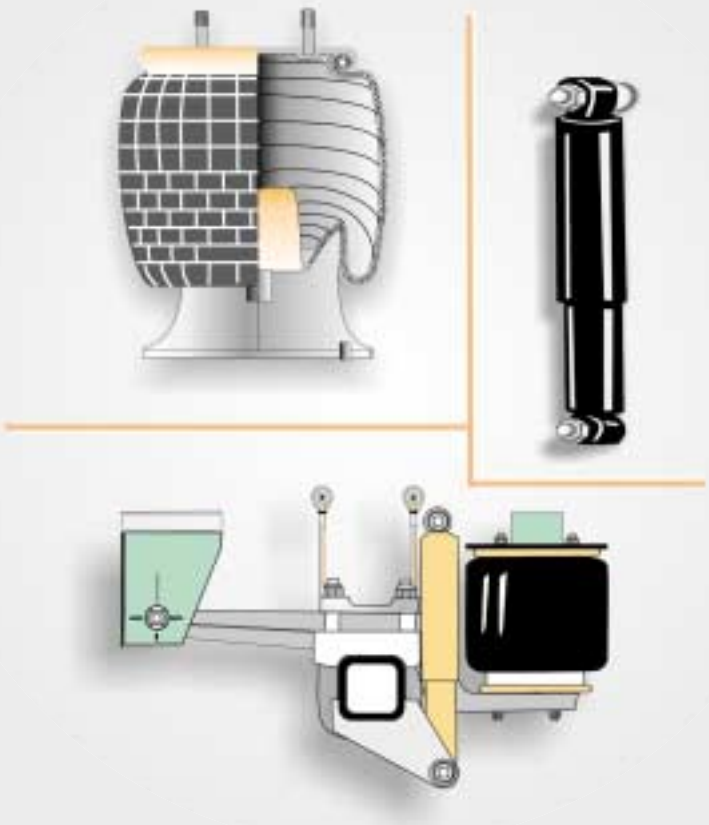
# Air Suspension Code



# Guidelines for Maintaining and Servicing Air Suspensions for Heavy Vehicles

ARTSA
AUSTRALIAN ROAD TRANSPORT SUPPLIERS ASSOCIATION

ATA
AUSTRALIAN TRUCKING ASSOCIATION

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**Disclaimer:**

This Code is intended to show recommended methods, maintain economies, safety and road friendliness. It is not possible to take into account all parameters which may have an influence on a vehicles' performance. No liability can be accepted for any information given.

ARTSA acknowledge that as sponsors of this Code that there may be alternative practices and procedures available. Owners and operators shall choose their own practices and procedures their business will follow.

ARTSA
AUSTRALIAN ROAD TRANSPORT SUPPLIERS ASSOCIATION

Dr Peter Sweatman,
Chairman, ARTSA

Formed in 1993, **ARTSA** provides a national focus for transport suppliers, operators and government agencies to share expertise for the benefit of the Australian road transport industry.

**ARTSA** is the combined technical resource for improved safety, environment and productivity. This resource is available to government agencies, transport operators and standards organisations.

**ARTSA** values its relationships with all stakeholders in the transport industry and provides factual and balanced information.

**ARTSA** membership is broad-based and includes:

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- trailer manufactures
- component manufacturers
- fuel suppliers
- driver trainers
- vehicle repairers
- test equipment manufacturers
- providers of testing and compliance services
- insurance service providers

**ARTSA** activities include:

- Codes of Practice
- Conferences and workshops
- Research
- Scholarships

**ARTSA**'s activities are managed by an Executive Officer who may be contacted at:

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# Heavy Vehicle Air Suspensions

## Introduction

Over the past 20 years suspension design changes, more durable components and operational needs have evolved to where the industry today has largely taken up air suspension, often considered to be “road friendly suspension”.

Reasons for this large scale uptake in Australia vary, but include:

1. Various comparative testing by road agencies has shown air suspensions to be the most road friendly, hence the now common reference to “road friendly suspensions”. Some mechanical suspensions have now been tested and found to meet the road friendly performance criteria.
2. Manufacturers have built a greater degree of durability, with longer warranties, extending vehicle component life, giving improved resale values.
3. Reduced vibration and shock loading giving better cargo ride through superior load springing and the lower natural frequencies of air suspension systems.
4. Improved driver comfort, and road holding, loaded or empty.
5. Improved braking, as a non-reactive system, no axle-hop, assisting the operation of load proportioning valves in certain cases.
6. The biggest incentive in Australia to use air suspensions has been the prospect of higher mass limits.

Issues with air suspensions have been encountered in some sectors of heavy vehicle road transport. Particularly in some off-road/on-road applications, such as road train operations, together with some other rough service applications. In some applications air suspended vehicles tend to be more demanding of unsprung components.

# Code Purpose

This code recommends practices and procedures that will help the vehicle owner, maintenance staff and drivers to better understand the operation and maintenance of air suspensions.

The Australian Road Transport Suppliers Association (ARTSA) membership includes not only major heavy vehicle suppliers but many major component manufacturers and suppliers to the Australian heavy vehicle market. ARTSA sees this code as a positive step to improving wider understanding among all levels of road transport industry personnel.

This code has been prepared with input from various ARTSA members, the Australian Trucking Association (ATA), and other contributors.

It is recognized that products are in a state of continuous development and improvement. The latest specifications, repair recommendations and supplementary service bulletins from the original equipment manufacturer, should be obtained to ensure that service information is current.

## Suspension Certification

The Department of Transport and Regional Services, Vehicles Safety Standards Branch manage a certification process that identifies "Road Friendly Suspensions – Performance and Component Requirements".

These requirements apply to all new suspension systems put into service after January 2000, with a "Road-Friendly" suspension classification as set out in performance standards developed by the National Road Transport Commission. *(See glossary.)*

Road-Friendly Certificate Numbers (RFCN) are issued, identifying the original equipment supplier with an RFCN, after the submitted suspension passes the required test. The supplier identifies the approved suspension with a label or plate in accordance with that supplier's component traceability procedure.

## Principles of an Air Suspension

The first "air-spring" patent was issued to John Lewis of New Haven Connecticut in 1847. The history of air suspension shows the first early development on production passenger cars in 1914. Further development progressed during the early 1950's with the GM Greyhound buses and GM parlor car passenger rail carriages. After early difficulties, air suspension has finally gained wide acceptance on trucks and trailers.

A heavy vehicle suspension system's basic design function is to attach the axles to the frame of the vehicle and to equalize or distribute vehicle weight in specific ratios between axles. Vehicle weight distribution becomes extremely important during brake applications, cornering and whilst negotiating uneven surfaces.

The design function of an air suspension is to reduce vehicle vibration due to road roughness while maintaining stability, including adequate roll stability. Springing is provided by the air springs and damping is provided by the shock absorbers. Because of reduced pavement and bridge wear, road friendly suspensions have been granted higher mass limits.

The main features of a modern air suspension are a set of air springs, hanger brackets, trailing arms and shock absorbers, which support the vehicle body at each axle or axle group. A key element is the shock absorber or damper as air springs alone are poorly damped. They effectively absorb the energy of the suspension's movement.

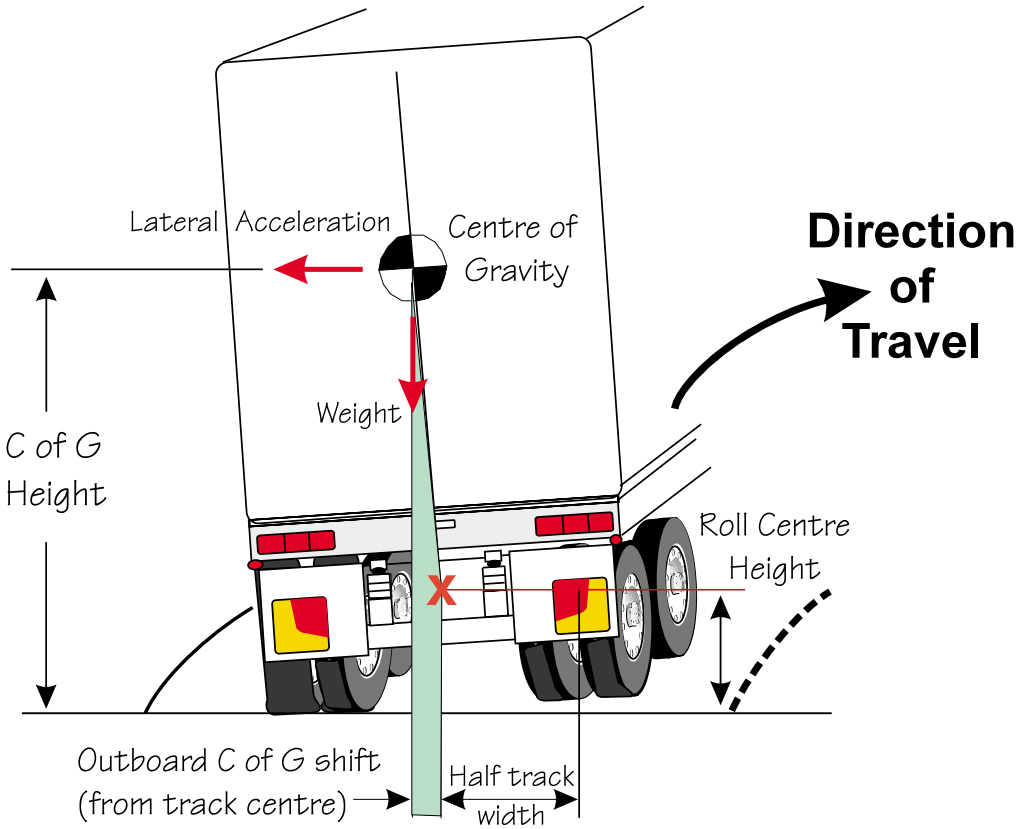
Several additional components and advanced features now vastly improve today's air suspension compared to that of 25 years ago. These include, shock absorbers, air compressor design, plumbing and control systems.

Air suspension may not suit all transport applications. In some instances the driver is not able to "feel" how the vehicle or combination is handling, as generally occurs with conventional mechanical suspensions.

# Suspension Roll Parameters — Roll Stiffness, Roll Centre and Roll Steer

The ability to control ride height while giving a relatively soft spring rate as well as good load sharing has improved the air suspension's performance greatly. By itself air suspensions have poor roll stiffness and require anti-roll devices to be included.

Rolling of the vehicle on the suspension causes the centre-of-gravity (COG) to shift sideways relative to the wheels, and this tends to destabilise a vehicle in a turn. The amount of roll depends principally on the suspension's roll stiffness and the suspension roll centre height




## Roll Stiffness

*Roll stiffness* is defined as the rate of change in the restoring couple exerted by the suspension of a pair of wheels on the sprung mass of the vehicle with respect to change in suspension roll angle. Roll stiffness may be viewed as a measure of the ability of a vehicle to resist body roll when subjected to cornering forces.

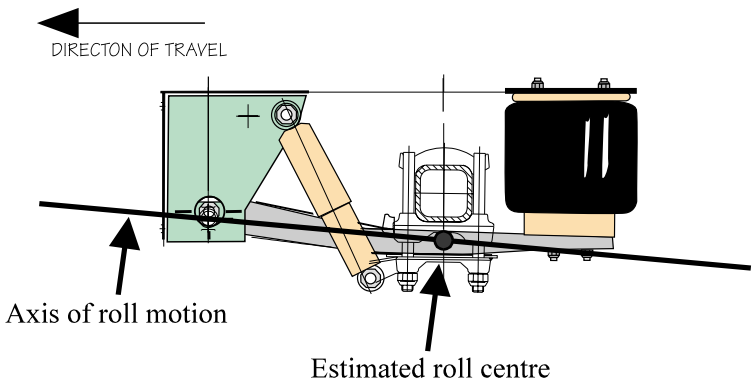
*The roll stiffness* of a heavy vehicle suspension is a function of (1) the vertical stiffness of the suspension springs, (2) the lateral spacing of the suspension springs and (3) any built in or auxiliary roll stiffening mechanisms.

Auxiliary roll stiffness is provided by several means, varying from the incidental twisting of the suspension members to the action of deliberately placed anti-roll devices such as sway bars.

## Roll Centre Height

*Suspension roll centre height* is defined as the vertical displacement from the ground plane to the roll centre.

Roll centre height may be viewed as directly affecting the "moment arm" from the roll centre to the vehicle centre of gravity (COG) height. The greater this moment arm (and the lower the roll centre height), the more the vehicle will roll for a given lateral acceleration applied to the vehicle COG.

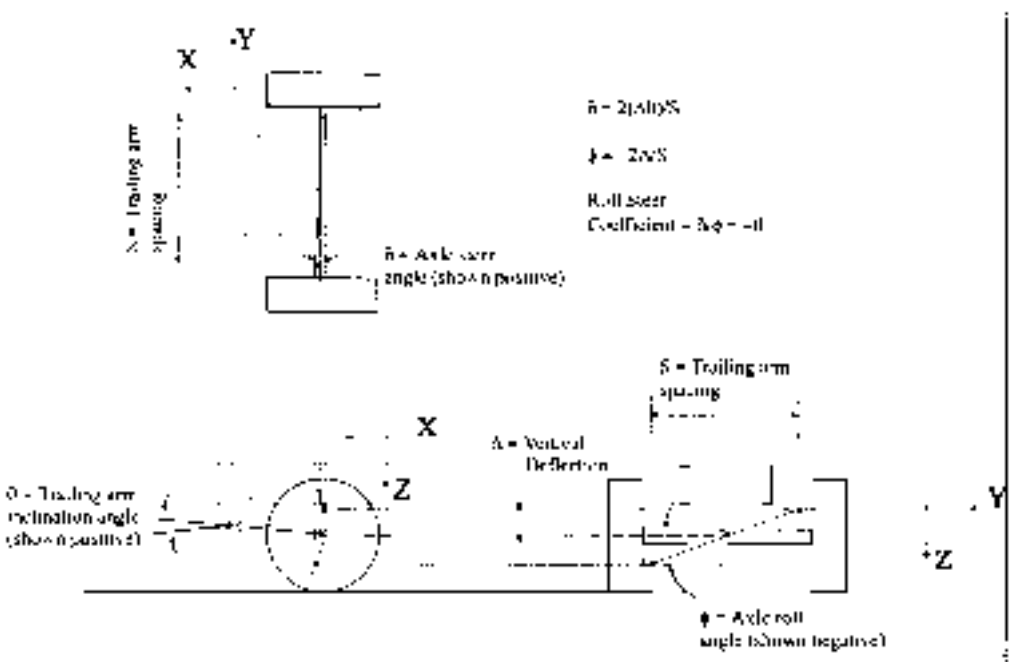



## Roll Steer

The handling and tracking behaviour of heavy vehicles is affected by the suspension roll steer properties. When suspension roll occurs, the mechanical layout of many suspensions is such that the suspended axle tends to steer slightly. For example, when a trailing arm suspension rolls to the left, the left side of the axle moves back a little and the right side of the axle moves forward a little, resulting in axle steer to the left.

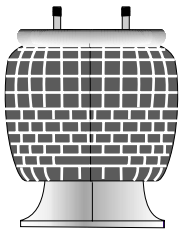
*Roll steer coefficient* is defined as the rate of change of axle steer angle with respect to change in suspension roll angle.

The lower the roll stiffness, the more noticeable the roll steer effects will become.



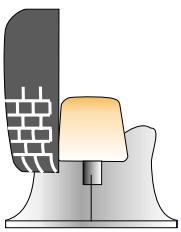
# Key Components and Their Purpose

## Air Spring



This is made of quality rubber compounds, permanently sealed by vulcanising the upper and lower retaining lids. With increased load the air spring rolls down over the piston, the air is compressed in the bag and spring resistance increases. Air springs are connected to each other by air-lines to ensure uniform axle loads and uniform braking under all operating conditions. Two common designs are the assembled type with a bead seal and the totally sealed type.

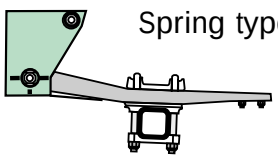
## Bump Stops



An integrated rubber bump stop is a fail safe device that protects major bag damage in the event of bag air loss. The bump stop will enable the vehicle to be slowly driven to the nearest available service centre. It is recommended that travel is at a greatly reduced speed, after the air supply to the damaged bag is shut off (if possible).

## Trailing Arms

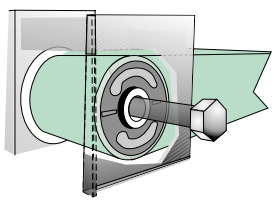
Spring type



Two common types are popular. One is designed as a spring. It connects the air bag and the axle to the vehicle via the suspension hanger bracket and the spring eye bush.

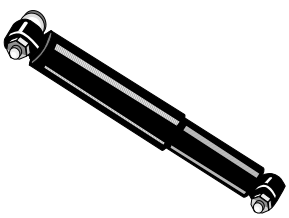
## Pivot Connection

Fabricated



The second is a fabricated trailing arm. The fabricated trailing arm connects to the hanger arm by a large pivot bush. The internal steel centre of this rubber bush design allows several millimetres of vertical travel. The pressed into the fabricated trailing arm. Correct torque is essential with this set-up and the type of fastening must be fitted as per the manufacturer's recommendations. This could include using a "huck" bolt or a tack weld. Several systems allow axle alignment adjustments.

## Shock Absorbers

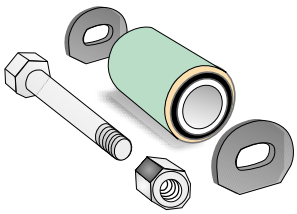


Their function is to absorb the energy caused by the up and down movement of the suspension. This is achieved by a set of hydraulic valves running in special oil. Shock absorbers are specifically designed and selected for each suspension application. They work extremely hard. They are currently the most difficult component to confidently assess and determine in-service performance.

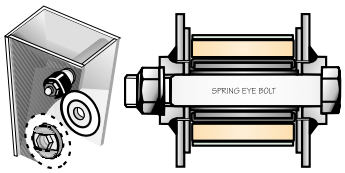
## Hanger Brackets

These attach the suspension to the vehicle and are dependent on vehicle type and operating application for each specific design. Location, height and bush component materials are very important to the suspension performance. Wear plates, anti-rotation and track adjustment features are common to most hanger bracket design.

## Spring Eye Bush

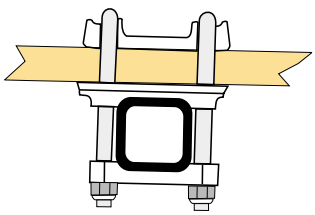


A range of bush designs used with spring leaf type trailing arms are available, made from a range of materials, usually incorporating strong rubber and synthetic materials capable of great flex and returning to the original position. Key requirements include critical torque requirements and regular inspections of side wear-plates, washers and lock nut tensions.



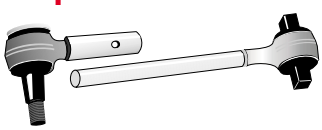

*Assembled cutaway view of spring eye bush and hanger bracket.*

## U Bolts



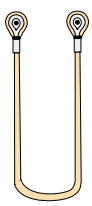
A means of fixing the suspension trailing arms to the axle. U-bolts are held in place using a “top-plate” and “bottom-plate”. The important issue for “U” bolts is to ensure the manufacturer’s recommended tension is correctly applied with a tension wrench.

## Torque Rods



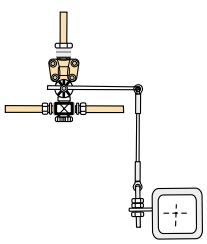
Torque rods are a common feature on many types of air suspensions. Their main purpose is to absorb lateral forces and add some lateral stiffness to the suspension stability. Rubber bushes at each end usually give a long working life.

## Axle Catch-Straps



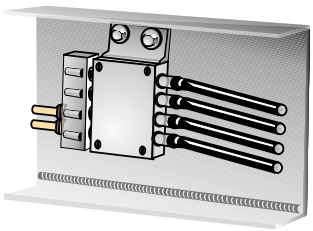
These are common items on some types of suspensions and limit axle travel within the shock absorber and air bag stroke as well as preventing shock absorber damage. Typically found in “rough-service” such as off road applications. A minority of designs have a stroke limiter incorporated into the shock absorber itself, or externally through a webbing strap loop or chain.

## Height Control (Mechanical) Valve



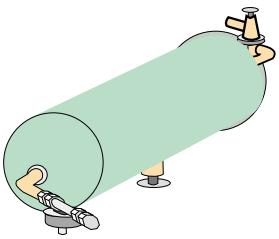
At least one height control valve is used for each suspension group. In some cases two ride height valves are set to independently control each side. The height control valve (HCV) regulates the ride height of the suspension, via adjustment settings taken at the manufacturer’s recommended ride height for that suspension.
Key features include the range of short time (or zero) delay settings to exhaust or replenish the system air flow.

## Height Control (Electrical) Valve



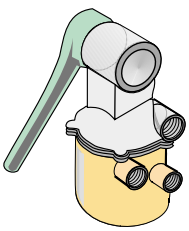
Some trucks and prime movers have electronic height control valves that regulate the vehicle height automatically to a pre-determined level. When the load weight changes, the sensor activates the solenoid valve assembly to adjust air accordingly.
An optional manual/hand held cable height control also allows the operator to adjust the vehicle to match any loading or unloading height requirements, such as a loading dock.

## Air Supply Tank

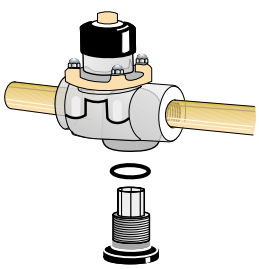


Is necessary to ensure adequate filtered air supply to the air suspensions during all operating circumstances. A separate air tank supply is often recommended for tri-axle trailer suspensions. A filter and drain plug are used to assist in ensuring clean dry air supply.

## Air Supply Controls



- Air filter to ensure clean air
- Hand control, pressure regulating valve (left)
- *(option)* Raise and lower system for dock leveling
- *(option)* Air pressure weight indicator. Air pressure, is converted by a transducer or air guage to show suspension weights in kgs. *(All brakes must be released for reading accuracy)*



- Pressure protection valves – as per Australian Design Rules

## Lift Axle

The optional lift axle is a feature able to be automatically deployed at a predetermined weight of the adjacent axle. The lift axle improves tyre wear, empty travel ride, and braking.

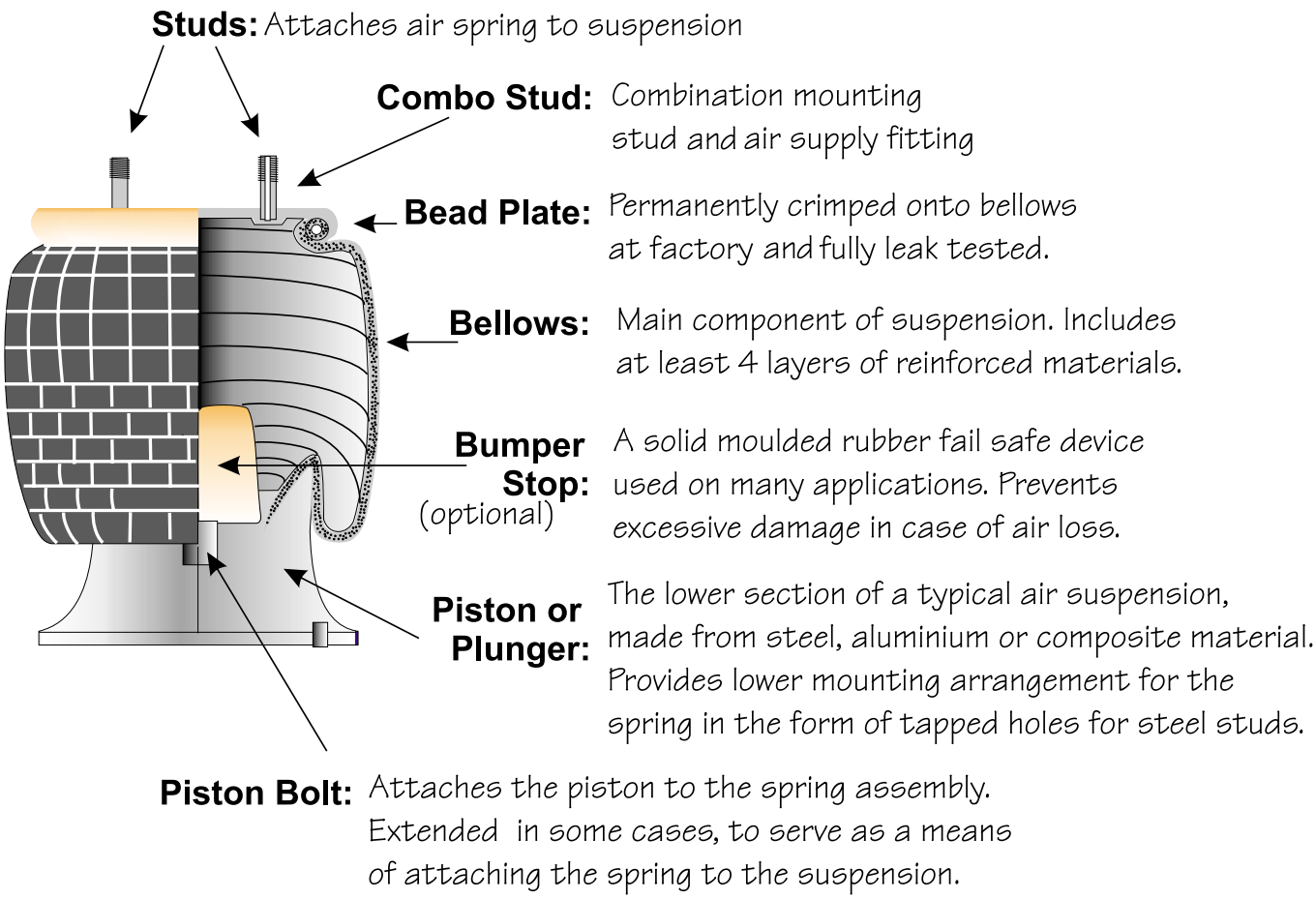
## Air Spring (Bag)

There are two types of air spring, one is often called a “complete” air spring and one that is known as an “assembled” air spring.

The complete air spring is attached to the bellows bead plate and cannot be disassembled. Its lower part is attached onto the hollow piston and attached with plate clips. The piston is fixed by the piston bolt to the centre guide of the assembly.

## Components

Air spring showing bump stop design.

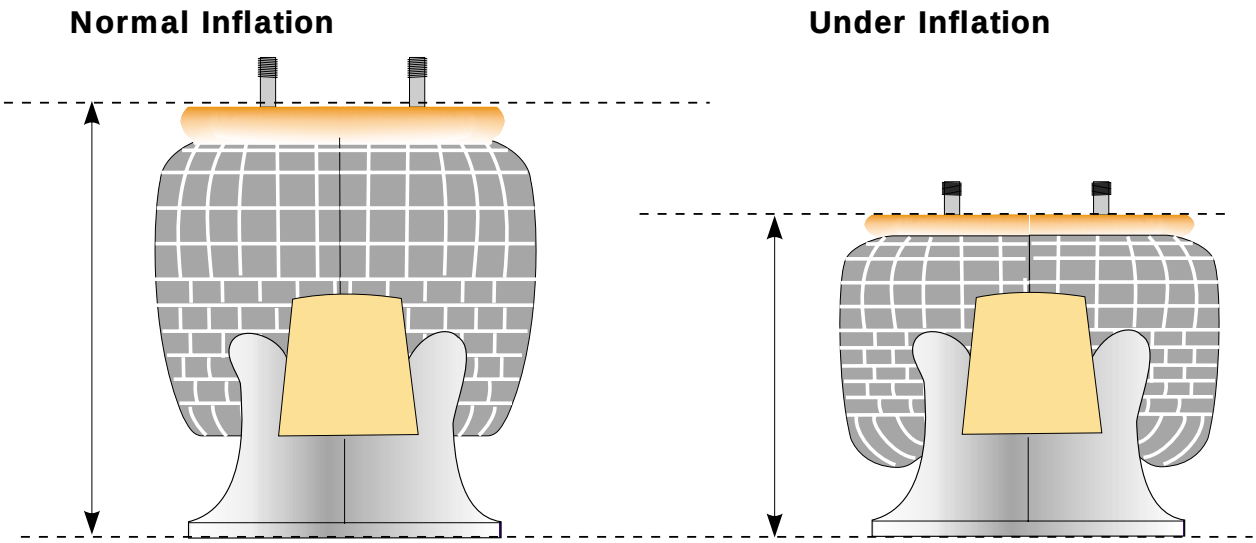



The assembled type of air spring has an upper section that is attached onto the bead plate secured with an attachment screw on a bellows plate in the frame. The lower part of the air bellows is attached to the hollow piston.

Each replacement air spring must be the same style design and type as the original. Other designs should not be substituted for the original air spring type. It is important to correctly identify the type of air spring required for replacement.

- Read the manufacturers name and spring model number
- If a number is not readable, measure the bag/spring circumference and height while un-inflated.
- Determine whether the air spring is fitted with “bumper” stops. Compress to the minimum height and measure from the bottom plate to the top bead plate. These dimensions should match the replacement spring specifications.

Air springs are designed to work in compression only and have limited travel capability. Shock absorbers or catch straps are the limiting device that prevent air springs from over-extending. Again shock absorber inspection is a key to air spring life.




✗ *Do not operate a loaded vehicle on the bump stops for any extended period unless driving at a very low speed to the nearest workshop.*

## Air Supply

It is common and popular practice for each suspension to have its own dedicated air tank of filtered compressed air. Air tanks cause few problems, but require internal condensation moisture to be drained at regular intervals. Daily visual checks for air line damage, or loose fittings can save major problems for other components.

A pressure protection valve is required by the Australian Design Rules (ADR's) to ensure that the vehicle's brake system maintains at least a 425kpa operating pressure in the event of serious air loss for any reason.

Air taken from the vehicle air supply system passes through the pressure protection valve (PPV) and thereby meets this safety requirement.

## Shock Absorbers

As a wheel passes over a bump in the road surface the vehicle's springs deflect and respond by "over-returning". This oscillating action will continue, slightly reduced each time the air bag deflects. These oscillations coupled with road shock can cause severe damage to truck components. The compression and rebound force resistance built into shock absorbers, reduces component failures caused by shock or vibration. *(See the performance standard for road friendly suspensions in the glossary.)*

There are three major design types of shock absorbers supplied to the heavy vehicle industry:

### *Non-Pressurised/Oil Valves*

This design is used by many manufacturers. Performance variations are influenced by different rebound lengths, compression and the use of multi-stage valving and different bore diameters.

### *Gas Charged/Oil Valves*

This design is widely used in the light duty market. It operates on the same principles as the non pressurized type. Instead of operating at normal atmospheric pressure the oil is subjected to a high pressure nitrogen gas. This high pressure gas is designed to reduce aeration by eliminating air bubbles in the oil.

### *Gas Cell Pressurised/Oil Valves/Manually Adjustable*

This design functions like and provides the same advantages as the gas charged designs, but with additional benefits. The gas cell provides an additional means of gas retention. This is a significant advantage since gas leakage is a common failure in standard gas charged systems. The manual adjustment provides for personal ride adjustment. This selection can be made before the shock absorber is installed, or by removing one end mount.

### *Non-Pressurised/Oil Valves/Manually Adjustable*

These shock absorbers are built for specific applications and should have no initial adjustment. After kilometres add up and performance deteriorates, the shock absorbers can be removed and re-adjusted to restore original damping performance. Each part number has a specific damping rate designed for a specific application. These shock absorbers provide an increased life through adjustment of internal parts.

The location, angle and adjustment of the shock absorber, including its hanger bracket is very important. The location of the internal valve system requires the shock absorber to be mounted correctly, ie; “top” marking to be in “top” position. Settings and adjustments are dealt with later in the code, but it is important that shock absorbers are correctly specified for each particular vehicle type.

Correct size, length and capacity are critical. Absorber size determines the ability to absorb and dissipate heat. Absorber length must be such that it cannot bottom out during maximum axle movement. All suspension components should be tensioned at the static ride height which allows the bush to flex to the designed amount. All bushes should be tightened using a torsion wrench as this will ensure correct torque.

Air impact wrenches cannot accurately deliver correct torque. Failure of mounting bushings still ranks the number one failure item for shock absorbers.

# Typical Layouts and Operating Features

The most common air suspensions assemblies in Australia are the tandem drive suspension in powered units and tandem and tri-axles for trailers.

## Powered Units – Trucks and Prime Movers

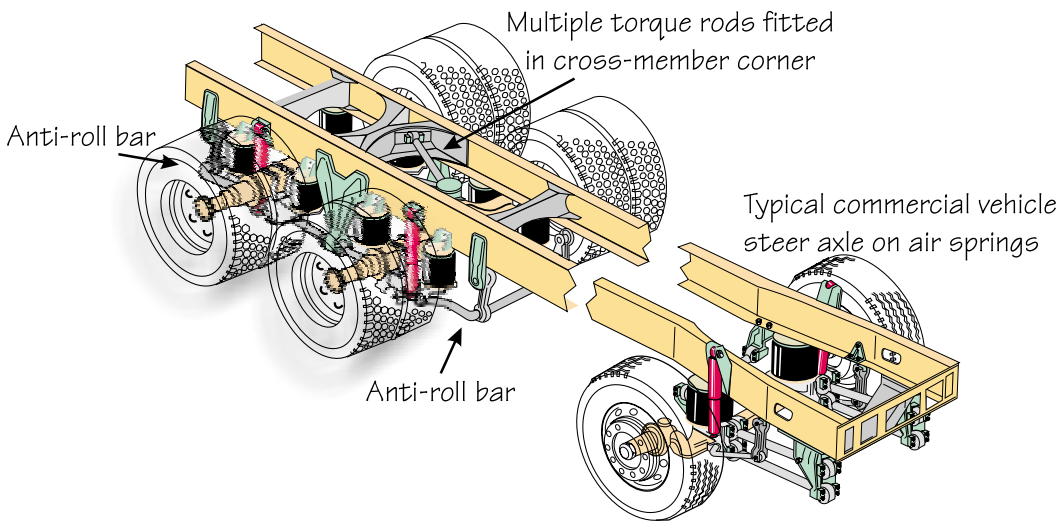
Many prime movers used for working at maximum GCM (Gross Combination Mass) are fitted with suspensions systems incorporating 8 air springs.

These suspensions have been developed for Australian operations and perform up to expectations in a wide range of conditions. Some designs incorporate multiple ride-height controls, servicing the left and right sides of the vehicle. Some manufacturers use anti-roll or anti-sway bars to provide additional stability for the vehicles.

Particular attention must be given to the choice of drive axle suspensions selected for high gross combination mass (GCM) applications.

Rigid vehicle applications show some preferences for manual ride-height controls. These are typically a favorite with many delivery dock applications. A wide range of ride height control features exist, including those that automatically re-set to the programmed ride height after the first brake application. Others operate outside the vehicle on a hand held switch panel. Nearly all have automatic re-set to a default ride height after a manual adjustment for loading is completed and the vehicle commences on-road travel.

## A Powered Unit Six-rod Suspension on Air Springs



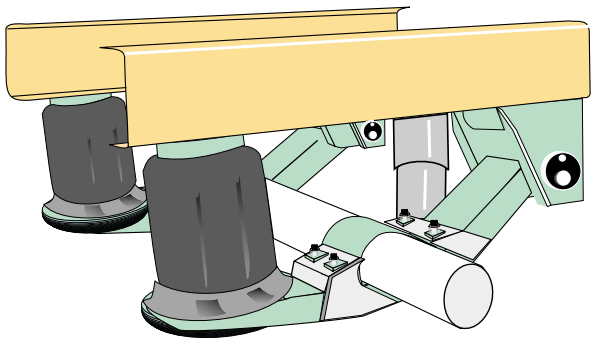

## Trailer Units

A wide range of air suspension configurations are available for most applications. Common operator selection requirements are influenced by the centre of gravity of the load and the trailer floor height preferences. Many of the first air suspension users included specialist carriers of damage or vibration sensitive freight such as furniture, fresh vegetables and electronic equipment. The range of commodities now demanding a more gentle ride on air suspensions is quite wide.

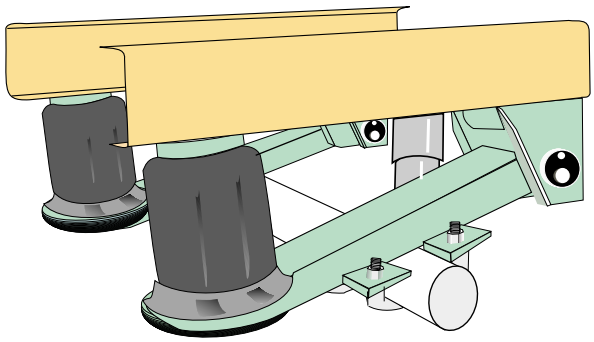
Trailer suspensions are recommended to be fitted with a dedicated air tank, air filters and ride height control valves as shown on the triaxle layout drawing on the following page. One of the main options is the ability to fit additional anti-sway bars or other features to increase roll stability, especially for loading with high centre of gravity (eg. livestock and logs).

# Components and Common Layouts

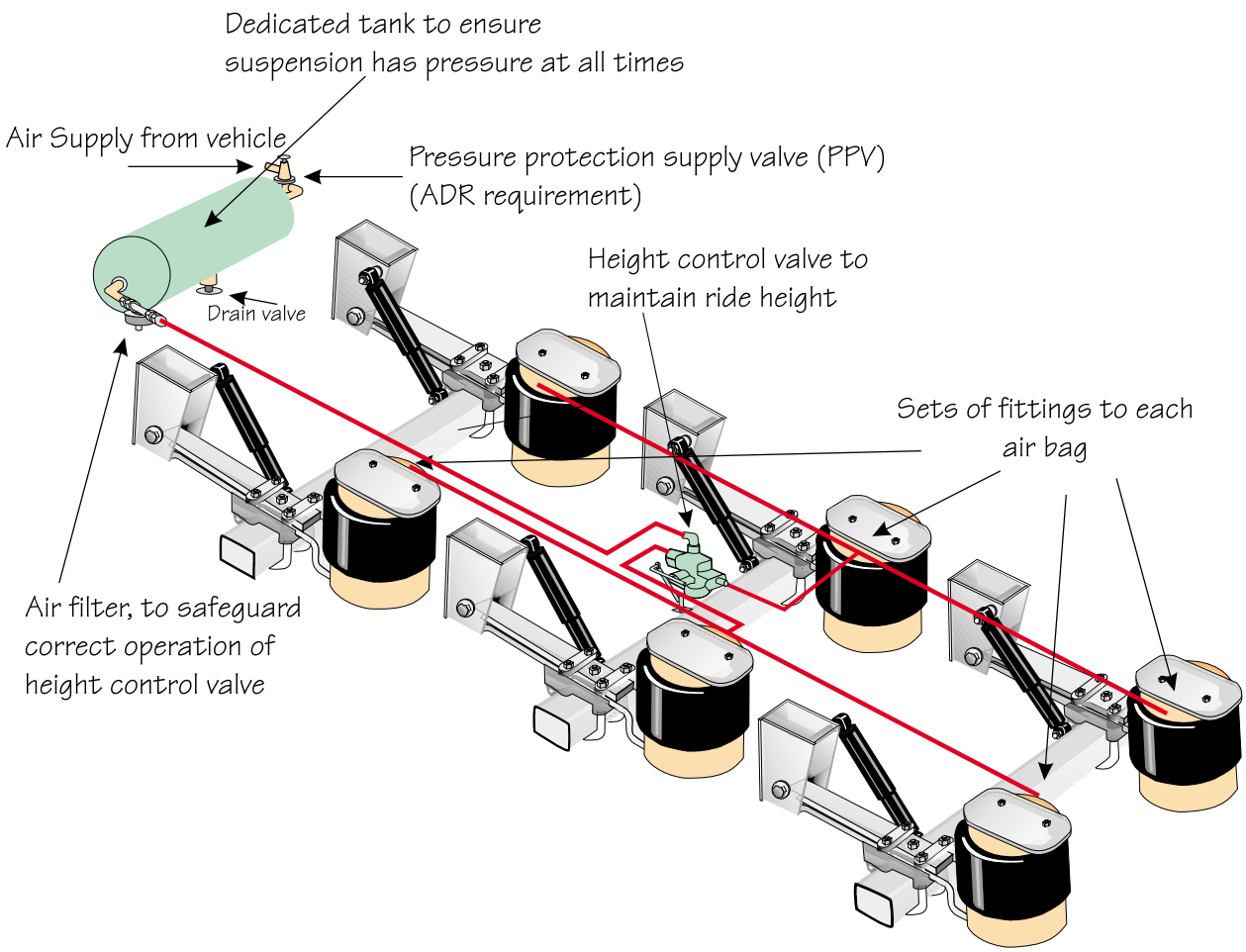
## Under-Slung Suspension



## Over-Slung Suspension



## Tri-Axle Trailer



# Setting Up An Air Suspension

After a suitable suspension design has been selected for a particular transport application, the key components and operating features should be well understood among those people servicing and operating the suspensions, All original equipment manufacturers supply detailed procedures for correct installation, adjustment recommendations and replacement part numbers. These should be closely followed to ensure the suspension's best operating performance is maintained.

# Maintenance and Inspection Recommendations

After taking delivery of a power unit or trailer the suspension should be checked by the transport service personnel to ensure the suspension is supplied and assembled as per specifications.

In order to maintain good in-service performance, a range of suspension function adjustments, regular service settings, including torque settings, are essential for top performance and long low cost operating life.

Most suspension manufacturers provide effective maintenance guidance to ensure that suspensions retain adequate operating performance, including road friendliness, in service. Such model and design specific detail should be used to confirm recommended servicing and adjustments.

## In-Service Performance Compliance

### Vehicle Service Bulletin 11 (VSB11)

From January 2000 all new road friendly suspensions are required to meet the Performance Standard as developed by the National Road Transport Commission as "Road Friendly Suspension – Performance and Component Requirements, and Acceptable Test Methods".

All "Road Friendly Suspensions" are required to be registered with the Vehicle Safety Standards Branch (VSSB) of the Department of Transport and Regional Services. When satisfied that a suspension system complies with VSB 11, a Road Friendly Certificate Number (RFCN) will be issued and is indicated by an appropriate marking method such as a plate, label or decal on the suspension.

## National Heavy Vehicle Accreditation Scheme

Operators may obtain higher mass limits for tri-axle vehicles fitted with Road Friendly Suspensions, certified and complying with VSB 11.

Such vehicles and fleets are required to participate in the National Heavy Vehicle Accreditation Scheme (NHVAS), Mass Management Scheme. This accreditation scheme is only required to gain the mass increase for tri-axles.

*At the time of publication, higher mass limits for RFS do not apply to steer axle groups, single drive axle trucks, single axle trailers or axles fitted with wide single tyres.*

## Replacement Parts

The Motor Vehicle Standards Act prescribes certain standards, called Australian Design Rules (or ADR's) that new vehicles must meet upon delivery. State and Territory Vehicle Standards legislation also extends these standards beyond delivery, throughout the working life of the vehicle by means of a regulatory compliance regime.

While "Road Friendly Suspensions" are not specifically covered in the ADR's, there is a formal registration process as mentioned above, for obtaining a RFCN. Approval under this scheme will be granted on the basis that a suspension system of a particular configuration conforms to the performance specification prescribed in VSB 11.

Any changes to that configuration, by way of substituting spare parts of unknown origins and hence of unknown performance, could render the suspension non-compliant. It is strongly recommended that operators consider carefully the temptation to fit parts that have no manufacturer's warranty or detailed performance specifications displayed on the actual components.

Compliance with an appropriate standard should be confirmed by your parts supplier in writing, before acceptance of new parts. Retain the written confirmation with the fleet maintenance records.

## Legal Responsibilities and Duty of Care

Directors and heavy vehicle owners as well as other persons, such as workshop managers and fleet supervisors should ensure that all replacement parts and components are suitable and will ensure the suspension will continue to meet the certification performance standard.

After market parts that do not comply and have no warranty may also lead to additional on-costs as a result of a vehicle manufacturer refusing to honor normal warranties, or insurers rejecting insurance cover for accidents where non-compatible parts have been fitted.

An investigation and report published by the National Road Transport Commission in 2000 concluded that on-road-in-service performance testing is not justified on economic grounds, however this does not preclude any road agency conducting such tests.

Several Road Authorities remain concerned that some operators may not maintain air suspensions to the required certification performance level, and reserve the right to test as required.

# Index — Component Inspections, Settings and Adjustments

| CHECKLIST: | Trouble Shooting – Indicators and Options |
|---|---|
| **SHOCK ABSORBERS** | Progressive or sudden loss of energy absorbing capability, increase in tyre wear and flat spots, vibration, and poor ride. |
| Inspections | What regular indications and signs to look for. |
| Bush Torque | The importance of correct torque for absorber bushes. |
| Visual and Heat Testing | Options to select from in various situations. |
| Supplier Testing | Will supplier tests always suit your application? |
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| **SUSPENSIONS AND AXLES** | Regular inspections are an important feature for suspensions. and axles, especially when replacing major components such as tyres and linings. |
| Tracking and Axle Alignment | Correct torque to hold the U-Bolt and upper and lower plates. |
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# Maintenance and Servicing

## 1. Shock Absorbers

Operators should establish a shock absorber replacement schedule, determined by the type of transport task or application the suspensions are working in.

Until some confidence is gained in determining a fleet or vehicle application replacement schedule for shock absorbers, it is recommended that they are removed and inspected at intervals between 150,000 kms and 200,000 kms. If vehicles are working under harsh conditions, such as off-road work, this interval should be halved.

One recommended procedure is to sample test representative shock absorbers of the same age and working in the same conditions, to build up a reliable performance history record for typical transport applications.

### Inspection

Conduct regular visual inspection to ensure there are no component parts damaged.

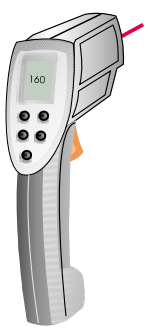
Check fastener torques with a torque wrench, re-torque to manufacturers recommended tension if necessary. These should be tensioned at the static load height. If bushes are tightened up at full droop, then the bush will wear out rapidly.

Do not “over tighten” when torquing up mounting fasteners, as this will restrict normal operating movements, causing early failure of mounts.

Ensure the shock absorbers are the correct length. It is important that the shock absorber length matches the minimum and maximum axle travel. Shock absorbers must not be allowed to “bottom out”.

Replace any shock absorbers that are leaking. Ensure the shock absorber is really leaking and not “misted”. Misting occurs when oil on the rod evaporates due to high heat and then condensates on the body leaving a fine oily residue. This is common during hotter times of the year and should not be of concern.

When ride deterioration or changes in tyre wear are noticed, a shock absorber failure may be the cause. Carefully touch or take temperature reading on the main body of the shock absorber near the bottom mount *(do not measure the dust tube at the top).* It is useful to touch a metal portion of the chassis to establish a temperature reference point. It is recommended that a “touch test” not be done after the vehicle has been working for hours. Test after operating the suspension for only a few minutes, as shock absorbers can get so hot as to burn fingers, with temperatures as high as 35 to 80 degrees Celsius.

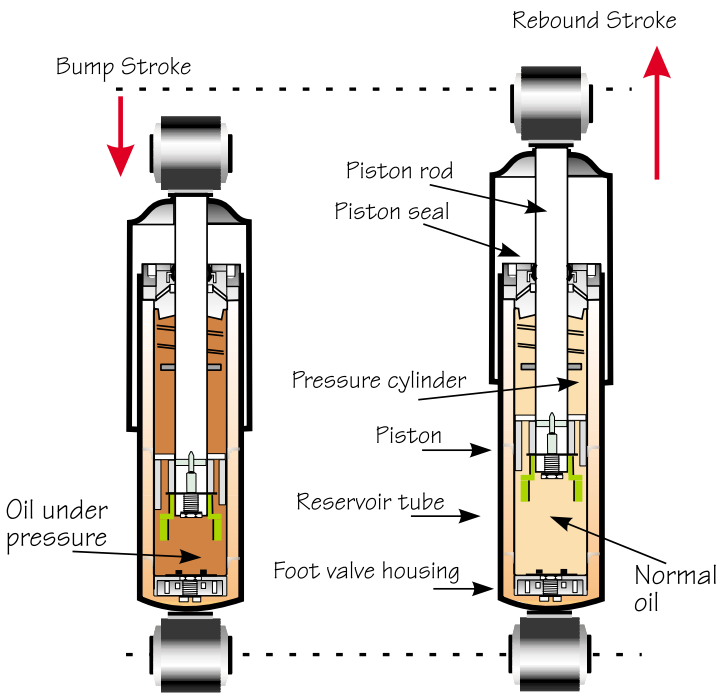


The recommended option to test for shock absorber failures that are visually undetectable is to use a non-contact hand held infrared thermometer. This is a more practical option to confirm that the shock absorber is functioning. These measuring instruments, commonly called “heat guns” are available in Australia from $300.

Check the shock absorber body on the opposite side on the same axle and compare the readings. Both shock absorbers should be warmer than the chassis reference point, but be similar in temperature to each other. Differences greater than 20% between shock absorbers on the same axle should be considered “suspect”.

Check for visible signs of wear. If the suspect shock absorber is cooler or cold, then it should be removed for closer inspection. Turn the shock absorber upside down and shake while listening for any rattles indicating broken internals.

Worn or broken shock absorbers show little or no resistance when compressed by hand.



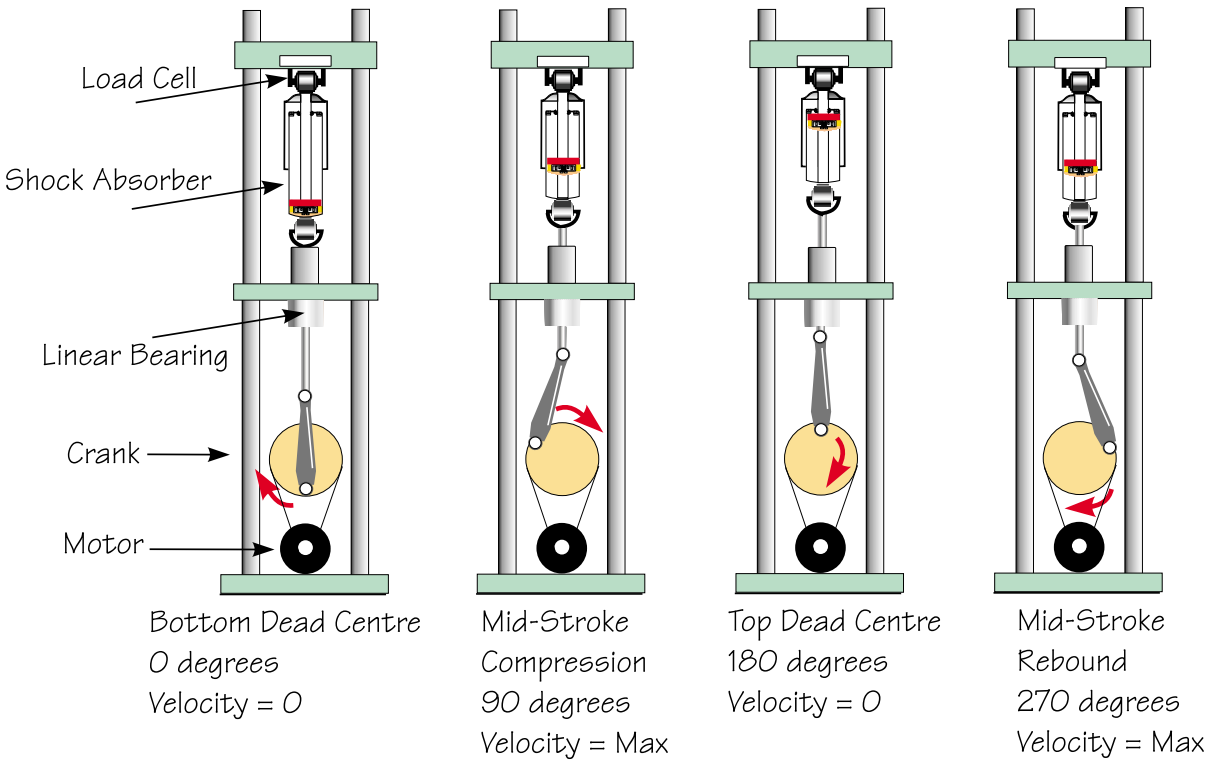

## Shock Absorber Testing

Shock absorber manufacturers use dynamometers to test damping performance. Testing of shock absorbers on a dynamometer has one major disadvantage in that the shock absorbers must be removed from the vehicle. Since the major cost of replacing shock absorbers is the removal and replacement, in many cases operators may determine to replace rather than test, even if the shock absorbers are only partially worn.

The dynamometer is a machine that compresses and extends the absorber at known speeds and measures forces produced as the shock absorber is moved through its full range of motion.

The diagram below illustrates the process, showing the general arrangement consists of the test machine frame, a drive motor at the bottom and a belt and pulley which spins a crank attached to the damper shaft through a linear bearing.

The motor spins the crank, moving the piston up and down and cycling the shock absorber through its normal range of movement until a working temperature is reached. After a working temperature is reached the range of forces are recorded on a data logger. These usually cover damper force, displacement, temperature and velocity.




This same procedure is used to test new shock absorbers from time to time.

## Shock Absorber Replacement

Check shock absorbers at each regular vehicle service inspection. Visual checks should cover leaks, broken mounts and extruded or worn bushings. A cold shock absorber is no longer a functioning shock absorber.

Also consider a possible shock absorber failure when a vehicle is experiencing more frequent light bulb replacements, excessive king pin wear, tyre wear or air spring damage.

## Shock Absorbers

**CHECKLIST:** Daily visual inspection, for oil leaks and loose fittings

- ✔ Keep suspension clean and free of road dirt build-up
- ✔ Check bush eyes and catch straps for wear
- ✔ Arrange regular "heat-tests" of shock absorbers; compare with other shocks
- ✔ Ensure ride height settings are correct, that absorbers do not "over-extend"
- ✔ Record your fleet history for a preventive maintenance change-over distance

**Replacing** Set vehicle at correct ride height

- ✔ Remove upper and lower mounting bolts and the absorber
- ✔ Replace with the OEM recommended shock absorber or one meeting appropriate standards
- ✔ Ensure torque adjustments are made to manufacturer's recommendations
- ✔ Replace both sides on an axle when replacing
- ✘ Do not mix a new shock absorber on the same axle as the old worn one
- ✘ Do not "over-tighten" any fasteners/nuts

# 2. Suspension

## Track Settings and Alignment

For most operators, suspension alignment is carried out by the vehicle manufacturer, or a member of the Australian Heavy Vehicle Alignment Association. However it is important to have an understanding of how alignment measurements can effect a suspension's performance and what checks and remedies are available. Observe the manufacturer's recommended settings, especially the toe-in, toe-out and camber.

## Inspection

Indicators of possible alignment issues include: excessive or uneven tyre wear, uneven braking and axles off-tracking.

Trailer alignment can be checked as follows:

1. Release all brakes and roll vehicle backwards and forwards on a level surface several times, to ensure suspension is free from any binding.
2. Suggest use of axle and king pin extensions to more easily take measurements.
3. Align the centre axle with "kingpin" as shown in the trailer example diagram.
4. Align and measure other axles to the centre axle as shown. (The front axle can be used for other axle configurations).
5. Torque up hanger clamp bolts using only a "torque wrench", to the manufacturer's tension eg; 815 Nm for 22mm clamp bolt.
6. Torque the external adjustment shaft alignment nut to 80 Nm, or if a "huck" bolt, then tack weld in position.
7. Re-check all fasteners after 1500 kms for correct tension and correct if necessary.

## U-Bolts

Standard U-bolts clamp the top plate, the leaf spring or fabricated trailing arm, the axle and the bottom plate together. The U-bolt must be correctly torqued in a diagonal sequence to the OEM's recommended tensions, typically in the torque range 600-700 Nm.

Because of the number of surfaces between these components there is a tendency for some "settling", which requires any resulting slack to be re-torqued, after the first 1000 or 1500 kms interval following assembly of a new or repaired axle assembly.

Operators have found that suspension component failure is greatly reduced by retorquing U-bolts during the first day of service following the initial tightening.

## Catch Straps – Stroke Limitation (if fitted)

Catch straps are commonly used on many Australian suspension designs to limit air spring deflection and extend suspension component life. These are set so as to limit excess downward axle movement, notwithstanding the shock absorbers may have the capacity to withstand the downward axle travel. When installing ensure that they do not rub against the axle beam.

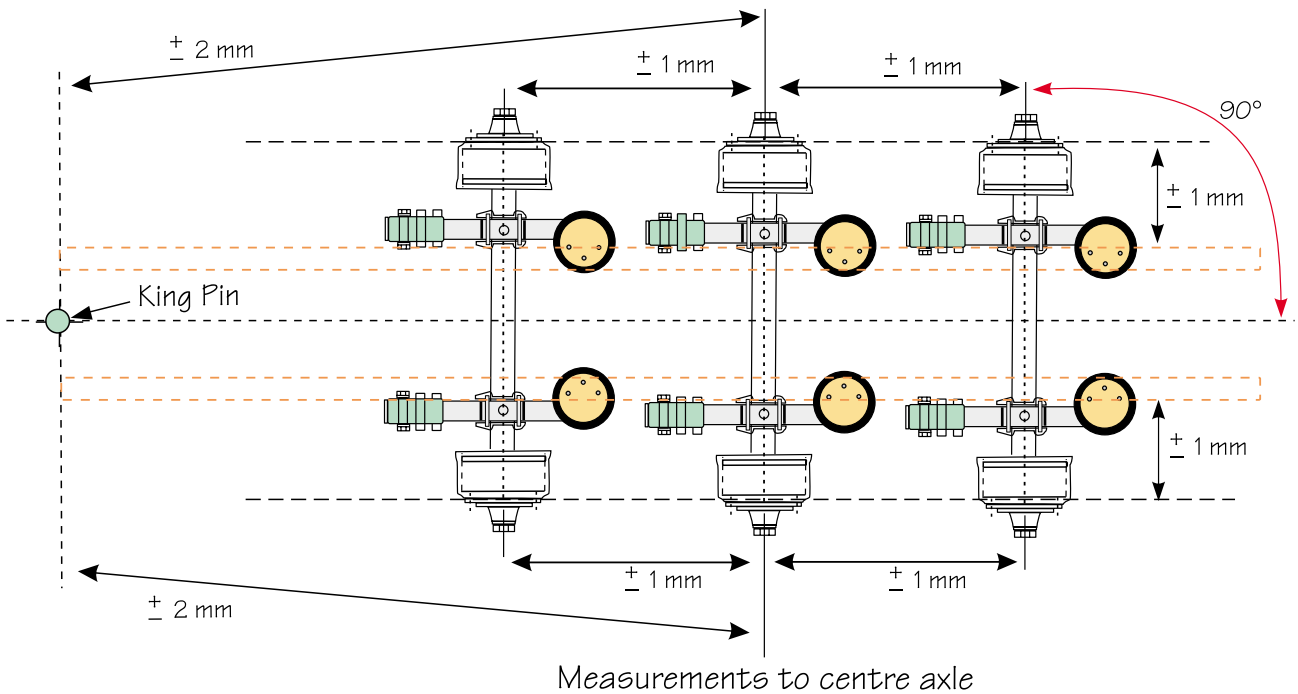
Other designs include heavy duty webbing or chain "stroke limiters" fitted to the shock absorbers. These limit the maximum shock absorber stroke.

## Alignment and Torque

**CHECKLIST:** Use the vehicle un-laden and on a level surface, release brakes

- ✔ Consider axle extensions to assist in getting accurate visual alignment
- ✔ Always use a torque wrench as per the manufacturer's recommended settings
- ✔ Recheck all fasteners for correct torque after 1500 kms
- ✔ Ensure all disc or spring washers have the CONCAVE side to the hanger
- ✔ Re-torque U-bolts diagonally and check after first day of work after major services
- ✘ Do not reassemble worn and or mis-matched parts
- ✘ Do not change the manufacturer's recommended torque settings

## Trailer Example




## Suspension Testing

Roads Authorities remain concerned that some operators may not continue to maintain air suspensions to the required certification performance level, and therefore reserve the right to test as required.

Road-friendly suspension performance, both new and in-service, is dependent on the performance of: **Shock Absorbers, Bushes and Air Springs**.

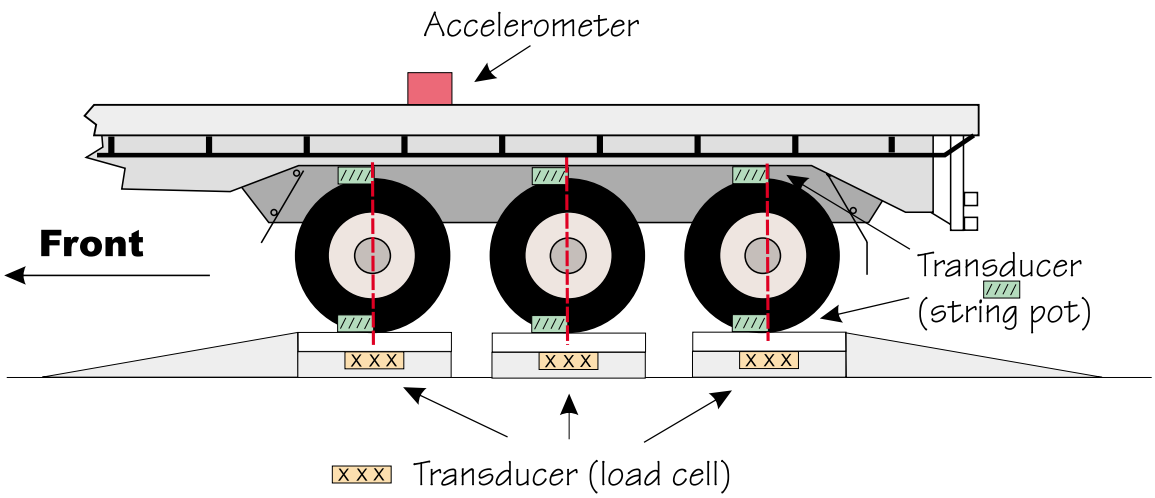
Road-friendliness is affected by the bouncing of the vehicle on the suspension (sometimes called vertical dynamics) and by the static load-sharing between the axles.

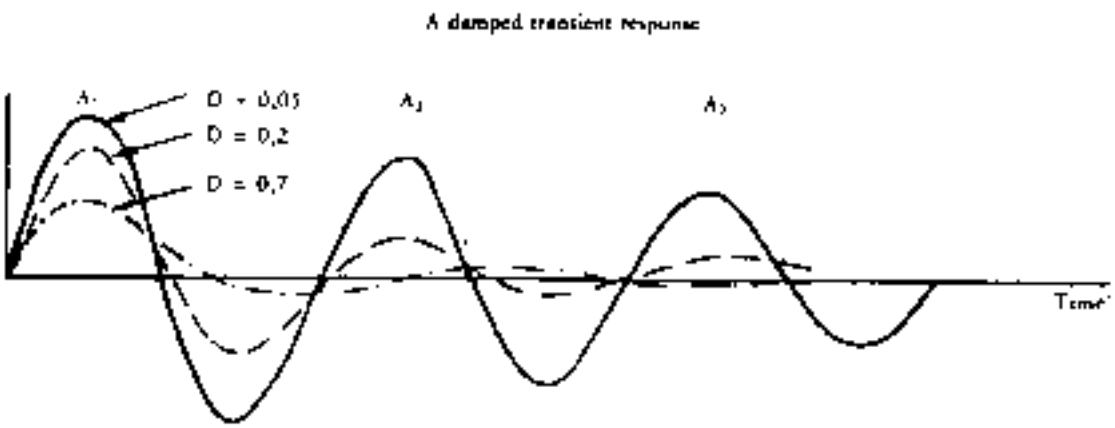
To be “road-friendly”, the suspension must control the bouncing of the vehicle in such a way that:

- The frequency of bouncing is sufficiently low
- The damping of bounce motions is sufficiently high
- The friction component of the total damping is not too high (and the component supplied by the shock absorbers is sufficiently high).

The whole suspension system may be tested on the vehicle using a “drop test” which can produce an appropriate level of bouncing in a repeatable manner. The relative bouncing motion between the vehicle chassis and the axle is recorded using a transducer such as a potentiometer, or the vertical acceleration of the chassis is recorded using an accelerometer; alternatively, the vertical tyre forces may be recorded directly. The frequency and damping of the bounce motion is measured from these recordings and compared with the requirements of Vehicle Standards Bulletin 11, namely:

- Bounce frequency less than 2 cycles per second
- Damping ratio more than 20 percent.



The drop test may be carried out using any of the following methods:

(a) Be driven at low speed (5km/hr ± 1 km/hr) over an 80mm step. The transient oscillation to be analysed for frequency and damping occurs after the wheels on the driving axle have left the step; or

(b) Be pulled down by its chassis so that the driving axle load is 1.5 times its maximum static value. The vehicle hold down is suddenly released and the subsequent oscillation is analysed; or

(c) Be pulled up by its chassis so that the sprung mass is lifted by 80mm above the driving axle. The vehicle held up is suddenly dropped and the subsequent oscillation analysed; or

(d) Be subjected to other procedures insofar as it has been proven to be equivalent.

## 3. Air System Component Servicing

The location and placement of air suspension components is usually part of the manufacturer's equipment design as well as knowledge of the working performance history of various suspension components. Air lines are designed and made to international standards.

### Air Line Inspections

Listen for possible air line leaks from any line pipes. Check that pipes have not become kinked or pinched in any way. Ensure all air lines remain properly clamped to the vehicle chassis and do not sag down so as to be able to get caught.

### Air Line Leaks

If a suspected leak proves hard to find, hand brush or spray soapy water over the lines and watch for air bubbles.

### Air Tank Services

Carry out regular visual inspections to ensure all tank fittings and mountings are tight and in place. Vent moisture from drain plug on a regular basis.

Clean and or replace air tank filters.

### Air Spring Inspections

Check all air spring connections to ensure torque settings are correct. Ensure there is no build up of small stones or other debris between the piston and the air spring. Check that the springs have no wear marks from rubbing on other components that may be out of alignment.

If constant wear is occurring, check that the air springs are not too large for the application. Rolling lobe pistons should be inspected for cracks and corrosion. If cracks or corrosion is found, replace the piston. Slight corrosion may be cleaned up, so long as a smooth rolling surface is restored. Check for leaks with soapy water.

### On-Road Air Spring Damage

Occasionally such damage can be caused by a tyre blowout or loss of a tyre tread.
If an air spring is punctured during a journey, it is possible under some circumstances to carefully continue if service centre approval is obtained and a replacement spring is not available.

The only type of air spring that is suitable for limited travel without air, on smooth roads, are those that have the inbuilt rubber "bump-stop" on top of the piston.

Isolate the damaged air spring by removing the air line and folding it back on itself, clamp tight with vice grips or a hose clamp. If not set up in series, then add a bridging "T" piece or bung jammer, to isolate the damaged air spring.

### Fitting an Air Spring

Each replacement air spring must be the same style and design as the original. Styles and designs are engineered for each of the OEM suspensions and should not be substituted. Follow the OEM parts catalogue.

Fitment of a new air spring should be carried out when the vehicle is empty. Support the vehicle frame with strong jack stands approximately 50mm above ride height. If jacks are not available then raise the suspension on the other air springs.

When the height control valve(s) is used as a means of jacking, then the linkage must be disconnected at the lower attachment. Move the control arm to an "up" position to raise the vehicle; place jack stands at the necessary height; move the control arms down to lower the vehicle onto the jacks; then completely exhaust the air from the springs.

If the air spring has a leak or is deflated the exhausting procedure must still be carried out. Some systems are fitted with pressure retention valves (PRV) to maintain a minimum 40-50 kpa pressure. These are typically used where dock leveling devices may lift the vehicle clear of the pavement and ensures that the springs do not pinch when lowered.

### Air Spring Replacement

**CHECKLIST:** Exhaust all air from the suspension system (even if the spring is deflated)

- ✔ Turn the hand control valve handle to deflate manual systems
- ✔ Disconnect the air supply line from the air spring
- ✔ Install the new air bag assembly, torque as per the OEM torque chart
- ✔ Reconnect air supply lines and link connections
- ✔ Inflate suspension in excess of 275-350 KPA and check for leaks (max is approx 690 KPA)
- ✘ Do not attempt to replace a spring with a vehicle loaded
- ✘ Do not use a non-conforming or non-approved air spring

## *4. Air System Valves*

The vehicle air system is an important part of the air suspension. A range of valves ensure the system meets the OEM's design performance.

### Height Control Valve – for a 1 or 2 HCV system

There is a range of different height control valve types. The main differences are whether they are on a powered unit or a trailing unit. Many powered units are fitted with dual height control valves including some that are electronic with a series of solenoid valves and sensors. Some single axle suspensions use fast response valves, eg. twin ride height control valves or on steer axles.

Proper ride height is especially important for driven axles, as driveline angles are directly affected by incorrect angles, including small variations. For vehicles with dual height control

valves, each OEM procedure should be followed. It is suggested that the settings made are checked with the vehicle loaded, using a duplex air pressure gauge, to ensure both valves are equalized.

Many newer ride height valves operate with a very simple flick of a switch. This has given rise to a grave misconception that ride height is not important and is an adjustment for driver convenience and comfort. Some suppliers fit "drive-away-protection" features saving unnecessary damage as the system automatically reverts to the pre-set ride height on the first brake application, or on reaching the selected road speed.

***There is only one correct ride height for each vehicle.*** *(Refer to your manufacturers' suspension drawing).* Improper ride heights will lead to component failures, including, poor ride, excessive vibration, shock absorber and shock absorber bush failures.

Trailing units are more likely to be fitted with mechanical height control valves. It is recommended they be fitted to the trailer centre-line, on the axle in the centre of the axle group, away from possible damage risk exposure or unauthorised tampering.

Ensure all settings and adjustment are carried out in accordance with manufacturer's procedures.

## Measuring Ride Height

1. The vehicle should be un-laden and parked on a level surface. Trailers should be attached to the prime mover. The air brake system pressure must be in excess of 550 KPA throughout the procedure. This is to ensure the pressure protection valve (PPV) opens. Ensure all tyres have the correct inflation pressure. Chock wheels to prevent vehicle movement. Release brakes.
2. Prior to measuring, exhaust the air from the air bags, then re-inflate to at least 6.5 bar.
3. Measure the distance X *(see XY illustration on page 32)* from the ground to the centre of the axle for that axle nearest the height control valve.
4. Measure the distance Y from the ground to the bottom of the frame at a point near the axle used in step 3.
5. The ride height is the difference between the two measurements, or Y-X= ride height. It is recommended that the ride height be permanently marked on the vehicle, eg; on the chassis adjacent to the height control valve, or near the driver's door. It is also worth recording these measurements on the vehicle history card.

If a trailer manufacturer's recommended ride height is not able to be set, the average of the highest and lowest possible settings can serve as an approximation.

For powered vehicles, follow the OEM recommended procedures so as to ensure the correct driveline angularity on powered vehicles is retained.

## Adjusting Ride Height

**Park the vehicle on a level surface.**

The air brake system pressure must be in excess of 550 KPA throughout the procedure. Ensure the tyres are correctly inflated, wheels chocked, then release brakes. (some fleets prefer to leave multi axle vehicles loaded)

**Dump air via suspension dump valve in vehicle cab.**
Disconnect the linkages to the lower brackets, then lift the control arm to the "up" (intake) position until air flow raises the air springs. Push the control arm to the neutral position when the correct ride height is obtained.

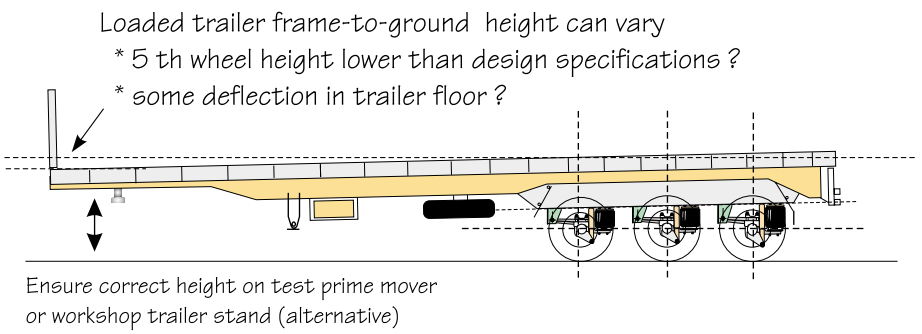
**Disconnect the linkage from the height control valve(s)** and release all air from the air springs by moving the control arm to the "down" (exhaust) position for 10-15 seconds. Some popular makes have a small wooden "locating-pin" that aligns the adjusting block and the control arm. This should be inserted at this point.

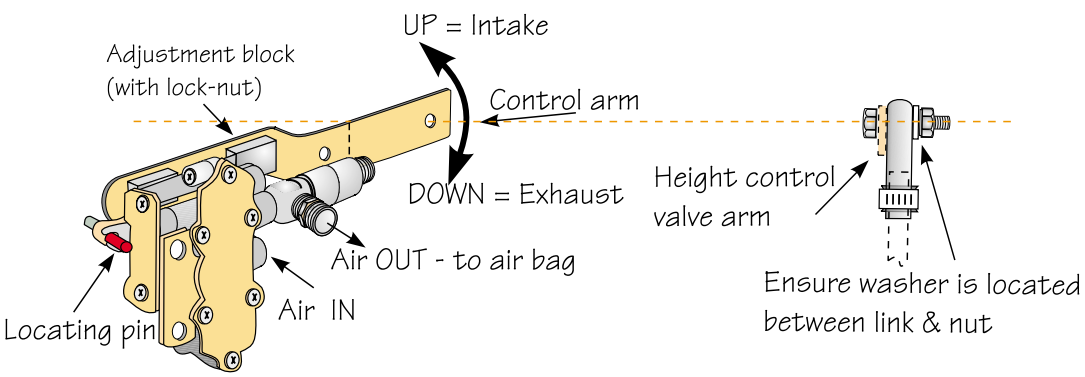
**Select the axle with the height control valve** and measure the distance from the axle centre and the underside of the chassis rail. Ride height adjustments are made by adjusting the valve or length of the vertical linkage *(see diagram page 12).* Adjustments should be made in accordance with the manufacturer's recommended procedures for that particular model suspension. Many supply a "ride height template". Adjustments may require multiple holes in brackets, shims, jam nuts or slotted holes to change the setting, depending on the type of fittings.

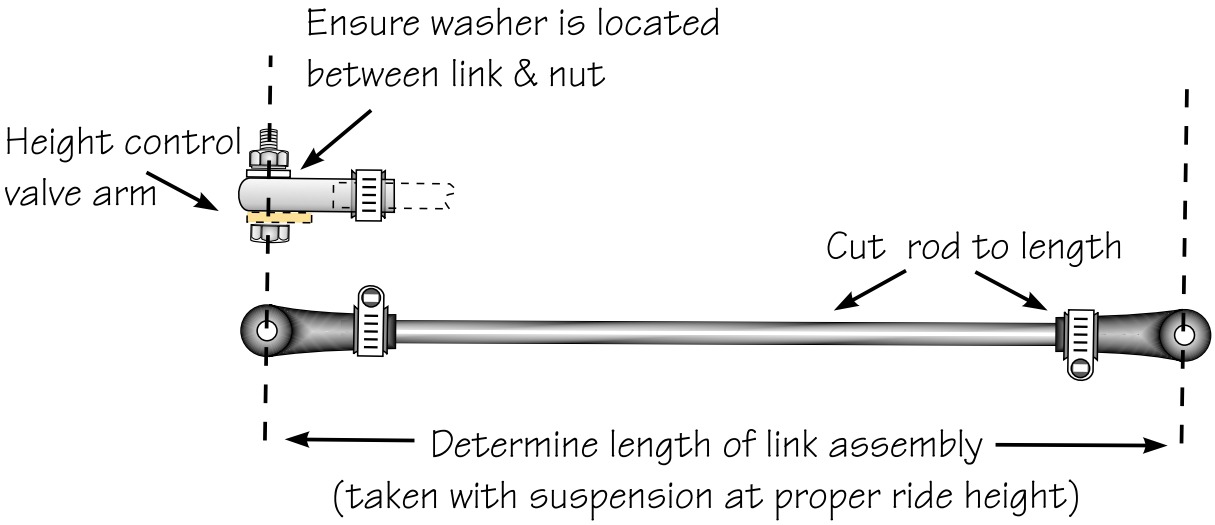
**Recheck the adjustment** by disconnecting the linkage and exhausting the air bags to about half full. Reconnect the linkage, which will inflate the air springs, then check that this is now at the correct setting height.

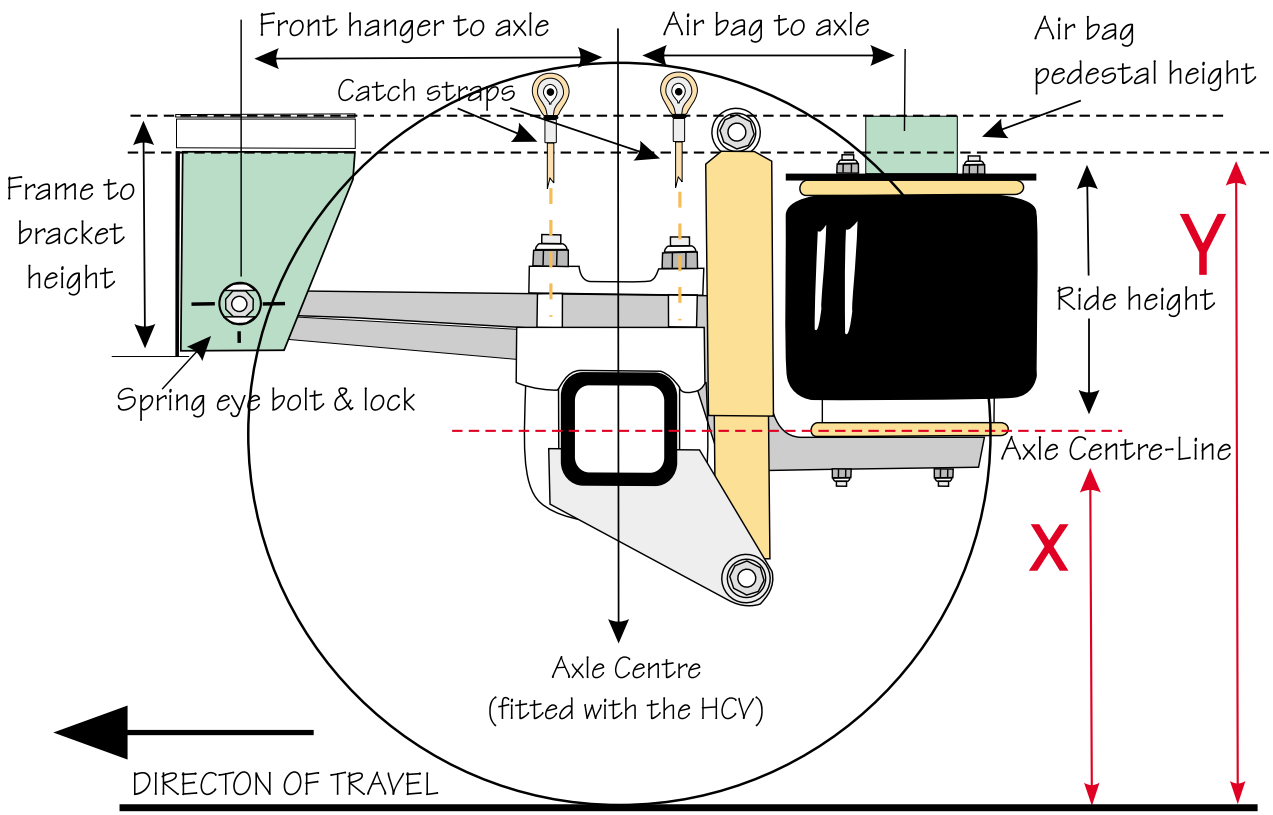
Make sure all adjustments and linkage connections are retightened to the manufacturer's recommended level of torque tightness. *(See linkage diagrams.)*

***Note:*** It is suggested that the settings made on vehicles fitted with dual ride height control valves are checked with the vehicle loaded, using a duplex air pressure gauge, to ensure both valves are equalized.





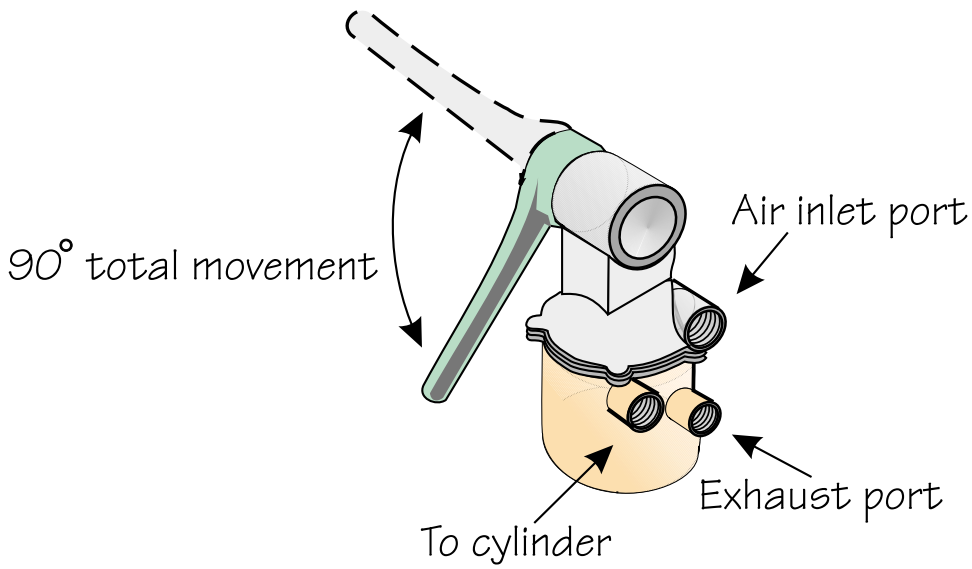

Some drivers incorrectly adjust ride height to deal with poor ride. If the suspension has damaged parts, then adjustments will not correct the problem.

## Ride Height Adjustment

**CHECKLIST:** Use the vehicle on a level surface, release brakes and chock wheels

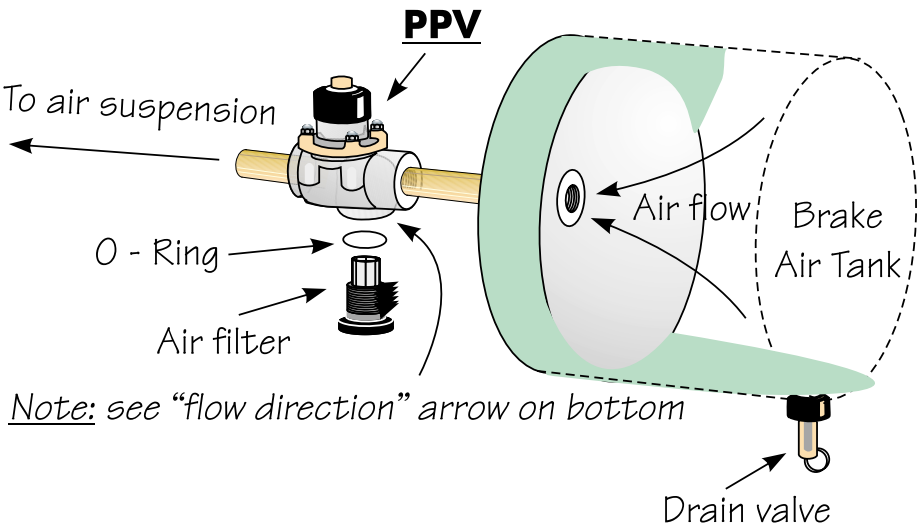
- ✔ Disconnect HCV linkage arms, exhaust all air from bags, then re-inflate
- ✔ Measure trailers with a correct height prime mover or correct height skid plate stand in place
- ✔ Always use axle centre (the one with the HCV) to measure to ground and to chassis underside, use the manufacturer's template or measuring tool
- ✔ Exhaust all air by rotating control arm to the "down" position
- ✔ Recheck the adjustment by repeating, ie. exhausting air and refilling air bags, use duplex air pressure gauge on dual HCV vehicles (loaded)
- ✔ Adjustments are made by lengthening the various types of vertical linkage
- ✔ Ensure driveline angles are maintained on powered vehicles as per the manufacturer's recommended settings
- ✔ Ensure ride height settings are "correct", that absorbers do not "over-extend"
- ✘ Do not grease the ride height valve
- ✘ Do not change the manufacturers recommended ride height

## Hand Control Valve




## Pressure Protection Valve

The pressure protection valve fitment is a legal requirement under ADR 35 and 38. It ensures the vehicle brake system is preferentially charged with air at all times, BEFORE air is supplied to the suspension. Pressure protection valve pressure is set at about 480 KPA or 70 PSI. If operating pressures on a prime mover fell below 420 KPA then the trailer spring brakes would apply automatically. ADR 38/02 requires 420 KPA, brakes must be fully applied when system reduces to 155 KPA. The low pressure warning light should come on at 450 KPA. (per ADR 35/01) *(See illustration over page.)*




### Air line filter Valve

This is a secondary line filter to ensure clean air supply and protect the operation of the height control valve plus any air suspension system accessories.

### Drain Valve

Drain valves are fitted to all air tanks and allow regular drainage of condensation.

### Air System Valves

**CHECKLIST:** Ensure tank drain valves are regularly used to clear all condensation

- ✔ Understand how height control valves must be set
- ✔ Clean dirt particles and foreign debris by keeping all line and tank filters clean
- ✔ Visually check that adjustment fasteners remain in correct set positions
- ✔ Ensure air line clip supports are in place on the suspension
- ✔ Check suspicious air line leaks with soapy water
- ✔ Adjust settings by lengthening or shortening the various types of vertical linkage
- ✔ Ensure ride height linkage angles are greater than 15° (up) and less than 90° (ride height) and less than 170° at maximum downward travel
- ✔ Check PPV operation when inspecting brakes
- ✘ Do not grease valves
- ✘ Do not use pipe compound or Teflon tape as it may clog valves

## 5. Suspension Bushes

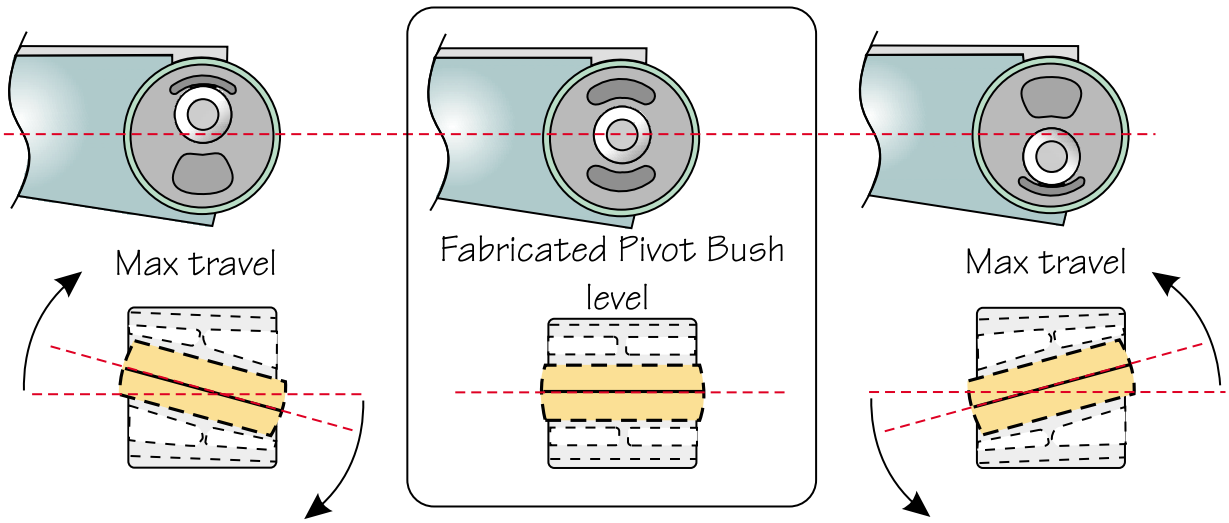
Whilst there are a range of different types of bushes, in general terms two design types of trailing arm bushes account for the majority in use in Australia. They are the types required for leaf spring and the fabricated beam design trailing arms.

An important, but often overlooked detail when inspecting and servicing suspension bushes is to be sure of the OEM model and part numbers. Without accurate model and part numbers, or the proper service repair kit, mismatching of components can lead to poor suspension performance.

## Pivot Connections

Fabricated trailing arms are typically fitted with a range of bushes that each have special fitting procedures. The manufacturer's procedures should be followed to ensure the optimum suspension performance.

This example shows the popular large rubber bushes used with fabricated trailing arm suspension connections. A varying range of lateral oscillation can occur depending on each manufacturer's design.

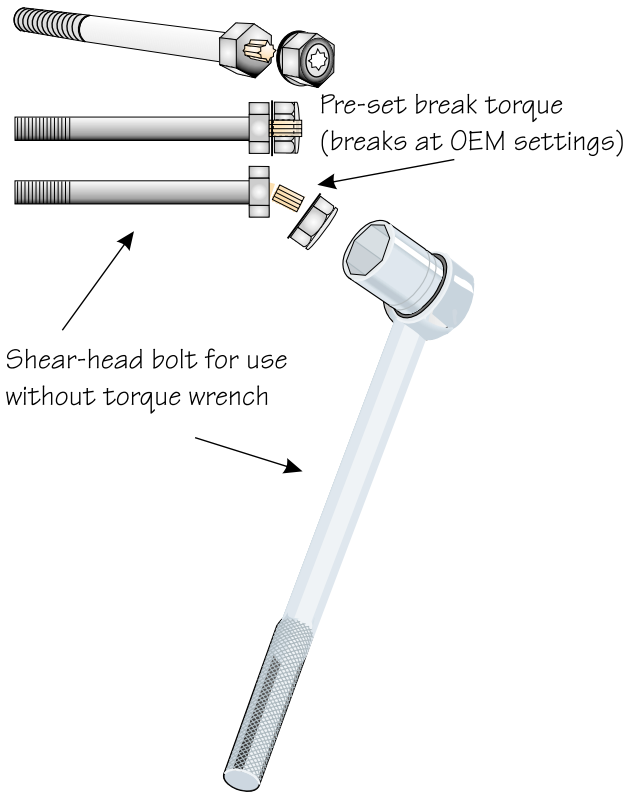



1. It is recommended that the vehicle be empty. If servicing all bushes, then remove all tyres, air springs, shock absorbers and height control valves at the lower connections.
2. The height control valve can be utilized as a jack to raise to the required height, then disconnecting the lower linkage, move the control arms "down" to lower the chassis onto the jacks.
3. Exhaust air from the suspension system. For a manual control, turn the hand control valve handle to the deflate position. For automatic height control valves, disconnect at the lower connection link, rotate the control arm downwards to about 45°.
4. Disconnect the air supply line from the air bag. If using the bushing service tool, remove the pivot bolt and lower beam to gain access to the bush.
5. Press out old bushings with a hydraulic press (5 tonne capacity) if not using the supplier's service repair kit tools. Clean out all dirt and foreign materials.
6. Inspect all components for wear, cracks and failed welds. Do not attempt to repair trailing arms.
7. Press new bush into beam eye. Lubricate with an approved lubricant or a soap and water solution.
8. Ensure flange washers and pivot shaft spring washers are fitted in the manner as set out in the OEM procedure manuals. There are a range of styles and these can be placed incorrectly without following the manual diagrams and instructions.
9. Reinstall trailing arm as per OEM recommended procedures. This typically includes setting the correct ride height levels before applying the appropriate torque. Factory installed "huck-type" fasteners are done using hydraulic press equipment and are replaced with a nut and bolt when field replacement is required. Some hardware uses

a specially patented “shear-bolt” to ensure proper clamping torque is applied. On reaching the prescribed torque the top part of the nut shears off, leaving the bush correctly torqued.

10. Reinstall air bags, shock absorbers, connect height control valve linkage, properly torque all fasteners, fit tyres. Remove jacks, build air pressure to at least 550 KPA and check for air leaks.

Example of shear-bolt design as described in 10 above.




On completion, ride height adjustment must be re-checked as well as axle alignment between each axle.

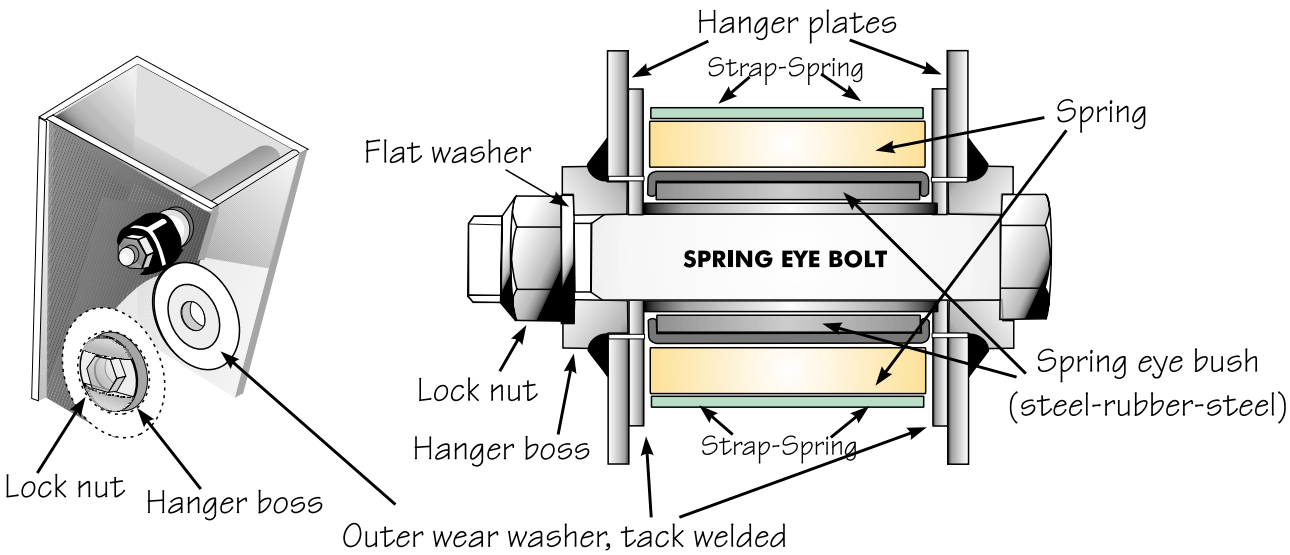
## Pivot Connection Adjustments

**CHECKLIST:** The axle alignment must be done BEFORE the shear-bolt is broken off

- ✔ Only use new nut and bolt sets
- ✔ Shear the bolt off AFTER confirming the ride height is correct
- ✔ Always replace the Teflon steel wear pads with new ones at time of refit
- ✔ Use the OEM hydraulic press equipment with the axle in the press
- ✘ Don’t forget to check the hanger integrity before replacing a pivot connection
- ✘ Don’t put old parts back into the pivot connections

## Spring Eye Bush

The spring eye pivot bush is a very common feature in many suspension systems. It consists of a steel encased rubber spring eye bush and positively locates the axle to the hanger bracket. The two most common types are the “huck” locking nut and the welded type.

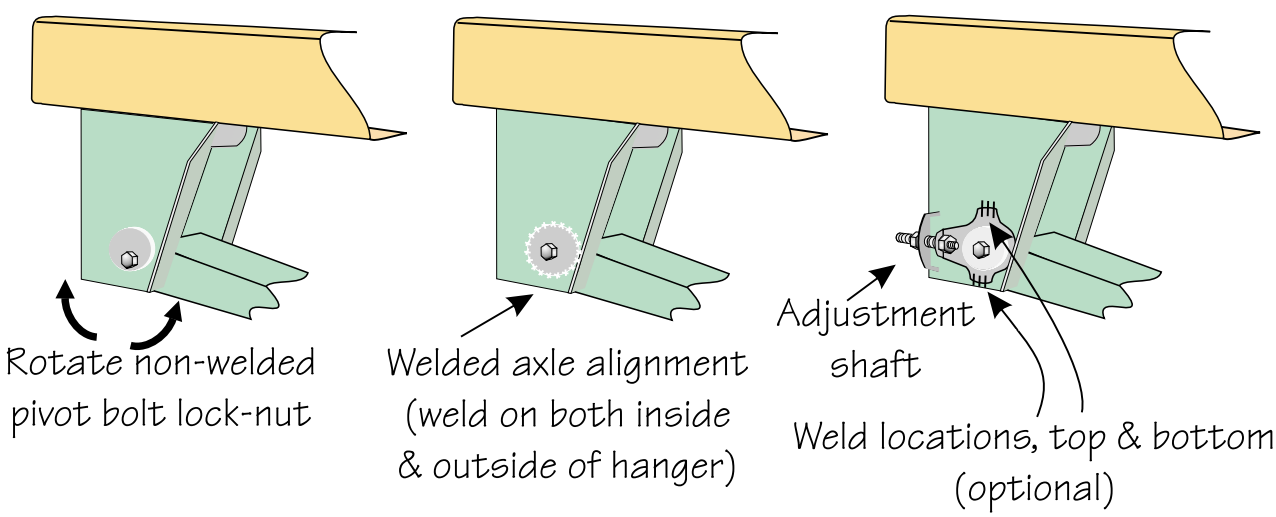



Spring eye bushes are usually bolted from the outside towards the inside of the hanger bracket. A range of different track correction and adjustment features vary between manufacturers.

## Track Corrections

1. Raise and support the vehicle chassis with suitable strength jack stands
2. Release air from all air springs
3. Slacken hanger arm bush lock nuts, or remove weld spots carefully and clean surfaces. Consider the careful use of a grinder in place of the gas welder.
4. Slide adjustment shaft towards the adjustment direction, using light hammer blows or if adjustment comprises of an adjustment nut and bolt, then turn in the alignment direction.
5. Check that all track settings are in correct alignment
6. Tighten all locking nuts up to specified torque at each bush, or if the means of adjustment requires spot welding, then place the tack welds as per OEM procedure.
7. Remove all jack supports and re-inflate air springs.

**Common Adjustment** – for fabricated trailing arms



### Spring Eye Bush Checks and Adjustments

**CHECKLIST:** Insert a pinch-bar between the spring top and rear hanger plate to check

- ✔ Clean all surfaces carefully after grinding old tack welds
- ✔ Follow the OEM recommended torque settings eg; M30 thread 1000 Nm
- ✔ Tighten to correct torque settings AFTER correct ride height is set
- ✔ Use a porta-power hydraulic press to press out old bushes, with axle in place
- ✔ Wear plates should be replaced in the hangers when bushes are replaced
- ✔ Use a “never-sieze” lubricant
- ✔ Always follow the OEM adjustment procedures
- ✔ Re-check adjustments after 2000 kms
- ✘ Do not push the springs apart
- ✘ Too much welding heat can burn Teflon wear plates / washers

## *Service Equipment and Repair Kits*

Ensure all repair and adjustment work is carried out in accordance with the manufacturer’s procedures and recommendations.

Most suppliers list specific tools for adjustment and repair tasks. In many cases service repair kits include a range of small hand tools and measurement templates to ensure correct assembly of components.

### Certified Torque Tools

A range of quality certified torque wrenches specifically designed and precision engineered to meet Australian and ISO torque wrench standards are readily available in Australia.

Quality equipment such as this is identified with a traceable certification mark or serial number. Such certified and tested equipment provides service workshops with peace of mind as to the accuracy of achieving recommended torque settings and adjustments. Depending on frequency of use, regular “re-calibration” may be required.

### Torque Multipliers

Consideration should be given to selecting the most suitable torque wrench for each particular task. In many cases the required range of torque can only be found on hand torque wrenches that may not be workable in the available space.

A range of small hand torque multipliers are available with multiplication factors ranging from 5:1 up to 25:1.

**Hand Torque Wrench Examples – Automotive and Industrial**

Typical torque range, in sizes: 70-350 Nm, 150-600 Nm, 500-1000 Nm.

Typical torque range, in sizes: 110-500 Nm, 300-1000 Nm, 500-1500 Nm.

Typical torque range, in sizes: 100-1000 Nm, 150-2000 Nm.

### Essential Adjustment Tools

**CHECKLIST:** Torque wrench (certified) and OEM recommended torque tables for the suspension model

- ✔ Hand held non-contact infrared thermometer for shock absorbers
- ✔ Chassis support jacks
- ✔ Tape measure, ride height calibration measure, or ride height spacers
- ✔ Bush pressing tools if available from supplier
- ✔ Use only approved lubricant for fitting rubber bushes into eye
- ✔ Use wall chart and parts manuals to ensure OEM replacement numbers are correct
- ✘ Do not re-use worn or damaged components
- ✘ Do not jack the spring down
- ✘ Do not use impact tools in place of proper torque tools

## *Diagnostic Fault Finding Guide*

The following pages are a checklist of common air suspension faults and wear symptoms, possible causes, inspection options and corrective procedures.

As with all mechanical equipment diagnosis a range of causes is possible. Priority for selecting any particular test or inspection must rest with each mechanic, who is likely to use previous experience and fleet history to aid making a sound judgment.

It cannot be recommended too strongly that comprehensive fleet workshop records will also assist in comparing common indicators for similar defective vehicle reports (DVR's). Good preventive maintenance is based on accurate recording of repairs and services made for critical components.

| Symptoms | Possible Cause |
|---|---|
| **Air spring leaking** | 1. Parts rubbing on bag.<br>2. Damage from foreign materials.<br>3. Any recent retread loss?<br>4. Air spring fatigued. |
| **Shock absorber oily** | Failure of shock. |
| **Shock absorber cold (in work)** | Failure of shock. |
| **Short shock absorber life** | Over-extending shock stroke.<br>Wrong ride-height. |
| **Loose shock absorber bushes** | Loose bush nut/torque. |
| **Poor tyre life or excessive wear** | Out of alignment.<br>Off tracking. |
| **Scalloped tyres** | Broken or worn bushes, axles out of alignment.<br>Tyre problems. |
| **Braking to one side.<br>Or tracking to one side** | Axles out of alignment.<br>One axle trailing arm loose?<br>Loose axle U-bolts. |
| **Vehicle leaning to one side** | Pivot bushes worn.<br>Trailing beams out of alignment.<br>Alignment washer welds broken. |
| **Excessive roll of vehicle** | Shock absorbers leaking or worn bushes.<br>Loose axle seat under “U” bolts. |
| **Harsh ride** | Loose frame attachments.<br>PPV malfunction.<br>Dirt in air lines.<br>Shock absorbers angle. |
| **Ride height not holding, (HCV)** | Dirt or particles in air lines.<br>Excessive moisture. |
| **Air leaks** | Loose fittings.<br>Damaged air lines, air springs or HCV. |

| Inspection or Function Test | Corrective Action |
|---|---|
| If on-road trip, isolate that leaking air spring, by crimping the airline to that spring. If springs have "bump-stops", driver may travel slowly to nearest workshop for changeover. | Replace air spring.<br>Clean out foreign materials.<br>Check working clearances between components. |
| Usually in need of replacement. Test by supplier if considered necessary. | Replace shock absorber. |
| Usually in need of replacement. Test by supplier if considered necessary. | Replace shock absorber. |
| Check suspension ride height, adjusting HCV.<br>Compare shock absorber length / specifications. | Re-set ride height.<br>Replace with correct parts. |
| Always do a visual, or a light push with a bar, or follow regular PM torque checks. | Re-torque or replace. |
| Measure axle centre to next axle centre.<br>Alignment bushings not correctly welded.<br>Loose or worn bushings.<br>Axle bent, or twisted frame. | If only 1 axle, there may be adjustment on the trailing arm bush.<br>Check all tyres for wear patterns.<br>Vehicle re-alignment. |
| Check axle centre to centre alignment.<br>Check all bushes for tightness.<br>If alignment blocks are welded in place, these must be removed. and re-welded after adjustment.<br>Check all tyre pressures for job application. | Re-align.<br>Re-torque bushes. |
| Visual inspection of all bushes, any broken?<br>Check-measure axle centre spacings.<br>Check all fastenings.<br>Check brake balance. | Identify and re-align specific axle.<br>Re-align all axles in group.<br>Replace / retighten all. |
| Check alignment.<br>Check all fasteners.<br>Check for any broken huck-bolts / washers.<br>Check ride height (HCV) and readjust.<br>Wrong bushings? | Repair, re-tighten, replace items. |
| Check for oil leaks.<br>Check for worn bushes.<br>If fitted, check load sensing valve. | Test, replace.<br>Replace, re-torque.<br>Fit if necessary. |
| Check all air tanks, valves and lines.<br>Check bushings – (wrong ones fitted).<br>Transverse beam connections.<br>Check all air filters.<br>Seek advice from supplier . | Tighten frame bolts.<br>Clean, repair, replace.<br>Replace connection bush.<br>Check and set ride height. |
| Visually inspect and check the HCV on a regular basis.<br>Drain moisture from air supply tank, especially in cold weather.<br>Confirm that air pressure exceeds 70 PSI. | Readjust HCV.<br>Check lines.<br>Check filters.<br>Drain moisture.<br>Replace valve if pressures cannot be held. |
| Listen for air escaping.<br>Brush on or spray with soapy solution to find leaks. | Tighten loose fittings.<br>Readjust HCV.<br>Replace worn parts. |

# Glossary of Terms

| | |
|---|---|
| **Road Friendly – RFS** | Sprung mass frequency no greater than 2.0 Hz |
| **"The Performance Measures Definition" as per VSB 11** | Hydraulic dampers on each axle<br>Damping ratio (D) more then 20% of critical damping, with dampers fitted<br>Load-sharing to within 5% between axles within an axle group<br>At least 50% of the suspension damping to be produced by the main damping medium ie; shock absorbers<br>Dual tyres or equivalent, with the exception of the steer axle |
| **Air Spring** | Air spring, (bellows, spring,) made of multi-layer bonded rubber and vulcanized to top and bottom plates, forming an "air-spring" suspension |
| **Air-Spring Stud** | Attaches air spring to suspension |
| **ABL Valve** | Air spring pressure sensing valve matching laden and unladen condition.<br>To modulate service brake performance. |
| **Air Dryer** | Sometimes fitted to powered vehicles' air intakes, to ensure a "dry-air" flow within air system. Reduces condensation and moisture. |
| **Air Bag** | See air spring |
| **Air Supply Tank** | Compressed air tank for ensuring operating air supply for suspension. |
| **Air Suspension** | A suspension is considered to be "air" if at least 75% of the spring effect is caused by the air bags/spring. |
| **Alignment** | Term for setting equal distances for axle centres to vehicle centre-line. On trailers, the king-pin is usually taken as the centre point. |
| **Alignment Bushings** | Bushings that allow adjustment of alignment on a particular axle. |
| **Alignment Plate** | Welded to spring hanger seat to maintain and retain alignment location |
| **Anti-Sway Bar** | A slabiliser bar used to increase roll stiffness |

| | |
|---|---|
| **Axle Drive** | On a powered vehicle, ie; truck or prime mover, the axles that are powered, through the drive-shaft and differentials. |
| **Axle Tandem** | An axle group (driven or not) with two axles. |
| **Axle-Tri** | An axle group with three axles. |
| **Bead Plate** | Rolled metal section, permanently crimped onto top and bottom of air spring. |
| **Bumper** | A solid molded rubber fail safe device that prevents excessive air spring damage in case of air loss. |
| **Bush – Pivot Connection** | Pivot bush, is the point where the trailing arm is directly connected to the chassis frame hanger. Also referred to as “spring eye-bush”. |
| **Bush- Mounting – Top** | Shock absorber mounting top end, when fitted in working position |
| **Bush-Mounting – Bottom** | Shock absorber mounting bottom end, when fitted in working position |
| **Combo Stud** | Combination mounting stud and air supply on top of some air springs. |
| **Dampers** | See shock absorbers. |
| **Damping-Bump** | Bump stroke, when the shock absorber piston travels DOWN the cylinder, producing a bump damping force. |
| **Damping-Rate** | Damping rate is specified in performance standard for road friendly suspensions. |
| **Damping-Rebound** | Rebound stroke, when the shock absorber piston travels UPWARDS, producing a rebound damping force. |
| **DOT&RS** | Commonwealth Department of Transport and Regional Services |
| **Hanger Bracket** | Used to attach the suspension to the vehicle. |
| **Huck Bolt** | A self locking bolt fitted to components subject to vibration and stress, able to hold correct torque under severe stresses. |

| | |
|---|---|
| **Lift Axle** | A operating design feature of some air suspensions, reduces tyre wear and improves braking when empty |
| **Lock Washer Fastener** | Washer used to ensure component remains in locked position. |
| **Nm Newtons/Metre** | (Nm) is the metric measurement of torque, previously measured in “foot pounds” (lbs) |
| **Off-Tracking** (low speed) | The measure of the swept path of the vehicle and its lateral road space requirements when turning at intersections or turning into loading areas. |
| **Panhard Rods** | Transverse rod pivoting at one end onto the vehicle chassis or the trailer sub-frame. The other end to the axle beam. The fitting limits lateral movement. Also called torque rods. |
| **Pivot Connection** | A connection point between the trailing arm and a hanger bracket. |
| **Ride Height** | See valves – ride height. |
| **Static Roll Stability** | The lateral acceleration required to produce total rollover of the vehicle. |
| **Shock Absorbers** | Absorb energy caused by the up and down movement of the suspension. |
| **Top/Bottom Plates** | Plates above and below the axle held together by the u-bolts. |
| **Torque** | Amount of tension applied to a fastener or nut, usually prescribed by manufacturer. |
| **Torque Rods** | Or torque arms, adjustable metal arms with rubber bushes that work together to ease the task of maintaining axle alignment, can be single or two pieces. |
| **Torque Wrench** | Hand operated tension measuring tool that confirms tension or torque applied to a fastener or nut. |
| **Trailing Arm** | Connecting arm (spring or fabricated) between axle and hanger bracket. |
| **U-Bolt - general** | A means of firmly fixing two items together at a known tension, eg axle and trailing arms. |

| | |
|---|---|
| **U-Bolt – axle/spring** | Used to clamp top plate, to axle and bottom plate together. Must be correctly torqued and re-checked, approximately 1000 kms after adjustments. |
| **Valve – Air Pressure Protection** | Pressure Protection Valve – factory set pressure setting to maintain at least brake operating pressure eg 60 PSIG, 65 PSI/450- KPA in the event of a serious leak in the suspension system. |
| **Valve – Ride Height Control** | An air valve set to a predetermined ride height setting that limits the axle travel within the shock absorber and air bag stroke length. |
| **Valve – Hand Control** | A hand operated valve that allows limited adjustment control to be affected by the driver. |
| **VSB 11** | Vehicle Standards Bulletin number 11, sets out Road Friendly Suspension Certification Test criteria required for all new suspension types. (For manufacturers and suppliers) |
| **Weld – Fillet** | Continuous run of weld between/around two surfaces, eg torque rods. |
| **Weld – Puddle** | When weld is into a round hole, as in joining two halves of a torque rod. |

# Notes