures are less than 100ºC prior to the start of the test and the temperature of the front and rear brakes are within 5ºC of each other
- The speed is 55 km/h
- The gear selector in the ‘neutral’ position.
- The brake pedal is subjected to sudden and instantaneous application and release such that the wheels lock.
- The vehicle is brought to a stop after the momentary wheel lock as quickly as possible and without further locking of the wheels. It may be necessary to reduce the pedal effort to allow the road wheels to commence rotation after the momentary wheel lock.

If the wheels do not lock then the vehicle has not passed the test. It may be necessary to increase the pedal force to achieve wheel lock. Difficulties in obtaining wheel-lock may indicate that the brake system is not be suitable for the vehicle.
The test shall be repeated ten times. At the conclusion of the tenth test cycle, if the temperature of the rear brakes does not exceed that of the front brakes by more than 10ºC, then the vehicle is deemed to have passed the test. It is acceptable for the rear brake temperature to be less than the front brake temperature.

If the rear brake temperature exceeds the front brake temperature by more than 10ºC, the licensed certifier assessing the vehicle must provide a sound technical argument for this before deeming the vehicle to have passed the test.

Note: The 10º criteria was adopted in light of experience testing vehicles with a rear brake bias to the extent that the rear wheels locked before the front.

Method 2: The technique as outlined in ADR 31/00 requires a pedal force of not less than 885 N applied within 400 ms of pedal application (maintained until the vehicle is stationary)

from an initial speed of 45 - 55 km/h and repeated 10 times.

Post-test inspection

At the conclusion of the spike stop test sequence a safety check shall be conducted to examine the brake system:

- check tightness of all hydraulic pipe and hose joints
- examine all pipes and hoses for leakage and chafing
- examine all clamps, brackets, penetrations, for damage or movement
- examine hoses at the wheel end for chafing and or rubbing on components; conduct a steering lock-to-lock wheel movement
- check that mechanical brake proportioning valves are free to move and are not binding or rubbing on any components including any component parts of the exhaust system
- examine all pad retention devices for loose or detached retainers
- examine drum brake backing plates for mounting bolts/devices and wheel cylinder mounting
- examine the hand / park brake mechanism at the wheel end and at the operator end for freedom of movement away from body / chassis components including hydraulic brake system components
- examine all brake system components for any defects, failures or permanent distortion

If any repairs or modifications are necessary then once those repairs or modifications are complete the entire Test H sequence must be repeated, including the post-test inspection to determine the effectiveness of the repairs or modifications.

Fatigue and structural analysis

As an alternative to the spike stop test, a fatigue and structural analysis of the structural adequacy of the brake system and its associated components may be carried out to assess the capability of the brake system to resist fatigue and absorb impact loads.
If this option is chosen then the fatigue and structural analysis must be carried out by a *competent person*. It is expected that the review utilise a method such as finite element analysis or comparison with a similar vehicle known to comply with the ADR - which may be a production vehicle or a modified vehicle that has been previously subjected to a fatigue and structural analysis in accordance with the Manual and found to be satisfactory.

Fatigue shall be assessed for infinite life of the materials used in the components including welds. A buckling analysis must be included that accounts for impact loading that occurs in the service life of such components.

Refer to VSB 14 section LS part 3 - Component stress levels for recommended loading condition, which are to be taken as the minimum applicable.

To follow the comparison path for spike stop assessment, the front and rear suspension and brake subsystems must remain as originally supplied by the manufacturer. When using complete sub-frames (front and rear) along with the associated suspension assemblies then a dynamic test H is not required. An assessment will need to be made by a competent person of the attachment of the complete sub-frame to the modified vehicle. For example, fitting both the front and the rear sub-frame and suspension assembly combined with the original brakes from a Jaguar XJ6.

If the fatigue and structural analysis option is chosen instead of the spike stop test, then the vehicle must be subjected to the hydraulic shock test.

Test I: Wheel lock procedure

[Based on: ADR 31/01, Appendix A, Annex 5, Appendix 1.]

This test is intended to check that the front wheels lock before the back wheels.

The test shall to be done with the vehicle both in the *MLTM* and *LLTM* condition, travelling at 65 km/h and at a braking rate of less than 0.5 m/s^2.

This test shall be done with *cold brakes*. The average temperature of the service *brakes* on the hottest *axle* of the vehicle, measured inside the brake linings or on the braking path of the disc or drum, must be between 65 ºC and 100 ºC prior to any brake application.

The braking manoeuvre shall be done on a surface with a low coefficient of friction, for example grass or a very wet road. It may be necessary to wet the test area.

The test is intended to ensure that lockup of both front wheels occurs at a lower deceleration rate than the lockup of both rear wheels when tested on road surfaces on which wheel lockup occurs at braking rates between 0.15 m/s^2 and 0.5 m/s^2.

A simultaneous lockup of the front and rear wheels refers to the condition when the time interval between the lockup of the last (second) wheel on the rear *Axle* and the last (second) wheel on the front *Axle* is less than 0.1 seconds for vehicle speeds greater than 30 km/h.

Wheel lock of the front wheels before the rear wheels must be visibly evident to the naked eye by an observer or through observation of a video recording of the test procedure.

Test J1: Type-O Engine disconnected

[Based on: ADR 31/01, Appendix A, Annex 3, Clauses 1.4 to 1.4.2 inclusive.]

The following general conditions apply:

- *ADR vehicles* in Modification Category 16 shall be tested at 100 km/h
- vehicles in Modification Categories 17, 26 & 27 shall be tested at the lesser of 80% of their maximum speed or 100 km/h
- vehicles in all other modifications categories shall be tested at 80 km/h
- the tests shall be done with the vehicle in the *MLTM* and *LLTM* conditions.

This test shall be done with *cold brakes*. The average temperature of the service *brakes* on the hottest *axle* of the vehicle, measured inside the brake linings or on the braking path of the disc or drum, must be between 65 ºC and 100 ºC prior to any brake application.

The test must be conducted in the following conditions:

- the vehicle shall be in the *MLTM* condition, the distribution of its mass among the *axles* being that stated by the *Manufacturer*; where provision is made for several arrangements of the load on the *axle*s the distribution of the maximum mass among the *axle*s shall be such that the mass on each *Axle* is proportional to the maximum permissible mass for each *axle*
- every test shall be repeated on the vehicle in the *LLTM* condition; there may be, in addition to the driver, a second person in the front seat who is responsible for noting the results of the test
- the limits prescribed for minimum performance, both for tests with the vehicle in the *LLTM* condition and for tests with the vehicle in the *MLTM* condition, shall be those set out below; the vehicle must satisfy both the prescribed stopping distance and the prescribed mean fully developed deceleration, although it may not be necessary to actually measure both parameters
- unless otherwise specified each test may comprise up to six stops including any needed for familiarization.

For a vehicle to pass the test, the stopping distance must be within $(0.1v + 0.0060v^2)$ metres, where v = the test speed in km/h, with a MFDD of at least 6.43 m/s^2, and the braking force between 65 N and 500 N.

Note: For vehicle tested at 80km/h and 100km/h, the stopping distances must be within 46.4m and 70m respectively.

Test K: Type-I Heating procedure, Engine disconnected

[Based on: ADR 31/01, Appendix A, Annex 3, Clause 1.5.1.]

This test is intended to heat the brakes until the onset of fade to verify the brakes can function when hot.

The service Brakes of all vehicles shall be tested by successively applying and releasing the Brakes until the onset of fade but not more than 15 times, with the vehicle in the MLTM condition.

The speed of the vehicle shall be reduced from 80 km/h to 40 km/h, with 45 seconds between the start of each braking cycle ie the time elapsing between the initiation of one brake application and the initiation of the next.

If the characteristics of the vehicle make it impossible to abide by the prescribed braking cycle, the duration may be increased; in any event, in addition to the time necessary for braking and accelerating the vehicle, a period of 10 seconds must be allowed in each cycle for stabilizing the speed at 80 km/h.

In these tests, the force applied to the Control must be so adjusted as to attain a mean deceleration of 3 m/s^2 during every brake application; two preliminary tests may be carried out to determine the appropriate Control force.

During brake applications, the highest gear ratio (excluding overdrive, etc) must be continuously engaged.

For regaining speed after braking, the gearbox must be used in such a way as to attain a speed of 80 km/h in the shortest possible time (maximum acceleration allowed by the engine and gearbox).

For electric vehicles not having a sufficient autonomy to carry out the cycles of heating, the tests shall be carried out by respecting speed during the first braking application then by using the maximum acceleration of the vehicle, and brake successively at the speed reached at the end of each 45 seconds cycle duration.

Test L: Type-I Hot performance, Engine disconnected

[Based on: ADR 31/01, Appendix A, Annex 3, Clause 1.5.2.]

This test is intended to check the performance of the *brakes* when hot.

The following general conditions apply:

- *ADR-vehicles* in Modification Category 16 shall be tested at 100 km/h
- vehicles in Modification Categories 17, 26 & 27 shall be tested at the lesser of 80% of their maximum speed or 100 km/h
- vehicles in all other modifications categories shall be tested at 80 km/h
- the tests shall be done with the vehicle in the *MLTM* condition only.

At the end of the Test K Type-I Heating Procedure, the hot performance of the service braking system shall be measured in the same conditions (and in particular at a mean control force no greater than the mean force actually used) as for the Test J1 (Type-0 Engine Disconnected) although the temperature conditions may be different.

This hot performance must not be less than 75% of that prescribed, nor less than 60% of the figure recorded for Test J. Speed stabilisation immediately prior to brake application shall be used to determine that the engine is disconnected.

Note: 75% corresponds to a stopping distance of 0.1v + 0.0080v2 and a mean fully developed deceleration of 4.82 m/s^2.

In the case of a vehicle which satisfies the 60% requirement, but which cannot comply with the 75% requirement, a further hot performance test may be carried out using a control force not exceeding 500 N. The results of both tests must be entered in the report.

For electric vehicles fitted with an electric regenerative braking system which is not part of the service braking system, during brake applications, the highest gear shall be continuously engaged and the separate electric braking *Control*, if any, not used.

In the case of the electric vehicles having carried out the cycles of heating, according to Test K (Type-I Heating procedure), the performance tests shall be carried out at the speed prescribed for the subject modification by the vehicle at the end of the cycles of heating.

Test M: Type-I Recovery procedure

[Based on: ADR 31/01, Appendix A, Annex 3, Clause 1.5.3.]

This test is intended to check the performance of the *brakes* when hot.

This test shall take place immediately after Test L (Type-I Hot performance). The vehicle shall be stopped four stops from 50 km/h with the engine connected, at a mean deceleration of 3 m/s^2.

The interval between the start of successive stops should be 1.5 km. A lesser interval may be used to suit the test location, but this results in a more onerous test as the *brakes* have less time to recover between tests. In extreme cases, too short an interval may cause the *brakes* to overheat.

Immediately after each stop, the vehicle shall be accelerated to 50 km/h at the maximum practicable rate, and that speed shall be maintained until making the next stop.

Test N: Type-I Recovery performance

[Based on: ADR 31/01, Appendix A, Annex 3, Clause 1.5.4.]

This test is intended to check the performance of the *brakes* when hot.

The following general conditions apply:

- *ADR vehicles* in Modification Category 16 shall be tested at 100 km/h
- vehicles in Modification Categories 17, 26 & 27 shall be tested at the lesser of 80% of their maximum speed or 100 km/h
- vehicles in all other modifications categories shall be tested at 80 km/h
- the tests shall be done with the vehicle in the *MLTM* condition only.

At the end of Test M (Type-I Recovery procedure) the recovery performance of the service braking system shall be measured in the same conditions as for the Test J1, Type-0 Engine Disconnected, (the temperature conditions may be different), using a mean force on the *Control*, which is not more than the mean control force used in the corresponding Test J1 (Type-0 Engine Disconnected).

This recovery performance must not be less than 70%, nor more than 150%, of the figure recorded for Test J1 (Type 0 Engine Disconnected).

Appendix F: Rationale for the brake tests in Appendix E

The Regulation specifies that the applicable vehicle standards are those contained in its Schedule 2. For vehicles manufactured after 1972, those standards are the Australian Design Rules (ADRs), and for brake systems, the applicable ADRs are ADR 31 *Brake systems for passenger cars*, and ADR 35 *Commercial Vehicle Brake Systems*. This Manual is primarily concerned with ADR 31.

Prior to the introduction of ADR 31 in 1977, there was no uniform national standard that applied to *brake systems*. Instead, *manufacturers* largely based the performance and reliability of *brakes* on their own specifications or a standard approved by a recognised standards writing organisation or technical body. The tests specified in Clause 122 to Schedule 2 in the Regulation that apply to *pre-ADR vehicles* are intended to check the roadworthiness of a registered vehicle, and not to determine the effectiveness of a modified *brake system* or the *brakes* in a modified vehicle. This means there are no standards and tests in the Regulation that can be applied to *pre-ADR vehicles* to assess their modified *brake systems*.

As these vehicles are being modified – as opposed to *restored* or simply maintained – in a similar manner and to achieve the same performance outcomes as later *ADR vehicles*, it is appropriate that all modified vehicles be subjected to the same tests regardless of their date of manufacture. A review of the tests specified in the different editions and versions of ADR 31/-- showed that the easiest set of tests to do is those in ADR 31/00 and ADR 31/01. The tests outlined in Appendix E are based on these tests, and have been carefully developed to ensure they can be used to objectively assess the safety performance capabilities of the brake systems.

Most of the tests have been modified to take into account that the tests specified in ADR 31/-- are intended to verify the effectiveness of a new braking system in a new, mass produced vehicle model; in contrast, in the majority of cases, the vehicles that are subject to the brake test schedule are existing, registered vehicles that have previously been proven to comply with the applicable vehicle standards, and many are being modified with components sourced from existing vehicles or have otherwise been approved. To allow for this, typically, both the number of repeats necessary and the test speeds have been reduced. In some extreme cases, however, a full ADR test will be required.

Appendix G: Variations for *N Category* vehicles and certain *M Category vehicles*

N Category vehicles subject to ADR 35/-- *Commercial Vehicle Brake Systems* must comply with the design requirements of that ADR. The tests specified in Table 3 and Appendix E of this brake test schedule shall be conducted to demonstrate compliance with the performance requirement of ADR 35/00, with the following amendments:

Lightly Loaded Test Mass 35/… -the mass of the unladen vehicle with a full capacity of lubricating oil and coolant and not less than 75 percent of full fuel capacity, but without goods, occupants or options except those options which are essential for the test procedures specified, plus additional loading distributed in the seating position adjacent to the driver‘s seating position so that the mass of such loading plus the mass of the driver and instrumentation mounted in the vehicle is 155±30 kg. In the case of a vehicle in "cab and chassis" condition an additional load not exceeding 7.5 percent of the *‘GVM’* shall be located with its centre of mass within 200 mm of the *‘Manufacturer(s)’* designated load centre, measured in a horizontal plane.

Maximum Loaded Test Mass 35/… - The mass of the laden vehicle loaded to *GVM* rating with the load so distributed over the load bearing area of the vehicle as not to exceed the *‘Manufacturer’s’* nominated individual *Axle Loads*.

Test C: Park brake: The applicable test gradient shall be 18%.

Appendix H: Exemption

TRANSPORT FOR NEW SOUTH WALES

EXEMPTION

Road Transport (Vehicle Registration) Regulation 2017 – Sch.2 cl.11E

I, Paul Duignan, Director Vehicle Safety, a delegate of Transport for NSW (TfNSW), pursuant to clause 11E of Schedule 2 of the Road Transport (Vehicle Registration) Regulation 2017 ('the Regulation') hereby **exempt** modified light vehicles and individually constructed vehicles (ICVs) to which the Brake Test Manual (version 3.0) published by Transport for NSW applies, from the requirements specified in the provisions set out in Schedule 1, subject to the conditions specified in Schedule 2.

Duration

This Exemption remains in force for the currency of the Brake Test Manual (version 3.0) and is an accompanying document to that Manual.

SCHEDULE 1 - PROVISIONS

The requirements in Schedule 2 of the Regulation relating to the testing of brakes on light vehicles, and in particular Part 3 Division 1 of Schedule 2, relating to the requirements to comply with the Australian Design Rules.

SCHEDULE 2 - CONDITIONS

This Exemption applies only subject to the following conditions:

a) The provisions to which the Exemption applies are limited to those provisions which deal with the testing of brakes and brake systems;
b) The Exemption applies only to modified light vehicles and individually constructed light vehicles subject to the certification regime in Part 6 of the Regulation;
c) To be covered by the Exemption, a vehicle must – in lieu of the requirements of the Regulation, be assessed and certified to comply with the requirements of the Brake Assessment Manual (version 3.0).

Note: Failure to comply with the above conditions means that the Exemption does not apply to the subject vehicle, and may render the registered operator in breach of the applicable vehicle standards for registration if the Regulation (and the brake testing regime as set out in the ADR's) has not been complied with. Any such vehicle may be liable to be subject to defect notice, and registration refused, suspended or cancelled.

Dated **3 May 2021**

Paul Duignan

Director Vehicle Safety

Delegate