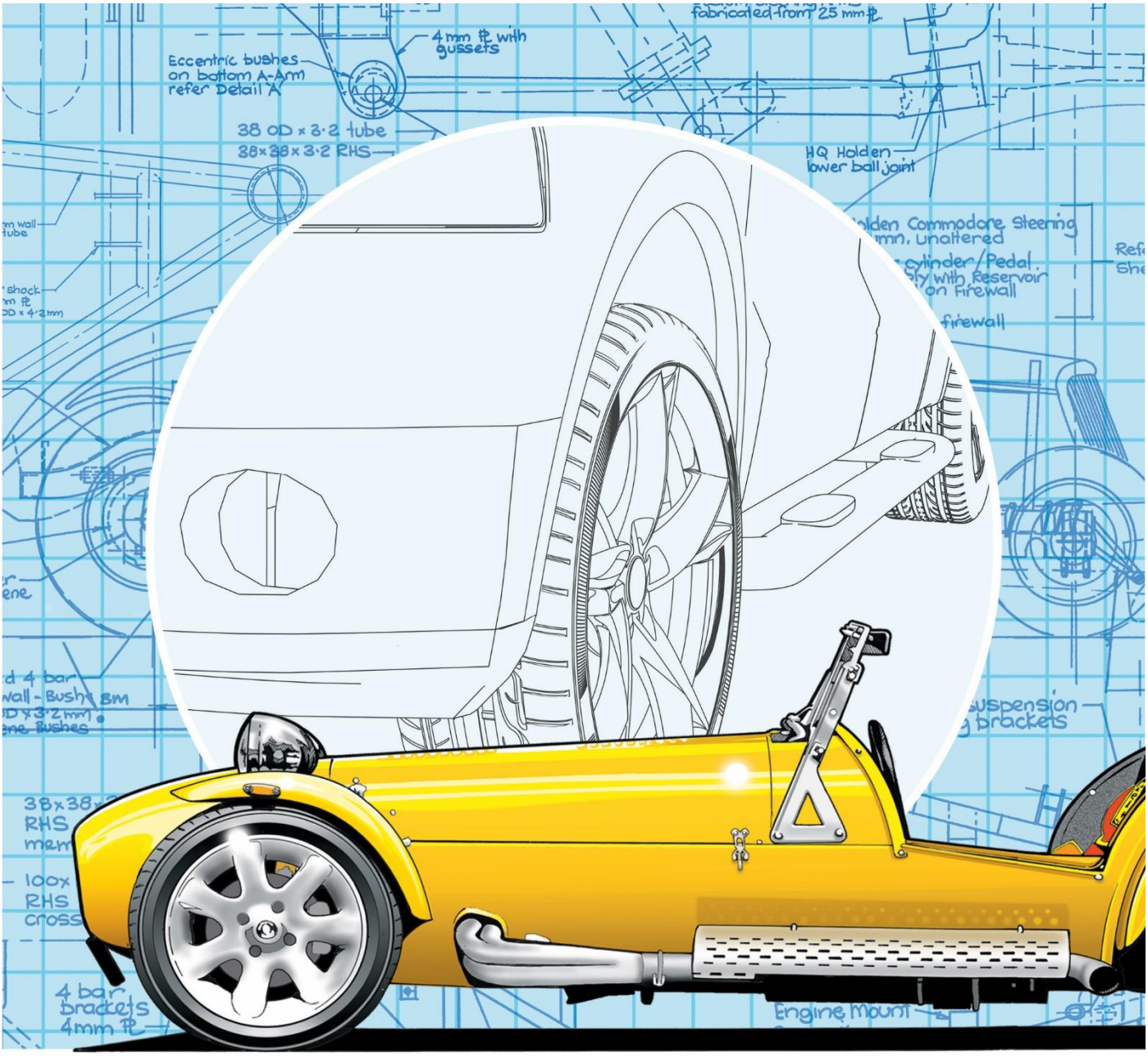
Low Volume Vehicle Technical Association (inc)

Helping New Zealanders Build & Modify Safe Vehicles

New Zealand Car Construction Manual

Chapter 12
Wheels & Tyres

2nd Amendment | Effective from 1 December 2021



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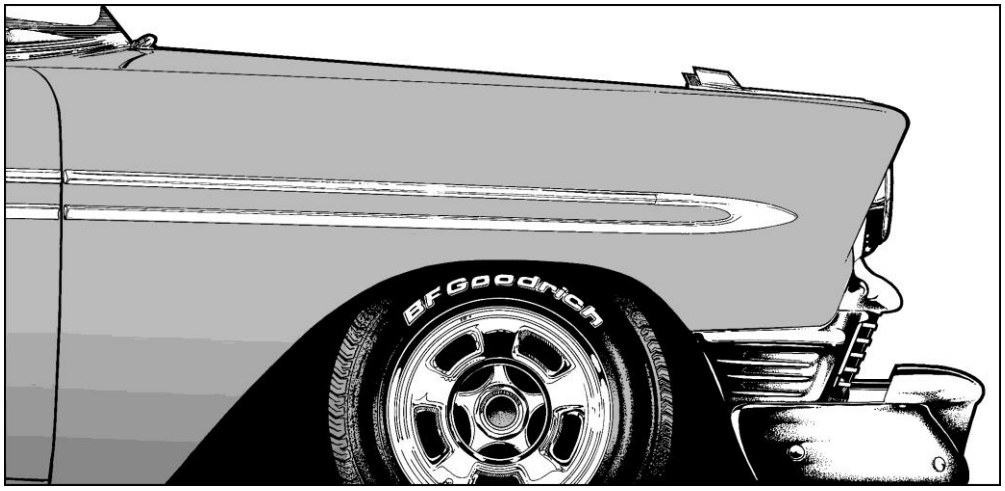

Tony Johnson Illustration

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The information in this NZ Car Construction Manual Chapter has stemmed from work undertaken by LVVTA founding member organisations that commenced prior to 1990 and has been progressively developed as an integral part of New Zealand Government safety rules and regulations by agreement and in consultation with the New Zealand Transport Agency.

As a result, the considerable experience in applied safety engineering built up by LVVTA and the specialist automotive groups over the past several decades can be of benefit to members of the New Zealand public who also wish to build or modify light motor vehicles.

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This NZ Car Construction Manual Chapter is supported by a lot of other documents (referred to as 'supporting information' on the same subject, which could be very helpful to someone using this chapter.

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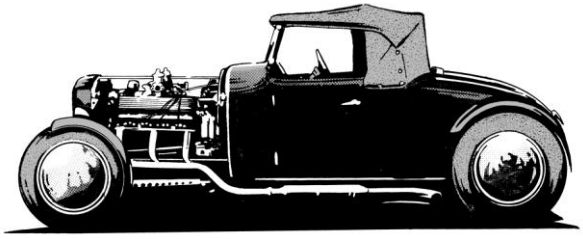
Normal type:	Provisions of the NZ Car Construction Manual for all vehicles.
Normal type in shaded box:	Special provisions of the NZ Car Construction Manual for vehicles built or modified before specified dates.
Script type:	Helpful hints, tips, explanations, clarifications, and interpretations.
Grey shaded text & grey vertical stroke in margin:	Latest amendments since previous version. Note that text which is high-lit in grey shows amendments that have been made since the document's previous version, and a grey vertical stroke to the left of the text denotes new or changed information which is important (rather than just a grammatical, formatting, or numbering change).



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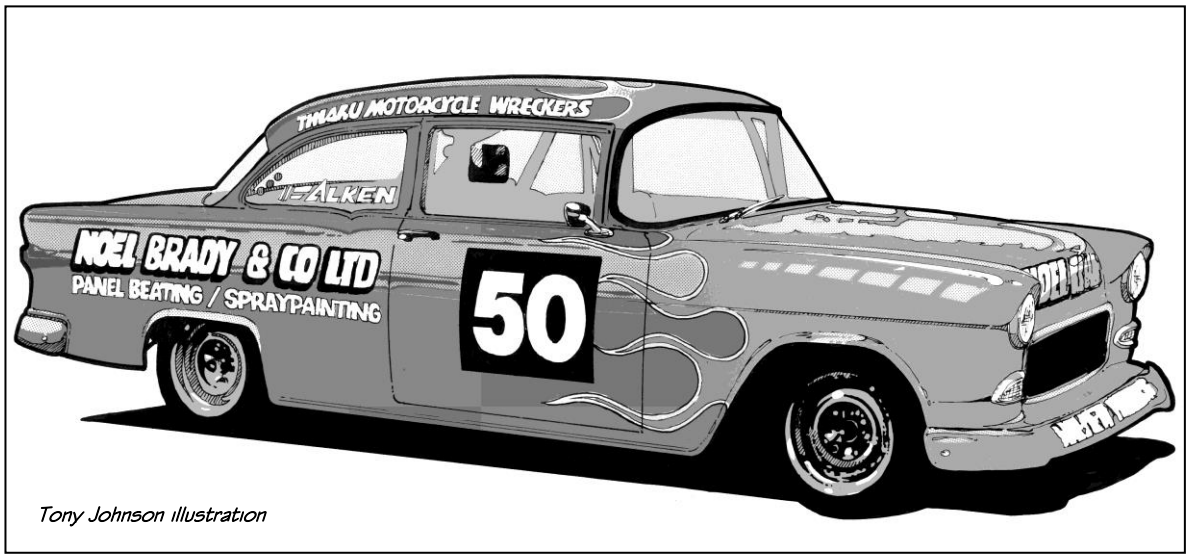


Tony Johnson illustration

CHAPTER 12: WHEELS & TYRES

Introduction:

The three key ingredients to the successful visual outcome of any hobby car is stance, colour, and wheels and tyres. However, this is an area where focusing on form without giving due consideration to function can have long-lasting negative effects on the way a hobby car rides and handles. If proper thought and attention is paid to the technical requirements in this chapter, that all important look can be achieved whilst still ending up with a vehicle that offers as much comfort and handling as it does visual appeal.

This chapter covers all common best-practice requirements for aftermarket wheel and tyre fitments and modifications, plus requirements for other related components including wheel spacers and wheel adaptors.

Note that where a production vehicle is fitted with its original wheels and tyres, and no other changes have occurred like the fitment of spacers or adaptors, or a substantial increase in weight, the requirements in this chapter do not apply.

General safety requirements:

12.0 Requirements applicable to all vehicles

12.0.1

A low volume vehicle must:

(a) be designed and constructed using materials and components that are fit for their purpose; and

(b) be safe to be operated on the road.

12.0.1

This is from 2.3 of Part 2 of the LVV Code, which makes it clear that, regardless of what technical requirements are or are not in place, every vehicle certified to the LVV Code must be fit for its purpose, and must be safe.

12.0.2

A tyre must be of good quality and construction, fit for its purpose and maintained in a safe condition.

12.0.3

A tyre must not have worn, damaged or visible cords apparent by external examination.

12.0.4

If fitted, a unidirectional tyre must be fitted to a wheel position corresponding to its direction of rotation.

12.0.5

A tyre on a motor vehicle must have a tread pattern around the entire circumference of the tyre of not less than 1.5 mm in depth within all principal grooves that contain moulded tread depth indicators, or for tyres manufactured without moulded tread depth indicators, across at least three-quarters of the width of the tread and around the entire circumference of the tyre.

12.0.6

Tyres on the same axle must be of the same size designation and construction, and of the same tread pattern type.

12.0.2 – 12.0.6

These are the applicable general safety requirements from the Land Transport Rule 32013 Tyres and Wheels 2001, which are required as part of this Chapter, reproduced here in the interest of convenience.

12.0.5

Winter tyres have different tread depth requirements than other tyres. Refer to the Warrant of Fitness Vehicle Inspection Requirements Manual for details.

12.0.6

Construction types include mixed steel ply, fabric radial ply, bias/cross ply and run-flat.

Tread pattern types include asymmetric, directional, normal highway, traction and winter.

Wheel suitability requirements:

12.1 Wheel compatibility

12.1.1

Each pair of front wheels, or rear wheels, fitted to a low volume vehicle, must be of the same width, diameter, mounting configuration, and offset.

12.2 Wheel design and loading

12.2.1

A wheel fitted to a low volume vehicle must be:

(a) purpose-designed for automotive road use; and

(b) designed to withstand:

(i) the combination of vehicle weight and vehicle load weight; and

12.2.1(b)

Wire spoke wheels shouldn't be used on high horsepower vehicles, or vehicles designed to achieve high cornering loads.

(ii) the cornering and braking forces applied by the motion of the vehicle.

12.2.2

A wheel that is manufactured by a high volume motor vehicle manufacturer, must not be fitted to a low volume vehicle that has a higher tare, or gross vehicle mass, than the vehicle to which the wheel was originally fitted.

12.2.3

A wheel fitted to a low volume vehicle must be thoroughly visually inspected to ensure that;

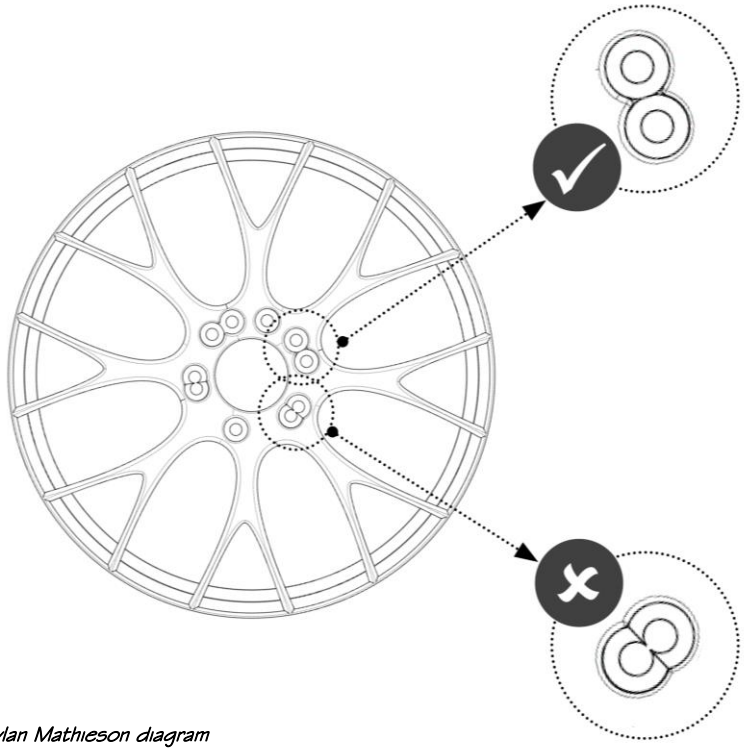
(a) the design and the strength of the wheel appears consistent with the common time-proven makes; and

(b) there is no evident deterioration or cracking, particularly around wheel attachment points; and

(c) the wheel is an appropriate size for the performance characteristics and weight of the vehicle to which it is fitted.

12.2.4

A multi-fit wheel fitted to a low volume vehicle must incorporate sufficient parent material between every wheel stud or bolt hole.



Dylan Mathieson diagram

Diagram 12.1 Multi-fit wheels

12.2.2

See the 'Terms and Definitions' at the back of this manual for definitions on 'tare' and 'gross vehicle mass'.

12.2.3

There is a popular brand of aftermarket wheel sold predominantly in the USA known as the 'Supreme' wheel, about which there is a known history of failure as a result of poor design and manufacturing. For detailed information on these wheels and what to look for, refer to LVVTA Information Sheet # 01-2011 'Supreme'-brand Aftermarket Wheels, available from www.lvvta.org.nz

12.2.3(b)

Old steel wheels in particular should be inspected on the outside of the rim (with tyre removed) to ensure that the wheel has not been weakened by rust.

Wire spoke wheels should be inspected to ensure that all spokes are tight.

12.2.4, and Diagram 12.1

The tapered parts of two holes may overlap but there must be separation of the base of the holes, never resulting in the two holes meeting, or a 'figure-of-eight' shaped hole in the wheel.

12.3 Wheel width and diameter

12.3.1

A wheel fitted to a low volume vehicle must have a minimum width of:

(a) 4 ½" (114mm); or

(b) in the case of either:

(i) a light-weight low volume vehicle based on a pre-1960 vintage, sports, or period special body style, 3 ½" (88 mm); or

(ii) an unusually light-weight low volume vehicle that has a tare of 500 kg (1100 lb) or less, not less than that which can be proven to be of adequate load rating for the application.

12.3.1

Wheel width is measured between the tyre seat beads.

If measuring the rim width with the tyre fitted, measuring on the outer faces of the rim where the tyre seats is accepting, allowing for the material thickness on both sides. A steel rim is typically 2-3 mm thick per side, and an alloy rim is typically 6 mm thick per side.

12.3.2

A wheel fitted to a low volume vehicle must be of sufficient diameter to enable the vehicle to meet the scrub-line requirements specified in 7.37 of 'Chapter 7 – Steering Systems'.

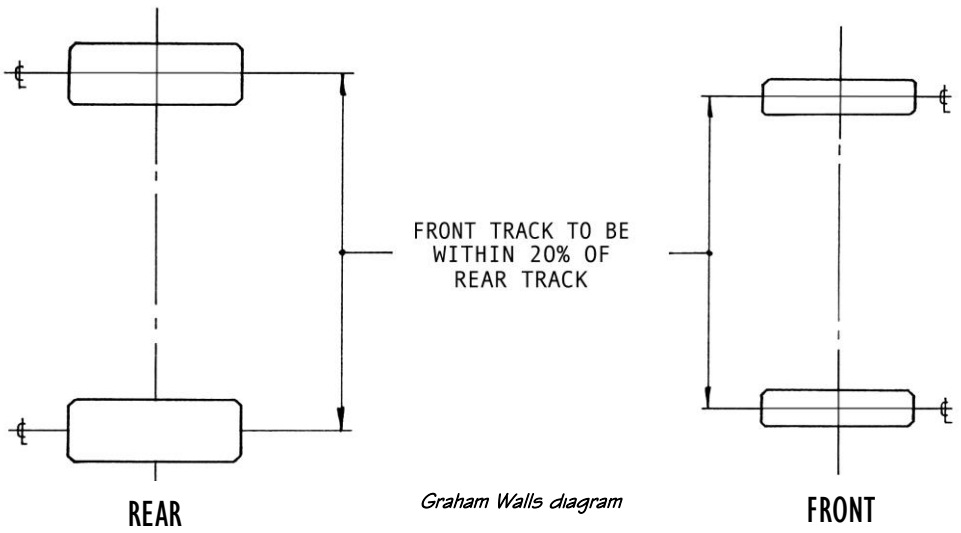
12.4 Wheel track

12.4.1

A low volume vehicle that has four wheels and tyres, must have a front wheel track, measured from centre to centre of the tyre treads, that is within 20% of the rear wheel track. (see Diagram 12.2)

12.4.1

In the case of a dual-wheel assembly (such as that commonly found on both light and heavy commercial vehicles) the wheel track is measured from the centreline of the dual-wheel assembly.



Graham Walls diagram

Diagram 12.2 Wheel track

12.5 Wheel offset

12.5.1

The wheel offset on a wheel fitted to a low volume vehicle, measured from hub flange to wheel width centreline, including any spacers or adaptors if fitted, must be either: (see Diagram 12.3)

(a) no more than 35% of the total wheel width positive or negative; or

(b) in the case of an offset of more than 35%, either:

(i) the axle and hub components used are from a vehicle which is substantially heavier than the vehicle to which the suspension and axle componentry is now fitted; or

(ii) a fully-floating hub and axle assembly is used.

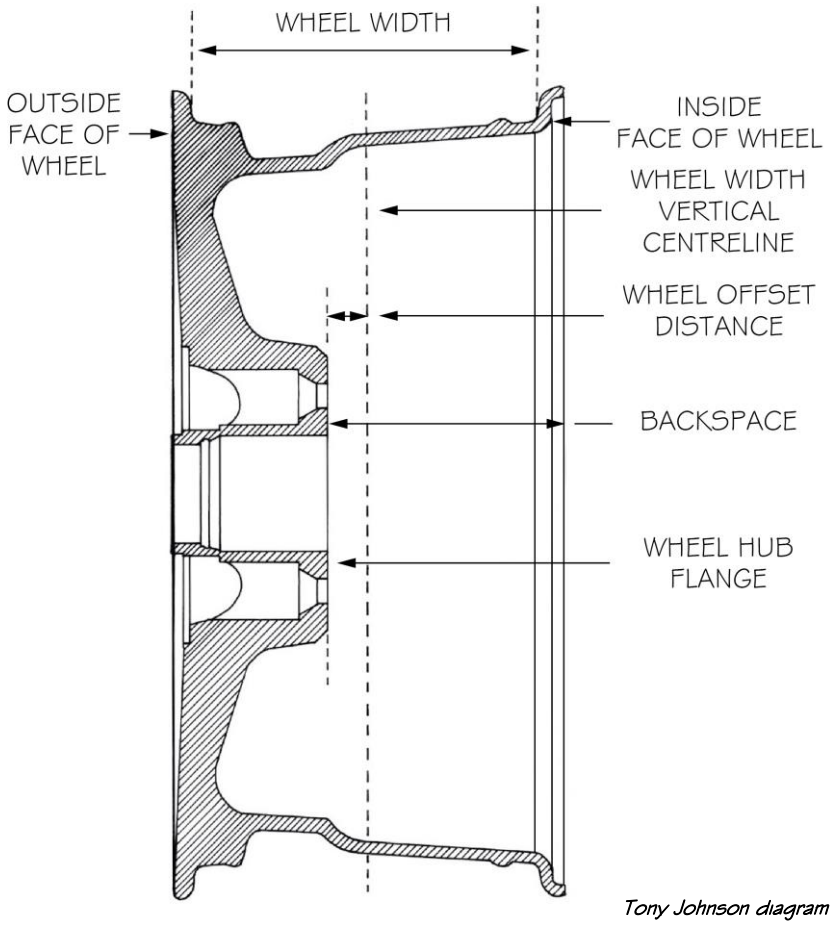


Diagram 12.3 Wheel offsets

12.5.1

A wheel fitted to an early Jaguar independent rear suspension assembly should ideally not exceed 10% offset.

Diagram 12.3

The diagram shows positive offset – the hub flange is to the outside of the wheel centerline – positioned toward the outside edge of the wheel. If the hub flange was positioned on the other side of the centre-line – toward the inside edge of the wheel - it would have negative offset.

When a spacer or adaptor is fitted, the reference point from which to measure the offset, shifts from the wheel hub flange to the wheel hub side of the spacer.

'Back-space' is the distance from the hub flange to the back edge of the wheel-rim.

12.6 Safety bead humps

12.6.1

A wheel fitted to a low volume vehicle, must be either:

(a) of a type which incorporates an internal hump to retain the tyre bead; or

(b) fitted with an inner tube which is compatible with the tyre to which it is fitted.

12.6.1

Wheels without safety bead humps should not be used in high-performance applications, especially in vehicles designed to achieve high cornering loads.

12.7 Dual wheel conversions

12.7.1

A low volume vehicle originally equipped with a rear axle that has a single wheel configuration, may be converted to a dual wheel configuration, provided that the greater loads imposed by the increased wheel offset introduced by the second wheel, are compensated for, by either:

(a) the fitting of a complete dual-wheel axle assembly sourced from a production vehicle of similar or greater weight; or

(b) the fitting of another single wheel axle that was sourced from a vehicle that is substantially heavier than the vehicle to which the axle assembly is now fitted; or

(c) the conversion of the original single wheel axle to a semi-floating or fully-floating hub and axle assembly.

Wheel modification and manufacturing requirements:

12.8 All wheel modifications

12.8.1

A wheel fitted to a low volume vehicle may be modified, provided that the modification is carried out by a person who is recognised by a low volume vehicle certifier as:

(a) being competent and experienced in the type of work being undertaken; and

(b) being professionally engaged in the wheel manufacturing or modification industry; and

(c) having the necessary equipment to carry out the modifications safely.

12.8.1

Wheel modification is a very specialised area, and builders should only deal with those 'in the business', who have been in the game for a long time and have a good reputation.

12.9 Wheel pitch circle diameter modifications

12.9.1

A wheel fitted to a low volume vehicle may be modified to provide a change in pitch circle diameter by re-drilling, elongating, or slotting of the wheel centre, provided that:

(a) the modification incorporates either:

(i) centering sleeves and washers to locate and secure the wheel; or

(ii) in the case of an aluminium wheel, the drilling and pressing in of a steel insert to accept a tapered wheel nut or bolt;

and

(b) the modification is carried out by a person who meets the requirements specified in 12.8.1.

12.9.2

A wheel fitted to a low volume vehicle may be re-drilled to accommodate a different wheel stud pattern, provided that:

(a) there is a space of at least one stud hole diameter between any original stud hole and any new stud hole; and

(b) the sections of wheel through which the repositioned studs pass, are sections which were designed by the wheel manufacturer to be clamped against the hub surface.

12.9.2(b)

Some wheels have recesses or other areas which are not intended by the wheel manufacturer to be attached to the hub, and studs must not pass through such areas.

12.10 Steel wheel widening

12.10.1

A steel wheel fitted to a low volume vehicle may be widened, provided that:

(a) there is no significant run-out or misalignment; and

(b) in the case of a wheel that has the centre fixed to the rim by riveting, the centre is re-fixed to the rim by welding; and

(c) the amount by which the wheel is widened is not more than:

(i) in the case of a wheel having a diameter of 254 mm (10″) or less, 51 mm (2″); or

(ii) in the case of a wheel having a diameter of more than 254 mm (10″), 76 mm (3″);

and

(d) the widening is carried out by a person who meets the requirements specified in 12.8.1; and

(e) the welding involved in the widening process is carried out by a person who meets all welding requirements specified in 18.7 of 'Chapter 18 - Attachment Systems'.

12.10.2

A steel wheel fitted to a low volume vehicle that is widened through the insertion of a steel band must, in addition to 12.10.1, be:

(a) joined at the section of the wheel that incorporates the smallest diameter; and

(b) made from a mild steel material of a thickness of not less than 3 mm (1/8").

12.11 Bead-lock conversion of steel wheels

12.11.1

A wheel fitted to a low volume vehicle may, in order to prevent inward dislodgement or rotational movement of a tyre on a wheel, be modified to incorporate a bead-lock tyre attachment system, provided that: (see Diagram 12.4)

(a) the wheel is of steel construction; and

(b) the two steel rings are manufactured from a mild steel material of not less than 6 mm (1/4") thickness, either:

(i) cut as a continuous ring with no joins; or

(ii) formed from a single piece of flat bar and joined by butt-welding;

and

(c) the inner ring provides not less than 15 mm (9/16") of bearing surface to support the tyre bead; and

(d) the two steel rings are welded fully around the circumference of their respective wheel sections; and

(e) the two steel rings incorporate a means of enabling a visual inspection to establish that the two surfaces are correctly positioned; and

(f) the wheel retains the 5-degree slope where the tyre bead seats at the base of the wheel rim; and

12.11

Bead-lock wheels are primarily used in off-road and drag racing events, in order to allow low tyre pressures for optimum grip, without resulting in tyre rotation on the rim.

12.11.1

Bead-lock wheels are not recommended for on-road use, due to the potential for the loosening of the multiple bolts. Aftermarket bead-lock wheels usually don't have the required amount of bolts to secure the bead-lock ring, and don't have an approved rim profile, so they don't meet LVV requirements and cannot be LVV certified.

This section does not apply to alloy wheels. To date, no aftermarket alloy bead-lock wheels have been identified as being purpose-designed for automotive road use, so alloy bead-lock wheels cannot be LVV certified.

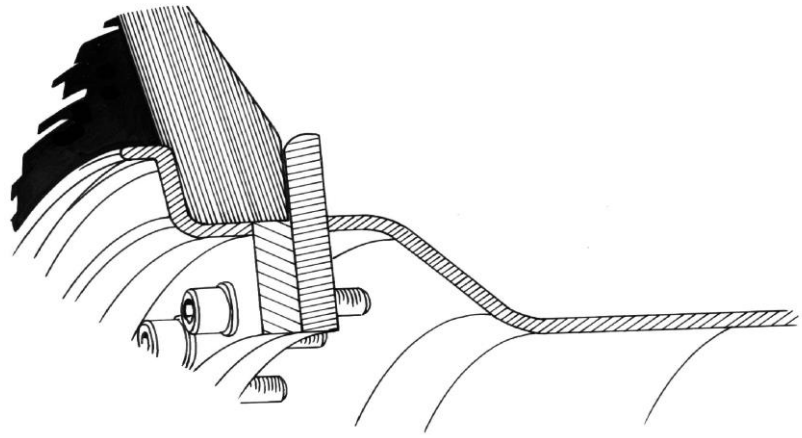
(g) all edges which contact the tyre surface incorporate a radius of not less than 3 mm (1/8"); and

(h) the pitching of the fasteners used to attach the two wheel sections are positioned no further apart than 10 degrees; and

(i) the torque setting specified by the wheel manufacturer for the tightening of the fasteners attaching the two wheel sections is clearly and permanently stamped on the outer face of each wheel; and

(j) the bead-lock conversion work is carried out by a person who meets the requirements specified in 12.8.1; and

(k) the welding involved in the bead-lock conversion process is carried out by a person who meets all welding requirements specified in 18.7 of 'Chapter 18 - Attachment Systems'.



Tony Johnson diagram

Diagram 12.4 Bead-lock wheels

12.11.2

A fastener used to attach the two wheel sections of a bead-lock wheel together must:

(a) be of equal or greater size and strength than either:

(i) 6 mm grade-10.9 metric; or

(ii) ¼" UNF grade-8 imperial;

and

(b) incorporate the correct length of bolt shank for the application; and

(c) incorporate a vibration-proof washer or other locking mechanism; and

12.11.1 (cont'd)

Some aftermarket wheels, known as 'bead-look', are designed to look like bead-lock wheels but have a standard rim profile which is compliant.

Some wheels are dual-purpose bead-lock and 'bead-look', with two locations for the tyre bead to sit into – normally on the approved rim profile which is compliant, or on the outer edge secured by the bead-lock ring which is not compliant.

(d) be coated with an anti-corrosive material; and

(e) not be electroplated unless:

(i) documented evidence is provided to substantiate that a post-plating heat-treatment process has occurred in order to prevent hydrogen entrapment; or

(ii) the electroplating process is carried out as part of the manufacturing process by the fastener manufacturer, and documented evidence is provided to substantiate the origin of the fastener.

12.12 Wheel welding

12.12.1

A steel wheel fitted to a low volume vehicle may be modified by welding, provided that:

(a) the modification is a specialised modification to a wheel, such as either:

(i) wheel widening or centre-changing; or

(ii) the conversion of a wheel to a bead-lock tyre attachment system using a design and modification method specified in 12.11;

and

(b) except in the case of 12.12.2, any welding involved in the modification process is carried out by a person who, in addition to meeting the requirements specified in 12.8.1, meets all welding requirements specified in 18.7 of 'Chapter 18 - Attachment Systems'; and

(c) the LVV Certifier is satisfied that the weld quality is, from a visual examination, acceptable.

12.12.2

A steel wheel fitted to a low volume vehicle that has been modified by welding, but does not meet 12.12.1(b) or 12.12.1(c), must:

(a) undergo a thorough visual inspection on both surfaces of each wheel for weld quality, penetration, fatigue cracking, and surface corrosion; and

(b) in a case where any doubt exists in relation to the condition of the wheel or quality of the welding, be:

12.12.1

An aluminium wheel must not be modified by welding. Welding may, however, be carried out in order to repair an aluminium wheel, provided that the requirements specified for wheel repair within the Land Transport Rule: Wheels and Tyres 2001 (Rule 32013) are met.

(i) non-destructively tested to, as a minimum, Table 6.2.2 of the current version of AS/NZS 1554.1 Standard, SP category, or an equivalent standard, or as applicable to the method of weld examination undertaken, by a person holding not less than a current NDT Level 2 qualification in CBIP, ASNT, AINDT, or other entirely equivalent certification; and

(ii) accompanied by a report, supplied by the NDT operator, to verify that the requirements of 12.12.2(b)(i) have been met, and that the wheel is considered to be serviceable for road use.

12.12.3

An aluminium wheel fitted to a low volume vehicle must not be welded for the purpose of modification.

12.13 Hand-built and custom-manufactured wheels

12.13.1

A wheel which is hand-built or custom-manufactured that is fitted to a low volume vehicle, either through a casting or a machining process by someone other than a recognised high-volume aftermarket wheel manufacturer, must be individually pre-approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc) using the process set out in 'Chapter 4 – Build Approval Process'.

Wheel attachment requirements:

12.14 Wheel and hub assembly compatibility

12.14.1

A wheel fitted to a low volume vehicle must:

(a) attach to a disc rotor flange or drum or hub face that is large enough in diameter to adequately support the wheel; and

(b) have an inside face that is compatible with the hub assembly face to which the wheel attaches; and

(c) have no obstructions that could prevent full and even contact between the wheel or the hub or drum face, including set-screws, balance weights, drum shoulder ribs, or the disc caliper; and

(d) be securely fastened to the hub assembly; and

12.12.2(b)(i)

Note that the tables referred to here are not tables in Chapter 6 of this manual, but are tables within the AS/NZS standard.

12.14.1

Methods of centering a wheel, as referred to in 2.14(1)(e), include a taper incorporated into the wheel nut or bolt, or a close tolerance fit of the wheel onto the hub centre spigot, including the use of a centering ring.

Some Cragar SS wheels do not have a centering system so it is important to follow the fitment procedure specific to these wheels, and to re-torque the wheel nuts regularly.

12.15.1

It is critical that a metal-to-metal contact is ensured, therefore, where a heavy paint build-up such as powder coating is applied to the wheel, the coating in contact with the wheel nut or bolt must be removed.

A wheel designed to be used with tapered wheel nuts must not be attached using shanked nuts, or vice versa.

Some OE vehicles use shanked nuts with a small integral taper on the leading edge. These are designed for the temporary attachment of a spare wheel only.

(e) where the vehicle originally incorporated a centre spigot or other system that centred the wheel in relation to the hub, incorporate a centering system.

12.15 Wheel nut or bolt engagement

12.15.1

A wheel nut or bolt fitted to a low volume vehicle to secure a wheel against a hub assembly must have a mating surface that is compatible to, and machined at the same angle as, the recess in the wheel to which it attaches.

12.15.1

See notes on previous page.

12.15.2

The wheel stud or bolt hole diameter machined into a wheel fitted to a low volume vehicle must be compatible with the diameter of the wheel stud or bolt, to ensure that the wheel nut or bolt properly pulls the wheel against the hub face.

12.15.2

Note that with a steel rim, a small-diameter stud may be unsuitable with a large diameter stud hole, as the taper on the nut needs to have enough surface area to pull up against the machined taper on the wheel, and not bottom out on the hub.

Also, eccentric nuts or bolts (referred to as 'wobble' nuts or bolts) may be used if the wheel is compatible, the wheel manufacturer's installation instructions are followed, and the wheel centres correctly on the hub.

12.15.3

A wheel stud or bolt attaching a wheel to a low volume vehicle must engage into or through the corresponding nut or hub assembly by either:

(a) not less than the diameter of the stud thread; or

(b) a specified number of full turns of thread engagement, which must be not less than:

(i) in the case of a 12 mm metric stud or bolt with a 1.5 mm coarse thread pitch, 6.5 turns; or

(ii) in the case of a 12 mm metric stud or bolt with a 1.25 mm fine thread pitch, 7.5 turns; or

(iii) in the case of a 14 mm metric stud or bolt with a 1.5 mm coarse thread pitch, 7.5 turns; or

(iv) in the case of a 7/16 inch or ½ inch imperial stud or bolt, 7.5 turns;

or

(c) in the case of an unmodified hub assembly, not less than that originally provided for the fitment by the original vehicle manufacturer.

12.15.3

This is a troublesome area. A lot of common and basic off-the-shelf aftermarket wheel fitments don't have sufficient thread engagement left, because of the extra thickness of the aftermarket wheel hub face.

12.16 Wheel studs, nuts, and bolts

12.16.1

A wheel stud, nut, or bolt fitted to a low volume vehicle must:

(a) be of a type that is purpose-designed for automotive use; and

(b) incorporate a thread that is correctly-formed and compatible with its counterpart; and

(c) except in the case of a wheel nut fitted as original equipment by a high volume vehicle manufacturer, be made from steel; and

(d) in the case of a stud, be attached to the hub assembly in such a way as not to be able to turn in either direction with wheel nut tightening; and

(e) in the case of adaptors being fitted, meet the requirements specified in 12.22; and

(f) be in good condition.

12.16

See 'Wheel nut and bolt types' in the Useful information section at the back of this Chapter.

12.16.1(b)

Some aftermarket studs, nuts, and bolts have incorrectly-formed and poor-quality threads. See LVVTA Safety Alert # 03-2021 Poor-quality Aftermarket Wheel Nuts as an example.

12.16.1(c)

Aftermarket wheel nuts made from aluminium must not be fitted to any vehicle, whether the vehicle requires LVV certification or not.

12.16.1(d)

A splined stud is an acceptable method, however a thread-locking adhesive is not.

12.17 Wheel stud or bolt load capabilities

12.17.1

A low volume vehicle fitted with an engine that is substantially heavier than that which the original hub assembly was designed to support, must have either:

(a) the original hub assembly replaced by a hub assembly from another vehicle which has an increased number of studs or bolts; or

(b) the original wheel studs or bolts replaced by studs or bolts of a diameter equivalent to that of a production vehicle which has a similar engine weight and number of wheel studs or bolts.

12.17.1

'Substantially heavier' in this context generally means where a 6 or 8 cylinder engine has gone into a 4 cylinder vehicle, or where a cast iron diesel has replaced an all-aluminium petrol engine.

12.17.2

A low volume vehicle fitted with a wheel that has an amount of offset specified in 12.5.1(b) must have either:

(a) the original wheel studs or bolts replaced by studs or bolts of a diameter not less than one size larger; or

(b) the original hub assembly replaced by a hub assembly from another vehicle that either:

(i) has an increased number of studs or bolts; or

(ii) is of a size, in comparison to the original, that will withstand the additional loadings presented by the increased wheel offset.

12.18 Centre-lock attachment systems

12.18.1

A splined hub with a centre-lock nut, or other system that uses a centre-lock attachment system, fitted to a low volume vehicle must, if not original equipment, be designed for a vehicle of equivalent or greater weight than the vehicle to which it is fitted.

Wheel spacing and adaptation requirements:

12.19 Spacer requirements for all wheels

12.19.1

A wheel spacer fitted to a low volume vehicle between the wheel and hub assembly, other than that fitted as original equipment by a high volume vehicle manufacturer, must:

(a) be purpose-designed for automotive applications, and either be manufactured by a recognised automotive wheel spacer manufacturer, or be manufactured by a person who is recognised by an LVV Certifier as:

(i) being competent and experienced in the type of work being undertaken; and

(ii) having the necessary equipment to carry out the manufacturing process correctly;

and

(b) have a maximum spacing of each wheel away from the hub surface of 20 mm (13/16"); and

(c) be set-screwed or attached by another secure mechanical method to either the wheel or hub face; and

(d) be manufactured from a solid block of suitable material; and

(e) have two machined or die-cast surfaces that are parallel, and contain minimal indentations or irregularities; and

12.19.1

A single dust shield fitted between the wheel and hub, made of sheet metal less than 2mm thick, and that can be removed without causing a clearance issue, is not considered a spacer and does not need to meet 12.19.1.

Note that multiple dust shields fitted instead of a spacer are not permitted. :-)

12.19.1(c)

Use of roll pins or adhesive products are not suitable methods for securing a wheel spacer.

If different size spacers are used on same size front and rear wheels, the spacers should be attached to the hubs and not the wheels, to avoid issues if the wheels are swapped front to rear.

12.19.1(d)

An example of a suitable material is machined 6061 T6 alloy.

(f) be fitted as to ensure the wheel locates snugly over the hub spigot so that the hub carries the weight of the wheel assembly instead of the wheel studs, or where there is a mis-match between the hub spigot and the wheel centre, a close tolerance fit centre bore locator must be provided; and

(g) maintain, with the spacer fitted, no less than the minimum required amount of wheel stud or bolt engagement specified in 12.15.3; and

(h) not be fitted in conjunction with another wheel spacer or wheel adaptor.

12.20 Additional spacer requirements for cast aluminium wheels

12.20.1

A wheel spacer fitted to a low volume vehicle with cast aluminium wheels, or any other wheels that incorporate a full hub contact surface area, in addition to meeting 12.19.1, may incorporate additional holes within the spacer for multi-fitting purposes, provided that:

(a) the spacer is designed to fit only one stud configuration; and

(b) there is sufficient material provided between the multi-fit holes in order to resist deformation of the spacer.

12.20.1(a)

'Configuration' means, in this context, that whilst a spacer can be of a multi-fitting design in that it fits varying pitch circle diameters, it must be of a type that will fit either a four-stud wheel or a five-stud wheel, but not both. Spacers that will fit both four-stud and five-stud wheels must not be used in any situations.

12.21 Additional spacer requirements for pressed steel wheels

12.21.1

A wheel spacer fitted to a low volume vehicle with pressed steel wheels, or any other wheels which incorporate a minimal hub contact surface area, in addition to meeting 12.19.1, must not incorporate any holes within the spacer other than those used to:

(a) where the design of the hub assembly allows, locate the centre hub spigot to the wheel, which must be a close tolerance fit; and

(b) attach the spacers to the hub face or wheel rim; and

(c) enable the wheel studs being used to attach the wheel to pass through, which must match the stud pattern of the vehicle.

12.22 Wheel adaptor design and manufacture

12.22.1

A wheel adaptor fitted to a low volume vehicle between the hub and wheel assembly must:

(a) be purposed-designed for automotive applications, and either be manufactured by a recognised automotive wheel adaptor manufacturer, or be manufactured by a person who is recognised by an LVV Certifier as:

(i) being competent and experienced in the type of work being undertaken; and

(ii) having the necessary equipment to carry out the manufacturing process correctly;

and

(b) be manufactured from a single block of suitable material, with no more material removed than is necessary to give effect to its function; and

(c) be of a thickness that:

(i) unless the hub assembly donor vehicle is substantially heavier than the vehicle to which the adaptors are fitted, provides a maximum spacing of each wheel away from the hub surface of 30 mm (1 3/16"); and

(ii) does not exceed the maximum allowable amount of offset specified in 12.5.1 when the wheel adaptor thickness is included within the wheel offset; and

(iii) ensures that the adaptor has sufficient material strength around the studs and holes;

and

(d) not be of a design that enables the adaption of more than one pitch circle diameter fitment.

12.22.1

An adaptor is generally used to effect a change in wheel stud pattern, but it is increasingly common to see adaptors also being used to achieve an increase in wheel offset, particularly where use of a spacer would necessitate longer studs in order to provide sufficient thread engagement. In such cases, an adaptor can be a better solution.

12.22.1(b)

An example of a suitable material is machined 6061 T6 alloy.

12.22.1(d)

This means 'multi-fit' adaptors are not allowed.

12.23 Wheel adaptor location

12.23.1

A wheel adaptor fitted to a low volume vehicle between the hub and wheel assembly must locate, with a close tolerance fit, using the centre spigot or tapered wheel nuts or bolts:

(a) the adaptor against the hub assembly; and

(b) the wheel assembly against the adaptor.

12.24 Wheel adaptor attachment

12.24.1

A wheel adaptor fitted to a low volume vehicle between the hub and wheel assembly must attach:

(a) with no interference between any fastenings attaching the wheel to the adaptor, or adaptor to the hub assembly; and

(b) using wheel nuts, studs, or bolts for both the attachment of the adaptor to the hub assembly, and the wheel to the adaptor, that:

(i) are a correct match for the type of wheel stud or bolt hole; and

(ii) are of a type purpose-designed for automotive use; and

(iii) are of a suitable size and pitch circle diameter to carry the loads imposed under normal vehicle operation; and

(iv) incorporate not less than the minimum required amount of wheel stud or bolt thread engagement specified in 12.15.3.

12.24.1(b)

'Slim-line' nuts are often used to attach thin adaptors to the hub. These nuts must still meet the minimum number of threads requirement in 12.15.3, be of a suitable material, and be of a design that enables application of the correct torque without use of a special socket.

12.24.2

A wheel adaptor must not be fitted to a low volume vehicle in conjunction with a wheel spacer.

12.25 Vehicle hub adaptation

12.25.1

A vehicle hub fitted to a low volume vehicle may be re-drilled to accommodate a different wheel stud pattern, provided that:

(a) there is a space of at least one stud hole diameter between any original stud hole and any new stud hole; and

(b) the sections of vehicle hub which have been drilled for new studs have at least as much material thickness as the original position for the studs.

12.25.1

A 'vehicle hub' is the part of a vehicle to which the wheel is attached.

It is generally not possible to re-drill a vehicle hub for a new configuration of studs (for example from 4-stud to 5-stud), without encountering clearance issues, unless the new PCD is substantially different from OE. It is unlikely that a hub will have a large enough diameter to increase the PCD sufficiently while retaining enough material around the stud. In contrast, any reduction in PCD may reduce the hub's load-carrying capacity.

12.25.1(b)

Some vehicle hubs have recesses or other areas which are not suitable to have a stud fitted to, and studs must not pass through such areas.

Tyre requirements:

12.26 Tyre suitability

12.26.1

A low volume vehicle must be fitted with tyres that:

(a) are specified by the tyre manufacturer for road use; and

(b) are an appropriate selection for the type and width of wheel to which they are fitted; and

(c) do not have any visible defects or removal of any sidewall information markings.

12.26.2

Tyres fitted to a low volume vehicle must be of the same carcass construction on both axles, except in the case of:

(a) a vehicle which is more than 30 years old, or which replicates a vehicle which is more than 30 years old; or

(b) a vehicle of Class MC, LE1, and LE2.

12.27 Tyre compliance

12.27.1

Except where 12.32.1 applies, a tyre fitted to a low volume vehicle must be permanently marked on the sidewall with the marking of the approved standard with which the tyre complies, which must be one of the approved standards specified in Table 12.1. (see Table 12.1)

12.26.1(a)

See 'Useful information' section for details about tyres which are unsuitable for road use, under 'Tyre markings indicating unsuitable for road use'.

12.26.1(b)

Tyre and wheel rim compatibility information can be found in LVVTA Information Sheet # 01-2009 Tyre Size to Rim Size Compatibility Guide.

12.26.2

Where a vehicle specified in 12.26.2 is fitted with tyres of differing front-to-rear carcass construction, the LVV certification plate data must contain the wording "unmatched f-to-r tyre construction".

Class MC is a four-wheel drive (off-road type) vehicle; LE1 is a trike with one wheel at the front; LE2 is a trike with two wheels at the front.

12.27

See 'Useful Information' section for more details.

APPROVED STANDARD	MARKING
▪ UN/ECE Regulation No 30	An 'e' within a circle
▪ UN/ECE Regulation No. 54	An 'e' within a circle
▪ 92/23/EEC	An 'e' within a circle
▪ Federal Motor Vehicle Safety Standard No. 109	'DOT' or 'SAE'
▪ Federal Motor Vehicle Safety Standard No. 119	'DOT' or 'SAE'
▪ The Standards of the Japan Automobile Tyre Manufacturers' Association, Inc.	(No compliance marking required on tyre)
▪ Japanese Industrial Standard D 4230, Tyres for Automobiles	'JIS' within a circle
▪ Australian Design Rule 23, Passenger Car Tyres	(No compliance marking required on tyre)
▪ Australian/New Zealand Standard AS/NZS 2230	(No compliance marking required on tyre)
▪ New Zealand Standard 5453	'NZS 5453'

Table 12.1 Tyre compliance table

12.28 Tyre loading and performance

12.28.1

A low volume vehicle must be fitted with tyres capable of meeting the load-carrying potential of the vehicle, in accordance with Table 12.2. (see Table 12.2)

12.27.1 (previous page)

Alternatively to a sidewall marking, a tyre can be accepted if supporting evidence can substantiate compliance with an approved standard specified in Table 12.1.

LOAD INDEX SYMBOL	0	10	20	30	40	50	60	70	80	90	100	110	120
MAX. LOAD RATING (kg)	45	60	80	106	140	190	250	335	450	600	800	1060	1400

Table 12.2 Tyre load symbols and rating

12.28.2

A low volume vehicle must be fitted with tyres capable of meeting the performance potential of the vehicle, in accordance with Table 12.3. (see Table 12.3)

SPEED RATING SYMBOL	L	M	N	P	Q	R	S	T	U	H	V	Z
MAX. VEHICLE SPEED (km/h)	120	130	140	150	160	170	180	190	200	210	240	240+

Table 12.3 Tyre speed symbols and rating

12.28.3

Except for a Class-LE vehicle, a tyre fitted to the front of a low volume vehicle must have a tread section width of no less than 30% of the tread section width of the rear tyre.

12.29 Tyre positioning and mudguards

12.29.1

A tyre fitted to a low volume vehicle must be positioned in such a way that it does not rub on any suspension, steering, or braking components, or the chassis, sub-frame, body structure, or outer body panels, during all normal vehicle operation.

12.29.2

Except where 12.31.1 applies, the tread section of a tyre fitted to a low volume vehicle must not extend beyond the original or modified body panels or guard extension.

12.29.2

A vehicle issued with an LVV Fender Exemption Authority Card by the NZ Hot Rod Association is not required to comply with this (see Exclusion 12.31.1). Note however, that a Fender Exemption cannot be issued for a vehicle with tyres that protrude from beyond the mudguards. This exemption system is only applicable to traditional fenderless vehicles that meet the criteria specified in 'Chapter 13 – Body Modification and Construction'.

12.29.3

Except where 12.31.1 applies, a low volume vehicle must:

(a) maintain similar mudguard effectiveness and coverage of the tyre tread when compared to OE; or

(b) be fitted with a mudguard over each wheel and tyre that covers not less than 33% of the tyre circumference, with the rear edge positioned no higher than the centre-line of the wheel.

12.30 Tyre valves and inner tubes

12.30.1

A tyre valve fitted to a low volume vehicle must be readily accessible so as to enable the checking and maintenance of correct tyre pressure.

12.30.2

An inner tube fitted to a low volume vehicle must be compatible with the wheel and tyre.

Exclusions:

12.31 LVV Authority Card (mudguard) exclusions

12.31.1

A low volume vehicle, for which a valid Low Volume Vehicle Authority Card is issued by an LVVTA-approved organisation, that specifies 'mudguard exemption', is not required to comply with 12.29.2 and 12.29.3.

12.32 Original equipment exclusions

12.32.1

A low volume vehicle that is 30 years old or older, or replicates a specific make and model of vehicle that is 30 years old or older, is not required to comply with 12.27, provided that the vehicle is fitted with a size and type of tyre that was supplied as standard or optional equipment by:

(a) the original vehicle manufacturer; or

(b) in the case of a scratch-built low volume vehicle, the original manufacturer of the vehicle being replicated.

12.29.2 (cont'd)

Raised vehicles expose the tyre tread more, so mudguards or mudflaps should be extended to provide similar coverage to the original unmodified vehicle.

12.29.3

An example of 33% coverage would be a mudguard positioned between 9 o'clock and 1 o'clock when viewed from the right side of the vehicle.

Useful information:

Tyre compliance

Whilst most overseas standards jurisdictions (such as those found in Table 12.1) require their marking to be permanently stamped onto the sidewall of the tyre, some, such as one of the Japanese, and the two Australian jurisdictions, don't require this. This makes it hard for us to look at a tyre and know whether or not it complies, especially if we're looking at a tyre that was designed for sale into the Australian market.

Generally speaking, if a tyre has 'Made in Japan' on it, and it is either a Bridgestone, Yokohama, Ohtsu, Nitto, Sumitomo, Michelin, Toyo, Dunlop, BF Goodrich, or Riken tyre, it is deemed to comply with an approved standard, despite the fact that no approved standards marking appears on the tyre.

Tyre markings indicating 'unsuitable for road use'

The NZTA Vehicle Inspection Requirements Manual (VIRM) shows a number of markings which can be commonly found on what appear to be road tyres, which indicate that the tyres are in fact not suitable for road use.

These markings are as follows:

- 'NOT FOR HIGHWAY USE'
- 'NHS' (Not for Highway Service)
- 'FOR TRAILER USE ONLY'
- 'ADV' (Agricultural Drawn Vehicle)
- 'RACING PURPOSES ONLY'

It should also be noted that these markings over-ride any Department of Transportation (DoT) marking that may be present on the tyre.

Directional tyres

There are two different types of directional markings on tyres. These are 'rotation', and 'drive'. Race tyres are marked with 'drive' direction, as distinct from performance unidirectional road tyres that are marked with 'rotation' direction.

The front tyres on a rear drive race car are subjected only to braking 'drive' forces, and the rear wheels mainly acceleration 'drive' forces, hence the 'drive' arrows are fitted in opposite directions in a racing tyre situation, whereas unidirectional road tyres on a road car would always face the same direction.

Pro-street rear tyre selection

'Bias-construction' and 'cross-ply' construction tyres are effectively the same. Essentially, this is technology from the 1930s, when vehicles were so slow that such poor tyre technology didn't matter. Nowadays, even most trucks don't have cross-plys anymore.

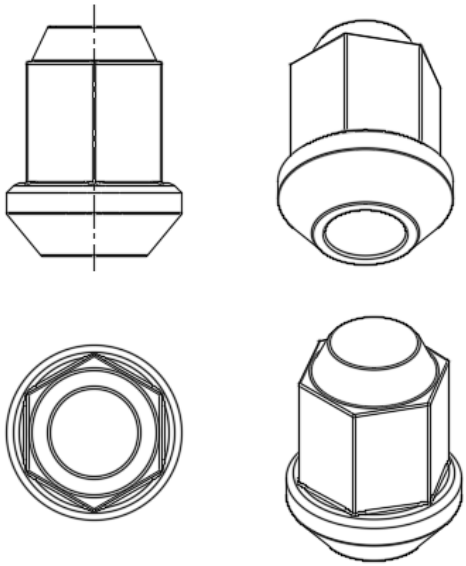
A bias-ply or cross-ply tyre has its place on nostalgia-style hot rods and period special sports cars, but they shouldn't ever be used on a modern performance-oriented hobby car. The one type of modern high-performance vehicle that does need a bias or cross-ply tyre, simply because there isn't an alternative, is the 'pro-street' style of car, where 12" or more of rubber is needed on each side at the rear. Most of the bias-ply tyres that have traditionally been used on pro-streeters, have been a hard-compound tyre, only designed for long life. The traction characteristic of these tyres on wet roads is comparatively poor, especially so if the vehicle is light-weight as well.

If you need a big tyre for the back of your pro-streeter, and because of size availability you have to go with a bias-ply tyre, make sure you use a bias-ply tyre designed for drag racing. These tyres are (comparatively) of a very soft compound, which allows the tyres to generate sufficient heat to provide better grip, on both wet roads and dry. They'll wear out in half the time of the others, but that's a small price to pay for the safety they provide over the other type. When selecting these tyres, make sure they are in fact road-legal, and don't feature any of the markings specified in the *Tyre markings indicating 'unsuitable for road use'* part of this Useful Information section. Users of this type of tyre should be aware that, given the wide availability of radial 'pro-street' type tyres nowadays, the ability to mix bias-ply or cross-ply tyres with radial tyres will be phased out in due course.

Wheel nut and bolt types

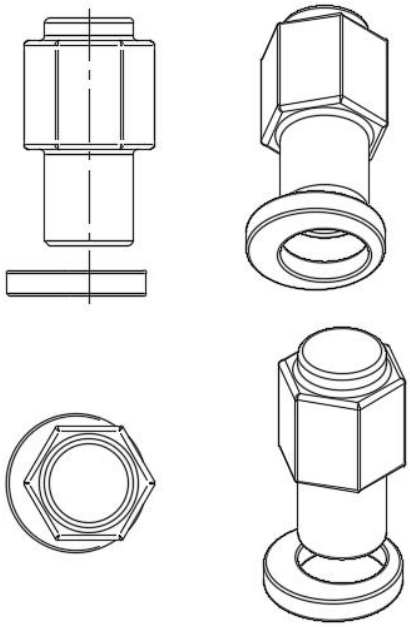
There are a number of different types of wheel nuts and wheel bolts commonly used to attach a wheel to a vehicle hub. To follow is an illustration of the most common types, together with a basic description of the wheel nut or bolt type.

Dylan Mathieson diagrams



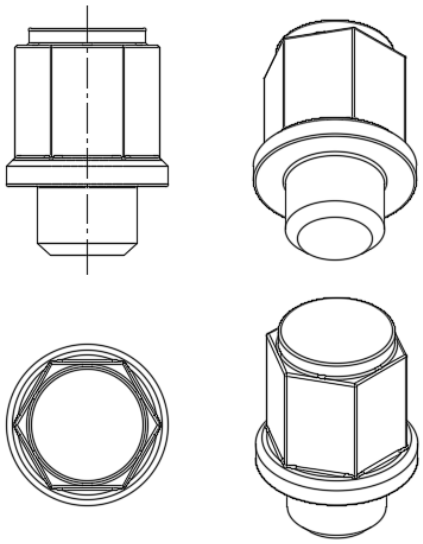
Taper nut

Arguably the most common wheel fastener. The tapered surface centres the wheel on the hub.



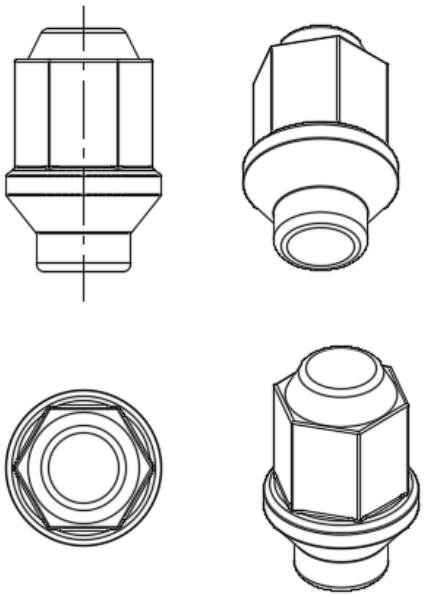
Shank nut (also known as tube nut/shouldered nut)

Sometimes paired with a washer that sits in a recess on the wheel. The washer can be eccentric to allow for two PCDs.



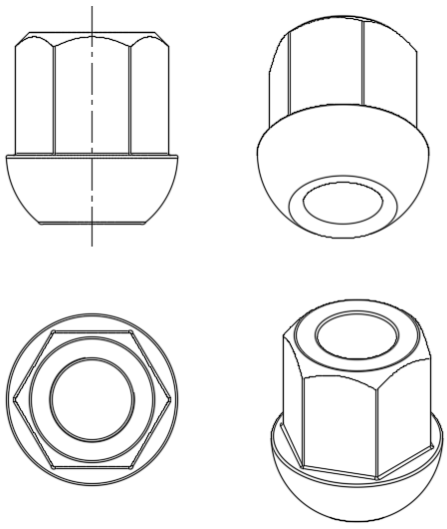
Combination nut

Used as a shank nut to attach an alloy wheel, but also has a small taper at the end, so that it can be used with a steel spare wheel.



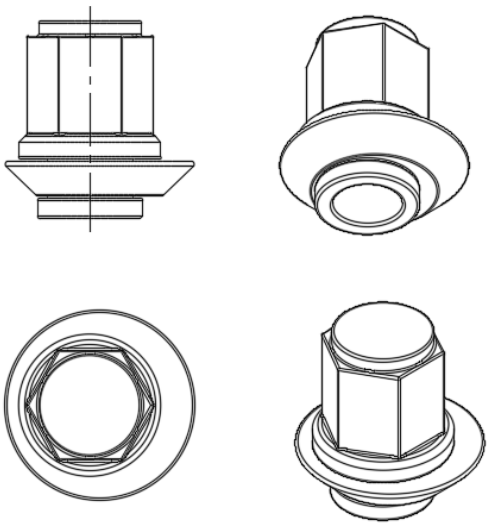
Taper nut with shank (known as a 'drop nut')

The taper locates/clamps the wheel, and the short shank ensures that there is sufficient thread engagement.



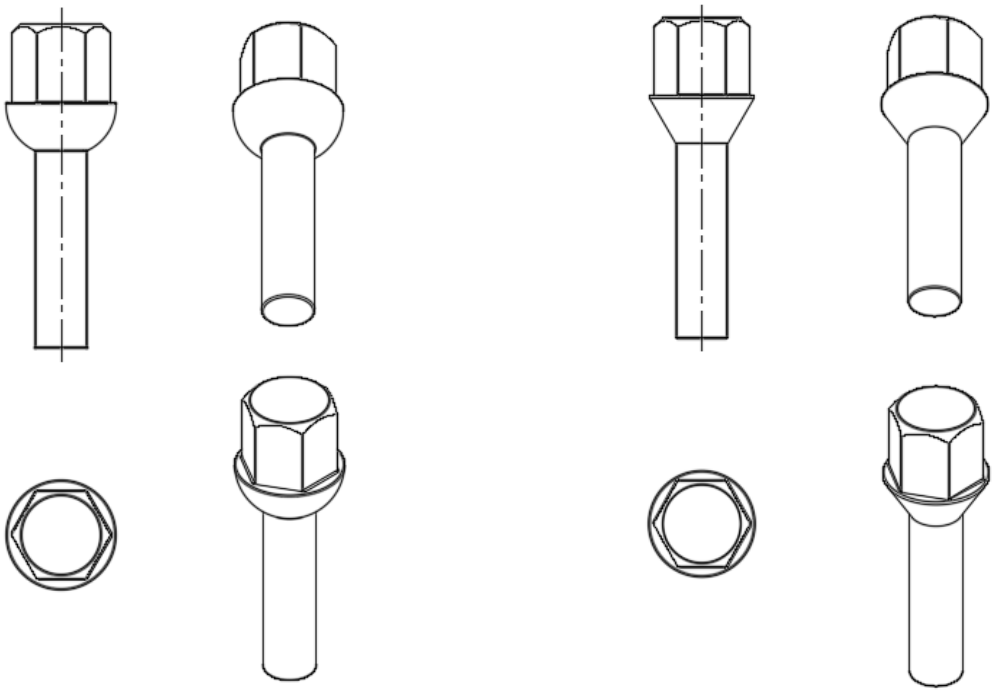
Ball nut

The tapered surface has a radius to suit some European and aftermarket wheels.



Eccentric nut/wobble variable nut

The taper is on a separate floating ring enabling it to be used on a range of PCDs on a multi-fit aftermarket wheel.



Wheel bolt

Some vehicles - usually European - do not have wheel studs, but instead use wheel bolts. Wheel bolts can have ball tapers (as shown above left), or normal straight tapers (as shown above right), and can also have eccentric features.

LVV certification of two sets of wheels

A vehicle can be LVV certified with two different sets of wheels. This is commonly requested for rally cars running tarmac and gravel wheels. It has recently become much easier with the introduction of the Electronic Data Plate as there is no longer a limit to the maximum number of characters that can be used to describe the modifications, as existed with the old engraved aluminium LVV certification plate.

To certify two sets of wheels, both sets will need to be suitable for the vehicle and comply with the requirements of LVV Standard 205-00 (Wheels and Tyres). The vehicle will be inspected with each set of wheels fitted, and the LVV Certifier will be required to perform two road tests and brake tests, one with each set of wheels. Two sets of wheels cannot be LVV certified if spacers or adapters have to be fitted or removed between wheel changes.

The diameter of the tyres on each set of wheels should be similar to prevent the speedo from being inaccurate with one or both sets, which would prevent the vehicle passing the road test.

To avoid confusion at Warrant of Fitness time, there will be photos uploaded to the Electronic Data Plate database that shows the vehicle with each set of wheels fitted, enabling the vehicle to be inspected with either set fitted.

Terms & definitions for Chapter 12 Wheels & Tyres

Introduction

The terms and definitions listed below are those terms and definitions which relate specifically to this NZ Car Construction Manual Chapter. Other more general terms and definitions which might apply across multiple subjects, or NZ Car Construction Manual Chapters, are provided within 'Terms & Definitions Chapter at the back of the NZ Car Construction Manual.

Adaptor	(also spelt 'adapter') means a component that has its own set of wheel studs and fits between the hub and wheel assembly, enabling a road wheel to be attached to a hub assembly that has a pitch circle diameter or number of wheel studs that is not directly compatible with the wheel. An adaptor can also be used as an alternative to a wheel spacer to increase track or wheel offset.
Bead-lock	means a type of wheel used primarily in four-wheel drive competitions, to enable the tyre to be operated at very low pressure in order to provide optimal grip.
Centre-lock	means a type of wheel attachment system, that relies on a single central method of location, such as a splined hub, rather than conventional multiple wheel nuts or bolts.
Centering ring	means a ring which is made from a hard material, slipped onto the hub to match with the centre-bore diameter of the wheel. These are often used to provide an approximate centering of the wheel against the hub before the fitting of tapered wheel nuts or bolts centres the wheel exactly.
Fully-floating	means a hub assembly which prevents the disconnection of a wheel from the vehicle upon failure of an axle.
L-class	is a New Zealand Transport Agency classification, which means, in very simple terms, a two-wheeled motorcycle or three-wheeled motor vehicle with a GVM of under 1 000 kg.
Mudguard/mudflap	means a fitting, inclusive of any portion of the vehicle and of any mudflaps attached, that serves to intercept material thrown up by a wheel more or less in the plane of the wheel.
Offset	means the distance between the vertical centerline of the wheel, and the hub flange to which the wheel attaches.
PCD	Is an abbreviation for pitch circle diameter.
Pitch circle diameter	means the spacing of the wheel studs or bolts away from the centre of the wheel hub.
Pro-street	means a particular style of hot rod or street machine vehicle that features typical drag racing vehicle attributes and characteristics in order to achieve a performance-oriented look, including large wheel tubs to accommodate extremely large rear tyres, low stance, and a powerful (sometimes supercharged) engine.

Spacer	means a plate that is fitted between the hub assembly and the wheel, usually to provide clearance between the tyre and the vehicle's structure, body panels, or mechanical components.
Stud	means one of a series of fixed threaded pins, to which is fitted a matching nut, used as a method of securing a wheel to a hub assembly.
Tyre tread	is the portion of the tyre that contacts the road. This does not include sidewall tread on off-road tyres.
Vehicle hub	means the part of a vehicle to which the wheel is attached.
Wheel hub	means the central section of a wheel which attaches to the vehicle hub, and through which the wheel studs or bolts typically pass.
Wheel track	means the distance between the centre of a tyre to the centre of the opposite tyre on the same axles.

Tony Johnson illustration