Vehicle Standards Bulletin 14

NATIONAL CODE OF PRACTICE
for
LIGHT VEHICLE CONSTRUCTION
and
MODIFICATION

NATIONAL GUIDELINES For INDIVIDUALLY CONSTRUCTED LE1 MOTOR TRICYCLES (OTHER THAN GOODS VEHICLES) in AUSTRALIA

1st February 2006

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

Warning to Users

Users of the Guidelines need to be aware that this document needs to be used in conjunction with the appropriate administrative requirements of the jurisdiction in which the vehicle is to be registered. "Administrative requirements" include, amongst other things, processes for:- vehicle registration, obtaining exemptions, obtaining modification approvals, vehicle inspections, preparation and submission of reports and the payment of appropriate fees and charges.

If unsure of any of these requirements, or if more information is needed for any other issue or processes, users should contact the relevant registration authority ***prior*** *to commencing any work.*

Whilst these Guidelines present a great deal of information with respect to the construction of trikes, it is nonetheless important that builders make themselves familiar with the content of the National Code of Practice for Light Vehicle Construction and Modification (NCOP).

Users of the Guidelines also need to ensure that they refer to the most recent version of the relevant documents when working on a project. The version is identified by the date on the face page of each Section of the NCOP, or the Guideline in question. On the website, each Section and Guideline has the version date contained in its appropriate file name for easy identification.

It is prudent to check for new versions if a project is taking a long time to complete.

If they have not already done so, users must also download the Preface and Introduction.

Whilst these Guidelines provide assistance with respect to the construction of trikes, they are not to be taken to be a design manual. Determination of component strength, performance, suitability and functionality must be either calculated or determined on a case by case basis by suitably qualified personnel experienced in each matter under consideration.

If in doubt about any issue concerning or contained in the Guidelines, users should seek clarification from the appropriate state or territory registration authority.

Please do not contact the Department of Transport and Regional Services (DOTARS) about the Guidelines. DOTARS provides the central website as a service only.

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PREFACE

BACKGROUND

This document has been prepared in consultation with the WA Trike Construction Working Group.

These Guidelines have subsequently been endorsed by all Australian State and Territory Jurisdictions responsible for vehicle standards and the registration of vehicles for road use.

These Guidelines apply to the construction of Motor Tricycles, hereafter referred to as *trikes*.

INTENT

The aim of these Guidelines is to provide a nationally acceptable set of technical specifications that ensure *trikes* built in accordance with these Guidelines comply with the applicable requirements of the *Third Edition Australian Design Rules (ADRs)* and the *Australian Vehicle Standards Rules 1999 (AVSR)*.

These Guidelines do not cover vehicle registration policies or procedures, nor do they cover the technical requirements for *trikes* that must be certified under the provisions of the Federal Motor Vehicle Standards Act.

SCOPE

These Guidelines are applicable to motorcycle type *trikes* falling within the classifications of LEM1 and LEP1 as defined in the ADRs.

These Guidelines do not cover the construction of LEG vehicles (goods vehicles), "passenger car type" LEP1 vehicles or LEM2 and LEP2 vehicles ("Morgan" type *trikes*). These vehicles will continue to be dealt with on an individual basis by the jurisdiction in which the trike is built.

These Guidelines form an integral part of the *National Code of Practice for Light Vehicle Construction and Modification* (NCOP). *Section LO Vehicle Standards Compliance* of the NCOP outlines the minimum requirements for the assessment and certification of compliance with the Australian Design Rules (ADRs) for individually constructed vehicles. The NCOP provides codes under which modifications or vehicle construction can be shown to be in conformity with the ADRs. Code LO4 applies to LEM1 trikes whilst Code LO5 applies to LEP1 trikes.

The checklists for LO4 and LO5 are contained in these Guidelines.

Whilst these Guidelines present a great deal of information with respect to the construction of trikes, it is nonetheless important that builders make themselves familiar with the content of the NCOP.

RELATIONSHIP WITH THE LAWS OF AUSTRALIAN JURISDICTIONS

Subject to Federal laws and the laws of the States and Territories of Australia, this document defines standards of practice for the design, manufacture and modification of *trike*s. Other procedures are acceptable subject to adequate technical justification.

NOTE**:** Nothing in these Guidelines is to be regarded as in any way limiting the powers and duties of the Chief Executive Officer of the registration authority in question, or any agent or employee of that Officer, under the appropriate Act/s of that jurisdiction, or subsidiary legislation made thereunder.

Where any Australian Design Rule or any Australian Vehicle Standards Rule is referred to in these guidelines, the appropriate Australian Design Rule or Australian Vehicle Standards Rules 1999 should be read in full to avoid misinterpretation.

It is also important to note that each jurisdiction may have different clause numbers in its adopted version of the Australian Vehicle Standards Rules.

ADMINISTRATION

These Guidelines provide a nationally consistent set of technical specifications for the construction and modification of trikes. Jurisdictions have their own administrative procedures and requirements for the registration of new vehicles and for the approval of modifications. Owners must familiarise themselves with the provisions of the jurisdiction in which they reside. Similarly, owners of trikes who wish to transfer their vehicle to another state or territory need to obtain relevant information from that jurisdiction.

Definition of "Signatory"

For the purposes of the NCOP and these Guidelines, engineers and tradespersons involved in the approval process will be defined collectively under the generic term of ***Signatory***. Wherever the term ***Signatory*** is used, it always means that the signatory referred to is one who has the necessary knowledge and technical expertise to assess and sign-off the matter under consideration.

NCOP Codes

Trikes built to these Guidelines qualify under Code LO4 and LO5 of the NCOP. Persons authorised under an authorised modification scheme, operated by a jurisdiction, may stamp these codes on the modification plate. The plate specifications, stamping and fixing must be in accordance with the jurisdiction's business rules for the scheme in question.

Persons not authorised to attach modification plates to a vehicle must also use these codes when submitting applications to their local registering authority. In all cases the checklists must be completed. Authorised persons must hold the checklists for auditing purposes, whilst non-authorised persons must submit the signed-off check lists with their final documentation.

Please refer to your registering authority's business rules for more detailed information about the management of checklists.

FUTURE DEVELOPMENTS

It is recognised that a set of Guidelines that covers all eventualities is not feasible. This document needs to be recognised as being a "live document" and hence will need to be revised from time to time to include future developments arising from regulatory changes, improvements in technology and the development of alternative designs.

The document may also be revised to improve its editorial content.

FUTURE REVISIONS

Future revisions are the responsibility of the Australian Motor Vehicle Certification Board Working Party. Revisions, other than those of a legal or editorial nature, will be processed in consultation with the appropriate user groups.

The Working Party may consider applications from individuals concerning recommended revisions to the Guidelines. However, it is preferable that applications are submitted after consideration by the appropriate user groups. In any event, the Working Party will consult widely before making a final decision on any proposed amendments to the Guidelines.

DATE AT WHICH THE DOCUMENT TAKES EFFECT

This document takes effect at the date of issue.

DOCUMENT FORMAT

This document will be available in electronic format and will be available for download from the Department of Transport and Regional Services website. < www.dotars.gov.au >

Please note that whilst the Guidelines may be downloaded in sections for the convenience of persons who may have a specific issue to address, it is vital that any referenced sections applicable to the specific work being undertaken are downloaded also. "Lack of information" resulting from insufficient downloads will not be accepted as an excuse for non-compliance by jurisdictions.

REVISION HISTORY

Revision	Comments
First Published	This document was approved at the AMVCB Working Party meeting held on xxx

NOTE**:** *Trike* builders and owners need to be aware that compliance with these Guidelines does not guarantee that a *trike* will be registered by the Jurisdiction in question. If, for example, a *trike* does not handle or brake satisfactorily or has any other feature which renders the vehicle unsafe or not roadworthy, it may not be registered. Further, changes to relevant legislation may mean that a *trike* cannot be registered without appropriate modifications.

Whilst these Guidelines present a great deal of information with respect to the construction of trikes, it is nonetheless important that builders make themselves familiar with the content of the NCOP.

ACKNOWLEDGMENTS

This document has been adopted by the Australian Motor Vehicle Certification Board Working Party (AMVCB WP) as the nationally accepted Guidelines for the construction and modification of *trike*s in Australia. These Guidelines form an integral part of the *National Code of Practice for Light Vehicle Modification and Construction* (NCOP). The *National Code of Practice* is a major project currently being undertaken by the AMVCB WP.

- The AMVCB WP wishes to acknowledge the key role played by the WA Trike Construction Working Group, and
- Mr M Winter from Wintercreative for the diagrams used in this document.

The project was managed by Mr John Dombrose on behalf of the AMVCB WP as an integral part of the *National Code of Practice for Light Vehicles Construction and Modification*.

Members of the AMVCB WP at the time of Publication include:

- Barry Hendry National Road Transport Commission
- Dr Gray Scott VicRoads
- Harry Vertsonis RTA NSW
- Rod Paule DUS ACT
- Roland Earl Transport SA
- Robert Gibson Transport QLD
- Simon Saunders DIPE NT
- Tony Beard DIER Tas
- John Dombrose DPI WA

Previous members who assisted in the development of this project included Mr Jorge Montano (RTA NSW), Mr Rickman Smith (Transport SA) and Mr Angus Draheim (Transport QLD).

1 DEFINITIONS

1.1 ADR MOTOR TRICYCLE CLASSIFICATION

Motor Tricycles, to which these Guidelines apply, are defined in the Australian Design Rules as follows:

Motor Tricycle (LE): A motor vehicle with 3 wheels symmetrically arranged in relation to the longitudinal axis, with a '*Gross Vehicle Mass*' not exceeding 1.0 tonne, and either an engine cylinder capacity exceeding 50 ml or a '*Maximum Motorcycle Speed*' exceeding 50 km/h.

LE vehicles are further categorised as follows:

Sub-category

LE1	-	one wheel at front, 2 at rear.
LE2	-	2 wheels at front, one at rear.
LEM1	-	up to 450 kg '*Unladen Mass*' and
	-	the driver's *'Seat'* is of a saddle type and
	-	one wheel at the front, 2 at rear.
LEM2	-	up to 450 kg '*Unladen Mass'* and
	-	the driver's *'Seat'* is of a saddle type and
	-	2 wheels at front, one at rear.
LEP1	-	over 450 kg '*Unladen Mass'* and/or
	-	the driver's *'Seat'* is not of a saddle type and/or
	-	has more than two seating positions and/or
	-	has a permanent structure to the rear of and
	-	200 mm above the undeformed upper surface of the driver's '*Seat*' cushion and
	-	one wheel at the front, 2 at rear.
LEP2	-	over 450 kg '*Unladen Mass*' and/or
	-	the driver's *'Seat'* is not of a saddle type and/or
	-	has more than two seating positions and/or
	-	has a permanent structure to the rear of and
	-	200 mm above the undeformed upper surface of the driver's *'Seat'* cushion and
	-	2 wheels at front, one at rear.
LEG1	-	over 450 kg *'Unladen Mass'* and
	-	constructed primarily for the carriage of goods and
	-	one wheel at front, 2 at rear
	-	a vehicle constructed for both the carriage of persons and the carriage of goods shall be considered to be primarily for the carriage of goods if the number of seating positions times 68 kg is less than 50 per cent of the difference between the *'Gross Vehicle Mass'* and the '*Unladen Mass*'.

LEG2 - over 450 kg '*Unladen Mass'* and
- constructed primarily for the carriage of goods and
- 2 wheels at front, one at rear

A vehicle constructed for both the carriage of persons and the carriage of goods shall be considered to be primarily for the carriage of goods if the number of seating positions times 68 kg is less than 50 per cent of the difference between the *'Gross Vehicle Mass'* and the *'Unladen Mass'*.

These Guidelines are applicable to motorcycle type *trikes* within the LEM1 and LEP1 subcategories. These will generally be a motorcycle derivative, with a fabricated rear frame section and an original motorcycle front frame section, or a vehicle powered by a car engine and transmission and utilising a purpose built frame.

ADRs and AVSRs that are applicable to trikes are summarised in Appendix 2.

It is important to note that once a *trike* exceeds a Gross Vehicle Mass (GVM) of 1000 kg, it is no longer defined as a motor tricycle, and is therefore not covered by these Guidelines. These vehicles are classified as MA, MC or NA category vehicles, and must comply with ICV requirements applicable to passenger cars.

Please refer to the National Code of Practice for Light Vehicle Construction and Modification for the ICV requirements applicable to passenger cars.

2 TECHNICAL AND SAFETY REQUIREMENTS

Trikes covered by these Guidelines fall into the LEM1 and LEP1 categories. Note that the ADRs vehicle category listing classifies 'LE-type' vehicles as motor tricycles. Consequently, all ADRs and AVSRs applicable to motor cycles are considered to be applicable to *trikes*. There are also additional ADRs and AVSRs applicable to *trikes* that are not applicable to motorcycles. Relevant ADRs and AVSRs applicable to *trike* construction are summarised in Appendix 2.

It is important to note that once a *trike* exceeds a GVM of 1000 kg, it is no longer defined as a motor tricycle, and is therefore not covered by these Guidelines. These heavier vehicles are classified as MA, MC or NA category vehicles, and must comply with ICV requirements for passenger cars.

Where proof of full ADR compliance may not be practical, the vehicle builder will be required to demonstrate compliance with the intent of the ADR. Comparative assessments are acceptable where components have been sourced from an already certified vehicle.

Trikes built to these guidelines qualify under Code LO4 for LEM1 category trikes and Code LO5 for LEP1 category trikes.

The checklists for LO4 and LO5 are contained in these Guidelines in Appendix 5. The checklists may be copied. In fact it is recommended that the builder use a separate copy of the checklist to ensure no item or requirement is forgotten during the construction phase. In these circumstances the signatory must use a separate and independent checklist.

2.1 FRAMES

SIGNATORY CERTIFICATION

All frames, whether a full purpose built frame, or a frame section attached to a production motorcycle frame, will require certification by a signatory.

The signatory must firstly certify that the design and materials proposed are satisfactory for safe road use, and secondly, that on completion, the vehicle has been constructed in accordance with the original approval, and to a satisfactory standard of workmanship. The latter will require an inspection of the vehicle at rolling chassis stage, and prior to grinding/smoothing of welds and application of any surface finish. (i.e. paint or powder coat). The signatory may require Non-Destructive Testing, such as radiography, of critical weld areas.

A final Signatory's report will be required to certify that the vehicle is sound in its design and construction, has been constructed to a satisfactory standard of workmanship, and compliance with relevant ADRs and AVSRs has been met. A completed checklist must accompany the Signatories report. Please check with your local Registering Authority about the processes involved in retaining reports for audit and/or the need to submit reports to the Authority. Whilst the technical standards are the same across Australia, administrative arrangements may differ.

Note that for LEM1/LEP1 vehicles where the motorcycle frame being used is not the original manufacturer's frame for the motorcycle derivative being used, eg a "custom" frame, a Signatory's report will be required certifying that the frame being used is satisfactory for the *trike* application.

WELDING

Frame welding is to be conducted with the frame constrained in a suitable frame jig to ensure alignment is maintained. It is recommended that frame welding be carried out by a certified welder to the Signatory's approved weld procedures.

FRAME VIN

Any original manufacturer's ID/Identification Plates and/or frame numbers must not be removed.

A VIN issued by a jurisdiction must be attached to the vehicle in accordance with that jurisdiction's procedures.

2.2 FASTENERS

Tabled below are the minimum standards acceptable for the choice of nuts and bolts to be used on *trikes,* unless supported by specific engineering design.

Table 1: Minimum Bolt Sizes.

Bolt Specifications	**Application**
Ungraded bolts -	Panel fixing, lightly loaded brackets
SAE Grade 8 or - Metric 10.9 bolts	Brake callipers, master and slave cylinder mounts and all heavily loaded assemblies.

Stainless steel bolts must not be used in high load or stressed situations as they do not possess high tensile strength. It is recommended that these bolts be used in locations where the use of ungraded bolts is permitted.

The bolt or fastener must be long enough to ensure that at least ***one clear turn*** of thread is visible. This applies to all nuts, including nyloc and locking nuts.

Locking devices ***must*** be fitted to all fasteners. These devices include:

- Spring and shake proof washers.
- Nyloc nuts.
- Deformed thread locknuts or Huck nuts.
- Castellated nuts with split or roll pins.
- Lockwire.
- Split pins.
- Locking tabs, and staking.

Nyloc nuts are only to be reused once, and only if the nylon locking area is in good condition.

2.3 STABILITY COMPLIANCE TESTING

It is necessary to demonstrate that the *trike* being constructed complies with the requirements of Clause 42.22 of ADR 42/03. Compliance requires that the height of the centre of mass of the vehicle must not exceed: -

- The horizontal distance from the centre of mass to the nearest roll axis in the case of LEM1 and LEP1 vehicles.

Demonstration of compliance will require a physical stability test to be conducted as detailed in ADR 42.22.3. The stability test must be conducted or witnessed by the Signatory, who is to certify the result, using the proforma provided in Appendix 1. A *calculated* compliance without a physical stability test is not acceptable. Note that the vehicle must be in a fully completed state, with all components, bodywork etc fitted, at the time of stability testing.

Where a *trike* is fitted with car tyres, for the purpose of calculating the distance from the centre of gravity to the roll axis, the track is taken as being from the outer contact edge of the tyre tread of one wheel, to the outer contact edge of the tread of the other tyre. This is considered to be the “effective” track.

It is acceptable to remove the battery during stability testing to avoid acid spillage.

2.4 ENGINES

Where a car engine is being utilized in a LEP category vehicle, the vehicle emissions must comply with the requirements of ADR 37/01. Compliance with the requirements of the IM240 test as detailed in the NCOP, will be deemed as sufficient evidence of compliance with the ADR.

Where a car type engine is used, all drive belts and rotating parts must be adequately shielded.

2.5 EXHAUST SYSTEMS

Exhaust system noise must not exceed 94db (A) with the vehicle stationary in accordance with the AVSR.

The exhaust system must not have sharp edges or protrusions.

Adequate shielding must be provided to prevent rider/passenger contact with the exhaust system.

2.6 BRAKES

Braking systems utilising a combination of hand and foot controls to apply front and rear brakes separately must meet the requirements of the Front and Rear tests of ADR 33. LEP vehicles which utilise a single foot pedal to operate the brakes on all three wheels must comply with ADR 31.

A parking brake is required on all *trikes* in accordance with ADR 33, and must be capable of holding the vehicle stationary, for not less than five minutes, facing in either direction on a gradient of 30%. The application force required must not exceed 405N if foot operated or 245N if hand operated.

Master cylinders must have a displacement volume of at least 1.5 times the combined new to worn displacement of all wheel cylinders/callipers that it activates.

The brake pedal must not contact any part of the vehicle before the master cylinder piston has reached the end of the piston travel.

Pushrods between the master cylinder and the pedal arm must be straight and must act through the centreline of the master cylinder bore. In circumstances where a straight pushrod cannot be used alone, additional leverage systems such as a "bell crank" may be used provided that the system is assessed and approved by a Signatory.

Manufactured pushrods used in braking systems must have a diameter not less than that specified in the table below.

Table 2: Minimum Pushrod Diameters According to Length

Pushrod Length	Pushrod Diameter (minimum)
Up to 250mm	10mm
250 to 400mm	12mm
400 to 600mm	14mm

Where any doubt exists on the brake system compatibility or performance, a brake performance report certifying that a brake test has been performed and that the braking system complies with Rules 128 and 129 of the AVSR may be required.

Rigid brake pipes must be made from tubing designed for use with automotive braking systems. Connections must be flared in a manner suitable for the chosen fittings, and the tubing must be supported with a rigid mount at intervals of no more than 300mm. Joining of brake pipes by welding or brazing is prohibited.

Only flexible brake lines and hoses marked as complying with ADR 7/00 or the applicable SAA, SAE, BS, JIS, DIN, ISO or ECE Standard are acceptable. Flexible braided hoses must not be forced into a radius tighter than the manufacturer's specified minimum radius for each hose diameter.

Brake lines that pass under the frame must be protected. Brake lines must be installed without sharp bends. Radius of bends must not be tighter than the manufacturer's specified minimum radius for each tube diameter.

2.7 FRONT SUSPENSION

When designing a trike, there are a number of types of front suspension that may be considered. Each has particular advantages and disadvantages and all are acceptable provided that it is possible to show that the arrangement used is adequate for the task. Fork type front suspensions will be dealt with here. The design of "hub-centre" and car type front suspension systems is beyond the scope of this document.

In all cases, this is a safety critical component and great care must be taken in design and manufacture. Professional advice should be sought.

Telescopic forks

The simplest option is the fitment of telescopic forks from a motorcycle. These are widely available and can be relatively inexpensive. However, it is important to note that they are designed to withstand loads applied principally in line with the fork legs, as occurs with a

motorcycle that leans in corners. When fitted to a three-wheeled vehicle such as a trike or a sidecar combination, the forks are subjected to lateral (sideways) forces when cornering. They may also be subjected to increased bending loads under braking due to the greater mass of the vehicle. This can lead to the suspension action being impaired, bushes and seals failing prematurely or, in extreme cases, failure of the fork legs.

It is therefore very important to ensure that the forks used are sufficiently stiff in bending to resist the expected cornering and braking loads. It is also recommended that the fork assembly is reinforced by connecting the sliding elements of the fork legs with a suitable brace. A larger diameter front axle may also be used to enhance rigidity.

It should also be noted that the steering geometry of the donor bike (the rake and trail dimensions) are unlikely to be appropriate for a trike. New fork yokes (triple clamps) may be required to adjust this.

Telescopic forks tend to compress excessively (dive) under braking. This should be taken into account when selecting spring rates.

Leading links

Leading link forks are more suited to applications where lateral loadings will occur. For this reason they are popular on both trikes and sidecar combinations. Three main types exist.

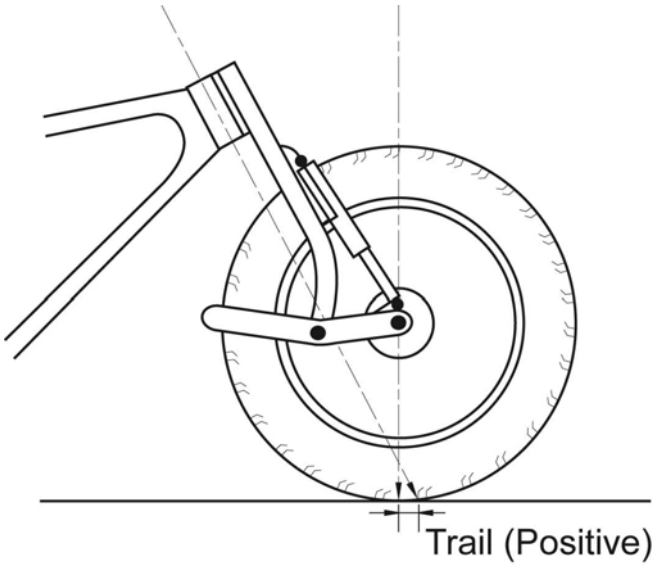


Figure 1: Typical Example of an "Earles Fork"

Type 1: "Earles" type leading link fork: An "Earles" type leading link fork consists of a swinging arm similar to that used for motorcycle rear suspensions, supported by rigid legs extending from the steering head. Suspension is by separate coil spring/shock absorber units.

A properly designed leading link arrangement can incorporate adjustment for trail and spring and damping rates to allow the front suspension and steering to be "tuned" for optimum results.

Fork dive under braking can be eliminated by careful design of the braking system.

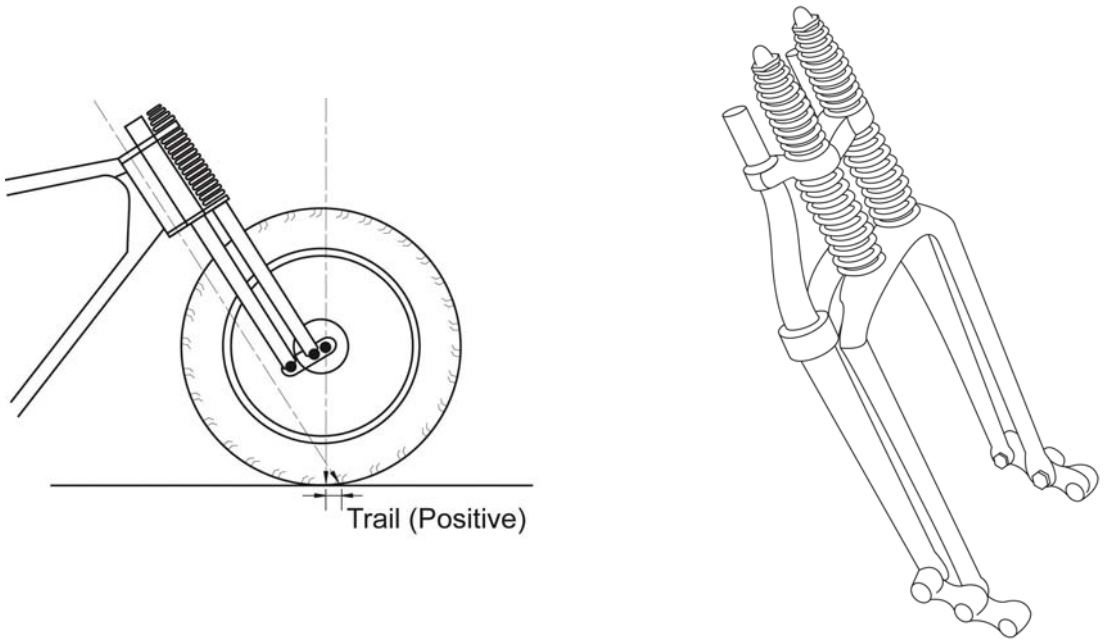


Figure 2: Typical Example of "Springers"

Type 2: "Springers". These differ from the "Earles" type leading link fork in that a short rocking lever on each leg replaces the swinging arm. They are based upon a design used for many years by certain motorcycle manufacturers. They can be better than telescopic forks at resisting lateral and braking loads and can be designed with "anti-dive" characteristics. However, "springers" generally lack the adjustability and rigidity of the "Earles" type leading link and it may be found that the vertical travel is too limited to offer a comfortable ride.

Fabricated suspension systems, either front or rear, will require Signatory certification with respect to welding and metallurgical soundness - refer Appendix 3.

Where a suspension system, in particular a front fork assembly, is sourced from a production vehicle and is unmodified, it must be from a vehicle of similar front axle loading.

Where a *trike* utilises a production motorcycle frame assembly, the front forks supplied by the motorcycle manufacturer for the particular motorcycle being used are considered adequate.

Where forks designed for use on a production vehicle are used and these are subject to either increased loading, a more severe rake angle or where they are extended, the assembly will require Signatory certification.

Due to the increased lateral loading applied to the forks of a *trike* over those of a motorcycle, leading link type forks will generally give superior performance to telescopic designs and should be considered for use where practicable.

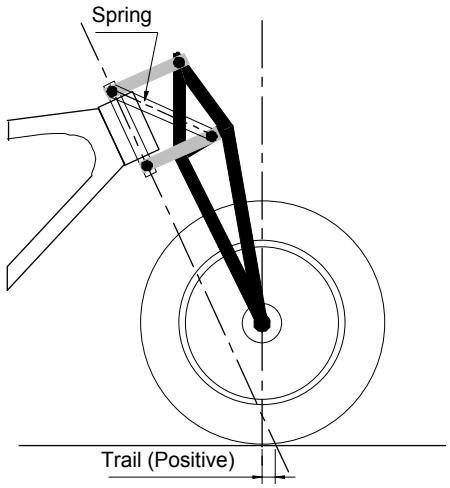


Figure 3: Example of "Trapezoidal or Girder Forks"

Type 3: "Girder Forks".

Girder forks are fitted to many trikes. These consist of a girder type assembly (hence the name) connected to the steering stem via a parallelogram arrangement of links to allow suspension movement. Girders can be made extremely stiff to deal with the additional loadings to which trike forks are subjected. However, the unsprung weight of girder forks is high, reducing ride quality, and the wheelbase of the vehicle will shorten as the suspension compresses under load.

If fitting girders it is important to ensure that the forks chosen are sufficiently stiff in bending to resist the expected cornering and braking loads. It should not be assumed that a girder fork assembly designed for use on a motorcycle will be of adequate strength and rigidity for a trike.

It should also be noted that the steering geometry (the rake and trail dimensions) of girder forks is critically dependent on the lengths and pivot point positions of the links connecting the girder to the steering head. It is particularly to ensure that the trail dimension does not approach zero or become negative at any point in the suspension's travel.

2.8 REAR SUSPENSION

When designing a trike, there are a number of types of rear suspension which may be considered. Each has particular advantages and disadvantages and all are acceptable provided that it is possible to show that the arrangement used is adequate for the task.

In many cases, the type of rear suspension employed will be influenced by the source of the other mechanical components of a particular trike.

In all cases, this is a safety critical component and great care must be taken in design and manufacture. Professional advice should be sought.

Rigid ("hardtail") rear ends

The simplest option for light trikes is to bolt a car type rear axle directly to the rear end of the frame.

Such an arrangement has no moving components to wear and there is no need to select appropriate spring and damping rates. It is also much easier to arrange a reliable drive-line as

the distance from the differential to the rear of the gearbox is fixed, eliminating the problems of tensioning a chain drive or incorporating sufficient length variation in a shaft drive.

However, the ride quality will be poor, necessitating the use of at least a sprung saddle for rider comfort. Handling, on bumpy surfaces, is unlikely to be as good as if suspension were provided. The fixed rear axle will also be subject to large shock loadings, some of which will be transmitted into the frame. It is important to ensure that all components and fabrication techniques used are capable of withstanding such loads.

Live axle rear ends

Falling between the rigid arrangement and the various types of independent suspension in complication is the live axle.

In this case, a car type solid axle is again used. The suspension action is usually provided by coil spring/damper units and the axle is located longitudinally by pivoted radius arms and laterally by either a Panhard rod or a radius arm arrangement. The so called “four bar” rear suspension shown in Figure 3 below is a typical form of this type of suspension.

The ride and handling will generally be better than for the rigid arrangement but careful attention must be paid to spring and damper rates.

It is also important to ensure that the geometry of the radius arms and Panhard rod does not cause excessive bump steer. The suspension should be arranged so that any longitudinal movement of the axle as the suspension compresses is towards the front of the vehicle.

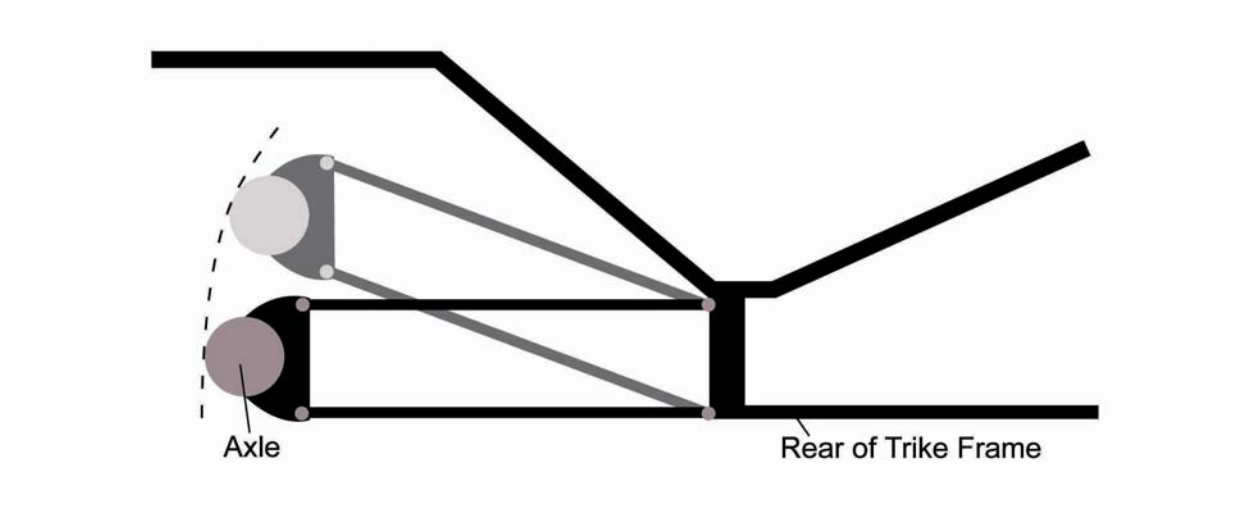


Figure 3: Typical Example of “Four-bar” suspension locaters

Table 3: Suggested Limits for Fabricated Mild Steel ‘Four-Bars’

Maximum Length – 900mm
Minimum Outside diameter of Tube – 22mm
Minimum Wall Thickness – 3mm

Note: If threaded ends are used with 3mm wall thickness tubing, a bush must be welded into the end of the tube to accommodate the thread.

Heim joints must not be used as a suspension or steering component without engineering approval.

Independent rear suspensions

There are a large number of designs of independent rear suspension (IRS) which may be used and a description of every type is beyond the scope of this document. However, IRS may be divided into two main categories.

Type 1 IRS - Swing axles

In a swing axle suspension, the differential is rigidly mounted in the centre of the frame and a separate axle shaft each side is pivoted outboard of the differential as illustrated in Figure 4 below.

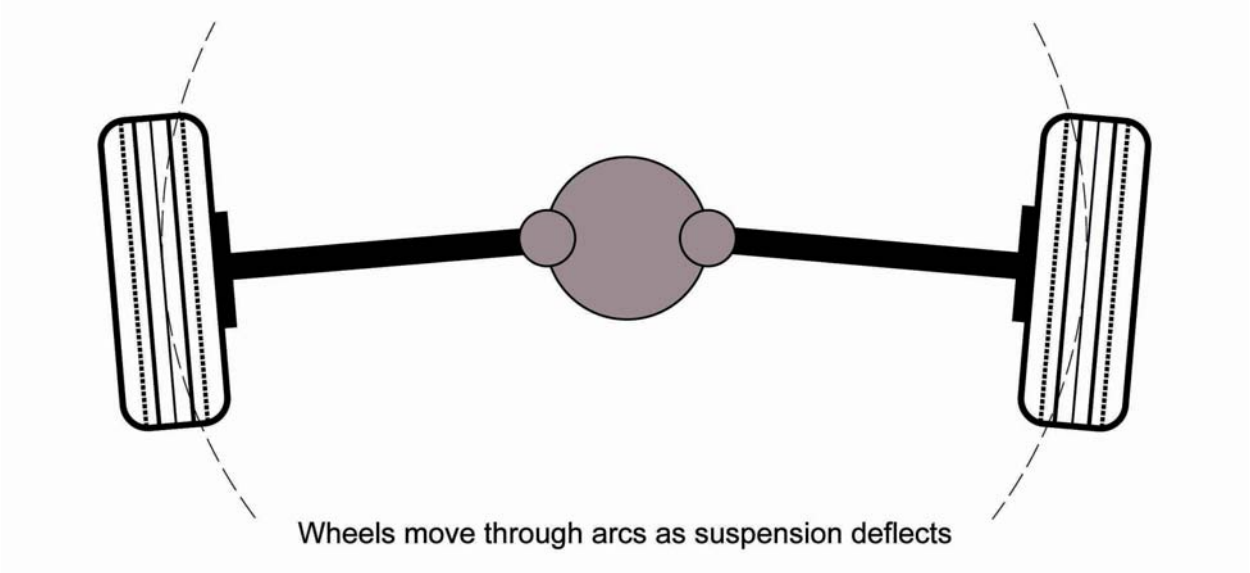


Figure 4: Simple Swing Axle Configuration

The outer end of each axle shaft is usually located longitudinally by a trailing arm. This arrangement was used by Volkswagen (VW) and is, therefore, common on trikes using VW transaxles. Springing may be provided by a coil spring/damper unit at each side or, in the case of VW based vehicles, by the original torsion bar springs mounted ahead of the axle.

This is the simplest form of IRS and its use may be dictated by the use of an older VW transaxle. With careful selection of spring and damper rates and attention given to trailing arm length and ride height, a comfortable ride and good handling may be obtained.

However, it will be noted that, as the suspension rises and falls, the wheels cannot remain vertical (their camber angle will change), nor can they rise and fall in a straight line. The action of a trailing arm will also cause the ends of the axle shafts to move back and forth longitudinally.

Due to the camber changes inherent in this type of suspension, care must be taken in selecting appropriate wheel rim and tyre widths. It may be found that a wide tyre will contact the road only at one edge, reducing the available grip and resulting in uneven wear.

For optimum handling, it is recommended that the ride height be set so that the axle shafts are horizontal when the vehicle is normally operated, so that they will tend to slope up towards the wheels as the load increases or the suspension compresses over bumps.

When designing the radius arms, it is important to bear in mind that a longer arm will allow less longitudinal displacement of the wheel for a given suspension movement. This will assist in minimising bump-steer and roll-steer effects.

Type 2 IRS – Multiple Link systems

More sophisticated IRS arrangements attempt to eliminate the disadvantages of swing axles at the expense of greater complexity. A great many different designs exist, using a variety of means of controlling wheel movement. However, most operate on the basic principle illustrated in the "Double Wishbone" example shown in Figure 5 below.

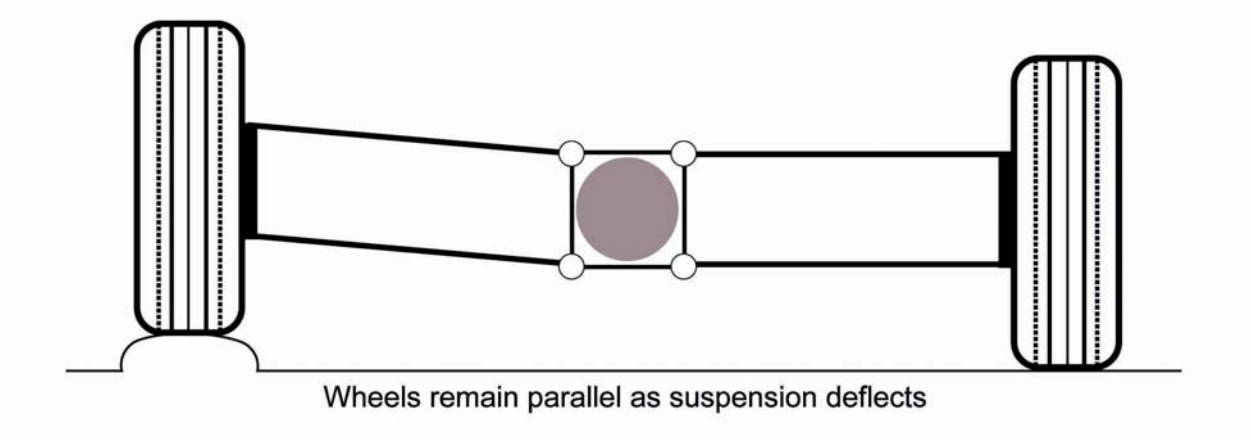


Figure 5: Example of a "Double Wishbone" Rear Suspension

These systems all attempt to minimise the change in wheel camber with suspension movement. Most employ coil spring/damper units for suspension and trailing arms for longitudinal wheel location.

Ride quality and handling can be very good with such a system, although design of the system itself and attachment to the frame of the trike can be more complicated than with other designs.

The use of an existing suspension system complete with a mounting subframe (eg. Jaguar) can simplify matters.

As with other systems, attention must be paid to spring and damping rates and to the elimination, as far as practicable, of bump-steer and roll-steer.

2.9 GROUND CLEARANCE

Ground clearance must be at least 100mm and in the event of a tyre failure, no part of the vehicle other than the wheel rim must be able to come in contact with the road surface.

2.10 RIMS AND TYRES

Where passenger car tyres are fitted, they must be compliant with ADR 23/01. The speed and load capacity, placarding and tyre/rim combination must comply with ADR 24/02 or Clause 25 of ADR 42/04.

Maximum rear rim width for LEM1/LEP1 vehicles is recommended to be 200mm (8").

Tyres must be fitted to rims in accordance with the Australian Tyre and Rim Association Manual.

Double sided safety rims are required.

No wheel rim is permitted to have more than one weld around its circumference.

Slotted stud type multi-fit rims are not permitted.

Where a passenger car tyre is fitted to the front wheel of LEM1/LEP1 vehicles, the front and rear tyres must all be of the same carcass construction, i.e. all radial, or all belted bias.

A tyre placard must be attached to the vehicle clearly showing the rim and tyre sizes, and tyre inflation pressures applicable to that vehicle.

2.11 MAXIMUM WIDTH

The maximum overall width of a *trike* must not exceed 1850mm.

2.12 FUEL SYSTEM

Where a fabricated fuel tank is used, it must be soundly constructed from appropriate materials.

The fuel tank must be compatible with the engine used with regard to breathing, fuel return and evaporative emission control provisions.

Fuel lines must be secured at intervals of no more than 300mm, and must not pass under frame rails unprotected.

Refer to Section LM of the NCOP for more information about fuel tanks, particularly if a motor car engine is used.

2.13 SEATING AND SEAT BELTS

Seats must be securely fitted and hinged or removable seats must not release under extreme deceleration.

Passenger seating positions, other than a pillion passenger seat directly behind the rider, require lap seat belts to be fitted.

All seat belts used must be new and marked as compliant with the appropriate Australian Standard.

Seat belt anchorage points must be installed in accordance with the general strength and location requirements of ADR 5/00 refer diagrams in Appendix 4.

Seat belts must be connected to the seat belt anchorage with bolts designed for seat belt use. A locking device or a nyloc nut must retain each seat belt mounting bolt that attaches to a non-captive nut.

2.14 HANDLEBARS

Whilst there are no specific provisions for *Trike* handlebars, it is recommended that they comply with the requirements for motorcycle handlebars in accordance with Rule 55 of the AVSR. The following measurements need to be taken with the handlebars in a stationary and straight ahead position.

1) The handlebars must extend at least 250 millimetres, but not over 450 millimetres, on each side of the centre line of the vehicle.

2) In taking a measurement for (1), mirrors and lights mounted on the handlebars can be disregarded.

3) The lowest part of the handgrip on the handlebars must not be higher than 380 millimetres above the attachment point of the handlebars to the vehicle.

4) Handgrips on the handlebars must be fitted symmetrically.

Handlebars must be constructed in a manner and of material conforming to accepted practice for motorcycles. Conventional tubular handlebars would generally be expected to be constructed from steel tubing of between 22 and 25 mm O.D. and of minimum 1.6mm wall thickness.

2.15 MUDGUARDS

Trikes must have mudguards fitted to all wheels that comply with the requirements of ADR 42.

2.16 DRIVE SHAFTS, CHAINS AND BELTS

Drive shafts, chains and belts must be adequately protected such that rider/passenger contact with moving or rotating parts is prevented. Note that more extensive guarding may be required than is necessary for a solo motorcycle.

2.17 ELECTRICAL

LIGHTING

Lighting equipment shall be in accordance with ADR 67/00.

HEADLIGHTS

The minimum requirement for both LEM1 and LEP1 vehicles is for a centrally mounted, single headlamp – a centrally mounted, dual headlamp assembly is also acceptable for both vehicle categories.

Maximum headlight height is 1400mm and the minimum 500mm to the centre of the light.

Headlights must be adjusted to comply with Rules 81, 82 and 83 of the Australian Vehicle Standards Rules 1999.

BRAKE LIGHTS

Two brake lights must be fitted to LEM1/LEP1 vehicles, one on either side, with an additional high mounted third brake light.

Brake lights must be red in colour.

Brake lights must be at least 350mm but less than 1500mm from the ground to the light centre.

Brake lights must comply with the requirements of Rules 98 and 99 of the Australian Vehicle Standards Rules 1999.

PARKING / TAIL LIGHTS

Two park/tail lights must be fitted to the rear of LEM1/LEP1 vehicles, one on either side, and one park light to the front. The rear lights must be positioned with centres no more than 510mm inboard from the vehicle extremity on either side, and at least 600mm apart, equidistant from the centre line of the vehicle.

Lights must be red to the rear, white to the front. Power must not exceed seven Watts and they must be visible at 200m.

Front parking lights may be positioned in the headlight assembly and rear parking lights may be incorporated with the brake lights in the rear light assemblies.

Rear park/tail lights must be at least 350mm but less than 1500mm from the ground to the light centre. Front park lights must be at least 500mm but less than 1400mm from the ground to the light centre.

Park/tail lights must comply with the requirements of Rules 86, 87, 88 and 89 of the Australian Vehicle Standards Rules 1999.

DIRECTION INDICATOR LIGHTS

Flashing indicator lights must be amber in colour. They must be located so that other road users will have an indication of the directional change intended.

The centres of rear lights on LEM1/LEP1 vehicles must be no less than 600mm apart and equidistant from the centre line of the vehicle in accordance with Rule 103(1)(b) of the Australian Vehicle Standards Rules 1999.

The centres of front lights on LEM1/LEP1 vehicles must be no less than 300mm apart and equidistant from the centre line of the vehicle in accordance with Rule 103(1) (a) of the Australian Vehicle Standards Rules 1999.

Lamp centre height must be between 350mm and 1500mm above ground level.

The operation and visibility of direction indicator lamps must be in accordance with Rule 104 of the Australian Vehicle Standards Rules 1999.

NUMBER PLATE LIGHT

A white light of seven Watts or less must be fitted to the rear to illuminate the rear number plate when the parking lights or headlights are switched on. All letters and numbers on the number plate must be clearly visible when viewed 20m from the rear of the vehicle. Performance must be in accordance with Rule 90 of the Australian Vehicle Standards Rules 1999.

HAZARD LIGHTS

Hazard lights that comply with ADR 67 must be fitted to all categories of *trikes*.

The ‘Vehicle Hazard Warning Signal’ shall remain capable of being actuated even when the device which controls the starting and stopping of the engine is in such a position that operation of the engine is impossible.

AUTOMATIC TRANSMISSION SAFETY SWITCH

All *trikes* fitted with automatic transmissions (manual valve bodies included) must be fitted with a neutral/park safety switch. The switch must prevent operation of the starter motor when a forward or reverse gear has been selected. Transmission selectors must be designed so that there can be no accidental engagement of reverse gear.

WIRING

Wiring shall be generally in accordance with Clause 9 of ADR 42/04

All sections of the wiring loom must be insulated and secured at intervals of not more than 600 mm. Wiring is not to be secured to either brake or fuel lines without approved automotive insulating clips attached. It is preferred that wiring is kept away from fuel lines.

Wiring must be adequately secured and clear of exhaust and moving parts.

All wiring must be neat and tidy, and any wiring passing through metal sections must be adequately protected from chafing, e.g. by the use of rubber grommets.

BATTERIES

Batteries must be secured and placed in a container suitable for the purpose of holding a battery.

Battery terminals and wiring must be positioned so that there can be no accidental shorting to ground of the live terminal. The battery leads must be secure and kept away from rotating components, fuel system components, and exhaust systems.

Fusible links between the battery and powered components are highly recommended.

2.18 INSTRUMENTATION

Instrumentation and warning lamps shall be fitted broadly in accordance with ADR 18/02. Odometers reading to a maximum of 99,999 km will be accepted on LEP category *trikes* where the speedometer and speedometer drive mechanism are driven from the front wheel and are taken from the same donor motorcycle as the front wheel and forks.

Speedometer and odometer accuracy shall be as specified in Clause 18.5 of ADR 18/02.

2.19 REVERSE GEAR

All LEP category Motor Tricycles must be able to be driven both forwards and backwards in accordance ADR 42/04.

2.20 CERTIFIED VEHICLE WEIGHT

As the weight of the finished, unladen *trike* is required to determine its category, it is recommended that the Signatory certifying the stability test includes the unladen weight in his report on the vehicle, since the vehicle must be weighed during the stability test process.

Note that a certified public weighbridge may not be sufficiently accurate to measure weights under one tonne.

2.21 IMMOBILISERS

LEP *trikes* must be fitted with an anti-theft lock as per ADR 25/02. This generally means a steering lock or a gear lock must be fitted.

Alternatively, a self-arming immobilising device that complies with the standards listed below may be fitted to LEP *trikes* where it is not practical to install a steering locking device complying with the ADR.

- an immobiliser fitted to a vehicle as an integral part of an alarm system complying with AS/NZS 3749.1:1997 *Intruder alarm systems — Road vehicles*, jointly published by Standards Australia and Standards New Zealand; or,

- an immobiliser that complies with AS/NZS 4601:1999 *Vehicle Immobilizers*, jointly published by Standards Australia and Standards New Zealand;

2.22 VEHICLE CONDITION

When presented for registration a trike should be presented in “as new” condition. All components used must be in a sound, serviceable condition, and should be either new or refurbished to a high standard.

3 COMPLIANCE WITH REDUNDANT AUSTRALIAN DESIGN RULES

In the review of the ADRs a number of ADRs, or clauses within ADRs have been made redundant. A number of these ADRs are also applicable to trikes and will soon have no effect. Many of these requirements have been superseded by clauses contained in ADR 42/04.

To assist trike builders in identifying these ADRs, reference has been specifically made in the description of these ADRs in *Appendix 2 - Summary of Applicable Australian Design Rules and Australian Vehicle Standards Rules.*

Compliance with an ADR subsequently superseded by ADR 42/04 will be deemed to constitute compliance with ADR 42/04. For example, if a braking system is used from an existing production motorcycle with hoses that comply with ADR 7, these hoses will be deemed to comply with relevant clause in ADR 42/04.

4 APPENDICES

APPENDIX 1

ADR 42/04 STABILITY TEST REPORT AND EXPLANATORY DIAGRAMS

Owner/Builder:	
Frame Number:	
Configuration Category (LEM/LEP1)	
Engine Number:	
Wheelbase (W):	mm
Track (t) (“actual” or “effective”)	mm
Rolling Radius (r):	mm
Reference Angle (θ):	degrees
Number of Seating Positions:	

AXLE LOADS

(a) LEM/LEP1 category:

Front Axle Load (F):	kg
Rear Axle Load (Left):	kg
Rear Axle Load (Right):	kg
Total Rear Axle Load (R):	kg
Certified Tare Mass: **(F + R - test masses = tare):**	kg
Longitudinal Location:	
L = WR/(F + R) =	mm
Height Location:	
H = r + (W - L)/tanθ =	mm
Horizontal Location:	
D = Lsin[arctan(t/2W)] (LEM1/LEP1 vehicles) =	mm
Conclusion:	

The vehicle as tested complies with the requirements of Section 42.22.3 of ADR42.03

Yes:

No:

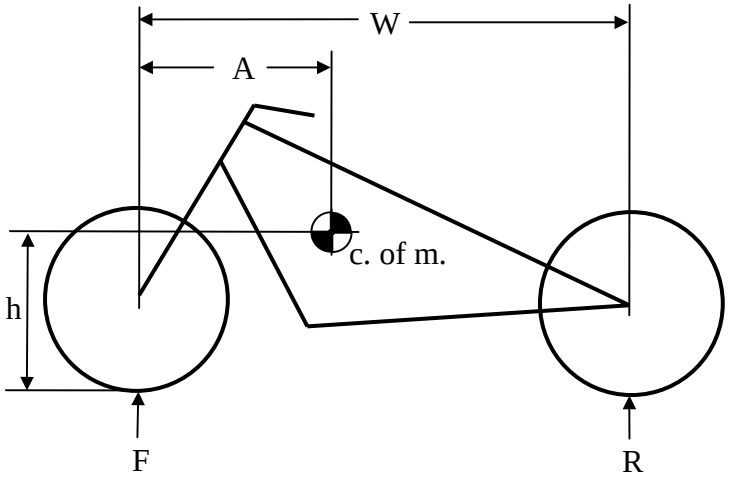
Test conducted by:

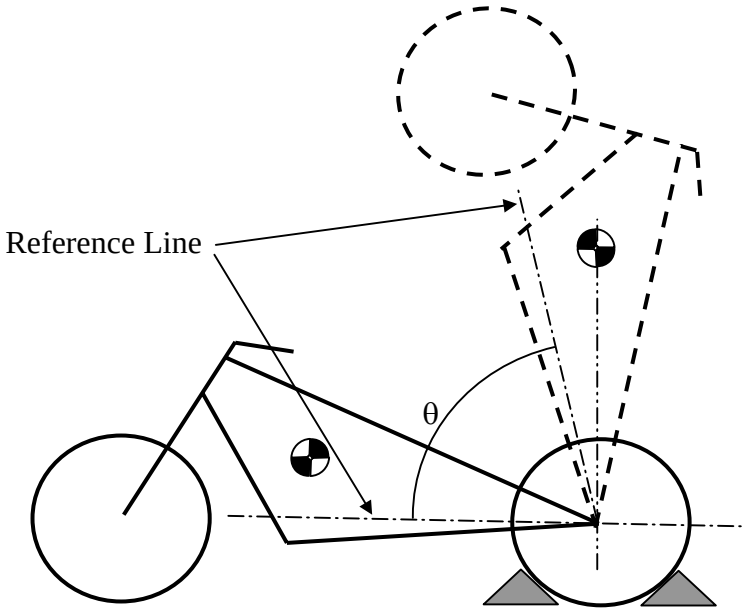
Qualification:

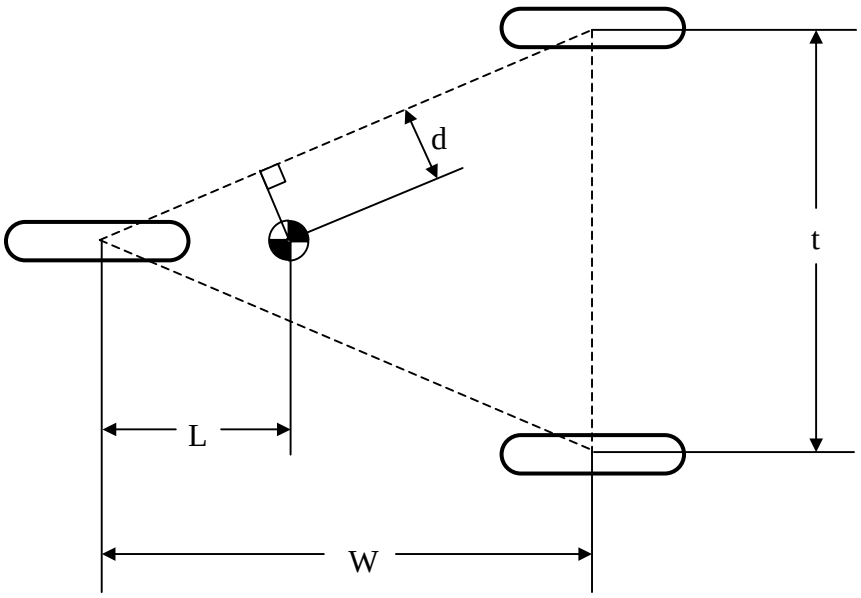
Signed:

Date:

Address




Reference Line
θ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APPENDIX 2

SUMMARY OF APPLICABLE AUSTRALIAN DESIGN RULES AND AUSTRALIAN VEHICLE STANDARDS RULES

Following is a summary of Australian Design Rules (ADRs) and a summary of the Australian Vehicle Standards Rules (AVSR) that are applicable to motorcycle type trikes. Note that not all of the ADRs mentioned in the summary will be applicable to all vehicles. Advice from a Signatory may be required to confirm which ADRs and AVSRs will be applicable to the LEM or LEP vehicle under consideration.

Those AVSRs highlighted in bold type are applicable to both LEM and LEP vehicles.

AUSTRALIAN DESIGN RULES SUMMARY

ADR 1 - Reversing Lamps

The function of this national standard is to specify the photometric requirements for reversing lamps which:

(a) warn pedestrians and other road users that the vehicle is about to move, or is moving, in the reverse direction; and

(b) aid the driver in reversing manoeuvres during the hours of darkness.

ADR 3 - Seats and Seat Anchorages

The function of this national standard is to specify requirements for 'Seats', their attachment assemblies, and their installation to minimise the possibility of occupant injury due to forces acting on the 'Seat' as a result of vehicle impact.

ADR 4 - Seatbelts

The function of this national standard is to specify requirements for seatbelts to: restrain vehicle occupants under impact conditions, facilitate fastening and correct adjustment, assist the driver to remain in his 'Seat' in an emergency situation and thus maintain control of the vehicle, and protect against ejection in an accident situation.

ADR 5 - Anchorages for Seatbelts and Child Restraints

The function of this national standard is to specify requirements for 'Anchorages' for both 'Seatbelt Assemblies' and 'Child Restraints' so that they may be adequately secured to the vehicle structure or 'Seat' and will meet comfort requirements in use.

ADR 6 - Direction Indicator Lamps

The function of this Australian Design Rule is to specify the photometric requirements for direction indicators which will provide adequate warning to other road users of the intention to perform a turning manoeuvre.

ADR 7 - Hydraulic Brake Hoses

The function of this Australian Design Rule is to specify the performance requirements of hydraulic brake hoses in vehicles so that the risk of failure in service will be minimised.

This rule ceased to have effect from 1 January 2005. Refer to ADR 42/04.

ADR 8 - Safety Glazing Material

The function of this Australian Design Rule is to specify the performance requirements of material used for external or internal glazing in motor vehicles which will ensure adequate visibility under normal operating conditions, will minimise obscuration when shattered, and will minimise the likelihood of serious injury if a person comes in contact with the broken glazing material.

ADR 14 - Rear Vision Mirrors

The function of this Australian Design Rule is to specify requirements for rear vision mirrors to provide the driver with a clear and reasonably unobstructed view to the rear.

ADR 18 - Instrumentation

The function of this Australian Design Rule is to specify requirements for the provision and location of certain 'Visual Indicators'.

It also specifies requirements for speedometers and odometers.

ADR 19 - Installation of Lighting & Light-signalling Devices on L-Group Vehicles

The function of this Australian Design Rule is to ensure that the installation of lighting and light-signalling devices on the vehicle is such that the effective operation of these devices is not impaired.

ADR 23 - Passenger Car Tyres

The function of this Australian Design Rule is to specify requirements of strength, construction and standard pressure/load relationships for passenger car tyres of particular size designations.

ADR 24 - Tyre & Rim Selection

The function of this Australian Design Rule is to specify requirements for tyres and 'Rims' appropriate to vehicle load capacity, 'Rim' size and speed characteristics.

This rule ceased to have effect from 1 January 2005. Refer to ADR 42/04.

ADR 25 - Anti-Theft Lock

The function of this Australian Design Rule is to specify requirements for a lock to inhibit unauthorised use of the vehicle and to minimise the possibility of inadvertent adjustment of steering locks to the anti-theft position when the vehicle is in motion.

ADR 28 - External Noise of Motor Vehicles

The function of this ADR is to define limits on external noise generated by motor vehicles in order to limit the contribution of motor traffic to community noise

ADR 30 - Diesel Engine Exhaust Smoke Emissions

The function of this Australian Design Rule is to limit the opacity of 'Diesel Engine' exhaust smoke emissions.

ADR 31 - Hydraulic Brake Systems for Passenger cars

The function of this Australian Design Rule is to ensure safe braking under normal and emergency conditions for vehicles equipped with hydraulic service brakes.

ADR 33 - Brake Systems for Motor Cycles and Mopeds

The function of this Australian Design Rule is to ensure safe braking under normal and emergency conditions.

ADR 34 - Child Restraint Anchorages and Child Restraint Anchor fittings

The function of this Australian Design Rule is to specify requirements for 'Child Restraint Anchorages' and 'Child Restraint Anchor Fittings' which provide for the connection of standard 'Attaching Clips' so that 'Child Restraints' may be adequately secured to the vehicle.

ADR 37 - Emission Control for Light Vehicles

The intention of this Australian Design Rule is to limit 'Fuel Evaporative Emissions' and 'Exhaust Emissions' from motor vehicles in order to reduce air pollution and to require new petrol fuelled motor vehicles to be manufactured to operate on 'Unleaded Petrol'.

ADR 39 - External Noise of Motor Cycles

The function of this Australian Design Rule is to specify requirements relating to external noise emitted from 'Motor Cycles' in order to limit the contribution by these vehicles to community noise.

ADR 42 - General Safety Requirements

The function of this Australian Design Rule is to specify design and construction requirements to ensure safe operation of vehicles.

ADR 43 - Vehicle Configuration & Dimensions

The function of this Australian Design Rule is to specify requirements for vehicle configuration and dimensions.

ADR 45 - Lighting & Light-signalling Devices not covered by ECE Regulations

The function of this Australian Design Rule is to specify the photometric requirements for lighting and light-signalling devices which will ensure adequate illumination for the driver of the vehicle and signal to other road users the position, orientation, intention and movement of the vehicle, without producing undue glare for other road users.

ADR 46 - Headlamps

The function of this Australian Design Rule is to specify the photometric requirements for headlamps that will provide adequate illumination for the driver of the vehicle without producing undue glare for other road users.

ADR 47 - Reflex Reflectors

The function of this Australian Design Rule is to specify the dimensional, photometric and stability requirements for reflex reflectors that will ensure that they effectively warn of the presence of the vehicle and continue to do so in normal use.

ADR 48 - Rear Registration Plate Illuminating Devices

The function of this Australian Design Rule is to specify the photometric requirements for rear registration plate illuminating devices that will ensure that the rear registration plate is adequately illuminated.

ADR 49 - Front and Rear Position (Side) Lamps, Stop Lamps and End-outline Marker Lamps

The function of this Australian Design Rule is to specify the photometric requirements for light-signalling devices that will signal to other road users the position, orientation and movement of the vehicle without producing undue glare for other road users.

ADR 50 - Front Fog Lamps

The intention of this Australian Design Rule is to specify the photometric requirements for front fog lamps that will provide adequate illumination for the driver of the vehicle without producing undue glare for other road users.

ADR 51 - Filament Globes

The function of this Australian Design Rule is to specify the dimensional and photometric requirements for filament globes that ensure inter-changeability and correct functioning when installed in a lamp.

ADR 52 - Rear Fog Lamps

The function of this Australian Design Rule is to specify the photometric requirements for rear fog lamps that will signal to other road users the position, orientation and movement of the vehicle without producing undue glare for other road users.

ADR 53 - Position Lamps, Stop Lamps, Direction Indicators & Rear Plate Lamps for L-Group Vehicles

The function of this Design Rule is to specify the photometric requirements for light-signalling devices that will signal to other road users the position, orientation and movement of the vehicle without producing undue glare for other road users.

ADR 55 - Headlamps for L-Group Vehicles other than Mopeds

The function of this Australian Design Rule is to specify the photometric requirements for headlamps that will provide adequate illumination for the driver of the vehicle without producing undue glare for other road users.

ADR 60 - Centre High-mounted Stop Lamp

The function of this Australian Design Rule is to specify requirements for a supplementary 'Centre High-mounted Stop Lamp' on the rear of the vehicle, to provide an additional indication to other road users to the rear of the vehicle that the driver of the vehicle is applying the service brakes.

ADR 61 - Vehicle Marking

The function of this Australian Design Rule is to specify requirements for vehicle marking.

ADR 62 - Mechanical Connections between Vehicles

The function of this Australian Design Rule is to specify requirements for devices for mechanical connections between vehicles and their fitment.

ADR 67 - Installation of Lighting and Light-Signalling Devices on Three-Wheeled Vehicles

The function of this Australian Design Rule is to ensure that the installation of the lighting and light-signalling devices on the vehicle is such that the effective operation of these devices is not impaired.

ADR 70 - Exhaust Emission Control for Diesel Engine Vehicles

The function of this Australian Design Rule (ADR) is to reduce air pollution, by limiting the hydrocarbons, carbon monoxide, oxides of nitrogen, and particulates emitted to the atmosphere from the exhaust system of motor vehicles fitted with a 'Diesel Engine'. This ADR is additional to ADR 30/00 which limits exhaust smoke emissions from such vehicles.

ADR 76 - Daytime Running Lamps

The function of this Australian Design Rule is to prescribe photometric requirements to daytime running lamps which are provided to improve the conspicuousness of vehicles in daylight.

ADR 77 - Gas Discharge Headlamps

The function of this Australian Design Rule is to prescribe photometric requirements for gas discharge headlamps.

ADR 78 - Gas Discharge Light Sources

The function of this Australian Design Rule is to prescribe photometric and geometric requirements for light sources for gas discharge headlamps.

ADR 79 - Emissions Control for Light Vehicles

The function of this Australian Design Rule is to prescribe exhaust and evaporative emission requirements for light vehicles in order to reduce air pollution.

ADR 82 - Engine Immobilisers

The function of this Australian Design Rule is to prescribe requirements for engine immobilising devices that are fitted to prevent vehicles from being driven away powered by their engines.

ADR 83 - External Noise

The function of this Australian Design Rule is to define limits on external noise generated by motor vehicles, motorcycles and mopeds in order to limit the contribution of motor traffic to community noise.

Those AVSRs highlighted in bold type are applicable to both LEM and LEP vehicles.

AUSTRALIAN VEHICLE STANDARDS RULES SUMMARY

RULE	SUBJECT
28	**Turning Ability**
29	**Ability to travel backwards and forwards**
31	**Driver's view and vehicle controls**
32	**Seating**
33	**Mudguards and spray suppression**
34	**Horns, alarms etc**
35	**Rear vision mirrors**
36	**Rear vision mirrors – surfaces**
37	**Additional rear vision mirrors**
38	**Automatic transmission**
41	**Electrical wiring, connections and installations**
45	**Windscreen wipers and washers**
46	**Wheels and tyres – size and capacity**
49	**Pneumatic tyres – size and capacity**
54	**Tyre tread**
56	**Foot rests**
57	**Chain guards**
58	**Vehicle and engine identification numbers**
73	**Ground clearance**
77	**Headlights to be fitted to vehicles**
78	**How headlights are to be fitted**
79	**How single headlights are to be fitted**
80	**How additional headlights are to be fitted**
81	**Performance of headlights**
82	**Effective range of headlights**
83	**Changing headlights from high-beam to low-beam position**

84 **Parking lights**

85 **Daytime running lights**

86 **Tail lights generally**

87 **Pattern of fitting tail lights**

88 **Performance of tail lights**

89 **Wiring of tail lights**

90 **Number plate lights**

98 **Fitting brake lights**

99 **Performance and operation of brake lights**

100 **Reversing lights**

101 **Direction indicator lights on vehicles**

103 **Location of direction indicator lights**

104 **Operation and visibility of direction indicator lights**

109 **Rear reflectors**

125 **Parts of a braking system**

126 **Provision for wear**

128 **Performance of braking systems**

129 **What braking system a motor vehicle must have**

130 **Operation of brakes on motor vehicles**

147 **Visible emissions**

149 **Silencing device for exhaust systems**

150 **Stationary noise levels – car-type vehicles and motor bikes and *trikes***

153 **Measurement of stationary noise levels**

154 **LPG-powered vehicles**

APPENDIX 3

HEATING, WELDING OR PLATING OF STEERING AND SUSPENSION COMPONENTS

The heating or welding of steering or suspension components will only be accepted if the modification in question is accompanied by a satisfactory report from a Signatory or Metallurgist*. The report must confirm that the modified parts are at least as strong as the original and contain no latent defects. Every modified part must be given a unique permanent identity number, which must be recorded by the modifier.

In the accompanying report, it would be expected that the following issues would be considered and commented on:-

- Material specifications of the component to be modified.
- A specification of weld material and compatibility with the parent material if welding is involved.
- Description and/or diagrams of the preparation of the component if welding is involved.
- Details of preheating if required prior to the modification.
- Details of heat treatment procedure after modification.
- Hardness testing before and after modification of the modified zone.
- Results of non destructive testing

Note: Welding must be conducted in accordance with Australian Standard 1554 *Part 1 Welding of Steel Structures*.

For multiple component modifications it is permissible to replace the Signatory's report with a *Letter of Conformity* providing that the components being modified or manufactured are all to an identical specification. The *Letter of Conformity* must make reference to the Signatory's report that provided the initial approval for the work in question. Jurisdictions may also request evidence of procedures and practices that ensures conformity of production.

* The Signatory or Metallurgist specified in this section must be appropriately qualified in the assessment of welded or heat-treated metal components.

CHROME PLATING

Critical steering and suspension components are not to be chrome plated.

*{**Advisory Note:***
An unfortunate side effect of chrome plating in some instances is a phenomenon known as "hydrogen embrittlement". The hydrogen produced as a result of the plating process causes weak spots in the base metal and is undetectable as embrittlement occurs under the surface of the chrome plating.

The process of embrittlement can develop into cracks that result in components failing catastrophically under relatively low forces.

Hydrogen embrittlement is more likely to occur if:

- *The component is made of high grade alloy, is cast or is heat treated.*
- *The component is subject to reversing stresses.*

Failure of a component through hydrogen embrittlement can be catastrophic and failures can occur without warning. This is compounded by the fact that chrome plating may hide other defects. A component may appear to be in good order without visible cracks on the surface, but can fracture easily from a shock load such as driving over a pot-hole.

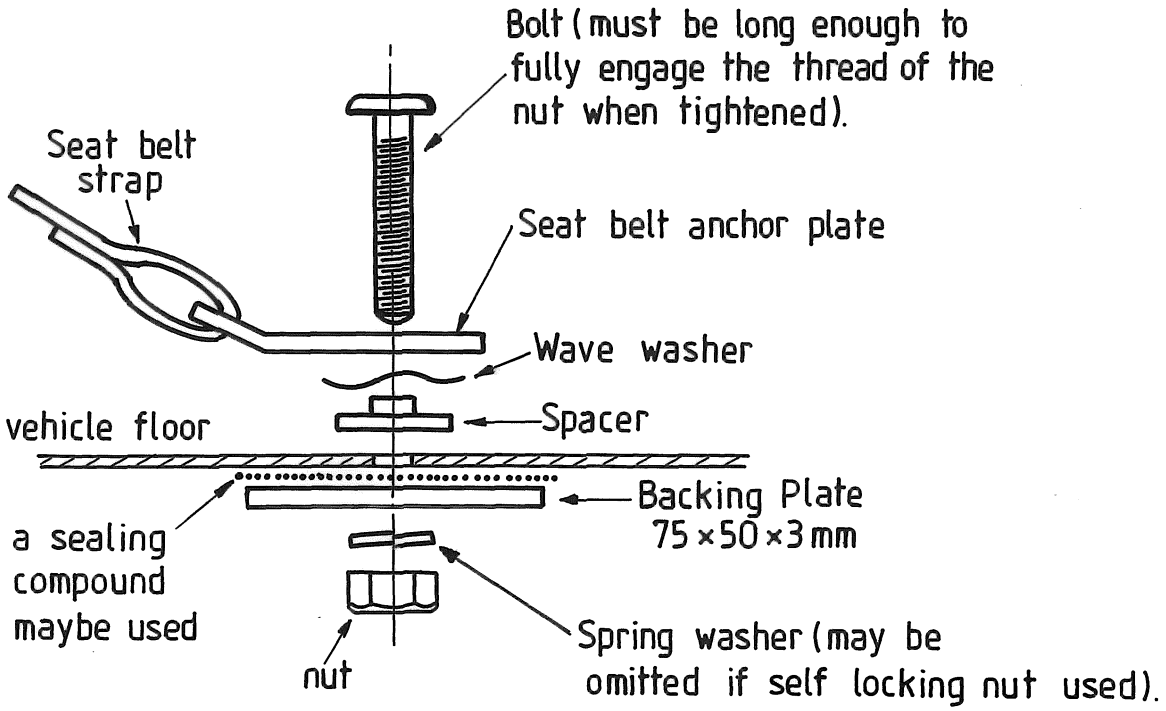
Hydrogen Embrittlement Minimisation by Baking
Certain alloys can have the effects of hydrogen embrittlement reduced by "embrittlement relief baking". This procedure, if carried out within 24 hours of plating, may result in the dissipation of the hydrogen atoms and hence reduce the likelihood of embrittlement. The baking process may however, in certain circumstances, cause a reduction in the physical properties of the parent material.

In order to maintain a high order of certainty as to the strength of critical components jurisdictions will not accept "relief baked" components unless:

The components are both plated and then baked in a prescribed manner that ensures a high level of conformity of production. The processes thus carried out must be supported by physical test data that confirms the material strength of the finished part is adequate for the function of the part in question. A report must accompany the finished part that is signed by a Signatory or Metallurgist who is appropriately qualified in the assessment of welded or heat-treated metal components. The report must confirm that conformity of production processes were used in the plating and baking process and that the necessary physical testing was carried out to confirm the strength of the final product.}

APPENDIX 4

SEAT BELT MOUNTING EXAMPLES



Appendix 5

CHECKLISTS

The following checklists apply to LEM1 and LEM2 Trike ICV construction:

- CODE LO4 LEM1 Category Tricycle Checklist
- CODE LO5 - LEP1 Category Tricycle Checklist

Each checklist may be downloaded from the following Department of Transport and Regional Services (DOTARS) website:-

www.dotars.gov.au