Low Volume Vehicle Technical Association Incorporated

Low Volume Vehicle Standard

85-40(02)

(Engine & Drive-train Conversions)

This Low Volume Vehicle Standard corresponds with: Land Transport Rule 32014 (Light-vehicle Brakes) and Land Transport Rule 32003 (Steering Systems)

2nd Amendment – effective from: 25 October 2016

Signed in accordance with clause 1.5 of the Low Volume Vehicle Code, on……by:	
on behalf of the New Zealand Transport Agency: ……	*on behalf on the Low Volume Vehicle Technical Association(Inc):* ……

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Note that highlighted text shows amendments that have been made subsequent to the document's previous issue, and a grey vertical stroke to the left of the text denotes information that is of a technical (rather than a formatting) nature.

Overview

Background

The Low Volume Vehicle Technical Association Incorporated (LVVTA) represents ten specialist automotive groups who are dedicated to ensuring that vehicles, when scratch-built or modified, meet the highest practicable safety standards. The information in these standards 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 NZ 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 twenty years can be of benefit to members of the NZ public who also wish to build or modify light motor vehicles.

Availability of low volume vehicle standards

Low volume vehicle standards are developed by the LVVTA, in consultation with the New Zealand Transport Agency, and are printed and distributed by the LVVTA. The standards are available to the public free of charge from the LVVTA website; www.lvvta.org.nz

Further information on the availability of the low volume vehicle standards may be obtained by contacting the LVVTA at info@lvvta.org.nz.

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Associated information

Other associated information relevant to the subject matter contained in this low volume vehicle standard, which in the interest of comprehensiveness, should be read in conjunction with this standard, includes:

Document	Page #/Section/Chapter
• LVVTA News June-September 2013 Issue 47	Page 4 Watch Out For Fake Drive-shaft Loops!
• LVVTA News June-September 2013 Issue 47	Page 6 Bonnet (Engine Hood) Removal
• LVVTA News June-September 2013 Issue 47	Page 11 Gearbox Swaps & LVV Certification
• LVVTA News October-December 2013 Issue 48	Page 6 No Throttle Stops Cause Accidents in Australia
• LVVTA News January-July 2014 Issue 49	Page 8 Don't Forget the 'Check Engine Light'
• LVVTA News August-December 2014 Issue 50	Page 5 Battery Requirements in Boots or Passenger Compartments
• LVVTA News August-December 2014 Issue 50	Page 7 Drive-shafts – What Could Possibly go Wrong?
• LVVTA News January-April 2015 Issue 51	Page 6 Drive-shafts – What Could Possibly go Wrong (Part 3)?

• LVVTA News May-July 2015 Issue 52	Page 9 Drive-shaft Safety Loop Requirements for Composite & Carbon-fibre Drive-shafts
• LVVTA News May-July 2015 Issue 52	Page 10 Automatic Transmission Shift Position Indicator
• LVVTA News May-July 2015 Issue 52	Page 10 Drive-shaft Safety Loop Attachment
• LVVTA Information Sheet # 06-2009	Converting 4-wheel Drive Vehicle to 2-wheel Drive
• LVVTA Information Sheet # 09-2011*	Drive-shaft Safety Loop Requirement Clarification*
• LVVTA Information Sheet # 10-2011	Exhaust Gas Emission Standard Revision
• LVV Standard 35-00 (Braking Systems)	All relevant requirements
• LVV Standard 75-00 (Electric & Hybrid Vehicles)	All relevant requirements
• LVV Standard 90-20 (Exhaust Noise Emissions)	All relevant requirements
• LVV Standard 90-10 (Exhaust Gas Emissions)	All relevant requirements
• NZ Car Construction Manual*	Chapter 5 Chassis Modification & Construction*
• NZ Car Construction Manual	Chapter 6 Suspension Systems
• NZ Car Construction Manual	Chapter 7 Steering Systems
• NZ Car Construction Manual	Chapter 8 Braking Systems
• NZ Car Construction Manual	Chapter 9 Engine & Drive-train
• NZ Car Construction Manual	Chapter 10 Fuel Systems
• NZ Car Construction Manual	Chapter 18 Attachment Systems
• NZ Car Construction Manual	Chapter 19 Vehicle Operation

* LVVTA Information Sheet # 09-2011 (Drive-shaft Safety Loop Requirement Clarification) and NZ Car Construction Manual Chapter 5 Chassis Modification & Construction should be referred to for additional requirements relating to drive-shaft safety-loops.

Note that all documents referred to in this table, with the exception of the NZ Car Construction Manual, can be accessed from www.lvvta.org.nz free of charge. For information on obtaining the NZ Car Construction Manual, contact info@lvvta.org.nz

Note also that paper copies of documents can become out of date and as such should not be relied upon, therefore LVVTA advises users of this standard to check to ensure that the Associated Information listed here is current, by going to www.lvvta.org.nz/standards.html

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Engine & Drive-train Conversions (85-40[02])

Purpose of this standard

The purpose of this low volume vehicle standard is to specify sound practical engineering principles and procedures relating to the conversion of engines and drive-trains to motor vehicles, to ensure that such conversions are as safe as practicable, having regard to their effect on inter-related vehicle components and systems, especially those relating to braking and steering control.

Section 1 Scope and application of this standard

1.1 Scope of this standard

1.1(1) This low volume vehicle standard applies to all light vehicles other than those specified in *1.1(2)*, that are:

(a) modified on or after 1 January 1992 in such a way that any braking or steering systems may, directly or indirectly, be affected as a result of an engine or drive-train conversion or modification; or

(b) scratch-built on or after 1 January 1992.

1.1(2) This low volume vehicle standard does not apply to:

(a) powered bicycles of Class AB; or

(b) motorcycles and mopeds of Class LA, LB, LC, LD, or LE; or

(c) light trailers of Class TA or TB; or

(d) those vehicles specified in *section 4*.

1.2 Application of this standard

1.2(1) A light vehicle that is modified or scratch-built as in *1.1(1)*, becomes a low volume vehicle, and must:

(a) be certified in accordance with the procedures specified in *chapter 2* of the *Low Volume Vehicle Code*; and

(b) unless *section 3* applies, comply with all applicable technical requirements contained in *section 2* of this standard.

NOTE: Where a light vehicle is required to be certified to the *Low Volume Vehicle Code*, but the modification date precedes the date upon which this standard takes effect (1 September 2002), an LVV Certifier must ensure that the vehicle meets the general safety requirements contained in *2.1* of this standard, and should use the applicable technical requirements of *section 2* of this standard as a guideline upon which to base his judgements on the safety of the vehicle.

Section 2 Technical requirements of this standard

2.1 General safety requirements

2.1(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.

NOTE: The requirements specified in *2.1(1)* are selected from *2.3* of *Part 2* of the *Low Volume Vehicle Code*, reproduced here in the interest of convenience, and are over-riding requirements which make it clear that, regardless of what technical requirements are or are not in place, every vehicle certified to the *Low Volume Vehicle Code* must be fit for its purpose, and must be safe.

2.1(2) A steering system on a motor vehicle, and associated systems and components that could directly or indirectly affect the directional control of the vehicle, must:

(a) be sound and in good condition and must provide the vehicle with safe, efficient, convenient, and sensitive control; and

(b) be strong, durable and fit for its purpose, taking into account whether adverse effects have resulted from a loss of integrity of any protective system used by a relevant component.

NOTE: The requirements specified in *2.1(2)* are the applicable general safety requirements from *Land Transport Rule 32003/1 Steering Systems 2001*, which are required as part of this low volume vehicle standard, and are reproduced here in the interest of convenience.

2.2 Engine conversion requirements

Engine mount design and construction

2.2(1) An engine mount fitted to a low volume vehicle must be designed and constructed in such a way that:

(a) it is able to withstand all fore and aft, rotational, and vertical loads and dynamic forces that may be imposed on it, taking into consideration engine weight and torque output; and

(b) its design will not impair the life of the flexible mount by stress.

2.2(2) Where solid-mounted front and rear engine plates are fitted to a low volume vehicle instead of conventional rubber mounts, the:

(a) plates must be designed and constructed in such a way that they are able to withstand all fore and aft, rotational, and up/downward loads imposed on them; and

(b) gearbox, if attached to a gearbox cross-member or other part of the vehicle structure, must also be solid-mounted.

2.2(3) An engine mount fitted to a low volume vehicle must be designed and constructed in such a way that upon failure of either one or both of the engine mounts, the engine weight could not cause the steering system to become jammed or affected by engine weight, which may include either:

(a) an engine mount chassis or sub-frame bracket designed to prevent the engine from dropping; or

(b) a safety-type engine mount that features a through-bolt that prevents detachment of the mount upon separation of the rubber from the backing plate; or

(c) an engine mount safety-strap.

2.2(4) An engine mount fitted to a low volume vehicle used to attach an engine positioned to the rear of the vehicle occupants, must be designed to minimise forward movement of the engine as much as practicable during a frontal crash.

2.2(5) Where a non-original or custom manufactured engine cross-member is installed on a low volume vehicle, the cross-member must be:

(a) designed and constructed so as to withstand:

(i) the weight of the engine and gearbox it supports; and

(ii) any rotational or other dynamic loads it may be subjected to;

and

(b) attached to chassis rails using all applicable requirements contained in *section 5.4* of *Chapter 5* of the *New Zealand Car Construction Manual*.

2.2(6) When engine mounting to a low volume vehicle necessitates bolting through a boxed, RHS, or tubular chassis or sub-frame section, fasteners must pass through steel tubular reinforcing within the chassis or sub-frame section to prevent crushing.

Engine positioning

2.2(7) The engine in a low volume vehicle must be positioned in such a way that the crankshaft centre-line either:

(a) in the case of a modified production vehicle, duplicates as closely as possible the original engine crankshaft centre-line, ensuring that the drive-shaft universal angles of the new drive-train match the original as closely as possible; or

(b) in the case of a scratch-built vehicle, is correctly aligned with the drive-shaft and differential.

2.2(8) The engine in a low volume vehicle must be mounted in such a way that when maximum engine torque is applied, it cannot come into contact with any part of the engine compartment, or items within the engine compartment.

2.2(9) An engine in a low volume vehicle which is positioned above a beam-type axle assembly, must be mounted in such a way that adequate clearance is still available between the engine and the axle assembly, when the suspension is under full compression.

NOTE: The requirement specified in *2.2(9)* is especially important for 4WD off-road vehicles that have a substantial amount of suspension travel, and are likely to be subjected to rough treatment.

Engine attachment

2.2(10) A flexible mount used in an engine conversion or installation in a low volume vehicle must be of a type and size that will withstand all loads imposed on it.

2.2(11) Attachment of an engine mount to the engine, and an engine mount to the chassis or sub-frame section of a low volume vehicle, must either:

(a) in the case of a modified production vehicle, incorporate fasteners of a quantity, size, type, and grade of equal or greater specification than that used by the original engine manufacturer; or

(b) in the case of a scratch-built vehicle, incorporate fasteners of a quantity, size, type, and grade suitable for:

(i) the weight of the engine; and

(ii) the rotational or other dynamic loads the engine is capable of applying.

2.2(12) A fastener used in the process of mounting an engine to a chassis or sub-frame of a low volume vehicle must meet the applicable requirements specified from *18.2* to *18.6* inclusive in *Chapter 18 Attachment Systems* of the *New Zealand Car Construction Manual.*

Engine compartment and floor modifications

2.2(13) Any part of a firewall, floor, gearbox tunnel, or other structural section of a low volume vehicle that has been cut or removed to provide room for engine conversion clearance, must be adequately re-strengthened.

2.2(14) A low volume vehicle that is fitted with an engine-cooling fan or other rotating component that could easily be contacted and cause injury, must be fitted with a shroud or protective cover to minimise the likelihood of contact.

2.2(15) All flexible hoses and wiring which extend from the body or chassis or sub-frame structure to the engine and gearbox of a low volume vehicle must incorporate sufficient slack to allow for full engine rotational movement on its mounts.

2.2(16) An opening between the engine compartment, floor, or transmission tunnel and the passenger compartment of a low volume vehicle must be sealed to prevent exhaust gases, vapour, and liquids from entering the passenger compartment.

Engine weight

2.2(17) A low volume vehicle fitted with an engine that is substantially heavier than the original engine, and is of a configuration never intended by the original vehicle manufacturer for fitment to the vehicle in question, must incorporate:

(a) a means of preventing the chassis or sub-frame rails from spreading apart as a result of the additional weight or torque loading of the new engine; and

(b) springs and shock absorbers that are up-rated as necessary to support the additional weight of the new engine; and

(c) an engine cross-member beam, if fitted, that either:

(i) is strong enough to withstand the additional weight or torque loading of the new engine; or

(ii) has been reinforced to provide the necessary additional strength;

and

(d) the wheel hub assembly's load capability increased by having either:

(i) the hub assembly replaced with one which has an increased number of studs, or pitch circle diameter; or

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

NOTE: The requirement specified in *2.2(17)* applies in particular to more traditional engine conversions such as a cast-iron V8 into a Holden Torana or Ford Cortina.

2.3 Engine equipment and system requirements

Superchargers & engine protrusions

2.3(1) An engine fitted to a low volume vehicle with a mechanical supercharger protruding above the line of the engine hood must have any exposed forward-facing moving components protected by the incorporation of a shield or cover to minimise the likelihood of contact.

2.3(2) An engine fitted to a low volume vehicle with protrusions extending beyond the line of the engine hood must comply with:

(a) the external projection requirements specified within *section 2.3* of the *LVVTA Low Volume Vehicle Standard 100-30 (External Projections)*; and

(b) the visibility requirements specified within *section 2.4* of the *LVVTA Low Volume Vehicle Standard 100-30 (External Projections)*.

Nitrous oxide systems

2.3(3) A nitrous oxide injection system fitted to an engine in a low volume vehicle must:

(a) incorporate hoses and fittings which are purpose-designed for automotive applications; and

(b) have all hoses routed outside the passenger compartment, and be installed in such a way that gas from a leaking hose or fitting cannot escape into the passenger compartment; and

(c) be fitted with a fail-safe arming switch to prevent unintentional activation of the system.

NOTE: Ideally, a vehicle using nitrous oxide injection should incorporate some form of prominent labelling similar to that used on LPG and CNG equipped vehicles, in order to warn emergency services of the presence of the nitrous oxide bottle(s).

2.3(4) A bottle used within a nitrous oxide injection system fitted to a low volume vehicle must:

(a) have a current test mark applied by the cylinder manufacturer or a New Zealand Government-approved cylinder testing station; and

(b) be securely mounted, either:

(i) outside the passenger compartment; or

(ii) if mounted inside the passenger compartment, sealed and vented to the outside of the vehicle;

and

(c) be specifically designed and manufactured:

(i) for the carriage of nitrous oxide; and

(ii) as a high pressure vessel, incorporating a high pressure safety blow-off valve.

Fuel systems

2.3(5) A low volume vehicle must comply with the relevant fuel system requirements specified in *Chapter 10* of the *New Zealand Car Construction Manual*.

2.3(6) A low volume vehicle fitted with an alternative fuel system, including liquid petroleum gas or compressed natural gas, must comply with the requirements of the approved New Zealand standard for alternative fuel systems.

Accelerator systems

2.3(7) An accelerator system on a low volume vehicle must:

(a) be designed so as to ensure against being pulled or jammed in the open position in the event of an engine mount failure; and

(b) in the case of a low volume vehicle incorporating a modified or custom-built accelerator system, be fitted with a minimum of two return springs that work independently of each other; and

(c) have linkages that:

(i) move freely and give good return response without interference from any other part of the vehicle; and

(ii) are designed and positioned in such a way that they cannot jam over-centre;

and

(d) have an effective end stop for the accelerator pedal to prevent cable stretch at maximum travel.

2.3(8) An accelerator system fitted to a low volume vehicle that is either hydraulically or electrically-actuated, must be designed in such a way that the accelerator system, in the event of a loss of hydraulic pressure or electrical power, will fail to the fully closed position.

NOTE: The accelerator return springs should connect directly to the carburettor(s) rather than the accelerator linkage system. The accelerator system must be set up so that the carburettor(s) return to the closed position in the event of either the accelerator return-springs or the linkages or cable breaking.

Exhaust Systems

2.3(9) An exhaust system fitted to a low volume vehicle must:

(a) be of a good design using materials suitable for the purpose; and

(b) terminate in a position where the outer end of the exhaust pipe is not directly underneath or in front of the passenger compartment; and

(c) in the case of an external exhaust system which extends beyond the outer longitudinal extremity of the vehicle or the outer sidewall of the tyres:

(i) have a radius of no less than 3 mm on any sections facing toward the front of the vehicle; and

(ii) have any sections of exposed exhaust contactable from the front of the vehicle or adjacent to points of occupant entry and exit adequately heat-shielded;

and

(d) be in good condition and free of leaks; and

(e) be securely attached to the vehicle, using a mounting system that enables all necessary engine movement without stressing the exhaust system; and

(f) along with the body of a low volume vehicle in the areas adjacent to the vehicle's exhaust system, be sufficiently sealed so as to prevent the entry of any exhaust gases into the passenger compartment, and

(g) be designed, constructed, and fitted in such a way that the exhaust system, or components within the exhaust system, cannot be removed, altered, or interfered with, without the use of hand tools.

NOTE: Exhaust noise output is an operational issue, and not a safety one, however an LVV certifier should ensure that a vehicle undergoing low volume vehicle certification has an exhaust system that meets Warrant of Fitness requirements, and that provides sufficient silencing so as to prevent the emission of exhaust noise levels that are likely to be alarming to pedestrians and other road users.

2.3(10) A fuel pipe, fuel hose, brake pipe, brake hose, or any rubber or fabric component within the steering system of a low volume vehicle must be protected from exhaust heat by either:

(a) the exhaust system being positioned at a minimum distance of:

(i) 50 mm from any pipes and hoses; and

(ii) 25 mm from any steel steering universal joints; and

(iii) 50 mm from any rubber or fabric steering components; and

(iv) in the case of a catalytic converter, 100 mm from any pipes, hoses, steel steering universal joints, or rubber or fabric steering components;

or

(b) the inter-positioning of a suitably-fabricated and mounted heat-shield.

Braking systems

2.3(11) A low volume vehicle that has undergone an engine conversion that results in braking system modifications, or that may affect the performance of the braking system, must comply with the applicable requirements contained in either:

(a) *LVVTA Low Volume Vehicle Standard 35-00 Braking Systems*; or

(b) where the modifications are not provided for within *LVVTA Low Volume Vehicle Standard 35-00 Braking Systems*, the relevant braking design and construction requirements specified in *Chapter 8* of the *New Zealand Car Construction Manual.*

Vacuum systems

2.3(12) A low volume vehicle that has been fitted with an engine which draws its vacuum from an alternator-mounted pump must have an alternator and drive system that:

(a) enables correct operation of the vacuum pump; and

(b) has correctly aligned drive pulleys; and

(c) incorporates fanbelts which are:

(i) in good condition; and

(ii) correctly adjusted; and

(iii) of the correct section type and width for the pulleys; and

(iv) of a purpose-designed heat and oil-resistant automotive type.

Electrical systems

2.3(13) A battery fitted to a low volume vehicle must:

(a) be secured by, or enclosed in, a device or structure, appropriate for the weight and load of the battery being used, to prevent it from shifting during braking, cornering, acceleration, or impact; and

(b) incorporate some method of preventing acid spills from entering the passenger compartment of the vehicle; and

(c) be sealed from the passenger compartment and ventilated to the vehicle exterior, where charging and subsequent gas emission may occur while the vehicle is operating; and

(d) be safely wired and protected from short circuits.

2.3(14) An earth lead of a size suitable for the application must be fitted to a low volume vehicle:

(a) in the case of a unitary construction vehicle, between the engine and body; and

(b) in the case of a vehicle with a separate body and chassis, between:

(i) the engine and chassis; and

(ii) the body and chassis.

2.3(15) Electrical wiring within the engine compartment of a low volume vehicle must:

(a) be tidily clipped and securely attached to the body or chassis or sub-frame structure; and

(b) positioned at a safe distance away from moving parts and exhaust heat.

2.3(16) An electrical system within a low volume vehicle must be designed to have electrical equipment such as pump motors and solenoids isolated from the fuel tank and system.

Steering system modifications

2.3(17) Where an engine conversion in a low volume vehicle results in the power steering system fitted to the vehicle being driven by a different means than that provided by the vehicle manufacturer, the pressure and supply delivery provided by the new engine must be sufficient to safely operate the power steering system.

2.3(18) A low volume vehicle that has undergone an engine conversion that results in steering system modifications other than that specified in *2.3(16),* or that may affect the performance of the steering system, must meet the applicable requirements specified in *Chapter 7 Steering Systems* of the *New Zealand Car Construction Manual.*

2.4 Gearbox conversion requirements

Gearbox mount design and construction

2.4(1) Where a non-original or custom manufactured gearbox mount or cross-member is installed into a low volume vehicle, the cross-member must be:

(a) designed and constructed so as to withstand:

(i) the weight of the gearbox it supports; and

(ii) any rotational or other dynamic loads it may be subjected to;

and

(b) attached to chassis rails using all applicable requirements contained in *section 5.4* of *Chapter 5* of the *New Zealand Car Construction Manual*.

Gearbox attachment

2.4(2) When gearbox mounting to a low volume vehicle necessitates bolting through a boxed, RHS, or tubular chassis or sub-frame section, fasteners must pass through steel tubular reinforcing within the chassis or sub-frame section to prevent crushing.

2.4(3) A gearbox fitted to a low volume vehicle must use the same flexible-mounting or solid-mounting system that is used for the mounting of the engine.

2.4(4) A flexible mount used within a gearbox conversion or installation in a low volume vehicle must be of a type and size that will withstand all loads imposed on it.

2.4(5) Attachment of a gearbox to a gearbox mount, a gearbox mount to a gearbox cross-member, and a gearbox cross-member to the chassis or sub-frame section of a low volume vehicle, if bolted, must:

(a) in the case of a modified production vehicle, incorporate fasteners of a quantity, size, type, and grade of equal or greater specification than that used by the original engine manufacturer; or

(b) in the case of a scratch-built vehicle, incorporate fasteners of a quantity, size, type, and grade suitable for:

(i) the weight of the gearbox; and

(ii) the rotational or other dynamic loads the engine is capable of applying.

2.4(6) A fastener used in the process of mounting a gearbox to a chassis or sub-frame of a low volume vehicle must meet all requirements specified in *18.2* to *18.6* inclusive in *Chapter 18 Attachment Systems* of the *New Zealand Car Construction Manual*.

Other Gearbox requirements

2.4(7) Any part of a unitary-constructed low volume vehicle that has had floor or gearbox tunnel material cut or removed for clearance or shifter installation, must be adequately re-strengthened.

2.4(8) A gear-shift mechanism in a low volume vehicle must:

(a) operate easily, smoothly, correctly, and logically; and

(b) operate without any binding, or interference caused by the shift mechanism touching any other components or part of the vehicle structure; and

(c) in the case of an automatic transmission, provide to the driver a clearly visible and accurate indication of the selected gear; and

(d) be sealed, where the mechanism enters the passenger compartment to prevent the entry of fumes.

NOTE: The requirement specified in *2.4(8)(c)* requires a proper device to show the selected gear position to the driver at all times. For the avoidance of doubt, a gear pattern indicator (such as that typically engraved into a gear knob) is not sufficient as it does not indicate the gear that has been selected.

2.4(9) A low volume vehicle fitted with an automatic transmission must feature an operative inhibitor switch, to enable engine starting only in neutral and park positions.

2.5 Drive-shaft and axle housing requirements

Drive-shaft modification and construction

2.5(1) A drive-shaft fitted to a low volume vehicle must be manufactured from:

(a) tubing of a material specification appropriate for a drive-shaft; and

(b) of a diameter and wall thickness appropriate for the power, torque, and weight of the vehicle.

NOTE: When replacing a 2-piece driveshaft system with a single driveshaft, the new longer drive-shaft must be made from tubing that has a significantly greater strength than the tubing from which the two shorter drive-shafts are made from.

2.5(2) A drive-shaft fitted to a low volume vehicle may be lengthened only if:

(a) the complete original tube is replaced by a complete new single piece of tubing, without any spigots or joined sections; and

(b) the main tubing material thickness is not reduced during any machining processes that are carried out; and

(c) in the case of a substantial increase in drive-shaft length or engine power output, the diameter of the drive-shaft is increased proportionately with the drive-shaft length or engine power output.

NOTE 1: A drive-shaft lengthened before September 2002 is not required to comply with *2.5(2)* provided that after thorough visual inspection, no fatigue cracking or fracturing is evident.

NOTE 2: The intention of the requirements in *2.5(2)* is to prevent vehicle modifiers from lengthening a drive-shaft tube with the addition of a welded extension, rather than using a correct length section of tubing.

2.5(3) A modified, custom-manufactured, or non-original equipment drive-shaft fitted to a low volume vehicle must be manufactured or modified by a person who is a recognised industry specialist in the field of drive-shaft modification and manufacture.

2.5(4) In the case where it cannot be determined that a modified, custom-manufactured, or non-original equipment drive-shaft fitted to a low volume vehicle has been manufactured or modified by a person who is a recognised industry specialist in the field of drive-shaft modification and manufacture as required by *2.5(3)*, then the drive-shaft must either:

(a) be visually inspected and dynamically balanced by a person who is a recognised industry specialist in the field of drive-shaft modification and manufacture; or

(b) be assessed by an LVV Certifier and found to be satisfactory as a result of:

(i) a thorough visual inspection which has determined that the drive-shaft has no visible damage or defects, and has been built to a tradesman-like standard; and

(ii) driving the vehicle during a 100 kph road-test, and determining that there is an absence of any harmonic vibration from the drive-shaft.

NOTE 1: Examples of cases where it would be appropriate to apply *2.5(4)* are situations such as:

- where a modified or custom-manufactured drive-shaft is fitted to a vehicle that has been imported from overseas, and for which no information about the drive-shaft exists; or
- where an LVV Certifier is inspecting a vehicle for recent modifications to which a modified or custom-manufactured drive-shaft was fitted some years previous to the recent modifications which have caused the vehicle to require LVV certification.

NOTE 2: Where an LVV Certifier has any doubts or concerns during his assessment process in *2.5(4)(b)*, he should refer the drive-shaft for an expert assessment as provided for in *2.5(4)(a)*.

2.5(5) A drive-shaft fitted to a low volume vehicle must maintain the majority of its drive-shaft yoke coupling depth engaged into the gearbox output shaft throughout the full range of suspension travel.

Drive-shaft attachment

2.5(6) A drive-shaft fitted to a low volume vehicle must be attached such that interference is unlikely to occur between the drive-shaft and the underside of the body or any other components during full suspension travel.

2.5(7) Fasteners used in the attachment of a drive-shaft to a low volume vehicle must:

(a) in the case of a modified production vehicle, be of a quantity, size, type, and grade of equal or greater specification than that used by the original engine manufacturer; or

(b) in the case of a scratch-built vehicle, be of a quantity, size, type, and grade suitable for:

(i) the weight of the drive-shaft; and

(ii) the loads the engine torque is capable of applying;

and

(c) where fasteners are not original equipment for the drive-shaft or the vehicle, meet all requirements specified in *18.2* to *18.6* inclusive in *Chapter 18 Attachment Systems* of the *New Zealand Car Construction Manual.*

Drive-shaft universals

2.5(8) A drive-shaft universal fitted to a low volume vehicle must:

(a) be of a size appropriate for the torque loads that the engine is capable of applying; and

(b) not be able to bind throughout the full range of suspension travel; and

(c) be aligned in such a way as to not induce premature wear or cause vibration; and

(d) operate at angles that are within the universal manufacturer's specifications; and

(e) if not original universals in the original application, operate at a minimum of three degrees angle to prevent brinelling; and

(f) be positioned so that all universal angles and phasing are in alignment, unless exact factory misalignment is duplicated.

NOTE 1: Generally, drive-shaft manufacturers recommend operational angularity of not less than 1 degree, and not more than 5 degrees. Even when a drive-shaft safety loop is fitted, 5 degrees should not be exceeded.

NOTE 2: Universal phasing is a complex area, and is misunderstood even by many experienced car builders, which is one of the reasons why it is a requirement to use an experienced drive-shaft specialist to build a drive-shaft.

Drive-shaft safety-loops

2.5(9) A drive-shaft safety-loop must be fitted around the forward end of each section of driveshaft on any low volume vehicle that is of a front-engine and rear-wheel drive configuration, and which incorporates an open drive-line, if:

(a) the vehicle has had an engine conversion that has resulted in a significant increase in power or torque; or

(b) the vehicle has had its factory-fitted engine significantly modified, such that a significant increase in power or torque has resulted; or

(c) the drive-shaft fitted to the vehicle is aftermarket including steel, carbon-fibre, aluminium or composite, or where the drive-shaft has been modified by welding; or

(d) the vehicle has been fitted with a turbocharger, supercharger, or a nitrous system, unless the vehicle was originally fitted with a mechanical injector-pump equipped diesel engine and has been retro-fitted with a complete original equipment turbo system from the same make and model of vehicle.

NOTE 1: *2.5(9)* is not required to be met in a situation where a vehicle which has had a bolt-in engine or transmission conversion or bolt-in turbocharger/supercharger addition, and where documented proof is provided by the vehicle manufacturer or their agent verifying that all driveshaft components are identical between the two vehicles, and where the driveshaft remains unmodified.

NOTE 2: A vehicle that has a two or three-piece driveshaft is not required to have a drive-shaft safety-loop fitted to any section of drive-shaft where a drive-shaft hanger bearing is positioned directly behind a universal, and where the hanger will effectively contain a disengaged drive-shaft.

NOTE 3: A front drive-shaft in a four wheel drive vehicle is not required to have a drive-shaft safety loop, unless an unusual situation arises where a front drive-shaft is able to make contact with the road surface or critical mechanical components. In such cases vehicles should be dealt with by the LVV Certifier on a case-by-case basis.

NOTE 4: Where a vehicle is required by these rules to have a drive-shaft safety-loop, and the vehicle has a two or three-piece drive-shaft, a drive-shaft safety loop must be fitted to each drive-shaft section.

2.5(10) A drive-shaft safety-loop required by *2.5(9)* to be fitted to a low volume vehicle must meet the relevant requirements specified in *section 5.22* of *Chapter 5 Chassis Modification & Construction* of the *New Zealand Car Construction Manual*, relating to:

(a) correct design, material specification, and construction of a drive-shaft safety loop; and

(b) correct attachment of a drive-shaft safety-loop to the vehicle structure; and

(c) correct positioning of a drive-shaft safety-loop in relation to a drive-shaft universal; and

(d) re-direction, where necessary, of hydraulic brake pipes; and

(e) situations where two or more drive-shafts are present.

NOTE 1: In addition to the requirements for drive-shaft safety-loops specified within *section 5.22* in *Chapter 5* of the *New Zealand Car Construction Manual*, *LVVTA Information Sheet # 09-2011 (Drive-shaft Safety-Loop Requirement Clarification)* contains additional requirements for drive-shaft safety-loops and should also be read in conjunction with *section 5.22* in *Chapter 5* of the *New Zealand Car Construction Manual*. This LVVTA Information Sheet is available free of charge from www.lvvta.org.nz

NOTE 2: It is vitally important to follow the detailed requirements set out in the *New Zealand Car Construction Manual* and *LVVTA Information Sheet # 09-2011 (Drive-shaft Safety-Loop Requirement Clarification)* for drive-shaft safety loops in order to ensure that a drive-shaft safety loop, together with its attachment system, is sufficiently well designed and engineered so as to be capable of containing the significant rotational energy of a failed or disengaged drive-shaft.

Axle housing and differential modification and attachment

2.5(11) Where an axle housing assembly conversion has taken place on a low volume vehicle, either:

(a) the vehicle's original suspension geometry and suspension locating mounting points must be duplicated on the replacement axle housing assembly, and at the chassis or sub-frame attachment points; or

(b) in the case of a changed suspension system configuration, the suspension must, in addition to this standard, comply with the applicable requirements in *Chapter 6 Suspension Systems* of the *New Zealand Car Construction Manual*.

2.5(12) A differential fitted to a low volume vehicle must not be fitted with a permanently locked diff centre, spool, or mini-spool.

2.5(13) A differential fitted to a low volume vehicle which is of a type that, upon failure of an axle could result in the loss of a wheel, must be fitted with axles that are appropriate for the torque loads that the engine is capable of applying.

2.5(14) Fasteners used in the attachment of an axle housing assembly to a low volume vehicle, must:

(a) in the case of a modified production vehicle, be of a quantity, size, type, and grade of equal or greater specification than that used by the original differential manufacturer; or

(b) in the case of a scratch-built vehicle, be of a quantity, size, type, and grade suitable for:

(i) the weight of the differential; and

(ii) the loads the engine torque is capable of applying;

and

(c) where fasteners are not original equipment for the axle housing or the vehicle, meet all requirements specified in *18.2* to *18.6* inclusive in *Chapter 18 Attachment Systems* of the *New Zealand Car Construction Manual.*

2.6 Other requirements

Welding of drive-train components

2.6(1) Welding of any engine or gearbox mounts or cross-members, or in relation to any differential housing modifications on a low volume vehicle, must comply with the applicable requirements specified in *Chapter 18 Attachment Systems* of the *New Zealand Car Construction Manual*.

Four-wheel drive to two-wheel drive conversions

2.6(2) A vehicle that has been converted from four-wheel drive to permanent two-wheel drive must meet the requirements specified in *2.6(3)* and *2.6(4)* if the vehicle:

(a) does not have a selectable four-wheel drive system; and

(b) does not have a solid (live) front axle.

2.6(3) A vehicle specified in *2.6(2)* must:

(a) retain and be correctly fitted with any original equipment drive-coupling or constant velocity joint which is relied upon to securely retain a wheel bearing or hub assembly; and

(b) where an original equipment inner constant velocity joint 'cup' remains in place where a half-shaft has been removed, or where a rear driveshaft is removed leaving an exposed tail-shaft spline or yoke, the cup or yoke must be either:

(i) securely attached by a method other than a 'C'-clip to prevent unexpected ejection of the joint, and the resultant escape of any transmission fluid; or

(ii) substituted by a properly machined plug to prevent unexpected ejection of the joint under high load or RPM conditions, and the escape of any transmission fluid.

NOTE: If a drive-coupling or constant velocity joint is modified (by machining off of the CV 'cup') the coupling or joint must retain the unmodified OEM joint main shaft, with the clamping, threaded, splined and stepped sections and locking nut.

2.6(4) A vehicle specified in *2.6(2)* must, in addition to the technical requirements specified in *2.6(3)*:

(a) retain any anti-locking braking system components required by the vehicle's anti-lock braking system to continue to operate correctly; and

(b) when compared to a same make and model unmodified vehicle, exhibit safe handling characteristics during normal road use; and

(c) meet the 3-cycle brake performance test requirements of *LVV Standard 35-00 (Braking Systems)*, tested both with and without the anti-lock braking system active, without exhibiting any adverse front-to-rear brake balance characteristics; and

(d) have a warning label supplied by the LVV Certifier attached to the vehicle in a position clearly visible to the driver, that makes a driver aware that the vehicle may handle differently to when it was manufactured in its original four-wheel drive configuration.

Compliance with other requirements

2.6(5) A low volume vehicle that is required to comply with this standard must also meet the applicable requirements of:

(a) *LVVTA Low Volume Vehicle Standard 35-00 (Braking Systems);* and

(b) *LVVTA Low Volume Vehicle Standard 195-00 (Suspension Systems);* and

(c) *LVVTA Low Volume Vehicle Standard 90-10 (Exhaust Gas Emissions);* and

(d) *LVVTA Low Volume Vehicle Standard 90-20 (Exhaust Noise Emissions);* and

(e) *Chapter 6 Suspension Systems* of the *New Zealand Car Construction Manual; and*

(f) *Chapter 7 Steering Systems* of the *New Zealand Car Construction Manual; and*

(g) *Chapter 8 Braking Systems* of the *New Zealand Car Construction Manual; and*

(h) *Chapter 9 Engine & Drive-trains* of the *New Zealand Car Construction Manual; and*

(i) *Chapter 10 Fuel Systems* of the *New Zealand Car Construction Manual.*

2.6(6) A low volume vehicle that has been converted to electric or hybrid power and is required to comply with the applicable requirements of this standard, must also meet the applicable requirements of *Low Volume Vehicle Standard 75-00 (Electric & Hybrid Vehicles)*.

Section 3 Exclusions to this standard

3.1(1) No exclusions apply to this low volume vehicle standard.

Section 4 Vehicles not required to be certified to this standard

4.1 Vehicles not covered by this standard

4.1(1) A light vehicle is not required to be certified to this low volume vehicle standard, if the vehicle is modified for the purposes of law enforcement or the provision of emergency services.

4.1(2) A light vehicle is not required to be certified to this low volume vehicle standard, if the vehicle is identified as having been modified by a second-stage vehicle manufacturer, and complies with an approved overseas standard that is listed in *Annex 6* of the *Low Volume Vehicle Code.*

4.2 Vehicles that pre-date legal requirements

4.2(1) A vehicle is not required to be certified to this standard, if the vehicle was either:

(a) modified before 1 January 1992 in such a way that any braking or steering systems may, directly or indirectly, be affected as a result of an engine or drive-train conversion or modification, and the engine and drive-train fitted to the vehicle is the same as that fitted at the time of the vehicle's modification; or

(b) scratch-built before 1 January 1992, and the engine and drive-train fitted to the vehicle is the same as that fitted at the time of the vehicle's construction.

4.3 Modifications that do not require certification

Engine modifications that do not require certification

4.3(1) A vehicle is not required to be certified to the *Low Volume Vehicle Code*, provided that the safe performance of the vehicle is not compromised, where the only modifications to the vehicle are those to the engine originally fitted to the vehicle by the vehicle manufacturer, that result in an increase of no more than 20% in engine power output from the original vehicle manufacturer's specifications.

Engine conversions that do not require certification

4.3(2) A vehicle is not required to be certified to the *Low Volume Vehicle Code*, provided that the safe performance of the vehicle is not compromised, where the only modification to the vehicle is the fitting of an engine other than that fitted by the vehicle manufacturer, and that the replacement engine when compared with the original equipment engine:

(a) is of the same or less cubic capacity; and

(b) has equal or less weight; and

(c) has the same or less power output; and

(d) uses the same fuel (petrol, diesel, LPG, CNG); and

(e) uses the same unmodified attachment points and system (ie bolts-in); and

(f) uses the same family of block and cylinder head from the same vehicle manufacturer; and

(g) is of the same configuration.

Gearbox conversions that do not require certification

4.3(3) A vehicle is not required to be certified to the *Low Volume Vehicle Code*, provided that the safe performance of the vehicle is not compromised, where the only modification to the vehicle is the fitting of a gearbox or automatic transmission other than that fitted by the vehicle manufacturer, and that:

(a) the original equipment gearbox cross-member has not been heated, cut, or welded; and

(b) the original equipment gearbox cross-member mounting to the OE body or chassis members is unchanged; and

(c) no replacement gearbox cross-member is used; and

(d) the original equipment driveshaft(s) remains and is unmodified; and

(e) no substantial modifications have occurred to the floor or gearbox tunnel area, other than provision for gear-shift mechanism; and

(f) the braking system is not modified or changed, including the brake pedal.

Axle housing assembly conversions that do not require certification

4.3(4) A vehicle is not required to be certified to the *Low Volume Vehicle Code*, provided that the safe performance of the vehicle is not compromised, where the only modification to the vehicle is the fitting of an axle housing assembly other than that fitted by the original vehicle manufacturer, and that:

(a) the braking system has not been changed or modified; and

(b) the suspension attachment points have not been changed or modified; and

(c) the drive-shaft has not been modified, or substituted for a drive-shaft of insufficient strength for the application.

Change from four-wheel drive to permanent two-wheel drive

4.3(5) A four-wheel drive vehicle is not required to be certified to the Low Volume Vehicle Code, provided that the safe performance of the vehicle is not compromised, where the only modification to the vehicle is the removal of drive-train components fitted by the original vehicle manufacturer, provided that:

(a) the vehicle was originally manufactured with selectable four-wheel drive; and

(b) the vehicle was originally manufactured with a solid (live) front axle.

Section 5 Terms and definitions within this standard

Aftermarket	means a manufacturer or supplier, other than a high volume motor vehicle manufacturer, who produces components or systems on a production-run basis for the mass-market.
Alternator	means a device mechanically driven by the engine that provides an electrical supply to maintain the battery's charge.
Automatic transmission	means a type of gearbox, or transmission, that automatically varies the ratios between the input shaft and the output shaft to suit engine speeds automatically, without the driver having to physically select the gears.
Boxed	means to add a capping plate to convert a c-section or channel chassis rail or cross-member to a fully enclosed section like a RHS.
Brinelling	means premature wear of drive-shaft universal bearings due to a lack of rotary movement.
Carbon Fibre Composite	Is a strong and light material, usually consisting of a plastic which contains fibres of carbon. A carbon-fibre drive-shaft may also include aluminium in the design.
Chassis	means the supporting frame or platform of a motor vehicle to which the major mechanical components and body attach.
Cross-member	means a section of material positioned between or connecting the main chassis rails or sections to provide support to the chassis or body, or for the attachment of related components and systems.
Differential	means the mechanical assembly used for transferring the engine and gearbox power output to the driving wheels.
Drive-shaft	means the assembly which transfers the power output from the gearbox to the differential.
Drive-shaft safety loop	means a safety device designed to contain the drive-shaft in the event of a drive-shaft universal failure, to prevent the drive-shaft from contacting the vehicle floor or the road surface.
Drive-shaft universal	means the devices positioned at each end of the drive-shaft to enable the power transfer to take place from the rigidly mounted gearbox to the differential operating on an upward and downward plane whilst the suspension operates throughout its range of travel.

Engine mounts	means the devices that fasten the engine onto the chassis or sub-frame section.
Engine plates	means an alternative method of fastening the engine onto the chassis or sub-frame section through the use of a rigid plate system positioned vertically at the front and the rear of an engine, instead the more common flexible engine mounts.
Fan-belt	means flexible drive-belts, which operate the engine-cooling fan, water, pump, alternator, and other accessory motors from the engine crankshaft pulley.
Gearbox	means the mechanical assembly used to convert engine speed to road speed through the use of a number of different gear ratios.
Gear-shift	means the device by which the different gear ratios in the gearbox are selected.
Gearbox tunnel	means the floor of a motor vehicle surrounding the area where the gearbox is positioned.
Locked differential	means a differential that drives both left and right side axles simultaneously without the usual mechanical slippage designed into production motor vehicles to provide safe and comfortable cornering.
Nitrous oxide	means a liquid chemical composition of one part of nitrogen and two parts of oxygen, which when introduced with the fuel mixture entering an internal combustion engine, converts to a gas and may increase the oxygen content in the combustion chamber producing a momentary increase in power output.
Nyloc	means a type of vibration-proof locking nut that incorporates a nylon section, which enables the nut to lock itself against the corresponding bolt.
RHS	is an abbreviation for rectangular hollow section, which is a configuration of steel section commonly used in the manufacture of chassis and other motor vehicle component fabrication.
Spool	means a device which when fitted, has the effect of a locked differential.
RPM	is an abbreviation for revolutions per minute, a measurement of engine speed.
Sub-frame	means a structural part of a unit-construction vehicle to which the major mechanical components attach.
Supercharged	means a mechanical device driven by the crankshaft pulley of an engine which forces an air/fuel mixture into the engine to provide increased levels of power output.
Torque	means rotating effort produced by applying a force to a lever arm about a pivot.

Unitary construction	means a type of vehicle construction that incorporates the vehicle body and chassis frame in one unit, as opposed to having a separate and removable chassis.

NOTE: The terms and definitions found in section 5 are limited to those terms and definitions that are unique to this low volume vehicle standard, and are not necessarily contained within the terms and definitions section of the *Low Volume Vehicle Code*.