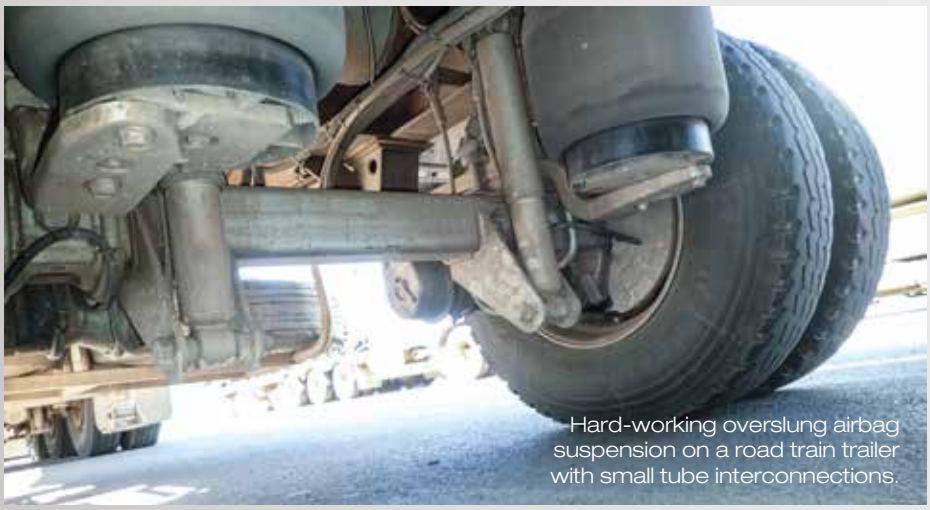
Road-friendly suspensions and the great airbag controversy

Road friendliness depends upon the size of the peak force that is transferred to the road just after a bump is experienced and how fast subsequent force peaks decay. Vehicle Standards Bulletin 11 gives a definition of road friendliness and describes the testing that can be used to prove that a suspension is 'road friendly' (see my November 2016 Prime Mover article for details about road-friendly suspension testing).

The road-friendly suspension test is to be conducted with a 10t load for a single axle, 17t load for a tandem-axle and 22t for a tri-axle group. For airbag suspensions, it is common to test a single axle and to claim that the use of two or three axles in a group will also be road friendly. Multiple axles must share the group load. Dual tyres must be fitted so a front steering axle cannot achieve road-friendly status.

Heavy vehicles that have road-friendly suspensions on the rear axle groups are eligible for Concessional Mass Limits (CML) and Higher Mass Limits (HML). Whilst mechanical spring suspensions are not debarred from being road friendly, it is unlikely that adequate damping will be achieved by spring-leaf friction alone. The list of approved road-friendly suspensions can be found on the Road Vehicle Certification System (RVCS) website.

The approvals for two road-friendly suspensions are shown below, one with mechanical springs and one with airbags.



Hard-working overslung airbag suspension on a road train trailer with small tube interconnections.

Notice that the maximum distance between axles is a listed variable, at least for the mechanical spring suspension.

The great majority of the approved road-friendly suspensions have either two or four airbags with two shock absorbers per axle. The shock absorber part number is stated on the approval and the suspension ceases to have road-friendly status if a non-listed shock absorber is fitted. If the suspension contains an airbag the diameter of the bag is stated. The smallest diameter tyre and the highest tyre pressure are also stated. These ratings need to be maintained. The listing of the smallest diameter indicates that it is the tyre footprint onto the road that applies the weight, and the higher the pressure, the smaller the footprint.

An airbag suspension contains an airbag spring that distorts when the axle moves suddenly and this reduces the force experienced by the chassis rails. The road force is applied via the tyres and the size of the tyre footprint is an important factor in suspension performance. Tyre stiffness and inflation pressure are therefore important aspects. Tyres absorb some of the bump energy due to distortion of the rubber and a little more is absorbed by the airbag rubber as it distorts. However, additional damping is needed to absorb bump energy. A shock absorber is needed to absorb at least half of the bump energy. The angle of operation of the shock absorber is important as it determines the travel of the shock absorber for a given road deflection.

Shock absorbers will eventually wear out and leaking seals will produce oil dribbles on the outside. Don't confuse this with 'misting' – the build-up of a

	Varient 1	Varient 2
Variant:	ECONIC AIR T	SIX ROD
Number of Axles	1	2
Overslung/Underslung	Underslung	Overslung
Maximum Axle Spread (m)		1.350
Dampers Part Numbers	A0063260000	YA9543260000
Smallest Tyre Size Designation	295/80R22.5	11R22.5
Highest Tyre Pressure (Kpa)	825	825
Airbag Diameter (mm)	300	Not Applicable
Reference Drawings No of Suspension (parts list & assembly details)	RK957000T040	A948 320 06 05 A954 320 00 08

fine oil coating on the outside. Misting is produced by hot oil vapour that gets through the seal and settles on the outside body. There it attracts road grime and makes the shock absorber look dirty. Misting is normal and is the result of deliberate porosity of the seal so that it gets lubricated. Working shock absorbers get hot, non-working shock absorbers don't. They also lead to scalloping wear on the tyres and worn-out wheel bearings. There has been talk about an in-service test for shock absorber condition for at least the past seventeen years but no practical test has emerged. The best way to check the condition of the shock absorber is to routinely feel for temperature when the vehicle stops at a truck stop. This is an important check because worn-out shock absorbers result in excessive wheel vibration and this degrades the vehicle condition.

There is controversy about the performance of airbag suspensions. The elements of the controversy are:

1. Whether road friendliness occurs at driving speed.
2. Whether the tubes that connect airbag pressure should be large or small.
3. Whether one or two levelling valves should be used.
4. Whether a road friendliness test of one axle can be accurately applied to a group of axles.
5. Whether airbag suspensions have adequate roll stiffness.
6. Whether airbag suspensions can cause the rear end to wander or hop.

Airbag suspensions have been widely adopted because of operator assessment that they result in a less harsh ride than mechanical suspensions. Whilst this may not be true in all cases, it is probably generally true. If the suspension produces a better ride quality in the cabin, it is also likely to produce a softer ride as experienced by the road. So road friendliness probably does translate from a low-speed test into a high-speed driving experience.

There are modification kits in the market that allow original small diameter hoses that supply and link the airbags to be replaced with large diameter hoses (≥20mm ID) and smoother internal air fittings. Some OEM manufacturers have also increased the diameter of the standard hoses. The effect is likely to be better load sharing between adjacent airbags when the vehicle encounters a bump at driving speed. If the axles are separated by, say, 1.35m, then the time between the first and second axles experiencing the same bump when the vehicle is running at 90km/h is 0.054s. For air pressure to increase in the following bag in this time, large diameter hoses are needed. The early suspension designs did not anticipate dynamic load sharing between bags on the same side. Use of large diameter tubes is now regarded as sensible.

Use of two levelling valves will result in the truck or trailer sitting up straighter on a highly cambered road. The levelling valves work to keep the height between the sensed axle and the chassis rails about the same, irrespective of load or road shape. If the trailer leans left then the left-side bags will be inflated to lift that side up. The levelling valves probably have a two to four second delay so that they do not respond to road bump vibrations. There is an after-market kit that is intended for concrete agitators to improve roll stability when cornering. The claim is that low-side bags can be inflated during the first part of a turn and move the weight to the inner side to help with roll stability.

The road friendliness of an axle group can probably be optimised by making the tubes between airbags large diameter. Consequently, the dynamic performance of a group will be different to that of a single-axle suspension. The certification test should be applied to an axle group and not just one axle in the group.

The road handling performance of a truck depends heavily on the rear suspension performance. Wandering or hopping behaviour is systematic of axle twisting and/or dynamic misalignment of the axles. This might be caused by a poor suspension design, however airbag suspensions per se are not the problem. Fifteen years ago, there were many complaints from road train operators about the road handling of long combinations with airbag suspensions, particularly on dolly trailers. These problems were real and they were related to low roll stiffness design with high roll centres. Claims were made that use of large diameter hoses between bags improved the road handling. This is unlikely to be the full story – suspension design is a complex business!

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