

Light vehicle modifications manual: Suspension and ride height

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Light vehicle modification manual – Suspension and ride height

Preface

This *Light vehicle modification manual – Suspension and ride height* (the Manual) is intended to provide guidance on modifications to a vehicle's suspension and other components that may alter its original ride height. It outlines modifications that require certification in accordance with the Road Transport (Vehicle Registration) Regulation 2007 and the Vehicle Safety Compliance Certification Scheme, and how to obtain the certification.

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 user 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, and the members are:

- Australian Aftermarket Automotive Association
- Australian Confederation of Motor Clubs
- Confederation of Australian Motor Sport Inc
- Institute of Automotive Mechanical Engineers Motorcycle Council of NSW
- Motorcycle Council of NSW
- Motor Traders Association
- NRMA Motoring Services
- NSW Motorcycle Alliance
- NSW Police Force
- Roads and Maritime Services
- Transport for NSW
- Vehicle Safety Certification Scheme Licensed Certifier

This Manual was first published in December 2016. It is a live document and subject to change in response to practical feedback.

1.0 General

1.1 Scope

This *Light vehicle modification manual – Suspension and ride height* (the Manual) applies to all types of light vehicles, except motorcycles and motor tricycles. It is intended to assist persons in modifying a vehicle's suspension and other components that may alter its original *ride height*.

It provides guidance on how to raise and lower a vehicle's ride height, and outlines modifications that require certification in accordance with the Road Transport (Vehicle Registration) Regulation 2007 (the Regulation) and the Vehicle Safety Compliance Certification Scheme (VSCCS), and how to obtain the certification.

The manual has been gazetted as an Authority standard compliance specification in accordance with the provisions of the Regulation, which means it can be used as means to demonstrate compliance with the Regulation and associated standards.

This Manual only covers changes in ride height of up to 150mm (see Section 3.3).

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. Terms that are *italicised* are defined in Appendix A.

1.2 Introduction

The Regulation requires that all registrable vehicles comply with the applicable vehicle standards, and modified vehicles continue to comply with those standards; and that the vehicle and its parts and equipment are suitable for safe use, and are in a thoroughly serviceable condition.

To assist vehicle owners in meeting these obligations, the Roads and Maritime Services (RMS) has created the VSCCS under the Regulation. This is a modification scheme that authorises persons with appropriate technical qualifications, training and experience, known as 'licensed certifiers', to inspect a modified vehicle and issue a compliance certificate if they are satisfied that it complies with the applicable vehicle standards. 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 52, 55A, 76AC, 76AD and 76AF of the Regulation.)

There are a number of reasons that an owner or operator may choose to raise or lower a vehicle. Typically, these are: to gain additional under-chassis clearances for operational or recreational purposes; to increase its load carrying capability; for a special need, (such as improving access for a disabled passenger); or simply to alter its appearance for aesthetic purposes.

A vehicle's suspension is critical to its safe operation, and is designed by the *manufacturer* to provide safe and predictable performance under specified driving operations. Modifying the suspension beyond the *manufacturer's* specification, or raising or lowering its *ride height*, has the potential to reduce the level of safety a vehicle provides its occupants or other road users; the more extensive these modifications, the greater this potential reduction in safety. As a result, many modifications that result in a change in *ride height* are deemed to be significant and require certification by a licensed certifier. Expert advice from a licensed certifier or other competent person should be obtained early in the modification process to help minimise and control the risks associated with the modifications.

The level of assessment a vehicle must undergo to obtain a compliance certificate is based on the extent of the modification and the risk they pose to the vehicle's occupants and other road users. There are a number of options for obtaining a compliance certificate for the modified vehicle, and these are:

1. A detailed examination of the vehicle combined with the tests specified in the applicable vehicle standard and a road test.
2. Inspection of approved aftermarket components.
3. Assessment based on tests previously done on a similarly modified vehicle.

1.3 Regulatory status of the Suspension Manual

To assist in meeting the requirement that a modified vehicle must comply with the applicable vehicle standards, Clauses 55A and 76AD of the Regulation state that a modified light vehicle is taken to comply with the applicable vehicle standards if the vehicle complies with an *Authority standard compliance specification*, or with the relevant provisions of Vehicle Standards Bulletin 14, *National Code of Practice for Light Vehicle Modification and Construction* (VSB 14).

This Suspension Manual has been gazetted as an Authority standard compliance specification, which means modifications done in accordance with it, will be accepted as complying with the vehicle standards for certification purposes. The Suspension Manual, does refer to VSB 14 for advice on a specific type of modification. If using the Suspension Manual there is a conflict with VSB 14, the requirements of the Suspension Manual take precedence. However, in all cases, if there is any inconsistency between the applicable vehicle standards and the Suspension Manual, the modification must comply with the applicable vehicle standards.

Note: VSB 14 can be accessed at http://www.infrastructure.gov.au/roads/vehicle_regulation/bulletin/vsb_ncop.aspx

1.4 Disclaimer

This Manual is intended to provide guidance to persons who modify a vehicle in a manner that affects its suspension and/or ride height, and to licensed certifiers who assess and certify vehicles modified in this manner. It attempts to provide advice on vehicle standards and the legal obligations on vehicle owners, and every attempt has been made to ensure the advice is accurate and current. In addition, it must be emphasised that compliance with vehicle standards may not be sufficient to ensure a modified vehicle is safe to use on the road network, and the modified vehicle must be assessed to ensure it does not pose an unacceptable risk to its occupants and other road users.

1.5 Limits of assessments

The assessments detailed in this Manual apply to vehicles intended to be registered for use on the road, in normal driving operations at posted speed limits. If it is intended to also use a vehicle for specialised activities, such as extreme off-road activities, more rigorous assessment and tests may be required to ensure the vehicle is stable under normal travel conditions and does not pose an increased risk to its occupants and other road users.

If a vehicle is equipped with electronic stability control (ESC), the ESC must remain functional after the modification. After a *significant modification*, as identified in this Manual, the ESC must be checked as part of the licensed certifier's assessment. The vehicle must not be issued with a compliance certificate unless the ESC is shown by testing, calculation or other suitable means, to operate within the functional range specified by the vehicle manufacturer for the pre-modified vehicle. If necessary, the ESC must be reprogrammed to function within that range.

1.6 Competence of licensed certifiers

The RMS has assessed the competencies of persons registered as licensed certifiers. The areas of competence for every licensed certifier are published on the Roads and Maritime's website. Only licensed certifiers identified as being competent in suspension – Field of Competency C5 – must be engaged in assessing and certifying vehicles with modifications to their suspension or that changes their *ride height* as identified in this Manual.

NB: Modifying a vehicle's suspension and other ways of altering its *ride height* can affect other components, such as its brakes. It is important to ensure that the licensed certifier engaged is competent to assess all relevant aspect of the modified vehicle.

A list of licensed certifiers and their applicable areas of competence can be obtained at <http://www.rms.nsw.gov.au/documents/business-industry/examiners/vsccs-bulletin-01-licensed-certifiers.pdf>.

1.7 Documents referenced in this Manual

The following documents are referenced in this Manual:

Legislation

Road Transport (Vehicle Registration) Regulation 2007
Road Rules 2014 (the Road Rules)
Road Transport Act

Australian Design Rules (ADRs)

ADR 8/01 Safety glazing
ADR 10/02- Steering column
ADR 13/00 Installation of Lighting and Light Signalling Devices on other than L-Group Vehicles
ADR 14/02 Rear Vision Mirrors
ADR 31/03 Brake Systems for Passenger Cars
ADR 35/05 Commercial Vehicle Brake Systems
ADR 42/04 General Safety Requirements
ADR 43/04 Vehicle Configuration and Dimensions
ADR 61/02 Vehicle Markings
ADR 62/02 Mechanical Connections Between Vehicles
ADR 69/00 Full Frontal Impact Occupant Protection
ADR 72/00 Dynamic Side Impact Occupant Protection
ADR 73/00 Offset Frontal Impact Occupant Protection

Vehicle Standards Bulletin (VSB)

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

Vehicle Standards Information (VSI)

VSI 9 Guidelines for alternative wheels and tyres

Australian Standards

AS 1742.3 Manual of uniform traffic control devices – Traffic control for works on roads
AS 2971 Serially produced pressure vessels

Society of Automotive Engineers

SAE J10 Automotive and Off-Highway Air Brake Reservoir Performance and Identification Requirements – Truck and Bus
SAE J844 Nonmetallic Air Brake System Tubing
SAE J1402 Automotive Air Brake Hose and Hose Assemblies

Other technical standards

ISO 10392 Road vehicles – Determination of centre of gravity
ISO 3888-1 Technical Report – Passenger cars – Test Track for a Severe Lane-Change Manoeuvre – Part 1: Double lane change test
EN 286 Pressure vessels and air receivers

DOT-106-10 Laboratory test procedure for FMVSS 106 brake hoses
DIN 74310 Air braking systems; hoses

Other documents

- Application of ANCAP Safety Ratings to Vehicle Model Variants
- Tyre and Rim Standards Manual, issued by the Tyre and Rim Association of Australia
- VSCCS Bulletin 2: Modified or individually constructed vehicles – means to demonstrate compliance with Third Edition Australian Design Rules
- Brake assessment manual
- Road Vehicle Descriptor Sheets

2.0 Regulations, standards and performance

There are no specific vehicle standards or regulations that apply to a vehicle's suspension. There are, however, a number of standards and regulations that do have an impact on the suspension. These are listed in Table 1 below.

Note: The Regulation requires a vehicle to continue with the standards that applied at the time it was manufactured or Third Edition ADRs.

Item	Reference	Subject
1	Regulation, Clause 52	Registrable vehicles to comply with vehicle standards specified in Schedule 2
		A vehicle used on a road or <i>road related area</i> must comply with mandatory standards, and its parts and equipment must be and in a thoroughly serviceable condition.
2	Regulation, Schedule 2, Clause 16	Alteration of specifications – tyres and rims
		Tyres must be appropriate to the wheel rim as specified in <i>the Tyre and Rim Standards Manual</i> issued by the Tyre and Rim Association of Australia or in any applicable second edition ADR or third edition ADR
3	Regulation, Schedule 2, Clause 21(b)	General requirement to keep vehicles in good order
		In addition to complying with requirements of Schedule 2 (Vehicle Standards), a vehicle must be maintained in such a manner that it will not cause danger or unreasonable annoyance to any person.
4	Regulation, Schedule 2, Clause 23	Turning ability
		Turning circle must not be more than 25m.
5	Regulation, Schedule 2, Clause 78	Ground clearance
		Minimum ground clearance.
6	Regulation, Schedule 2, Clause 61(2)	Number-plates
		Height of number-plate above the standing ground.
7	Regulation, Schedule 2, Clause 32	Mudguards and spray suppression
		Size and position of mudguards.
8	Regulation, Schedule 2, multiple clauses	CI 87 – How headlights are to be fitted CI 95 – Tail lights generally CI 104 – Location of side marker lights CI107 – Fitting brake lights CI 109 – Reversing lights CI112 – Location of direction indicators CI 115 – Rear fog lights CI 118 – Rear reflectors CI 130 – Turn signals
		Position of different lights fitted to the vehicle.
9	Road Rules, Rule 219	Lights not to be used to dazzle other road users
		Lights must not be used to dazzle another road user.

Item	Reference	Subject
10	Road Rules, Rule 297(2)	Driver to have proper control of a vehicle etc. A driver must have a clear view of the road, and traffic, in all directions.
11	ADR 8/01	Safety glazing A person must be able to see the ground 11m ahead of them.
12	ADR 13/00	Installation of Lighting and Light Signalling Devices on other than L-Group Vehicles Position and associated aim of headlights.
13	ADR 14/02	Rear Vision Mirrors View of the road behind the driver.
14	ADR 18/02	Instrumentation Accuracy of speedometer.
15	ADR 31/03	Brake Systems for Passenger Cars
16	ADR 35/05	Commercial Vehicle Brake Systems
17		Hydraulic brake hoses.
18	ADR 42/04	General Safety Requirements Field of view in front of and behind the driver.
19		Mudguards
20	ADR 43/04	Vehicle Configuration and Dimensions Minimum <i>running clearance</i> .
21	ADR 61/02	Vehicle Markings Position of number plates.
22	ADR 62/02	Mechanical Connections Between Vehicles Height of tow attachment.
23	ADR 10/02	Steering Column
24	ADR 69/00	Full Frontal Impact Occupant Protection
25	ADR 72/00	Dynamic Side Impact Occupant Protection
26	ADR 7300-	Offset Frontal Impact Occupant Protection

Table 1: Vehicle standards and regulations related to suspension modifications

With respect to Items 1 and 2 in Table 1, there are a number of vehicle components that can be affected by modifying the suspension and which, in turn, need to be modified to allow for the change in the *ride height*. Failure to do so can impact on the performance of the vehicle and its road worthiness, posing an increase risk to its occupants and other road users. These items are listed in Table 2 below.

Lowering an MC-category (i.e. an off-road) vehicle may affect its vehicle classification, in which case it will become subject to the standards that apply to that category of vehicle.

Item	Type of modification	Component
1	Suspension changes	<p>Brake hoses.</p> <p>Springs and dampers.</p> <p>Steering rack.</p> <p>Sway bars.</p> <p>For large lifts of IFS 4WDs – lower control arm anchorages, Driveshaft alterations.</p> <p>Lowering the differential/transmission.</p> <p>Steering and suspension ball joints.</p> <p>Steering arms.</p> <p>Approach and departure angles.</p> <p>CV shaft joint (risk of premature wear).</p> <p>Differential breather pipes.</p> <p>For lowered suspension – Rubbing wheels inside guards, especially with front wheels at full lock and/or bump.</p>
2	Body lifts	Any component passing from the cabin/body to the vehicle chassis/driveline, including electrical looms, fuel filler hoses, steering shafts, bull bars, handbrake cables, hydraulic plumbing for brakes/clutch, gear selectors, radiator and plumbing.
3	Changes to wheel/tyre combination	<p>Raised wheel/tyres – rubbing wheels inside guards, especially with front wheels at full lock and/or bump.</p> <p>Speedometer accuracy.</p>

Table 2: Vehicle components related to suspension modifications

3.0 Categories of modifications

3.1 Changes that do not require assessing or certification

1 Not classed as modifications:

The following are not considered to be modifications and do **NOT** require assessing or certification:

- a. Replacement of parts or components by identical or equivalent parts or components.
- b. Replacement of parts or components with parts or components of equivalent functional performance.
- c. Optional parts or components as prescribed by the vehicle's *manufacturer*.

2 Minor modifications:

In addition to the above, the following are not considered to be *significant modifications* and do **NOT** require assessing or certification:

- a. Except where specified below, modifications to the suspension that does not increase or decrease the vehicle's *ride height* by more than 50mm.
- b. Changes in the diameter of the wheel and tyre combination of up to +/- 7% of the largest size specified by the vehicle *manufacturer*.
- c. Modifications to the *ride height* up to 75mm that incorporate a maximum change in the suspension of 50mm, and/or an increase in the diameter of the wheel and tyre combination of up to 50mm.
- d. Restoring a vehicle to the original trim height as established by its *manufacturer* to compensate –
 - i. for sag due to normal wear-and-tear; or
 - ii. as the result of permanent loading from fixed items, such as a bull bar, a winch or a second spare wheel.
- e. Changes in the vehicles *ride height* by up to 50mm by replacing the rear coil springs with air springs fitted to un-modified, original mounting points when used with slow speed air controls in accordance with Appendix B.6.1a.
- f. Changes in the vehicles *ride height* by up to 50mm by replacing the rear shock absorber assemblies with air adjustment, fitted to un-modified, original mounting points, when used with slow speed air controls in accordance with Appendix B.6.1a.
- g. Supplementary air springs that assist the original springs, and are fitted without other modifications, such as holes drilled in structural sections of a chassis.

Note: Items d, e and f above should comply with section LS 1.1 & 2.7 of VSB 14 and associated ADR's, including ensuring that the spring and damping systems are suitable for the category of vehicle.

The allowances provided above for modifications to *ride height* before certification is required exceed those given in VSB 14 and the previous requirements in NSW stipulated in *Code of Practice for Light Vehicle Modifications*. VSB 14 requires that any change in *ride height* above 50mm must be certified regardless how it is achieved, and includes aggregate increases from suspension lifts and changes to the wheel and tyre combination. VSB 14 also requires that available suspension travel must remain at least equivalent to two thirds of the original. Similarly, the NSW Code limited changes to *ride height* to one third of the working travel of the suspension travel from kerb mass height to metal to bump or rebound positions as specified by the *manufacturer*.

The 50mm limit before certification is required is consistent with the Australasian New Car Assessment Program's variants policy, which states that an ANCAP safety rating given to a vehicle cannot apply to a variant of the same model if its *ride height* is more than 50mm

different from the tested vehicle; refer to *Application of ANCAP Safety Ratings to Vehicle Model Variants*.

3.2 Modifications that require assessing and certification

The *significant modifications* below require a vehicle 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, the assessment must ensure that the cumulative effect of all the modifications are considered.

- a. A change in the vehicle's suspension –
 - i. that increases the vehicle's *ride height* between 50mm and 125mm; or
 - ii. of up to 125mm that combined with an increase in the diameter of the wheel and tyre combination of up to 50mm increases the vehicle's *ride height* between 75mm and 150mm.
- b. Except for items under (e), (f) and (g) above, installation of a variable *ride height* system.
- c. Any increase in the *ride height* using a *body lift*.
- d. A change in the diameter of the wheel and tyre combination in excess of +/- 7% of the largest size specified by the vehicle *manufacturer*.
- e. Modifications that produce no change to the vehicle's *ride height* involving –
 - i. conversion from coil to leaf springs;
 - ii. changes to the suspension configuration;
 - iii. fitting a suspension of a different design eg from a different make and model (eg from coil springs to leaf springs);
 - iv. fabricating suspension mounting points; or
 - v. any alteration of structural components.

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

3.3 Modifications not covered by this Manual

The following modifications are not covered by this Manual:

1. Modifications that increase the ride height by more than 150mm. This modification impacts on a considerable number of components, and requires extensive planning and execution to ensure the modified vehicle does not present an undue risk to its occupants and other road users. It is recommended that the advice of a person competent in these modifications, such as an appropriate licensed certifier, is obtained prior to commencing the work.
2. Increases in *ride height* greater than 50mm combined with a decrease in the vehicle's *wheel track*. This modification represents a significant risk as, typically, the higher centre of gravity combined with the reduced *wheel track* greatly increases the vehicle's propensity to overturn. Should such a modification be required, advice should be obtained from a competent person, such as an appropriate licensed certifier.
3. Modifications using components designated "not for road use" or "for off-road use only" by their manufacturer.

Note: When purchasing components, it is strongly recommended that their on-road designation is verified before the point of sale as sometimes restrictions for off-road use is only stated on the receipt.

4.0 Planning the modification

The Regulation prohibits a person to drive, on a road or road related area, a vehicle that has been subjected to a *significant modification* unless the modified vehicle has been assessed and certified by a licensed certifier.

Frequently, changing a vehicle's suspension and/or *ride height* is only one element of a larger modification to the vehicle. For example, a person may intend using their vehicle for off-road activity. To ensure it is fit for purpose, they may fit a number of items that will increase its overall weight (e.g. bull bar, additional spare wheel, winch), and raise its *ride height*.

Whereas the combined effect of all the modifications result in a vehicle that does not require assessment under the VSCCS, in some instances, an individual modification in isolation can constitute a *significant modification*, and the vehicle, in its semi-modified condition would require certification to enable it be continued to be used on the road. It is important to plan the modification avoid this happening.

For example, in the scenario above, the extra weight of the additional components that will be added to the vehicle (bull bar, additional spare wheel, winch) needs to be taken into account in modifying the vehicle's *ride height*. If it is intended to increase the *ride height* by 75mm by raising its suspension by 50mm and increasing its wheel/tyre diameter by 50mm, the modifier must raise the suspension an additional amount, say 20mm, to compensate for the amount the extra weight will compress the suspension.

The vehicle may require certification depending on when the suspension changes are made:

- If the suspension changes are made before the additional weight is added, the 70mm suspension lift constitutes a *significant modification*, and the vehicle will require certification if it is to be used on the road until all the modifications are completed.
- If the suspension changes are made after the additional weight is added, the final 75mm increase in *ride height* does not require certification.

In such circumstances, it is important to do the modifications in a sequence that does not affect its registration. In this situation, adding the additional components before increasing the *ride height* will ensure the vehicle's registration is not affected. However, care should be exercised to ensure the components, such as axles, are not overloaded.

Other items that should be considered before making the modification include:

- If it is intended to use the modified vehicle for different purposes, and the effect this may have on its compliance. For example, a utility may be used for commercial purposes during the week and for recreation purposes at weekends. If the *ride height* is modified to allow for an additional load used during the week and this load is removed for the weekend, the vehicle may require certification under its reduced load condition.
- If the vehicle is going to be used for towing, and the effect this will have on the respective axles.
- The type of spring coils used. Whereas this may depend on a number of other factors, such as increasing the mass of the vehicle, the type of spring coil used – light duty or heavy duty – will also affect the ride quality.
- That the vehicle is capable of being modified in the manner intended. For example, it may not be possible to correctly fit larger wheels/tyres in the vehicle's bodywork without extensively modifying the vehicle.
- How to measure the change in *ride height* caused by the modification; see below.

5.0 Items to be considered

5.1 General safety

A person modifying a vehicle's *ride height* should ensure that the effect of the modification on the items listed in Tables 1 and 2 have been considered. Even minor modifications can affect a vehicle's roadworthiness; for example, a small change to the ride height can cause the vehicle's headlights to dazzle other road users during normal driving conditions or reduce the effectiveness of its mudguards. If a vehicle's suspension and/or *ride height* has been significantly modified, the licensed certifier assessing and certifying the vehicle must ensure that the vehicle still complies with these items and is fully roadworthy. If not properly addressed, they can affect the road safety in the following ways:

- **Stability** - Raising a vehicle correspondingly raises its centre of gravity and increases its *slenderness ratio*, both of which increase its propensity to overturn.
- **Road handling capabilities** - In addition to the above, raising a vehicle's centre of gravity can affect its ability to manoeuvre, such as changing lanes and cornering.
- **Electronic stability control (ESC)** - ESC is an important safety feature that helps a driver retain control of a vehicle under extreme driving circumstances, such as cornering too quickly. ESC is specifically programmed by the *manufacturer* for a vehicle's particular configuration, and altering the ride or *trim height* could affect this programming.
- **Braking characteristics** - The higher centre of gravity of a raised vehicle increases its forward mass transfer which can affect its braking performance.
- **Ground clearance** - Lowering a vehicle decreases its ground clearance, which could cause the under chassis to impact the ground; see below for more information.
- **Occupant protection** - The design of a vehicle incorporates minimum specified levels of occupant protection that help safeguard persons travelling in the vehicle in the event of it crashing. This is usually achieved by the front and rear bumpers, crumple zones and by providing locally strengthened sections in the vehicle's structure and doors. These are positioned at designated heights above the ground specifically to absorb the impact from another vehicle. Altering a vehicle's height can, correspondingly, alter the position of these safety features, which can reduce the levels of protection the vehicle affords its occupants. by placing the unstrengthened parts of the vehicle in the crash impact zone
- **Risks to occupants of other vehicles** - In addition to the above, altering the position of a vehicle's bumpers means its point of contact with other vehicles can be above or below their bumpers, crumple zones and locally strengthened sections, thereby exposing their occupants to an increased risk of injury in the event of them being involved in a crash with a raised or lowered vehicle.
- **Risks to vulnerable road users** - Altering the position of a vehicle's bumpers changes its point of contact with vulnerable road users, such as pedestrians and cyclists, which can increase the risk of injury to them should they be struck, even at slow speeds. In addition, raising a vehicle exposes more of the rotating tyre and reduces the protection afforded by the mudguards and bodywork, as well as exposing steering, suspension and chassis components that are normally covered.
- **Driver's field of vision** - Altering a vehicle's height changes the driver's view of the road. When a vehicle is raised, the distance to the point the driver can see the ground in front of them is increased. This results in an increased blind zone immediately in front of the driver where they cannot readily see other road users, such as pedestrians, cyclists and smaller vehicles. Similarly, blind zones along the passenger side and rear of the vehicle are also significantly increased. Lowering a vehicle can reduce the driver's ability to see what is happening on the road ahead, especially in a line of traffic, and can result in less opportunity to anticipate traffic conditions and road changes.

- **Unexpected vehicle behaviour** - A vehicle's suspension system involves complex relationships between its components. Modifications to some components can introduce unexpected consequences in the vehicle, such as wheel or axle steer induced by body roll, which could significantly degrade its handling characteristics.
- **Impact on other components** - Modifications to *trim height* can stress or expose other components, such as brake hoses or ABS/ESC sensor wires, resulting in their premature failure.
- **Headlight aim**- Altering a vehicle's height alters the aim of its headlights, which could cause them to dazzle other road users either by shining directly in their eyes or by reflecting in rear vision mirrors.

5.2 Suspension travel

In all instances, modifications to a vehicle's suspension must ensure the integrity of the system and not compromise the ride quality. At least two thirds of the original suspension travel should be maintained in both directions (rebound (i.e. extension) and bump (i.e. compression)), and rebound must be limited by the same method used by the vehicle manufacturer or if this is not practicable due to the nature of the modification, an equivalent method. If an alternative method is used, evidence must be available that its functional performance is equivalent to the original.

If coil springs are used in the modification, they must be securely attached to the vehicle through the full range of movement. At full rebound, the coil springs must retain sufficient compression and not reach their free length. At full bump there must be a clearance between some of the coils.

5.3 Road clearance

When lowering a vehicle's *ride height*, it is very important to ensure there is sufficient room under the vehicle to avoid damaging the body or snagging components during normal travel operations, such as traversing speed humps or peaks and troughs in the road, or in the event of a flat tyre.

To avoid these problems, ADR 43/04 specifies two different requirements, *ground clearance* and *running clearance*. These are similar items that are measured differently: Ground clearance is a measurement based on the vehicle's dimensions and its ability to travel along a road or *road related area* in the fully laden condition (i.e. *maximum loaded vehicle mass* (MLVM)), and does not specify a specific dimension. Instead, the vehicle must meet the conditions illustrated in Figures 1.1 and 1.2 below. In contrast, *running clearance* specifies a minimum dimension of 100mm between the bottom of the vehicle and the supporting ground with the vehicle in the unladen condition (i.e. *unladen vehicle mass*).

The Regulation only specifies the requirements for *ground clearance*, and this aligns with Clause 6.4 to ADR 43/04.

Note: The Regulation has an additional requirement for *ground clearance* to be at least 100 millimetres at any point within one metre of an axle. This was previously in ADR 43/04 but removed it in 2007. It is unnecessary to meet this additional requirement.

For a standard vehicle fitted with variable suspension, the Commonwealth Department of Infrastructure and Regional Development (DIRD) advises that in assessing it for Identification Plate Approval, it requires the vehicle to meet the 100mm *running clearance* specified in Clause 6.6 to ADR 43/04 with the vehicle in the "normal" driving suspension height as specified by the vehicle *manufacturer*; and to meet the ground clearance requirements when loaded up as set out in in ADR 43/04 clauses 6.4. Vehicles modified to fit variable suspension must meet these requirements with the "normal" driving position specified by the component manufacturer.

NB In specifying the "normal" driving position, caution is required to ensure that when the suspension is lowered from that position, the vehicle is capable of safe travel on the road,

and there is sufficient clearance to allow it negotiate common features, such as peaks and troughs in the road, drains, culverts and traffic calming devices without scraping parts of its under-body along the ground.

Registrable vehicles must comply with the applicable vehicle standards when used on roads and road related areas in NSW. If a vehicle is modified with a variable suspension system, the owner should be advised that the minimum ground clearances specified above must be maintained while the vehicle is being used in NSW.

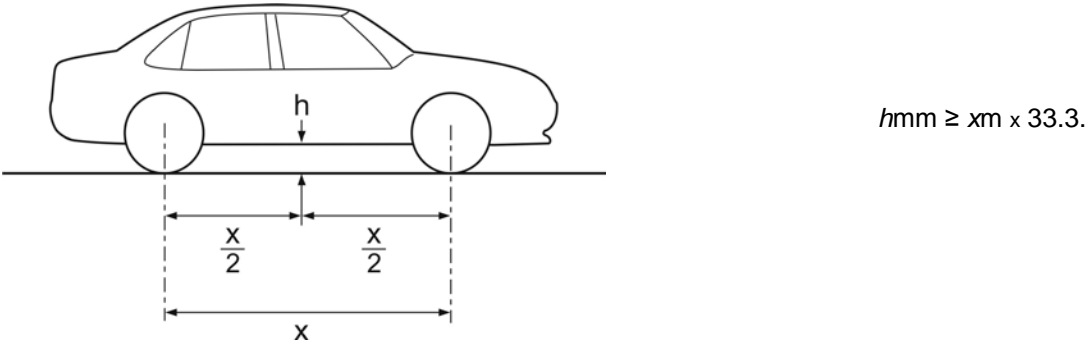


Figure 1.1: Ground clearance measured between consecutive axles.

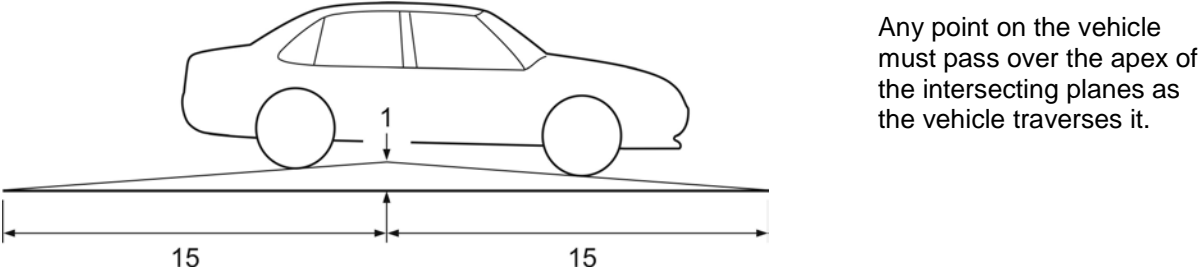


Figure 1.2: Ground clearance, general

5.4 Working out the change in ride height

5.4.1 General

It is important to know how modifying a vehicle affects its *ride height*. This is necessary to determine if it is a *significant modification* requires assessment and certification. The *ride height* should be recorded before and after the modification in case it is necessary to provide evidence of the extent of the change in *ride height*, especially if it was not a *significant modification*.

5.4.2 The *ride height* prior to modification

Modifications to a vehicle's *ride height* apply to the vehicle in its original configuration. Previous changes to the *ride height* must be included in the proposed revised *ride height*. For example, if a vehicle's suspension had been raised by 50mm and it is proposed to raise it a further 50mm, the change in the *ride height* for the purpose of assessing the vehicles is deemed to be 100mm.

If a vehicle's original *trim height* has dropped either through normal wear-and-tear or by the permanent addition of items such as a bull bar, a winch or a second spare wheel, the difference between the *ride height* immediately prior to the modification and the original *trim height* as established by the vehicle's *manufacturer* does not contribute to the increase in the *ride height* gained by the modification.

5.4.3 Methods for determining the ride height

There are a number of ways to work out the changes in *ride height*, and the examples below are some of these.

NB These examples are not exhaustive, and if a different method is used, the changes in *ride height* must be accurately recorded.

1. Using the information provided by the vehicle *manufacturer*

The vehicle's original *ride height* can be determined from its Road Vehicle Descriptor Sheet (RVDS). The RVDS has specifications provided by the *manufacturer* to DIRD as part of the process required under the *MVSA 1989* for approving the vehicle's supply to the Australian market; this information includes the vehicle's *running clearance* and *trim height*. The RVDSs are published on the DIRD's website at http://rvcs-prodweb.dot.gov.au/pls/wwws/pubrvcs.Notify_Search.

Note: Technical information for vehicles manufactured prior to the introduction of RVDS may be obtained from their *New Vehicle Data Sheet* or *Vehicle Specifications Sheet*.

The RVDS can be used to obtain the vehicle's *ride height* by either simply using the value given for the running clearance, or by calculating the *arch height* from the sum of the *trim height* and the wheel/tyre radius specified in the RVDS and *Tyre and Rim Standards Manual* respectively.

2. Measuring the *ride height*

Using the RVDS to estimate *ride height* is not recommended as it does not allow for manufacturing tolerances or sag from normal wear and tear during the in-service life of the vehicle, which means the actual *ride height* may be different from that obtained from the RVDS. It is therefore recommended that the actual *ride height* be measured by reference to a value related to a defined point on the vehicle, such as the *arch height* or *running clearance*. To do this, the *arch height* can be obtained by measuring the distance from the supporting ground to the top of the wheel arch. Alternatively, the *running clearance* can be obtained by measuring the distance from the supporting ground to the vehicle's lowest point excluding unsprung mass. In taking the measurements, the vehicle should be supported on a firm, nominally horizontal surface, with the tyres inflated to the nominated pressure and the vehicle in the unladen state. The *arch height* or *running clearance* as measured should be recorded and photographed for future verification.

Other points on the vehicle can be used to measure the *ride height*, such as the headlights or a point on the chassis or body. However, as these are not recorded on the RVDS, they cannot be used to determine if there have been any previous changes to the vehicle's original *ride height*.

Once the ride height has been measured, it should be compared to the vehicle's RVDS to see whether it has been previously modified or if the suspension has sagged.

5.4.4 The *ride height* after modification

Following the modification the change in *ride height* can be determined either by –

- measuring the revised *arch height*, *ground clearance* or other point on the vehicle and subtracting the original value measured prior to the modification; or
- using the data provided by the component manufacturer.

5.4.5 Tolerances

The modified vehicle may include tolerances in the ride height up to a maximum of +/- 15mm. These tolerances allow for variations in the manufactured component or in the modification process; they do not include changes in the suspension system due to temporary changes in the vehicle's configuration, for example, if a vehicle is modified to support an additional load for work purposes, but that load is removed at other times, the increase in *ride height* applies to the vehicle with the load removed.

It is important that tolerances incorporated in the modification are identified and clearly documented.

5.5 Verification of vehicle stability and road handling

All vehicles with altered *ride height* or modified suspension systems must perform in a manner which preserves at least the quality of steering control which could be reasonably expected when the vehicle was originally manufactured.

There is a particular increased risk of a vehicle losing control and even rolling over as its height increases unless compensatory measures are taken. Raising a vehicle's body height raises its centre of gravity and increases its *static roll threshold (SRT)*, which means the vehicle's propensity to overturn is also increased.

A vehicle with a high propensity to overturn represents a high risk to its occupants and other road users, and must not be issued with a VSCCS certificate.

To assess its road handling, the modified vehicle must be subjected to a test drive that replicates the types of road and speeds which it is reasonably likely to experience under normal driving conditions. During the test, the modified vehicle must handle in a manner which allows good steering control, including –

- (a) well controlled ride on uneven surfaces without excessive pitch movement, or direction change upon full suspension compression; and
- (b) progressive and positive feel with no kick-back through the steering wheel during turn-in and turn-out; and
- (c) no excessive under-steer or over-steer tendencies during constant radius cornering, including when encountering mid-corner bump disturbances; and
- (d) directional stability with immediate self-centring after sharp minor steering inputs; and
- (e) immediate and easy controllability when encountering direction change as a result of road camber changes or surface irregularities; and
- (f) no tendency to climb the road camber toward the opposing lane.

If a licensed certifier has concerns about a raised vehicle's stability, they must determine the level of risk it represents. The following may be used in this process:

- The height of the vehicle's centre of gravity should be determined. This can be done by the method outlined in ISO 10392 (which requires accurate wheel scales and angle measuring equipment), calculation or using a tilt table. Using this value, the vehicle's SRT should be estimated to determine its likelihood to overturn. An SRT less than 1.0 indicates the vehicle is potentially unstable.
- The load distribution on axles in modified vehicles must be assessed to determine if the vehicle can accommodate the proportion of the load on each axle. Where available, this assessment should refer to the *manufacturer's* specifications.

Following this assessment, the licensed certifier may require the vehicle to complete a more rigorous road handling test, such as the lane change manoeuvre specified in section LT of VSB14 but as qualified below in "Dynamic Stability Test".

5.6 Dynamic stability test

The assessment described above is based on the vehicle's static profile and may not be an accurate indication of how it would perform in motion when suspension and other components contribute to its stability. If a test is required to verify the vehicle's dynamic stability, the Test LT2 specified in VSB 14, Section LT *Test Procedures* should be carried out with the following variations:

- The licensed certifier should ensure that the components used to modify the vehicle have been installed correctly.

- It is important that appropriate equipment is used to measure and record test-critical data. The vehicle's speedometer should not be used for the test as it may not be sufficiently accurate. Instead, a device such as a fifth wheel or GPS for measuring speed should be used. Additional instruments may be used to record critical data (such as acceleration and deceleration, vehicle roll, yaw angular velocity and steering angle), to assist the licensed certifier in assessing the vehicle's performance.
- The equipment used must be checked before starting the test to ensure it is functioning correctly and, where applicable, be correctly calibrated and be within specified calibration periods at the time of testing, and records available to verify this. The equipment must be capable of recording the relevant test data for verification and audit purposes.
- The test area must have sufficient run-off to allow for loss of control during testing.
- The cones used in the test may be the "small cone" type specified in AS 1742.3.
- There is no maximum test speed. Test LT2 adopts the test track and procedures specified in ISO 3888-1. However, ISO 3888-1 explicitly does not specify a "pass" or "fail" test speed. Instead, it emphasises that it is a test "for the subjective evaluation of vehicles". It does recommend an initial test speed of (80 +/-3) km/h, but allows higher or lower speeds to be used; and requires additional tests to determine the maximum speed to complete the test course. The maximum speed used to complete the test course may be less than the initial test speed.
- If the maximum test speed of the vehicle is less than that specified in Test LT, the performance of the vehicle should be compared against a similar but unmodified vehicle that has undergone this dynamic stability test.

Based on the test results and feedback from the test driver, the licensed certifier may refuse to certify the modification if they deem the vehicle to become dynamically unstable in conditions reasonably expected to be encountered during normal road travel.

5.7 Brakes

A vehicle's brakes are probably its single most vital safety feature. Raising or lowering a vehicle, or even changing its suspension components or its wheel/tyre combination, can affect its brakes, and it is important to ensure that they are still functioning correctly after the modification. The document *Brake assessment manual* (the Brake Manual) identifies tests that should be done for certain modifications. Even if the Brake Manual does not specify a particular test for the modification in question, the brakes still should be checked. A simple road test may not give sufficient assurance that the brakes are functioning correctly, and consideration should be given to subjecting the vehicle to a static brake test as described in the Manual to determine if any action is required to ensure the efficacy of the brakes, such as further modifications or additional brake tests.

6.0 Ways to modify ride height

6.1 Standard suspension modifications

Suspension modifications must comply with the component manufacturer's specifications, or, if these are not available or assessed as being inadequate, VSB 14 Section LS *Tyres, Rims, Suspension and Steering*.

6.2 Variable suspension modifications

Variable suspension systems must comply with Section LS 1.2, 2.7 and applicable codes of VSB14 as qualified by Appendix B of this Manual.

The suspension system must be a catalogued and quality controlled product complete with full fitting and operating instructions, and be designed and manufactured by a recognised business with experience in supplying reputable suspension systems.

6.3 Changes to wheels and tyres

All tyres fitted to the vehicle must be appropriate to the wheel rim as specified in the *Tyre and Rim Standards Manual* or in any applicable second edition ADR or third edition ADR.

Guidance on modifications to the vehicle's wheels and tyres, or a combination of the wheels and tyres, is given in VSI 9

6.4 Body lifts

All body lifts are deemed to be a *significant modification*, even those within the 50mm allowance given to other types of changes to *ride height*. This is because lifting a vehicle's body above its original height can impact on a number of the vehicle's components, and affect its compliance and safe operation. It is essential that the body lift, its impact on components, and road handling are assessed and certified by a licensed certifier.

7.0 Methods for certifying the modified vehicle

7.1 Method 1 – Compliance with the ADRs and other standards

Each vehicle can be individually assessed by a licensed certifier for compliance with the ADRs and the other standards outlined in Section 2 above.

Prior to doing the verification tests, the licensed certifier must inspect the vehicle to ensure the modified components have been installed correctly.

Note: A checklist, like the one at Appendix C, can help the modifier ensure that the modifications and the components have been installed to the manufacturers' specifications and instructions. This should be provided to the licensed to assist in the inspection.

Most ADRs specify tests or other methods for determining if a vehicle complies with it. If a modification affects an ADR, the tests must be done unless the RMS has allowed alternative means to demonstrate compliance; refer to VSCCS Bulletin 2 to see what alternatives are permitted for certain ADRs. VSCCS Bulletin 2 may be accessed at <http://www.rms.nsw.gov.au/documents/business-industry/examiners/vscs-bulletin-02-modified-individually-constructed-vehicles.pdf>,

and the referenced *Brake Assessment Manual* at <http://roadsafety.transport.nsw.gov.au/stayingsafe/vehiclesafety/brakeassessment.html>.

Following the examination and verification tests, the licensed certifier may require other tests to ensure the overall safety of the vehicle prior to its registration. Finally, the performance of the vehicle should be checked by taking it for a test run, with the length of the run and the type of road depending on the nature and extent of the modification. If the vehicle's stability needs to be assessed, the procedures outlined in Section 5.5 must be applied.

NB Regardless of the means used to demonstrate compliance, evidence of the assessment process used and the results must be developed and maintained for each vehicle.

7.2 Method 2 – Approved aftermarket components

A vehicle may be modified to incorporate aftermarket suspension and associated components, other than those offered by the original vehicle *manufacturer*, without the need for testing providing:

- the make and model of vehicle in which the components may be installed is provided by the components supplier;
- the component supplier has done the necessary tests to confirm the components comply with the applicable standards and their compatibility with the nominated vehicle;
- all necessary instructions are provided at the point of supply by the components supplier to ensure the components can be installed correctly in the vehicle make and model;
- the instructions are in English and use SI Units, or for vehicles or components that use Imperial Units or other units, the applicable units; and
- the modified vehicle is examined by a licensed certifier who –
 - verifies that the components are compatible with the host vehicle as specified by the component's manufacturer;
 - the components have been installed in accordance with the manufacturer's instructions; and
 - that the vehicle is in suitable condition to accommodate the components (eg there are no signs of rusting where items are secured to the vehicle).

7.3 Method 3 – Comparison with similar vehicles

If a vehicle is modified using suspension and associated components identical to those that have been used in a similar vehicle – i.e. if it is within the tolerances listed in Table 2 – that has already been assessed and certified, 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 the ones used in the certified vehicle
- the components are examined to establish that they are in good condition
- a detailed examination of the vehicle is done to confirm its suitability for properly accommodating the components, e.g. load-bearing members display no evidence of structural degradation
- a detailed examination of the vehicle is done to ensure that the components have been correctly installed
- results of the assessment, including test results, done on the similar vehicle is available and referenced 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. For example, if *Vehicle X* is tested and *Vehicle Y* is similar to *Vehicle X*, the 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), the test results cannot be applied to *Vehicle Z*.)

Parameter	Tolerance
Wheel base	± 20%
Centre of gravity	± 50 mm
Tyre/wheel size	± 7%
Laden mass	± 10%
GVM/MLVM	0
Track width	0

Table 4: Tolerances for determining a similar vehicle

Appendix A: Glossary

The terms below are used in this Appendix. The terms below are used in this Appendix. Definitions marked “1” have been developed specifically for this Manual; those marked “2” from *Australian Design Rules – Definitions*; “3” from the Road Transport (Vehicle Registration) Regulation 2007; and “4” from the *Road Transport Act 2013*. To identify where they are used, they are *italicised* in the text.

¹ *Arch height* - the sum of the *trim height* and the vertical measurement from wheel centre to the supporting ground; refer Figure A.1.

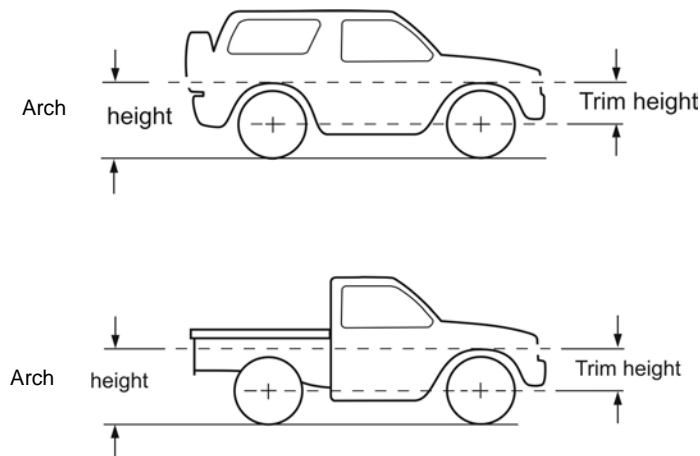


Figure A.1: Ride height and trim height

³ *Authority standard compliance specification* - any specifications that the Authority, by order published in the Gazette, has declared to be specifications the compliance with which will be taken to be compliance with the applicable vehicle standards for the purposes of clause 55A or 76AD [of the Regulation].

¹ *Body lift* - a modification that raises the vehicles *ride height* by lifting the body of the vehicle up off of its frame through the placement of blocks or spacers.

¹ *Fast speed air controls* - air controls that allow height changes in the body of the vehicle that result in any wheel becoming temporarily un-weighted (visually sighted) in all load conditions, and may be measured as a height change of the body of greater than 40mm/s at any point on the body or chassis.

² *Gross Vehicle Mass (GVM)* - the maximum laden mass of a motor vehicle as specified by the *Manufacturer*.

² *Ground clearance* - the minimum distance to the ground from a point on the underside of the vehicle, excluding its tyres, wheels, wheel hubs, brake backing plates and flexible mudguard or mudflap.

¹ *Hydropneumatic suspension system* – a variable suspension system combining pneumatic and hydraulic components.

² *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.

² *Maximum loaded vehicle mass* - the sum of the ‘*Unladen Mass*’ together with: the heaviest regular production options, if such individual options have a mass of 2.3 kg or more,

with a full capacity of lubricating oil, coolant and fuel; plus additional loading equivalent to 68 kg at each seating position; plus the number of seating positions times 13.6 kg for luggage in the appropriate luggage space, with the centre of gravity of the luggage load at the centre of the luggage space.

¹ *Ride height* - the height of the body of a vehicle above the ground while driving on a road or road related area based on its *unladen vehicle mass*.

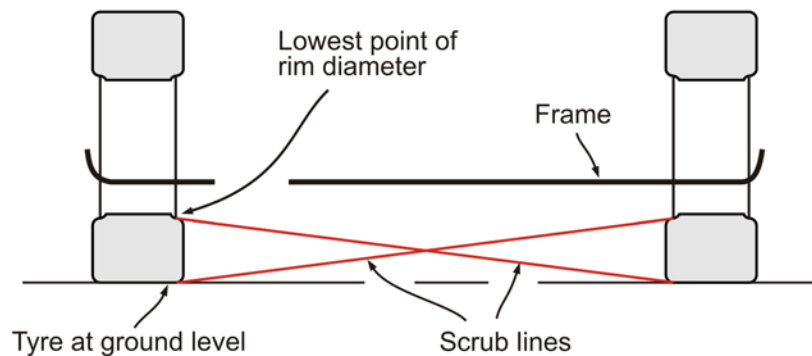
⁴ *Road related area*:

- (a) an area that divides a road, or
- (b) a footpath or nature strip adjacent to a road, or
- (c) an area that is open to the public and is designated for use by cyclists or animals, or
- (d) an area that is not a road and that is open to or used by the public for driving, riding or parking vehicles, or
- (e) a shoulder of a road, or
- (f) any other area that is open to or used by the public and that has been declared under section 18 [of the *Road Transport Act 2013*] to be an area to which specified provisions of this [*Road Transport Act 2013*] or the statutory rules apply.

² *Running clearance* - the distance from the surface on which an unladen vehicle is standing to the lowest point on the vehicle excluding unsprung mass.

¹ *Scrub line* – an imaginary line extended from the lowest point of the rim diameter of a wheel to the bottom of the tyre on the opposite wheel in the longitudinal and lateral planes; refer to Figure A.2.

Scrub lines - viewed from front or rear



Scrub lines - viewed from side

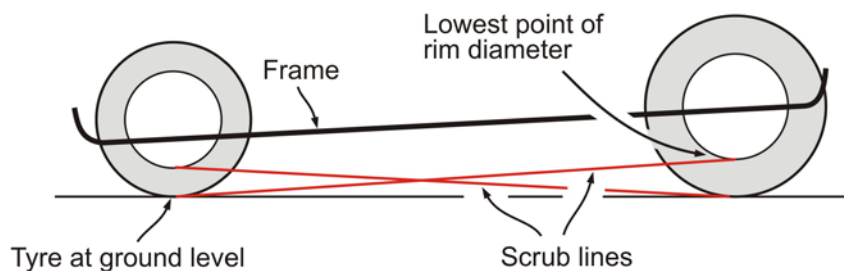


Figure A.2: Scrub lines

¹ *Significant modification* – a modification that requires assessing and certification by a licensed certifier registered on the VSCCS.

¹ *Slow speed air controls* - air controls that allow height changes in the body of the vehicle that in all load conditions are not excessive, and may be measured as a height change of the body of less than 40mm/s at any point on the body or chassis.

¹ *Static roll threshold (SRT)* – a ratio of a vehicle's width to its height determined by dividing its wheel track divided by twice its centre of gravity.

¹ *Trim height* – the vertical measurement from wheel centre to top of wheel arch opening at *unladen mass* as specified by the vehicle *manufacturer*; refer to Figure A.1.

² *Unladen Mass* - the mass of the vehicle in its operational configuration, unoccupied and unladen with all fluid reservoirs filled to nominal capacity including fuel.

¹ *Wheel track* – the distance between the vertical centre-line of a wheel on one side of vehicle to the centre line of the corresponding wheel on the other side of vehicle on the same axle.

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 a mandatory requirement under NSW or Commonwealth legislation.

Should indicates something that is recommended, but is not a mandatory requirement under NSW or Commonwealth legislation.

Appendix B: Variable Suspension

Variable suspension systems covered by this appendix include air spring (airbag), hydraulic and *hydropneumatic suspension systems* that were not fitted to or available on the vehicle, or variants of the vehicle, that was supplied to the market.

All modifications must be done in accordance with the component manufacture's specifications, and within the confines set by the regulations and standards outlined in the section "Regulations, standards and performance" of this Manual. .

Section LS to VSB 14 provides practical advice on modifying vehicles' suspension. In addition to these requirements, the requirements below must be met when installing a variable suspension system.

B.1 Manufacture

The variable suspension system, and the constituent components, must be manufactured by a company that is professionally engaged in the manufacture of purpose-designed automotive suspension systems; or independently tested to ensure it meets applicable standards and is fit for purpose.

B.2 Variable system installation

The suspension components must be either specifically designed for the particular make and model of vehicle; or a generic suspension system that is fitted in such a way as to maintain correct heights, geometry and driving characteristics, according to the category of the vehicle and the system manufacturers requirements.

B.3 Suspension performance

B.3.1 The suspension system must include suitable spring travel, spring rate, damping performance and bump stops to ensure the correct operation of the suspension. Where original mounting points and linkages are modified or not used, the suspension geometry and loadings must be verified as being suitable and within safe limits.

B.3.2 Hydraulic suspensions must also incorporate a suitable and well located coil or air spring in the suspension system

B.4 Bump stops

B.4.1 Bump stops must be provided to limit the suspension travel in compression such that the lowest point of the vehicle cannot contact the road surface under dynamic loads, which must be no lower than the vehicle's *scrub line* (see Figure A2).

NB: If a variable suspension system allows a vehicle's body to rest on the ground, this clearance must be maintained in the event of any failure in the system.

B.4.2 Bump stops must be of suitable construction and suitably mounted to allow for regular and higher loadings than with non-variable suspensions, particularly in the case of disability access or emergency vehicles.

B.4.3 Bump stops may be incorporated into airbag assemblies or separately mounted.

B.5 Modifications required to fit variable suspension systems

B.5.1 All modifications performed to fit variable suspension systems must be carried out by a competent person, in accordance with to industry practice, with particular attention paid to load bearing members to ensure that they are not weakened.

B.5.2 Where structural material has been removed it must replaced with suitable supporting material.

B.5.3 Brake lines, brake hoses, ABS lines and other components attached to the suspension system must be free to move with adequate clearance, and not subject to load, through the full range of suspension and steering movement.

B.5.4 Steering components and geometry require separate assessment and certification if modified or altered, as per the requirements of VSB14.

Note: Full steering lock is not required in the full bump position.

B.6 Variable height control operation

B.6.1 Where on-board controls for the suspension are provided they must not be adjustable while the vehicle is in motion, unless individually approved and checked on the vehicle. Controls that can be adjusted while the vehicle is in motion must be limited in their ability to make changes by either:

- a. rear only “slow speed” controls for air suspension, or
- b. front and rear electronically controlled “slow speed” controls that have pre-defined limits that only allow adjustment in a manner that does not render the vehicle un-safe (including headlight aim), and is within the height range prescribed by the vehicle *manufacturer* or approved by a competent person, such as an appropriate Licensed Certifier.

In all cases, the controls must return the vehicle to a prescribed safe height immediately once the vehicle is in motion.

B.6.2 Except for *hydropneumatic systems*, all controls must be capable of levelling the vehicle from side-to-side and front-to-rear, and be isolated side-to-side and front-to-rear while the vehicle is in motion, and not be capable of being manually adjusted while the vehicle is travelling.

B.6.3 The system must not be able to be adjusted or self adjust at a rate of movement that causes a wheel to become un-weighted or bounce (“fast speed” controls), and must not result in and sudden steering geometry changes; and

B.6.4 The system must not allow the front and rear of the vehicle to adjust in such a way as to provide excessive fore-aft height differences; this would usually be no more than $\pm 50\text{mm}$ at the wheel.

B.6.5 Hydraulic only controls must not be capable of being adjusted or making adjustments while the vehicle is travelling.

B.7 Variable height control system

B.7.1 The system must be assembled from components that have documented and certified (where required) performance characteristics, and they are assembled with documented evidence that shows they have been tested to show they perform correctly in all aspects of the system’s intended use.

B.7.2 The system must meet the requirements of electrical standards and automotive electrical codes of practice and guidelines.

B.7.3 Air or Hydraulic reservoirs or accumulators

- a. Air or Hydraulic reservoirs or accumulators must be purpose designed for automotive use.
- b. They must be securely mounted into the vehicle in a safe position.
- c. Air reservoirs (air tanks) or accumulators must comply with an appropriate standard, such as SAEJ10, AS2971 or EN286.
- d. Hydraulic reservoirs or accumulators approved to an appropriate standard.
- e. Hydraulic systems must hold a suitable reserve volume or at least 1.25 x the total cylinder volume.

B.7.4 Control valves, lines and fittings

- a. Control valves, lines and fittings must be securely attached with protection from rubbing and external damage.

- b. Articulating airline must be manufactured to an appropriate standard, such as SAE J1402 and appropriately fastened.
- c. They must be protected from moving components and sharp edges.
- d. They must be protected from heat or debris.
- e. They must be rated to suit the pressure and operational requirements, with suitable safety factors.
- f. They must provide adequate pressure retention to avoid leak down in the event of supply pressure loss.
- g. They must provide adequate pressure retention to avoid leak down in normal operation.
- h. They must have over-pressure protection in systems where the air supply is capable of charging the system above the safe limit of all supply components.
- i. Supply system pumps must be of suitable capacity to supply the system and re-plenish the system sufficient to maintain vehicle height under all operating conditions. Hydraulic pumps must be discrete to each wheel or fitted side in the case of *hydropneumatic suspension systems*, with power supplies that do not exceed 48 volts.

Note: It is recommended that an auxiliary fill point is provided for the system so that the suspension height can be corrected following a supply failure.

Appendix C: Suspension and ride height component modification checklist

The checklists below are intended to be used by the vehicle modifier and, where applicable, the licensed certifier to help ensure that the modification has included all necessary items to produce a safe vehicle that complies with applicable legislation. Checklist C.1 applies to every type of modification and should be completed before starting the modification, and the appropriate Checklist C.2-C.6 is to be used after the modification.

Vehicle owner:

Vehicle modifier:

Vehicle make and model:

Vehicle identification:

Licensed certifier:

Date of assessment:

C.1 All Modifications: Pre-Modification Vehicle Check List		
Item	Actual (mm) or N/A	RVD (mm)
Tyre and Rim Size		
Front		
Rear		
Hub centre to top of wheel arch at unladen mass.		
Front		
Rear		
Length of Coil at unladen mass.		
Front		
Rear		
Hub centre to top of wheel arch at full droop.		
Front		
Rear		
Length of Coil at full droop (trapped length, not free length).		
Front		
Rear		
Item	Y	N
Are tyre and suspension details consistent with RVD data?		
Are all driveline components OEM?		
Are all driveline components in good working order?		
Will existing brake hoses and other components allow for change in suspension height?		

Tick applicable box – Y=Yes, N=No, N/A= Not Applicable

C.2 Lowering the ride height			
ITEM	Y	N	N/A
Is the vehicle capable of a turning circle under 25m?			
Does the vehicle when in drive mode have a minimum ground clearance specified in the section "Road clearance"?			
Are the number-plates correctly positioned?			
Do all the following lighting positions comply with the applicable standards: number plate light? headlights? taillights? side marker lights? brake lights? reverse lights? directional indicators? rear fog lights? rear reflectors?			
Has the vehicle been checked for compliance associated with headlight aim?			
Do the vehicle's rear vision mirrors allow adjustment for viewing the road behind the driver?			
Can the driver see the ground 11 m ahead of the vehicle with the driver's seat in the most rearward position?			
Do all brake hoses and lines have sufficient clearance along with no binding through suspension travel and turning?			
If fitted and affected, has the brake load proportioning valve lever been adjusted to compensate for the modification?			
Has the vehicle been checked against the New South Wales brake assessment manual?			
Has the vehicles driveshaft's, ball joints, sway bars, control arms, steering arms, drag links, pan- hard bars, differential breather pipes been checked for suspension travel clearance, binding and angle tolerances?			
Does the vehicle have minimal bump steer?			
Are the springs or load carriers and dampener of the correct design and fitting for the vehicle mass?			
Do the front wheels have sufficient clearance at full lock and/or bump to clear inner and outer guards?			
Can the vehicle be easily steered?			
Has the working of the collapsible steering column been reduced or impeded?			
If the vehicle is fitted with a tow attachment does it meet the minimum-maximum height requirements?			
Has the correct tracking for all four wheels been verified?			
Has the vehicles front end camber/castor, toe in/tail out been checked?			
If coil springs are fitted, was the vehicle lowered by resetting and not by other means (e.g. cutting or heating)?			

If lowering blocks have been fitted to lower the vehicle, are they less than 51 mm thick and made from steel or suitable aluminium, and secured to the vehicle by means other than U-bolts?			
If lowering blocks have been fitted to lower the vehicle, are they secured to the vehicle by means other than U-bolts?			
Are all four wheels fitted with mudguards or otherwise protected by the vehicles body?			
Has front and rear suspension been altered by the same amount?			
Has the vehicle been test driven and an assessment made of its stability and handling characteristics?			
Has the vehicle been checked against the New South Wales brake assessment manual?			
Is the ESC functioning within the functional range specified by the vehicle manufacturer for the pre-modified vehicle?			
Are all safety features, including AEB, still functioning?			

Where “No” or “Not Applicable” are ticked, the reasons for choosing that option needs to be explained.

Tick applicable box – Y=Yes, N=No, N/A= Not Applicable

C.3 Raising the ride height – Suspension			
ITEM	Y	N	N/A
Is the vehicle capable of a turning circle under 25m?			
Are the number-plates correctly positioned?			
Do all the following lighting positions comply with the applicable standards: number plate light? headlights? taillights? side marker lights? brake lights? reverse lights? directional indicators? rear fog lights? rear reflectors?			
Has the vehicle been checked for compliance associated with headlight aim?			
Can the driver see the ground 11 m ahead of the vehicle with the driver's seat in the most rearward position?			
Can the gear selector move to all positions without fouling on the body?			
Are the handbrake/gear selector cables long enough to work effectively?			
Does the brake proportioning valve need to be adjusted/remounted?			
Is the steering shaft long enough and not foul on any other components?			
Is the spline engaged by a sufficient amount?			
Is enough slack left in all electrical cabling/looms?			
Does the fuel filler hose retain sufficient slack?			
Is all hydraulic plumbing (for clutch/brakes etc.) long enough?			
Is all radiator plumbing long enough and retain sufficient slack?			
Are all other assemblies spanning the body and chassis/engine suitable and allow for the additional distance introduced by the modification?			
Has suspension modification maintained at least two-thirds of the OEM suspension compression from unladen mass?			
Has suspension modification maintained at least two-thirds of the OEM suspension rebound from unladen mass?			
Has front and rear suspension been altered by the same amount?			
Does the headlight adjustment comply with regulations?			
Has the correct tracking for all four wheels been verified?			
Are all four wheels fitted with mudguards or otherwise protected by the body?			
Has the vehicle been test driven and an assessment made of its stability and handling characteristics?			
Has the vehicle been checked against the Brake Assessment Manual?			
Is the ESC functioning within the functional range specified by the vehicle manufacturer for the pre-modified vehicle?			
Are all safety features, including AEB, still functioning?			

Where "No" or "Not Applicable" are ticked, the reasons for choosing that option needs to be explained.

Tick applicable box – Y=Yes, N=No, N/A= Not Applicable

C.4 Variable ride height			
ITEM	Y	N	N/A
Variable Suspension System Style			
Air Suspension (Airbags, Air Springs)			
Hydraulic Suspension			
Hydro-Pneumatic Suspension			
Certification Required			
Spring assist only			
Rear only bolt-on replacement system			
Slow Speed controls			
Front and/or Rear Variable			
Front only variable			
Rear only variable			
Front and Rear variable			
On-Board Air Controls			
Are On-Board air controls fitted?			
Are the Controls Driver Adjustable?			
Do height changes occur at a rate or more than 40mm/s?			
Is a load levelling automatic system fitted?			
On-Board Hydraulic Controls			
Are On-Board Hydraulic controls fitted?			
Are the Controls Driver Adjustable?			
Is a load levelling automatic system fitted?			
Vehicle Height and Wheel Travel			
Has the suspension travel been reduced by more than 1/3 in either direction?			
With the system in its lowest position, can the vehicle be driven with enough steering change to manoeuvre?			
Is the trim height more or less than 50mm changed from the original standard height?			
For lowered vehicles, does the vehicle have at least 100mm ground clearance whilst in motion?			
Shock Absorbers			
Are suitable shock absorbers fitted?			
Does the vehicle have an acceptable on-road behaviour during a road test?			
Are the variable elements, e.g. Airbags, mounted on struts?			
Are the struts original or application specific struts?			
Are the spring or strut mounts modified from standard?			
Suitability for the Application			
Are the suspension components manufactured by a Company or Corporation?			
Are the suspension components designed for the specific vehicle model?			

Are any generic components suitable for the application?			
Are the suspension components suitable for the vehicles intended use (must not be "For off-road use only")?			
Have other parts or aspects of the vehicle changes that may affect the operation of the vehicle and/or require certification?			
Do the changes to the vehicle meet other legislative requirements and guidelines? e.g. ADR's, VSI's, VSB14			
Safe Operation			
Do all components used meet applicable standards?			
Do reservoirs (where fitted) have suitable storage capacity?			
Are air or hydraulic pumps used suitable for the application?			
Has documentation been provided for the system operation			
Are the number-plates correctly positioned?			
Has the vehicle been checked against the Brake Assessment Manual?			
Is the ESC functioning within the functional range specified by the vehicle manufacturer for the pre-modified vehicle?			
Are all safety features, including AEB, still functioning?			

Where "No" or "Not Applicable" are ticked, the reasons for choosing that option needs to be explained.

Tick applicable box – Y=Yes, N=No, N/A= Not Applicable

C.5 Wheels and tyres			
ITEM	Y	N	N/A
Do the replacement wheels/tyres comply with the <i>Tyre and Rim Standards Manual</i> ?			
Are the replacement wheels designed to suit hub and pcd?			
Do the replacement wheels keep wheel track within requirements?			
Do the replacement wheels meet load rating required including GVM upgrades?			
Do the replacement wheels meet all design standards?			
Do the replacement tyres meet load rating required including GVM upgrades?			
Do the replacement tyres meet overall diameter increase/decrease requirements?			
Do the replacement tyres meet the minimum speed rating requirements specified in the <i>Tyre and Rim Standards Manual</i> ?			
Are all four wheels fitted with mudguards or otherwise protected by the body?			
Has the vehicle been test driven and an assessment made of its stability and handling characteristics?			
Is the vehicle capable of a turning circle under 25m?			
Can the driver see the ground 11 m ahead of the vehicle with the driver's seat in the most rearward position?			
Do the replacement tyres foul at any point in normal operation?			
Is the vehicle's speedometer still accurate			
Has the vehicle been checked against the Brake Assessment Manual?			
Is the ESC functioning within the functional range specified by the vehicle manufacturer for the pre-modified vehicle?			
Are all safety features, including AEB, still functioning?			

Where "No" or "Not Applicable" are ticked, the reasons for choosing that option needs to be explained.

Tick applicable box – Y=Yes, N=No, N/A= Not Applicable

C.6 Raising the ride height – Body lifts			
ITEM	Y	N	N/A
Are the body blocks suitably designed to carry the downwards and braking load when the vehicle is loaded to its GVM?			
Are the number-plates correctly positioned?			
Do all the following lighting positions comply with the applicable standards: number plate light? headlights? taillights? side marker lights? brake lights? reverse lights? directional indicators? rear fog lights? rear reflectors?			
Has the vehicle been checked for compliance associated with headlight aim?			
Do the vehicle's rear vision mirrors allow adjustment for viewing the road behind the driver?			
Can the driver see the ground 11 m ahead of the vehicle with the driver's seat in the most rearward position?			
Can the gear selector move to all positions without fouling on the body?			
Are the handbrake/gear selector cables long enough to work effectively?			
Does the brake proportioning valve need to be adjusted/remounted?			
Is the steering shaft long enough and not foul on any other components?			
Is the spline engaged by a sufficient amount?			
Is enough slack left in all electrical cabling/looms?	Y	N	
Does the fuel filler hose retain sufficient slack?	Y	N	
Is all hydraulic plumbing (for clutch/brakes etc.) long enough?	Y	N	
Is all radiator plumbing long enough and retain sufficient slack?	Y	N	
Are all other assemblies spanning the body and chassis/engine suitable and allow for the additional distance introduced by the modification?	Y	N	
Are all four wheels fitted with mudguards or otherwise protected by the body?			
Has the vehicle been test driven and an assessment made of its stability and handling characteristics?			
Has the correct tracking for all four wheels been verified?			
Has front and rear suspension been altered by the same amount?			
Has the vehicle been checked against the Brake Assessment Manual?			
Is the ESC functioning within the functional range specified by the vehicle manufacturer for the pre-modified vehicle?			
Are all safety features, including AEB, still functioning?			

Where "No" or "Not Applicable" are ticked, the reasons for choosing that option needs to be explained.