Low Volume Vehicle Technical Association (inc)

Helping New Zealanders Build & Modify Safe Vehicles

New Zealand Car Construction Manual

Chapter 10
Fuel Systems

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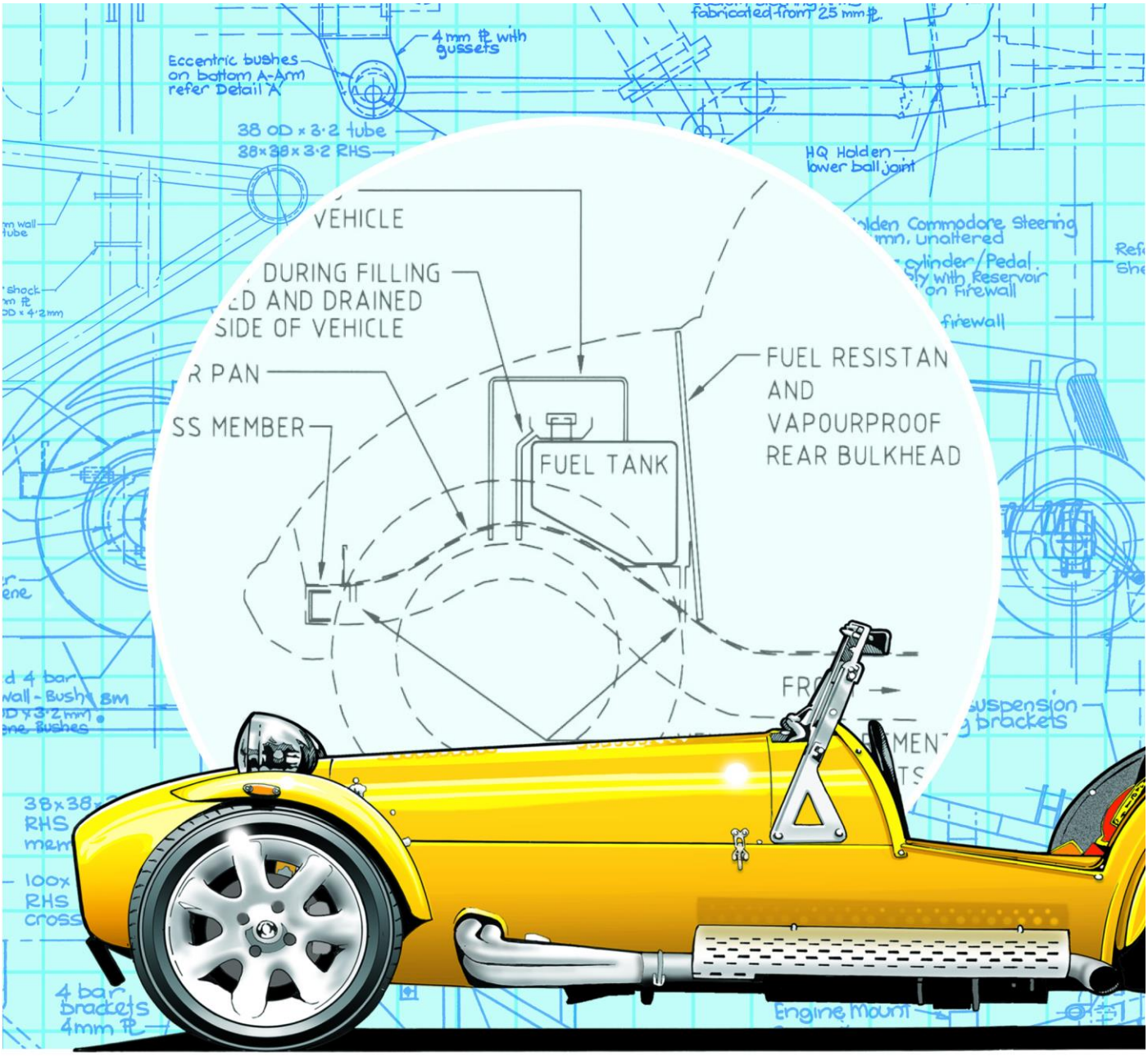

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Chapter 10
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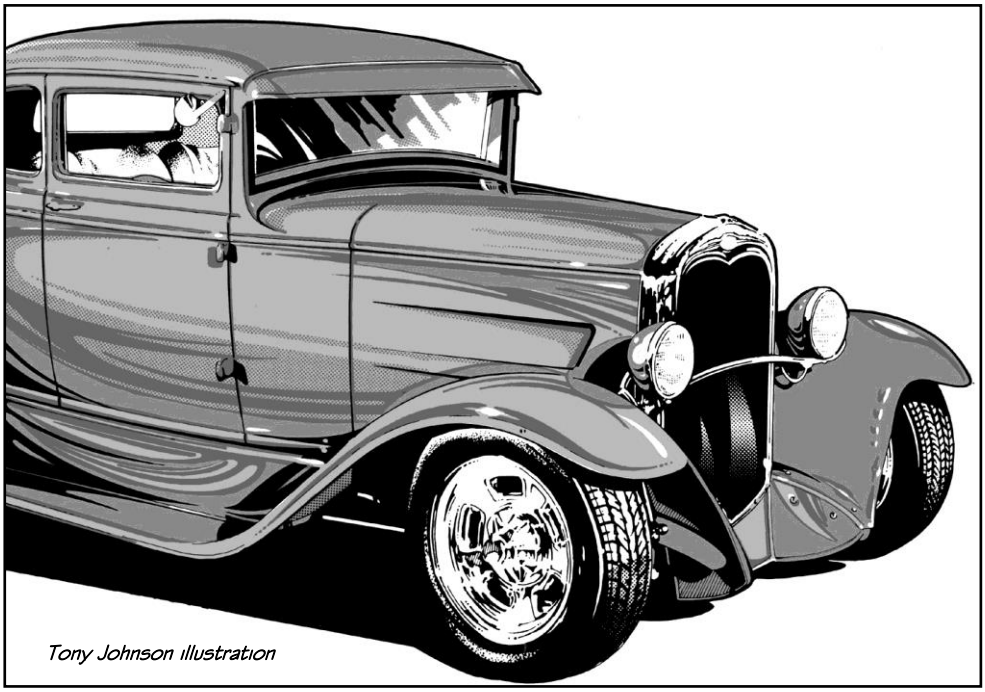

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The information in this NZ Car Construction Manual Chapter has stemmed from work undertaken by LVVTA founding member organisations that commenced prior to 1990 and has been progressively developed as an integral part of New Zealand Government safety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

LVVTA's contact details are below:

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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.
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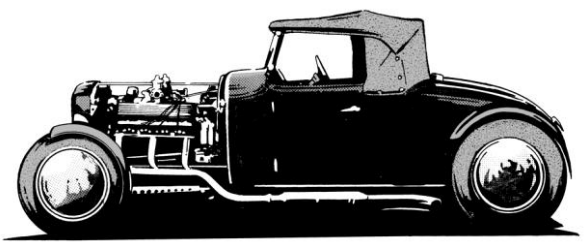
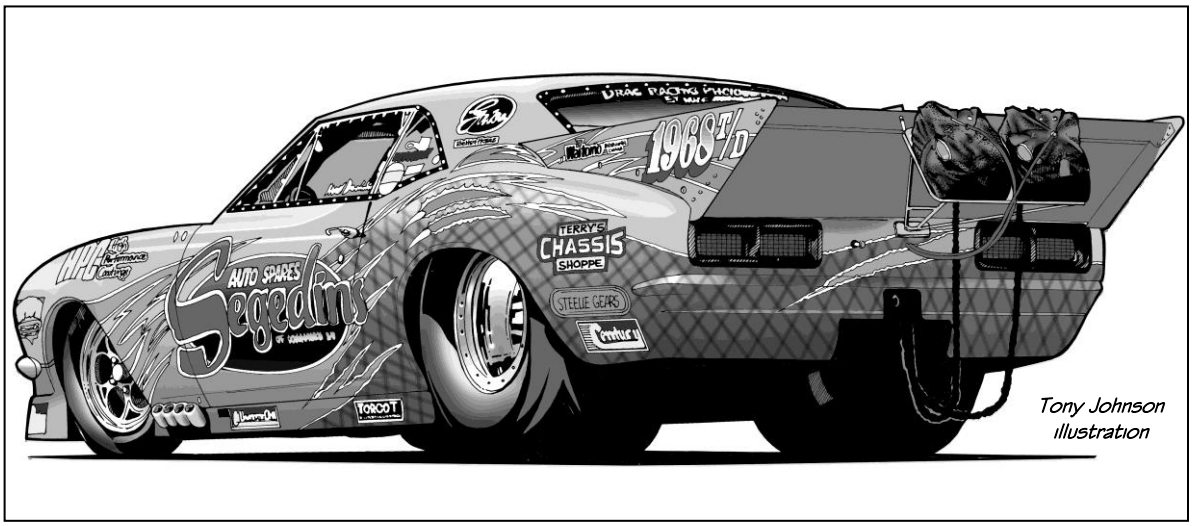


Chapter 10 Contents:



CHAPTER 10: FUEL SYSTEMS

Introduction:

The purpose of this Chapter is to specify sound design principles relating to fuel systems, to ensure that all new or modified fuel systems in low volume vehicles are as safe as practicable.

A vehicle's fuel system is important in terms of safety, performance, and reliability. A good fuel system in a low volume vehicle is dependent on the correct selection or construction of the tank, tank location within and attachment to the vehicle, correct venting, spillage and leakage dispersal, and care, even on the little things like fuel hoses and fittings.

Note that where a production vehicle is fitted with its original fuel tank or other fuel system components in their original locations, the requirements in this chapter do not apply. Note also that this chapter does not apply to components associated with compressible fuel types such as CNG, LPG, or hydrogen, all of which require a separate alternative fuels certification.

General safety requirements:

10.0 Requirements applicable to all vehicles

10.0.1

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.

10.0.1

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.

10.0.2

Fuel tanks, fuel lines and associated components in a motor vehicle must be:

(a) securely mounted; and

(b) made of suitable materials; and

(c) in good condition; and

(d) free from significant leaks; and

(e) positioned so that the risk of mechanical damage or heat gain is minimised.

Fuel tank requirements:

10.1 Surge tanks

10.1.1

A surge-tank fitted to a low volume vehicle must, with the exception of 10.2.6, meet all of the same technical requirements that are specified in this Chapter for fuel tanks.

10.2 Fuel tank construction

10.2.1

A custom or aftermarket fuel tank may be fitted to a low volume vehicle as an alternative to a fuel tank from a mass-produced vehicle, provided that the tank is constructed from fuel-resistant and corrosion-resistant materials, with a minimum thickness of:

(a) in the case of aluminium, 1.6 mm (16-gauge); or

(b) in the case of stainless steel, 1.0 mm (20-gauge); or

(c) in the case of 'electro-galv' mild steel, 1.2 mm (18-gauge).

Where a low volume vehicle built or modified before 1992 has a fuel tank that does not comply with 10.2.1, the tank may be retained provided that in the opinion of the Low Volume Vehicle Certifier the tank has demonstrated through the test of time that it is still in good condition and is fit for its purpose.

10.2.2

The sections of a custom or aftermarket fuel tank fitted to a low volume vehicle made from materials specified in 10.2.1 must be either gas or electric-welded.

10.2.3

A custom or aftermarket fuel tank fitted to a low volume vehicle that is constructed from materials specified in 10.2.1 may be modified, provided that the strength of the tank is not reduced.

10.0.2

These are the applicable general safety requirements from the Land Transport Rule 32017 Vehicle Equipment 2004, which are required as part of this Chapter, and reproduced here in the interest of convenience.

10.0.2(d)

An LVV Certifier is likely to treat any fuel leak as 'significant'.

10.1.1

Refer to the Useful Information section at the back of this chapter for more details about fuel-injection 'surge-tanks'.

10.2.1

A permanently corrosion-protected material is regarded as being corrosion-resistant.

If steel is used, it should be specifically 'electro-galv' steel, such as the 'zintec' brand.

If using 'electro-galv', the tank should be sealed internally with a proper fuel tank sealant after welding to prevent corrosion of weld joints.

10.2.2

Soldering must not be used for joining fuel tank sections, or attaching mounting points, but may be used for the attachment of fuel tank fittings.

10.2.4

A fuel tank that is constructed from a material which is not listed in 10.2.1 may be fitted to a low volume vehicle, provided that the tank is either:

(a) sourced from a high-volume production vehicle; or

(b) manufactured by a recognised manufacturer of motor sport, automotive, or marine fuel tanks or fuel cells; or

(c) manufactured by someone other than that specified in 10.2.4(a) or (b), but is individually approved in writing by the Technical Advisory Committee of the Low Volume Vehicle Technical Association (Inc).

10.2.5

A fuel tank fitted to a low volume vehicle, that is constructed from a material which is not listed in 10.2.1, must not be modified in any way by any person or company other than a person or company specified in 10.2.4(c).

10.2.5

Plastic tanks in particular should never be modified or repaired due to the types of materials used in the construction of these tanks.

10.2.6

A custom or aftermarket fuel tank fitted to a low volume vehicle must incorporate some form of baffling to minimise fuel surge within the tank during cornering, braking, and acceleration.

10.2.6

Baffling can include a fuel-resistant foam appropriate for the type of fuel used.

10.2.7

A fuel tank fitted to a low volume vehicle must not have any fuel lines positioned on the underside of the fuel tank unless they are suitably protected from road debris and jacking.

10.3 Fuel tank location & protection

10.3.1

A fuel tank and its related fuel system components may be located within the boot or passenger compartment of a low volume vehicle, provided that the requirements specified in 10.6 and 10.7 are met.

10.3.2

A fuel tank fitted to a low volume vehicle that is constructed from a material which is not listed in 10.2.1, must, other than for an L-class vehicle, be protected by a structural cross-member, chassis or sub-frame section, or rigid body section, between the tank and any outer extremity of the vehicle. (see Diagrams 10.1 & 10.2)

10.3.2

An 'L-class' vehicle is a motorcycle or trike.

Fuel tanks should be positioned so that they are protected during an impact.

Where a low volume vehicle built or modified before 1992 has a fuel tank that is not protected as required by 10.2.2, the tank may be retained in its location provided that in the opinion of the Low Volume Vehicle Certifier the tank positioning is not unsafe.

10.3.3

A fuel tank fitted to a low volume vehicle must be protected from any exhaust heat by either:

(a) the inter-positioning of a suitably fabricated and mounted heat-shield between the fuel tank and the exhaust system; or

(b) either:

(i) in the case of a fuel tank which is specified in 10.2.1, be positioned so that there is a minimum clearance between the fuel tank and the exhaust system of 25 mm; or

(ii) in the case of a fuel tank that is constructed from a material which is not listed in 10.2.1, be positioned so that there is a minimum clearance between the fuel tank and the exhaust system of 50 mm.

10.3.4

No part of a fuel tank fitted to a low volume vehicle may be located forward of the vehicle's front axle centre-line.

10.3.4

Traditional hot rod 'Moon' style tanks may be fitted to the front of a hot rod, provided they are not functional.

10.3.5

A fuel tank and its related fuel system components must be located within a low volume vehicle so that: (see Diagrams 10.1 & 10.2)

(a) the fuel tank and systems remain within the scrub-line of the vehicle, so that in the event of a tyre deflation, the fuel tank will not come into contact with the road surface; and

(b) no part of the fuel tank or fuel system is positioned at a point where damage could be caused by a curb, judder bar, or other road irregularities; and

(c) where there is less than 200 mm (8") clearance between the lowest part of the tank and the ground, the tank is protected by either:

(i) an adjacent part of the vehicle structure; or

(ii) a suitable shield or other vehicle component capable of protecting the tank.

10.3.5

This is aimed at preventing fuel tanks being damaged or ruptured through being positioned too low, particularly when crossing curbs.

10.3.5(a)

'Scrub-line' is the line drawn across the vehicle's width from the bottom of one wheel-rim to the contact patch of the opposite side tyre, and vice-versa.

10.4 Fuel tank attachment

10.4.1

A fuel tank must be attached to a low volume vehicle using:

(a) an attachment method that:

(i) is suitable for the type and size of the tank; and

(ii) uses components and materials that are equivalent to or greater than that used by a production vehicle using a similar tank location and capacity;

and

(b) fasteners that meet the general fastener requirements and 'locking device requirements' specified in 'Chapter 18 - Attachment Systems'.

10.4.2

A replacement fuel tank that is of a substantially greater capacity than that originally fitted to a modified production low volume vehicle must either:

(a) have an attachment system that has a greater load-carrying ability than that provided by the original vehicle manufacturer; or

(b) incorporate additional support to supplement the attachment system provided by the original vehicle manufacturer.

10.5 Fuel tank filling

10.5.1

A fuel tank fitted to a low volume vehicle must incorporate a correctly-fitting filler cap which: (see Diagrams 10.1 & 10.2)

(a) prevents fuel from leaking out of the fuel tank as a result of fuel surge during cornering, braking, and acceleration; and

(b) either:

(i) is a sealed or vented filler cap in the case of a fuel tank that is filled from outside the vehicle; or

(ii) is a sealed filler cap in the case of a fuel tank that is located and filled from inside the vehicle.

10.5.2

A fuel tank fitted to a low volume vehicle may be filled either:

(a) from outside of the vehicle; or

10.4.2

If a much larger than standard fuel tank has been fitted to a production vehicle, additional supports or mounts may be required.

10.5.2

See Diagrams 10.1 & 10.2 for the positioning of an isolation panel.

10.5.2 means, in effect, that because of the practical difficulties associated with providing an isolation panel in a hatch-back type vehicle (where the boot area is part of the passenger compartment), a hatch-back type vehicle cannot be filled from inside the vehicle.

Refer to the Useful Information section at the back of this chapter for more details about 'sealing the boot area from the passenger compartment'.

(b) from inside the vehicle, only if an impervious and fully-sealed isolation panel made from a fuel-resistant material is fitted to prevent fuel during a filling spillage, or fuel vapour, from entering the passenger compartment (see Diagrams 10.1).

10.5.3

A fuel tank fitted to a low volume vehicle, which is filled from inside the vehicle, must incorporate a means of catching any fuel during a refilling over-flow or spill, and dispersing it to the outside of the vehicle without spilling onto either: (see Diagrams 10.1 & 10.2)

(a) any part of the vehicle's exhaust system; or

(b) any part of the vehicle's electrical system.

10.6 Fuel tank leakage & rupture dispersal

10.6.1

A low volume vehicle that has a fuel tank located inside the trunk or passenger compartment must have the floor and surrounding area in which the fuel tank is located designed in such a way that any fuel, in the event of a fuel tank leak or rupture: (see Diagrams 10.1 & 10.2)

(a) cannot come into contact with the vehicle's battery or battery leads; and

(b) will escape to the outside of the vehicle, without draining onto either:

(i) any part of the vehicle's exhaust system; or

(ii) any part of the vehicle's electrical system.

10.6.2

A scratch-built low volume vehicle completed after 1 January 2008 must incorporate a means of preventing fuel leakage from the tank if the vehicle is upside down.

10.7 Fuel tank safety venting

10.7.1

A fuel tank fitted to a low volume vehicle that incorporates a safety venting system, must either:

(a) discharge vapour to the outside of the vehicle, away from: (see Diagrams 10.1 & 10.2)

(i) any part of the vehicle's exhaust system; or

10.5.3

This can be achieved by incorporating a simple spill-ring around the filler neck that collects and drains any excess fuel to the outside of the vehicle.

10.6.1

The intent of this clause is to prevent fuel from a fuel tank rupture, from gathering within the trunk area or passenger compartment. A simple drainage system can be incorporated into the floor where the tank is mounted, to prevent spilt fuel from collecting and remaining in the boot or entering the passenger compartment. 'Inside the vehicle' includes on top of the deck or tray of a utility.

10.6.2

In the case of an internally-mounted, externally-vented tank, this can be achieved by incorporating a one-way check-valve within the external vent system.

10.7.1

Older tanks use a vent or breather pipe to equalise air pressure within the tank, while modern tanks working with fuel-injected engines operate under a mild vacuum. Fuel tanks fitted to these vehicles must, therefore, be substantial enough to resist the deformation that can be caused through the constant residual vacuum designed into such systems.

(ii) any part of the vehicle's electrical system;

or

(b) in vehicles with carbon-vent canisters fitted, purge to the engine intake system in the same way as they are originally designed to do.

10.7.1

Builders need to be aware of the type of systems being used, especially with modern fuel-injected engines.

Where possible, the vent line should run to below the lowest point of the fuel tank. If this is impractical, a proprietary roll-over one-way check-valve can be incorporated.

All fuel systems must incorporate both entry and exit venting. This can be as simple as the fuel tank vent (or breather) shown in the diagrams.

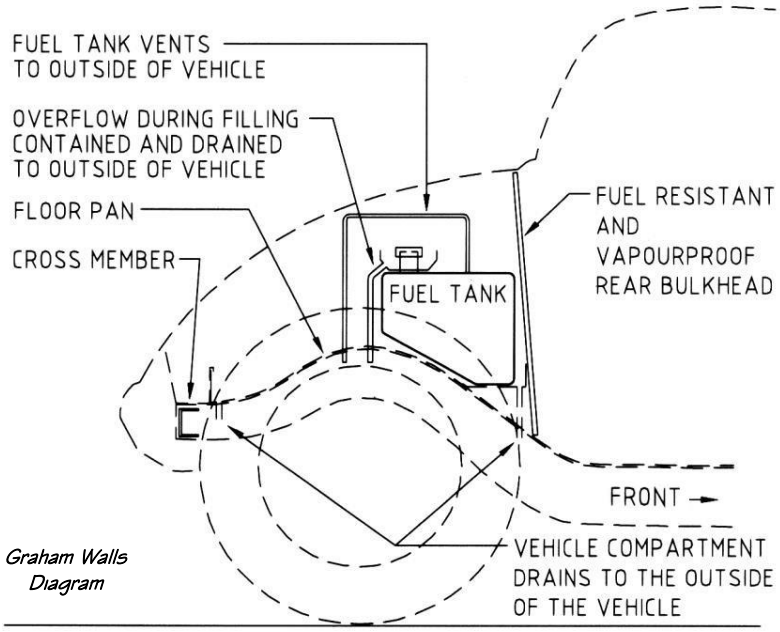


Diagram 10.1 Fuel tank with fill point located internally

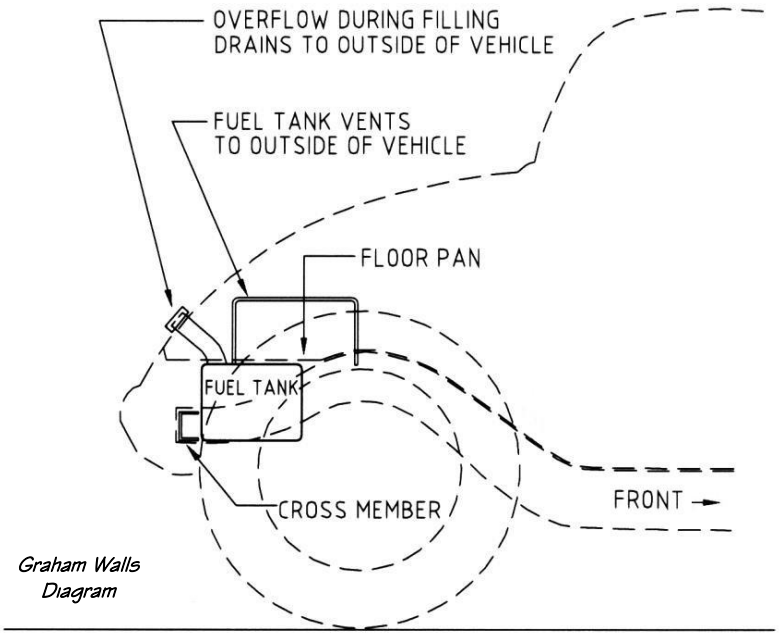


Diagram 10.2 Fuel tank with fill point located externally

10.7.1

In a configuration such as that shown in Diagram 10.2 where the fuel tank is mounted under the floor and filled externally, a fuel-resistant and vapour-proof bulkhead (as shown in Diagram 10.1) is not required.

Whenever a pressurised fuel feed line is in the boot, a bulkhead will need to be present, even for an under-floor and externally-filled system.

10.7.2

A fuel tank safety-vent system fitted to a low volume vehicle must prevent any fuel from being able to be discharged through the vent (see Diagrams 10.1 & 10.2).

10.7.2

The vent outlet should ideally discharge on the side of the tank that is opposite to where the vent pipe exits from the tank, and terminate below the lowest part of the tank, in order to protect against fuel spill during high G-forces.

Fuel pipe and hose requirements:

10.8 Fuel pipes and hoses

10.8.1

A low volume vehicle must incorporate a flexible fuel connection between the engine and the chassis, sub-frame, or body structure of the vehicle.

10.8.1

While coiled solid fuel pipe can meet this requirement, flexible fuel hose is preferred.

10.8.2

Flexible fuel hoses used within a fuel system in a low volume vehicle must be manufactured from a reinforced synthetic fuel-resistant rubber, or other fuel-resistant non-hardening flexible material, designed for automotive fuel-carrying applications.

10.8.3

Fuel pipes and hoses, and their fittings, fitted to a low volume vehicle, must be suitably matched to the operating pressure of the fuel system being used.

10.8.3

Modern fuel-injected engines run at very high pressures, and special care must be taken to ensure that the best quality hoses and fittings are used.

10.8.4

A push-on join between a flexible fuel hose and a rigid fuel pipe or fitting on a low volume vehicle must be secured with a suitable hose-clamp or clip to prevent unintended disconnection due to fuel delivery pressure or vehicle vibration.

10.8.4

'Swaged' pipe ends are highly recommended in all pipe to hose connections.

Push-lock fittings with multiple barbs are designed to grip the hose sufficiently as to not need a clamp. The hose can be damaged if a clamp is used with a push-lock fitting.

10.9 Fuel pipe and hose location & attachment

10.9.1

Rigid fuel pipes and flexible fuel hoses fitted to the underside of a low volume vehicle may only be:

(a) tubular steel, aluminium, copper, or stainless-steel rigid fuel pipe; or

(b) premium quality stainless-steel braided fuel hose; or

(c) suitably reinforced high-pressure fuel hose.

10.9.1

See side-bar text for 10.9.1 on the next page.

10.9.2

Rigid fuel pipes and flexible fuel hoses fitted to a low volume vehicle must not be positioned:

(a) on the underside of chassis or sub-frame rails or cross-members unless suitably protected from road debris or jacking damage; or

(b) adjacent to exposed electrical connections, fittings, or wires, unless suitably protected from potential fuel leakages; or

(c) adjacent to any moving mechanical components including drive-shafts, pulleys, fans, or supercharger drive systems, unless suitably protected; or

(d) within the maximum possible travel of a failed drive-shaft rotating inside the circumference of the drive-shaft safety-loop.

10.9.3

Rigid fuel pipes and flexible fuel hoses fitted to a low volume vehicle must either:

(a) be protected from any exhaust heat by the inter-positioning of a suitably fabricated and mounted heat-shield; or

(b) be provided with no less clearance from the exhaust system than that designed by the vehicle manufacturer; or

(c) be positioned so that there is a minimum clearance between the component and the exhaust system of:

(i) in the case of any part of the exhaust system other than a catalytic converter, 50 mm; or

(ii) in the case of a catalytic converter, 100 mm.

10.9.4

Rigid fuel pipes and flexible fuel hoses fitted to the underside of a low volume vehicle must be secured firmly against the chassis, sub-frame, or body structure, at intervals of no more than:

(a) in the case of a modified production vehicle with standard pipes and hoses, as the original manufacturer provided; or

(b) in the case of a scratch-built vehicle or a non-original fuel system on a modified production vehicle, 300 mm (12").

10.9.5

Rigid fuel pipe or flexible purpose-designed automotive braided stainless-steel covered fuel hose may be located within the passenger compartment of a low volume vehicle, provided that:

(a) the hose cannot come in contact with either the driver or other vehicle occupants during normal vehicle operation; and

10.9.1

Flexible fuel hoses should ideally be kept to a minimum because they are more susceptible to damage and wear than rigid fuel pipe, and they should also be in a visible location for easy inspection for wear and damage.

10.9.1(a)

Fuel pipe can be made from seamed or seamless material.

10.9.1(c)

'Push-lock' hose is a common type of hose that is suitable for fuel hose.

10.9.4

Fuel pipes and hoses can be run inside chassis rails, but if so, must still be secured, as pipes and hoses can rub and chafe if left loose.

An approved alternative is for fuel pipes and hoses to pass through a well-secured tubular section, known as a 'service tube', provided that the fuel pipes and hoses are suitably supported, and cannot whip or flex.

10.9.5

Note that some motor-sport safety regulations, (for example NZ Drag Racing Association), do not allow fuel hoses inside passenger compartments.

(b) the pipe or hose is secured firmly against the floor at intervals of no more than 300 mm (12"); and

(c) the hose can be readily inspected for wear or damage; and

(d) there are no pipe or hose joins or connections inside the passenger compartment, other than:

(i) where the pipe or hose transfers fuel through an aperture in a front or rear firewall, using purpose-designed bulkhead fittings; or

(ii) in the case of a fuel tank located inside the passenger compartment, the connection to the fuel tank; or

10.9.5(d)

This doesn't apply to fuel lines which are subject to vacuum (rather than pressure), and where the fuel lines which are positioned inside the passenger compartment remain above the fuel tank level to avoid syphoning.

10.9.6

A flexible fuel hose must, where passing through an opening in a panel or chassis or sub-frame section in a low volume vehicle, be secured or protected to prevent chafing or rubbing against any hard or sharp edges.

Other requirements:

10.10 Fuel pumps

10.10.1

Dry electric fuel pumps are a major ignition source.

10.10.1

A mechanical or electrical fuel pump fitted to a low volume vehicle must be protected from exhaust heat by either:

(a) being positioned at a safe distance away from the exhaust system; or

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

10.10.2

Wiring of internally mounted fuel pumps, auxiliary fuel pumps, or transfer pumps, is a specialised field and should be left to auto-electrical experts.

10.10.2

A fuel pump that supplies a fuel injection system in a low volume vehicle, must be prevented from being able to be operated when:

(a) there is no fuel in the fuel tank; or

(b) the engine is not running.

10.10.2(b)

'Running' means running continuously - operation of the fuel pump prior to normal engine start-up is acceptable.

10.10.3

Where a battery, and fuel system components, such as a fuel tank or fuel pump, are located within the same compartment in a low volume vehicle, the battery and the fuel system components must be separated from each other by the enclosure of one or both within a secured fuel-resistant non-conductive container.

10.10.3

A marine or motor-sport 'battery box' is ideal in this situation.

References to a 'compartment' do not include an engine bay.

10.11 Alternative fuels

10.11.1

An alternative fuel system, including CNG and LPG, must be located and attached in accordance with the requirements specified for alternative fuels within Land Transport Rule 32017 Vehicle Equipment 2004.

10.11.1

The presence of a valid alternative fuel certificate meets this requirement.

10.11.2

A nitrous oxide system must meet the requirements specified for nitrous oxide systems in 'Chapter 9 - Engine & Drive-train'.

Exclusions:

No exclusions apply to this chapter.

Useful Information:

Surge tanks

A 'surge tank' is used to make sure that the fuel pump inlet doesn't become starved for fuel, particularly during sustained acceleration. A surge tank is most often used in conjunction with electronic fuel injection systems.

Sealing the boot area from the passenger compartment

It's important to understand that the area in which a fuel tank, surge tank, fuel pump, or any other fuel system component (except for a fuel pipe or fuel hose) is housed, cannot be the same area as the area in which the vehicle occupants sit. When a fuel tank, surge tank, or fuel pump is positioned in the boot, and there is not a fully-sealed and impervious isolating panel separating the two areas, then this basic rule is broken, because a normal factory-installed perforated rear seatback support panel and rear seat does not properly isolate occupants from fuel or fuel vapour.

Similarly, if a leak or rupture occurs, or fuel is spilled during the filling process, the resulting fuel must be prevented from collecting and remaining in the boot area of the vehicle, or from entering the passenger compartment. The fuel system also has to be designed to prevent a leak draining onto either the exhaust or any part of the electrical system, including the battery or battery leads.

These principles also cover the situation of a pressurised fuel leak from a surge tank.

These vapour, rupture, leakage, and spillage situations need to be considered very carefully in the situation where an aftermarket fuel tank is mounted inside the vehicle, and even more-so when the fuel tank requires filling from inside the vehicle.

While it's practical to fit such a fully sealed and impervious isolation panel into the back of a regular sedan-type vehicle, it would be almost impossible in the case of a hatch-back where the boot space and the passenger compartment are effectively one and the same. In this case, the fuel system components must be fully sealed, or mounted outside the passenger compartment.

Terms & definitions for Chapter 10 Fuel Systems

Aftermarket	means a component or system made by a manufacturer, other than a high-volume motor vehicle manufacturer, who produces components or systems on a production-run basis for the mass-market.
Baffling	means, in the context of this manual, a barrier to prevent splashing and surging of fuel in a fuel tank, during braking, accelerating, and cornering.
Carbon-vent canister	means an activated carbon canister which is used to capture hydrocarbon vapor emissions from a fuel tank as part of an evaporative emission control system.
Check-valve	means a one-way safety-valve which closes in order to prevent backward flow of fuel, and in relation to a fuel system it refers to a safety-valve installed in the fuel tank breather line which operates in only one direction, which prevents fuel from coming out of the breather line in the event of a roll-over.
Custom	means a service provided, or a component or system manufactured, by an individual or a company who is not a high-volume motor vehicle manufacturer or an aftermarket manufacturer.
Electro-galv	is an abbreviation for electrogalvanizing.
Electrogalvanizing	is a process in which a layer of zinc is bonded to steel in order to protect against corrosion. The process involves running a current of electricity through a saline/zinc solution with a zinc anode and steel conductor.
Fuel surge	is the effect of fuel being pushed away from the pick-up point of a fuel system, usually during hard cornering or acceleration, resulting in air pockets in the fuel lines.
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 1000 kg.
Low volume vehicle	means, in simplest terms, a vehicle that is built or modified in small numbers, and includes individual home-built or modified vehicles. See the full low volume vehicle definition contained in the Low Volume Vehicle Code.
mm	is an abbreviation for the metric measurement of millimetres.
Modified production (low volume vehicle)	means, in simplest terms, a vehicle which, while modified, maintains a sufficient percentage of body or chassis from one primary mass-produced vehicle, that it can still be considered to be that vehicle. See the full modified production (low volume vehicle) definition contained in the Low Volume Vehicle Code.
Moon-style tank	means a fuel tank manufactured by the Moon Equipment company of Southern California, which in the context of this manual, is of a style that is traditionally used in hot rods, mounted ahead of the vehicle's grille and above the front axle.

Nitrous oxide	is 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.
Passenger compartment	means the part of a motor vehicle body that houses the passengers and driver.
Pressurised system	means a fuel system which operates under a constantly-metered pressure, to reduce the risk of interruption of fuel flow to an engine.
Push-lock	means a type of hose and fitting system that enables the hose to be easily pushed on, however because of the design of the male fitting, the hose grips against the male fitting such that its removal is very difficult.
Scratch-built	is as defined in the Low Volume Vehicle Code.
Scrub-line	means the line drawn across a vehicle's width from the bottom of one wheel to the contact patch of the opposite side tyre, and vice-versa.
Suction-only system	means a fuel system which delivers fuel to an engine by suction, usually through an electrically or mechanically-operated fuel pump.
Surge-tank	means a small tank used to hold the fuel to prevent fuel from moving away from the fuel pump pickup during cornering, acceleration, and braking.
Swaged	means a pressing formed at the end of a section of fuel pipe (instead of, or in addition to, using a hose clip).
Zintec	is the trade name given to cold-rolled and coiled mild steel sheet that has been electrolytically coated with a thin layer of zinc as part of the manufacturing process.