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CODE OF PRACTICE FOR
LP GAS FUEL SYSTEMS FOR VEHICLE ENGINES

SRI LANKA STANDARDS INSTITUTION

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SLS 1248 : 2002

Gr. 17

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SRI LANKA

Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This standard does not purport to include all the necessary provisions of a contract.

SRI LANKA STANDARD
CODE OF PRACTICE FOR LP GAS SYSTEMS FOR VEHICLE ENGINES

FOREWORD

This standard was approved by the Technical Advisory Committee on Vehicles Using LP Gas Fuel Systems and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 2002-12-16.

This standard is intended to provide designers manufacturers, installers and regulatory authorities with technical requirements for LP Gas fuel systems for vehicles so as to provide functional and safe installations. It should be noted that the practices contained in this standard are minimum requirements and they alone may not satisfy all regulatory aspects in relation to the safety of installation and use of LP Gas systems in vehicles. Relevant regulatory authorities should be consulted for advice on comprehensive regulatory requirements covering safety aspects.

Any alternative materials, equipment, designs, method of assembly or procedures, which do not comply with the specific requirements of this standard, or are not mentioned in it, but which give equivalent results to those specified, may be acceptable. Under such conditions the regulatory authority can give advice on the procedure for approval.

The Sri Lanka Standards Institution gratefully acknowledges the use of the following publication in the preparation of this standard.

a) AS/NZS 1425: 1999 Australian/New Zealand Standard LP Gas fuel, systems for vehicles engines

1 SCOPE

This standard specifies requirements for liquefied petroleum gas (LP Gas) fuel systems for engines mounted on motor vehicles, either for the propulsion of the vehicles or for driving some auxiliary function, e.g. a mixer or a pump. It provides requirements for the design and construction of component parts, and for their installation in vehicles, and for tests, commissioning, and periodic inspection.

NOTES

1 This standard may be applied to stationary engines and small engine-powered appliance such as floor sweepers. polishers, trolleys, etc. where it is relevant.

2 This standard does not apply to other LP Gas usage, such as the gas supply system for appliances in caravans, mobile homes or for the propulsion of marine craft.

3. This standard does not cover the areas where major structural modifications are to be carried out to the vehicle (major structural modifications are those not defined in). Prior to

commencement of such work guidance should be sought from the vehicle manufacturer or a professional engineer who is experienced in the automotive disciplines.

2 REFERENCES

AS 1210	Pressure vessels
AS 1432	Copper tubes for plumbing, gas fitting and drainage applications
AS 1743	Road signs-Specifications
AS 1751	Copper brazed steel tubes
AS 2030	The verification, filling, inspection, testing and maintenance of cylinders for the storage and transport of compressed gases
AS 2030.1	Part 1 : Cylinders for compressed gasses other than acetylene
AS 2337	Gas cylinder test stations
AS 2337.2	Part 2: LP gas fuel vessels for automotive use
AS 2430	Classification of hazardous areas
AS 2430.1	Part 1: Explosive gas atmospheres
AS 2473	Valves for compressed gas cylinders (threaded outlet)
AS 2613	Safety devices for gas cylinders
AS 2746	Working areas for gas-fueled vehicles
AS D26	Tube fittings with Dry seal American standard taper pipe and unified thread for automotive and industrial use
AS/NZS 1110	ISO metric hexagon precision bolts and screws
AS/NZS 1572	Copper and copper alloys - Seamless tubes for engineering purposes
AS/NZS 1596	Storage and handling of LP Gas
AS/NZS 1869	Hose and hose assemblies for liquefied petroleum gases (LP Gas), natural gas and town gas
AS/NZS 2465	Unified hexagon bolts, screws and nuts (UNC and UNF threads)
AS/NZS 3509	LP Gas fuel vessels for automotive use
ASTM A254	Specification for copper brazed steel tubing
BS 3463	Specification for observation and gauge glasses for pressure vessels
JIS C3406	Low-voltage Cables for Automobiles
NZ	Safety Inspection Guide
SAE J30	Fuel and oil hoses
SAE J369	Flammability of polymeric Interior Materials - Horizontal Test Method
SAE J533	Flares for tubing
SLS 1203	Filling unit for LPG for automotive use SLS 1215 Accessories fitted to the LPG container for automotive use
SLS 1205	LP Gas fuel containers for conversion of automotive to bi-fuel (Petrol-LPG) propulsion system.
SLS 1208	Vaporizer/Regulator for conversion of automotive to bi-fuel (Petrol-LPG) propulsion system
SLS 1237	Working areas for LP Gas-fuelled vehicles

3 DEFINITIONS

For the purpose of this standard the following definitions shall apply:

3.1 approved, approval : Approved by or approval of the regulatory authority.

3.2 authorized person : A person qualified, authorized or licensed by the relevant Government or local body to install or service LP Gas equipment in automotive vehicles.

3.3 authority : The authority having regulatory powers to control design, manufacture and installation of equipment described in this standard in the province in which the vehicle is registered.

3.4 automatic fill limiter : A provision in the filling system which automatically terminates filling when a predetermined liquid level in the container has been reached.

3.5 automatic fuel shut-off device : A provision for automatically shutting off the fuel supply unless certain essential conditions exist.

3.6 capacity (of a container) : The total internal volume of the container, expressed in litres.

NOTE
This was previously known as 'water capacity'

3.7 compartment : A structure which encloses the whole of the container and its fittings, whose purpose is to collect any gas leakage which might occur, so that it can be discharged to open air.

3.8 container : A pressure vessel, cylinder or tank for the storage of LP Gas to be used as fuel for the internal combustion engine.

3.9 contents gauge : A gauge which gives a visual indication of the liquid content of the container. This may be read at the container or remotely.

3.10 double non-return valve : Two non-return valves arranged in series to provide dual security against back-flow.

3.11 excess-flow valve : A valve normally in the open position which closes automatically when flow in a specified direction exceeds a predetermined limit.

3.12 fixed liquid level gauge : A gauge which indicates the maximum permitted liquid level in the fuel container. It is either of two types: one incorporates a tube arranged with its open end located at the liquid level, so that gaseous discharge changes to liquid discharge as the liquid surface reaches the level; the other is sight-glass of the circular window-type, marked at the level.

3.13 fuel filter : A component that is capable of removing from the fuel all particulate matter which could cause malfunction of other components or values downstream in the system and is capable of being removed, cleaned or replaced.

3.14 fuel service line : Piping used for the conveyance of LP Gas liquid from the filling connection to the fuel container or from the fuel container to the LP Gas vaporizer at a pressure exceeding 100 kPa.

3.15 gas-air mixer : A device for introducing gaseous fuel to the induction air of the engine.

3.16 hydrostatic relief valve : a valve whose purpose is to relieve and prevent over pressure in any fuel service line carrying LP Gas.

3.17 ignition source : A source of energy sufficient to ignite a flammable atmosphere and includes naked flames, exposed incandescent material , electric welding arcs, and electrical or mechanical equipment or components not approved for use in hazardous areas.

NOTE
A vehicle is not regarded as being an ignition source while it is entering or leaving the hazardous zone surrounding a fuel dispenser, for refueling

3.18 internal (component) :. A fitting or component constructed with its significant working parts within the tank perimeter so that any damage to exposed portions will not prevent effective safe functioning of the component, e.g. closure, reseating, pressure relief.

NOTE

The perimeter of the tank is taken to mean not only the surface of the tank shell and ends, but also the outline of any boss, spigot, or nozzle welded to the tank so as to project outwards from it. The outline of welded brackets, mountings, guards, sub-compartments, or the like would not be considered as being the perimeter for the purpose of this clause.

3.19 licensed installer : A person who has completed an authorized training course and is registered with the authority.

3.20 LP Gas : A mixture of propane and butane in varying proportions with minor traces of other hydrocarbons.

3.21 maximum permitted filling level : The level of the liquid in a container when the liquid contents are 80 per cent of the total available internal volume of the container.

3.22 may : indicates the existence of an option

3.23 non return valve : A valve which permits fuel flow in only one direction.

3.24 pol coupling : An LP Gas union connection as specified for Type 21 in **AS 2473** and having a left-hand thread.

3.25 pressure : Gauge pressure (as opposed to absolute pressure).

3.26 professional engineer : A person who is

1) a Corporate Member of the Institution of Engineers, Sri Lanka; or

2) eligible to become a Corporate member of the Institution of Engineers Sri Lanka, and has appropriate experience and competence in the relevant field.

3.27 regulator : A device which reduces fuel pressure to a level appropriate for delivery to the vaporizer and incorporates a system which prevents passage of vapour after the engine has stopped turning, irrespective of whether the ignition is on or off.

3.28 relief valve : A valve which automatically discharges fluid to atmosphere or a reduced pressure system so as to prevent a predetermined pressure being exceeded. It is used primarily for non-compressible fluids (i.e. liquids). It is activated by the static pressure upstream of the valve.

3.29 removable container : A container which is removed from the vehicle for refueling, usually in exchange for a full container.

3.30 safety coupling : A coupling which is normally open when in use, but which closes automatically to both directions when uncoupled.

3.31 safety valve : A valve which automatically discharges vapour to atmosphere so as to prevent a predetermined pressure being exceeded. It is activated by the static pressure upstream of the valve.

3.32 service valve : A manually operated shut-off valve fitted on the container which can open or shut-off the LP Gas supply for maintenance servicing or emergency requirements.

3.33 shall : Indicates that a statement is mandatory

3.34 should : Indicates a recommendation

3.35 sub-compartment : A structure attached to the container, which encloses the container fittings, and whose purpose is to collect any gas leakage which might occur, so that it can be discharged to open air.

3.36 vaporizer : A device which vaporizes LP Gas liquid for delivery to the gas/air mixer.

4 REQUIREMENTS

4.1 General

4.1.1 *Vehicle modifications*

Any alternations or modification to any vehicle resulting from the installation of LP Gas equipment shall be carried out in accordance with sound engineering practices. Modifications include any alternations to the following:

a) Suspension including mounting locations, geometry, ground clearance adjustment, axles and sub-axles, or steering mechanism.

b) Original fuel storage including the fuel tank assembly, fuel tank mounting, venting or filler assemblies.

NOTE
In some instances the original fuel tank constitutes a structural member of the vehicle.

c) Vehicle structure including any additional holes, welded joints, direct load bearing points and structural alternation near seat anchorages.

Holes greater than 13 mm shall not be located within 40 mm of the edge of a panel, welded joint or direct load bearing point or any structural alternations within 200 mm of any seat belt anchorage or child restraint anchorage. The only holes permitted greater than 13 mm diameter are for the installation of the filling valve or for venting purposes.

d) Braking system including the hand brake and components.

e) Spare wheel location including the spare wheel mounting and its anchorage.

The spare wheel mounting and its anchorage shall be designed to withstand a minimum design load of 20 g in any direction.

f) Anchorages Including seat anchorages, seat belt anchorages and child restraint anchorages.

The modifications listed in items (a) to (f) shall comply with, relevant codes and standards accepted by the Ministry of Transport.

4.1.2 Minor alternations

The weight of the LP Gas container (s) will affect the tare weight of the vehicle and consideration of the effect on the legal and manufacturer's rating on tyre and axle loadings should be considered. In no circumstances shall the vehicle's critical load distribution which affects safety considerations be compromised.

4.1.3 Engine management system

Any alternation(s) made to a vehicle's original equipment or the engine's fuel management system shall not adversely affect the original manufacturer's design, safety level and performance when operating on the fuel for which it was designed.

Where a vehicle was originally designed to operate with a closed loop engine management system, an LP Gas closed loop management system shall be installed that results in exhaust emission levels for LP gas operation that meet the requirements of the Ministry of Transport.

4.1.4 Approved equipment

Only equipment acceptable to the relevant authority shall be used.

4.1.5 Previously used equipment

Previously used equipment may be reinstalled or transferred to another vehicle provided that

a) the equipment is in good condition and continues to comply with current standards;

b) the fuel container has been subjected to the preliminary examination described under 'filling conditions' in **AS 2030.1**; and

c) the following components and materials are not reused;

i) Any piping or hose that has been subject to the liquefied LP Gas

ii) Any fittings used for the connection of pipes or hoses to components subject to container pressure.

iii) Any grommets or fittings used to seal piping through bulkheads.

4.1.6 LP Gas withdrawal from automotive systems

An automotive LP Gas fuel system shall not be provided with connection points to facilitate the decanting of LP Gas liquid or the withdrawal of LP Gas vapour for applications other than engine fuel.

4.1.7 Working area and safe practices

The working area or the practices applied during installation, inspection, testing and commissioning shall comply with **SLS 1237**

4.2 Components

4.2.1 General suitability

4.2.1.1 General
Components shall be suitable for conditions of use, e.g. temperature, pressure, corrosion. compatibility and vibration. Suitability of components shall be proved by testing wherever appropriate.

4.2.1.2 Suitability for pressure

The design pressure for a component or any portion of a component that is subject to container pressure shall be 2.55 MPa. The suitability of any such components shall be determined either by strength calculation in accordance with normal pressure vessel rocedures, or by the ability to withstand bursting in a hydrostatic pressure test at not less than 10.2 MPa applied for not less than 1 min.

In addition, each such component shall not suffer damage sufficient to cause leakage or malfunction after being subjected to a cyclic pressure test comprising 10 000 applications of a hydrostatic pressure of 5 MPa. Connections to the component under test, methods of mounting and means of blanking openings shall be representative of actual installation fittings, and shall not provide additional stiffening or support for the component under test.

4.2.2 Moving parts

Components having moving parts shall not leak or suffer unacceptable loss of performance when subjected to repeated cycles or normal operation as nominated in Table **1**.

TABLE 1 - Moving parts cycle test

Components	Cycles
Non-return valve	6 000
Bleed valve (of a fixed liquid level gauge	6 000
Service valve	6 000
Excess-flow valve	6 000
Automatic fill limiter (the valve functions	6 000
Liquid level sensor, whether a part of a shut-off valve or of another contents gaug	1 00 000
Safety valve and hydrostatic-relief valve	6 000
Automatic fuel shut-off device	1 00 000
Regulator	1 00 000
Filling connection	6 000

4.2.3 Suitability for installation

Components shall be robust enough to withstand the stresses imposed by fitting and tightening the connections.

4.2.4 Modification

Modifications to an approved component shall not be made without specific approval of the manufacturer and the regulatory authority.

4.2.5 Metals

Used in valves on the container shall be those specified in **AS 2473**. Aluminum alloys may be used for another components except piping and pipefittings. Metallic materials having a melting point lower than 500 ^{0}C shall not be used in any application where failure may result in gas escape.

4.2.6 Non-metals

Non-metallic synthetic materials used in seals or diaphragms in contact with LP Gas shall comply with the following requirements:

a) The part shall not change volume or mass in excess of that shown in Table **2** after immersion in hexane or pentane at 20 ^{0}C for 70 h.

b) The part shall not show visible evidence of deterioration after exposure to oxygen at 2 MPa and 20 ^{0}C for 96 h.

TABLE 2 - Immersion test limits

Nature of change	**Maximum permissible change per cent**	
	Diaphragms	**Other parts**
Volumetric swelling	25	25
Volumetric shrinking	10	1
Loss of mass	15	10

4.3 Container sub-assembly

4. 3.1 Application

This section addresses the location, mounting, protection, venting and installation requirements for the container sub-assembly.

4.3.2 Container

4.3.2.1 General

A fuel container shall comply with **SLS 1205**

4.3.2.2 Use of removable containers

Containers which are removed for refueling shall be used only in strict compliance with the requirements laid down in this code under relevant clauses.

4.3.3 Components for fixed containers

A container system that is installed for in situ filling on a vehicle shall be provided with the following components:

a) Filler connection

b) Filler cap

c) Filler non-return valve system
d) Automatic fill limiter

e) Service valve

f) Excess-flow valve

g) Safety valve

h) Contents gauge

i) Automatic fuel shut-off device.

4.3.4 Components for removable containers

A container that is removed from the vehicle for filling shall be provided with at least the following components:

a) Filler connection

b) Filler cap

c) Service valve

d) Excess-flow valve

e) Fixed liquid level gauge or automatic fill limiter, (only if filled by monitoring volume instead of by mass).

f) Safety valve.

4.3.5 Component suitability

Container components other than those makes and models nominated by the container manufacturer or professional engineer for use with that particular container shall not be fitted.

4.3.6 Filling connection

The container filling connection shall comply with **SLS 1203**.

4.3.7 Filler non-return valve system

Filler non-return valve system shall comply with Clause **4.2.2** of SLS **1203**.

4.3.8 Automatic fill limiter (AFL)

4.3.8.1 Design
Design of the automotive fill limiter shall comply with Clause **4.3.1** of **SLS 1215: 2001**

4.3.8.2 Performance

The performance of the AFL shall comply with Clause **4.5.7** of **SLS 1215: 2001**

4.3.8.3 Durability

The AFL shall continue to comply with the **4.3.8.2** subsequent to testing as follows:

a) The cycling and a function test specified in **4.2.2** shall be carried out using either air or water at a pressure of 700 kPa. The liquid level sensor may be operated either by a mechanical device or by changing the liquid level.

b) The liquid level sensor shall move through its full available travel, with acceleration and deceleration not exceeding 1 N/s**.**

c) The complete unit shall be subjected to vertical vibrations at 17 Hz and 6 mm amplitude for 200 h. The unit shall be mounted in the normal working altitude with the liquid level sensor unrestrained for this test.

d) The liquid level sensor shall be subjected to an external LP Gas liquid pressure of not less than 1.1 times the design pressure, i.e 2.8 MPa, for 30 min. It shall then be subject to LP Gas vapour pressure corresponding to ambient temperature for a further 30 min.

4.3.9 Fixed liquid level gauge

4.3.9.1 General

Where a fixed liquid level gauge is fitted, it shall indicate when the liquid level is at the maximum permitted filling level and shall be sufficiently accessible to permit periodic checking of the automatic fill limiter. The arrangement shall be such that any discharge that occurs during checking can be directed away from an enclosed passenger compartment or goods compartment. The use of temporary extension tubing is permissible.

Any opening communicating between the gauge and the interior of the container shall be restricted by an orifice not larger than 1.4 mm diameter, which shall be internal.

4.3.9.2 Gas-bleed type

A fixed liquid level gauge which relies on bleeding gas or liquid to atmosphere shall comply with the following requirements:

a) The gauge valve shall be of the sealed stem type.

b) It shall not be possible to remove moving parts of the gauge valve.

c) The outlet shall be provided with a cap or plug capable of retaining container design pressure.

4.3.9.3 Sight-glass type

A sight-glass type of fixed liquid level gauge shall be of a circular type, and shall comply with the following requirements:

a) The transparent viewing element is made of a toughened (tempered) glass complying with **BS 3463** or equivalent material.
b) The pressure at which the gauge glass fails is not less than 50 MPa.

c) The gauge incorporates a means to distinguish whether the sight glass is fully filled with liquid or empty of liquid.

4.3.10 Contents gauge

An electrically operated contents gauge shall be approved for use in a Zone 2 area (See AS **2430.1**).

4.3.11 Excess-flow valve

The excess flow valve shall comply with Clause **4.3.3** of **SLS 1215 : 2001**

4.3.12 Service valve

The service valve shall be a manually operated shut-off valve.

4.3.13 Automatic fuel shut-off device at container

The automotive fuel shut-off device shall comply with Clause **4.3.6** of **SLS 1215 : 2001**

4.3.14 Fuel filter

A fuel filter shall be fitted which is capable of removing from the fuel all matter that could cause malfunction of the automatic fuel shut-off device.

4.3.15 Safety valve

4.3.15.1 General

The safety valve shall comply with the following requirements:

a) The safety valve is internal

b) The safety valve complies with the requirements appropriate to the type of container to which it is fitted, **AS 2613** for a gas cylinder or an automotive fuel container, or **AS 1210** for a pressure vessel.

c) The start-to-discharged setting is 2.55 MPa

4.3.15.2 Safety valve discharge

The discharge provisions for a safety valve shall be such that discharging gas will not impinge directly on the container, on bystanders, or on adjacent vehicles, and will not discharge towards or directly into a passenger compartment. The following arrangements shall be deemed to comply with this requirement:

a) Discharge into a compartment or sub-compartment that complies with **4.3.17**.

b) Piping in accordance with **4.3.15.3** to a remote discharge point.

c) For externally mounted container having no compartment or sub-compartment, a short discharge pipe, directional guide, baffle having an equivalent effect, arranged to reduce the velocity of the discharge or direct it safely.

4.3.15.3 Safety valve discharge piping

Safety valve discharge piping shall comply with Clause **4.3.4.3** of **SLS 1215 : 2001**

4.3.16 Location of container components

4.3.16.1 The components listed in **4.3.3** shall be installed in accordance with the following requirements:

a) Each component to be mounted directly on the container without any intermediate pipe or fitting, except for those components associated with a remote filling arrangement or an automatic fuel shut-off device fitted to containers.

b) The safety valve communicates with the vapour space of the container, and no valve shall be installed between the safety valve and the container.

c) The automatic fill limiter to be installed so as to prevent the filling of the container to a level exceeding 80 per cent of its capacity, with the container correctly oriented in accordance with the manufacturer's specification.

d) The excess-flow valve to be arranged to control the flow of liquid from the container should an external valve be damaged leading to an excessive flow of LP Gas liquid.

NOTE
The excess-flow valve is usually combined with the service valve at the valve inlet side.

4.3.16.2 The components listed is **4.3.4** shall be installed in accordance with the following requirements:

a) Each component to be preferably mounted directly on the container without any intermediate pipe or fitting except for those components associated with a remote filling arrangement or an automotive fuel shut-off device fitted to container.
b) When pipes and fittings are used for connection they should be as short as possible and hardly sufficient to make a proper connection lea no excess lengths.

c) The excess-flow valve to be arranged to control the flow of liquid from the container should an external valve be damaged leading to an excessive flow of LP Gas liquid.

4.3.17 Compartment and sub-compartments

Compartments and Sub-compartments shall comply with Clause **4.3.7** and Clause **4.4.5** of **SLS 1215 : 2001**

4.3.18 Mounting of fuel container

4.3.18.1 Correct orientation

The container shall be correctly orientated so that the accuracy of the contents gauge, fixed liquid level gauge, safety valve, and automatic fill limiter is not impaired.

The date of inspection stamping of a permanently mounted fuel container shall be clearly visible when the container is installed.

4.3.18.2 Access to valves

It shall be possible to operate the service valve for the purpose of servicing, or a filler shut-off valve if fitted, in the installed position.

The valve may be arranged so that it can be operated from some internal area of the vehicle provided that the sealing of the compartment or sub-compartment shell is maintained by one of the following means:

a) If a valve-actuating device passes through the shell, a gastight seal shall be provided.

b) If the actuating handle is wholly within the shell, access shall be by a gastight captive hatch that could be opened without tools.

4.3.18.3 Attachment to vehicle

The container shall be securely attached to the vehicle and slipping, rotating, and jarring loose of the container shall be prevented in accordance with the following requirements:

a) The method of attachment does not cause unacceptable stresses in the container shell, or be a potential cause of deterioration of the container shell. In particular:

(i) clamping bands where used shall be a minimum of two flat bands as provided by calculation in **4.3.18.3** (d); round or square sections, wire, cable or material likely to localize loading shall not be used.

(ii) shearing burrs on flat straps shall be arranged to be on the side remote from the shell;

(iii) metallurgical incompatibility shall be avoided, e.g. galvanized bands should not contact stainless steel shells; and

(iv) corrosion of the container should be minimized by avoiding entrapment of moisture in non-draining features and resilient materials shall not be interposed between the shell and a band.

NOTE
Figure 1 illustrates design of container mountings

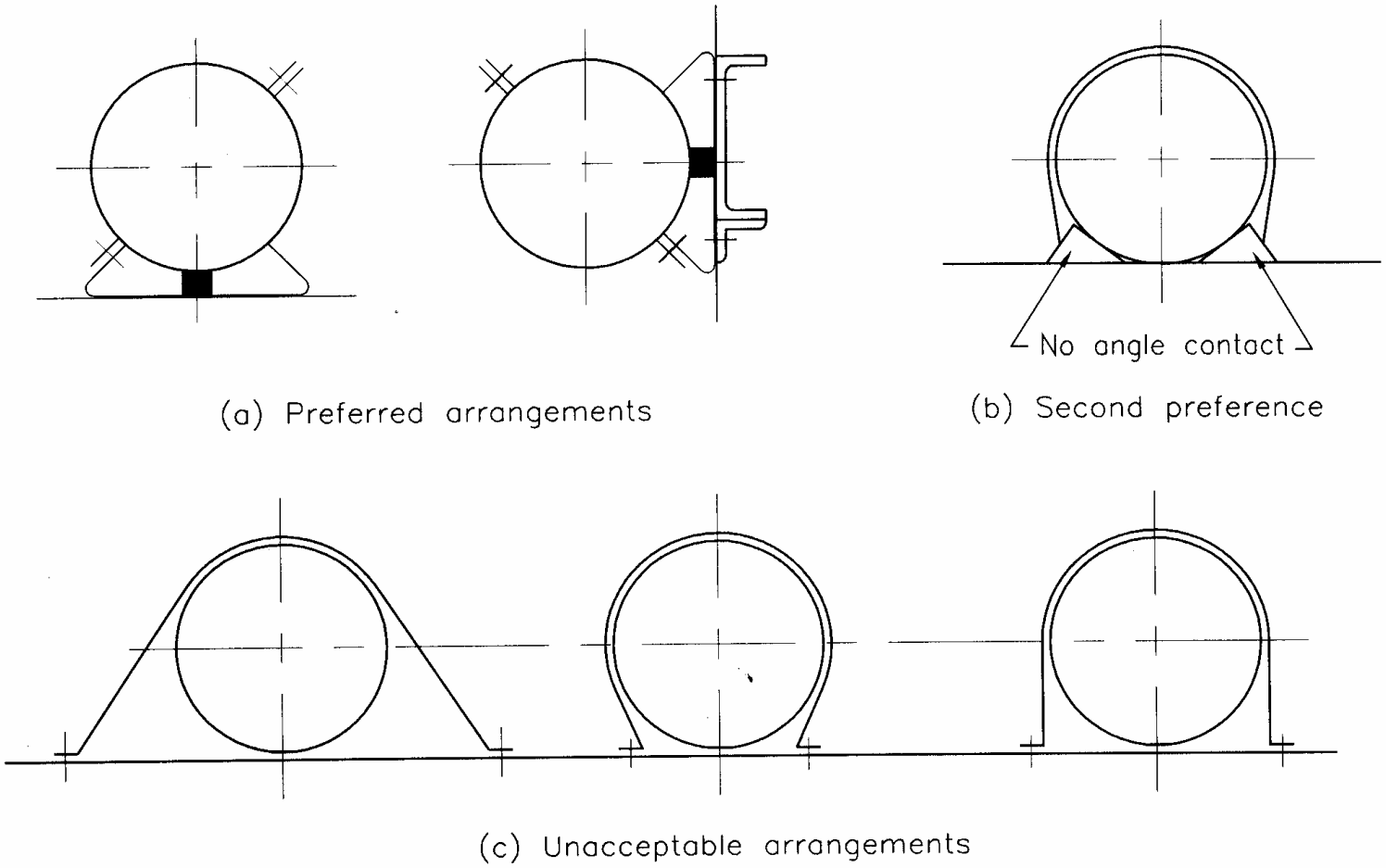

FIGURE 1 - Fuel container mounting

b) fixing lugs and brackets, if welded to the container, shall be attached only at original manufacture, and specifically shall not be attached by field welding or brazing.

c) the mounting method shall not significantly weaken the vehicle structure and reinforcement shall be added where necessary to ensure compliance with item below.

d) the force necessary to separate the container from the vehicle shall be not less than 30 g times the mass of the full container, in any direction.

The strength of the anchorages may be established by dynamic test (deceleration over 20 ms^{-1}) or static test (forces directed through the centre of mass of the container) or by calculation.

If dynamic testing, static test or calculations are impracticable, the following design requirements shall apply to containers of up to and including 150 l capacity:

(i) There shall be at least four points of attachment to the vehicle structure, the distance between which shall be sufficient to ensure the stability of the container.

(ii) Where the container is anchored to sheet metal, the sheet metal shall be sandwiched between two reinforcement plates at each attachment point with areas not less than 5500 mm^2 and thickness not less than 2.5 mm. Any such reinforcement plates shall be contoured to the shape of the sheet metal. It is preferred that a round washer be used but where a square plate is fitted the corners shall be radiused to 5 mm and the bolt hole shall be positioned in the centre of the plate/washer. Where the bolt hole is not central in the plate, the nearest edge shall be bent to from an L-section to provide additional stiffening.

(iii) Where anchorage bolts pass through a hollow section, a spacer tube shall be provided to prevent collapse of that section under load.

(iv) Anchorage bolts studs for band or flange mountings shall have a diameter of not less than that shown in Table 3 and shall comply with **AS/NZS 1110** or **AS/NZS 2465**, of a 5.6 HT grade.

(v) Where clamping bands are used, at least two steel bands shall be provided, the dimensions of which shall be not less than those shown in Table **3**.

(vi) Where parts are joined e.g. by welding a stud to a band, the strength of the joint shall be not less than the strength of either component. If a bolt is workshop/field welded to the end of strap then each welded joint will need to be tested to prove the strength of the joint.

NOTES

1) The attachment of a container to the roof of a vehicle, and particularly to the gutters, is generally considered to be of inadequate strength, and unsatisfactory for as number of other reasons. Such installations require specific approval, which is usually given only for special vehicles, and takes into account such aspects as vehicle speed, container protection and strength of mountings.

2) Cylindrical containers secured using clamping bands may require end retention features as a means of resisting longitudinal end loads on the cylinder due to vehicle impact.

e) Screwed fasteners or clamping devices shall either be inherently resistant to loosening or be locked or pinned after tightening.

f) Underslung containers shall be anchored to structural members or if containers are to be mounted to underfloor flat areas the attachment and mounting shall be approved by a professional engineer.

Containers exceeding 150 l capacity shall have the attachment and mounting designed by a professional engineer who shall provide a written report to the installer, stating that the mounting of the container meets the minimum strength requirements of this standard. (See self-certification requirements of the Table **3**) It remains the responsibility of the licensed installer to retain a copy of the report.

4.3.18.4 Multiple containers

For installations with more than one container, a specific design may be required for the mounting attachment.

TABLE 3 - Dimensions of attachment

Container capacity l		Band dimensions (minimum nominal size) mm	5.6 HT grade bolt or stud diameter for band or flange mountings(minimum nominal mm
Over	Upto and include		
0	100	30x3	10
101	150	50x6	12
151	-	Certification by a professional engineer	

4.3.19 Container location, ground clearances

A container shall be located in accordance with the following requirements:

a) The vehicle mass for determining ground clearances shall be the unladen mass, but with all fuel, coolant, and oil containers full. Dimensions shall relate to the vehicle manufacturer's standard product.

b) For a vehicle of less than 4.5 t mass or having a chassis ground clearance of not more than 600 mm at the rear (See Note 1), no part of a fuel container, compartment or sub-compartment that is beneath or towards the ends of the vehicle shall lie outside a zone whose boundaries are those shown in Figure **2**.

(i) 200 mm above the ground level:

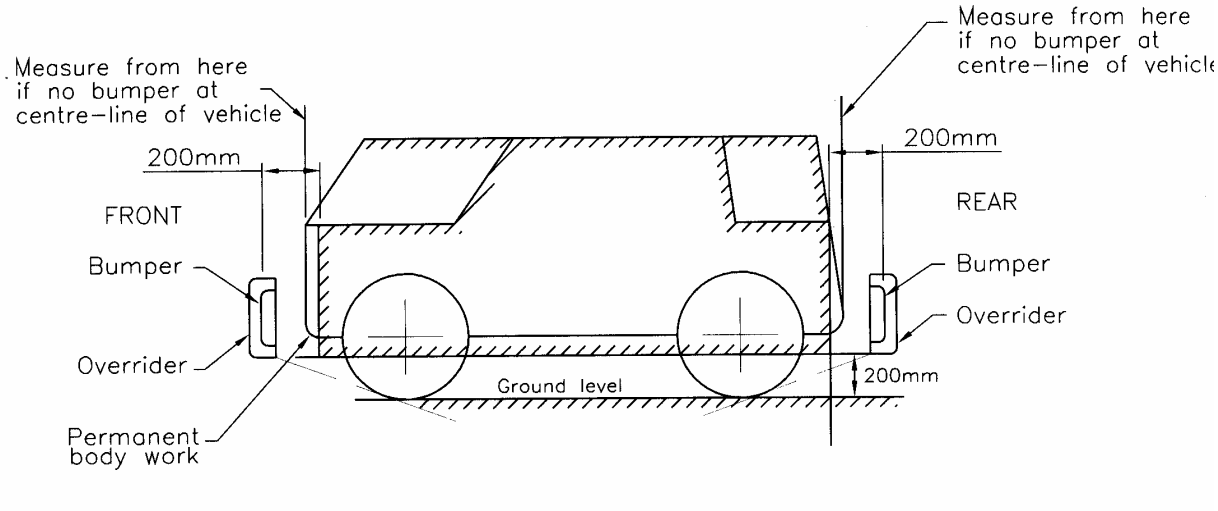

FIGURE 2 – Zone of clearance-lower or smaller vehicles

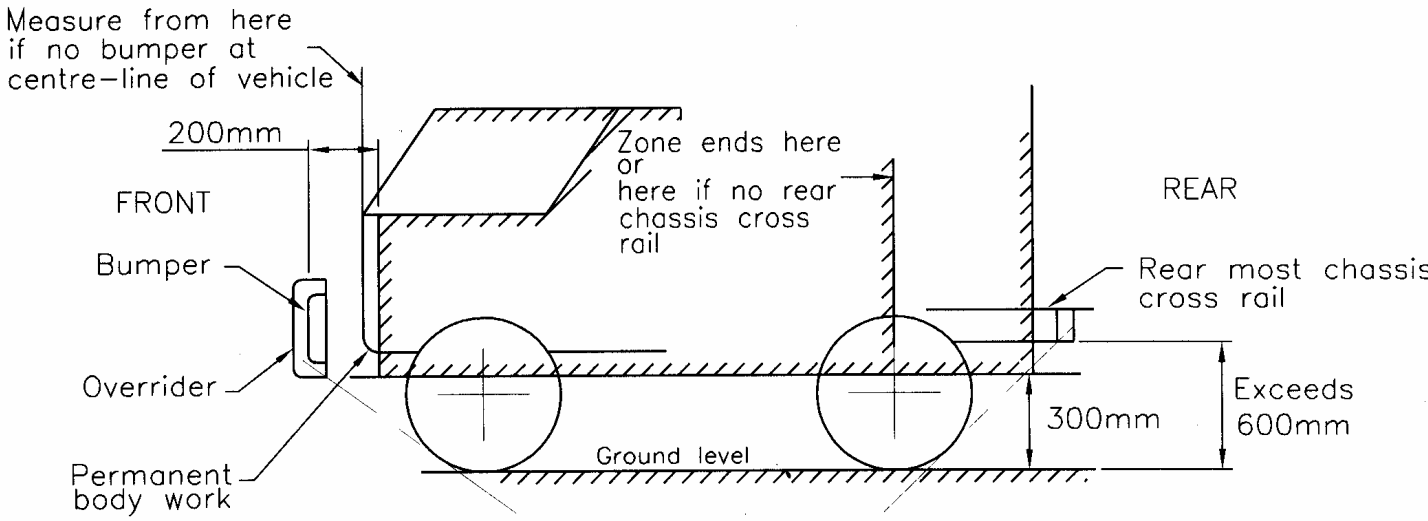

FIGURE 3 – Zone of clearance-lower or smaller vehicles

(ii) 200 mm inboard of the centre of the original equipment bumper bar at either end or, if a bumper bar is not fitted, the extremity of the bodywork on the vehicle's centre-line; and

(iii) Along an angular plane tangential to the front or rear wheels and sloping upwards and outward to the extremity of the original permanent bodywork or bumper bar if fitted.

c) For a vehicle of 4.5 t or more mass, or having a chassis ground clearance exceeding 600 mm at the rear (See Note 1), the zone boundaries shall be those shown in Figure **3**.

(i) 300 mm above the ground;

(ii) The front of the rearmost chassis cross members if provided otherwise the centre-line of the rearmost wheels;

(iii) 200 mm inboard of the centre of the original-equipment bumper bar at the front or, if a bumper bar is not fitted, the extremity of the bodywork on the vehicle's centre-line; and

(iv) an angular plane at the front of rear as defined in Item (b) (iii) above.

d) A container shall not be mounted outside the body contour to the front or sides of the vehicle.

e) A container shall not be mounted outside the body contour behind the vehicle without specific approval of the mounting, the location and the protection (See Note 2) .

f) A container installed inside a vehicle shall not be mounted forward of the rear of the driver's seat (seat adjusted in rearmost position) unless specifically approved by the authority.

NOTES

1 If the combinations of vehicle mass and chassis height places the vehicle outside the two cases described in Items (b) and (c, the vehicle will be treated on the basis of chassis height.

2 The Note to 4.3.18.3(d) addresses the mounting of fuel containers on the roof of vehicles.

4.3.20 Protection

A fuel container, together with its associated attachments, shall be located and protected so that the possibility of damage from impact, accident, or loose objects is minimized. The following specific requirements apply:

a) Each container shall be located in a position, or provided with protection, such that damage in the course of normal vehicle usage is minimized. In particular:

(i) locations vulnerable to impact by objects thrown by tyres shall be avoided; and

(ii) damage due to impact by objects being handled by or carried by the vehicles shall be prevented.

NOTE

For the purpose of this standard, the luggage space of a passenger car is exempt from Item (ii)

b) A container with a wall thickness of less than 2.2 mm shall not be installed. The location shall be so that no part of the shell is less than 75 mm from the side panels of the vehicle. Vehicle panels shall not be reshaped in order to comply with this requirement.

c) The shell of a container shall not be in contact with any part of the vehicle, any piping, or any objects, which could cause rubbing or the entrapment of moisture by the maintenance of not less than 2.5 mm clearance. (See **4.3.18.3**)(a) (iv).

d) Provisions shall be made to protect the container and its associated components from damage in the event of failure of the vehicle's tail shaft if the container is less than 200 mm from the tail shaft.

e) A fuel container which is below the floor of a vehicle shall be provided with a guard to protect against ground impact when one or more of the following conditions exist:

(i) The clearance between the container and the ground is less than 300 mm.

(ii) The mass of the vehicles is less than 4.5 t; and

(iii) The whole of the container is behind the centre-line of the rear axle of the vehicle.

The guard shall be at least equivalent to a 1.5 mm steel plate guard, arranged to shield the silhouette of the cylindrical portion of the container. Drainage shall be provided if shaping could otherwise accumulate water.

f) The valves or fittings or protective guard on a container that is located longitudinally at the side of a vehicle and is mounted in accordance with **4.3.18.1** shall not project beyond the vertical tangential to the container shell.
(See Figure **4**)

g) Engine exhaust outlets shall be directed away from the container.

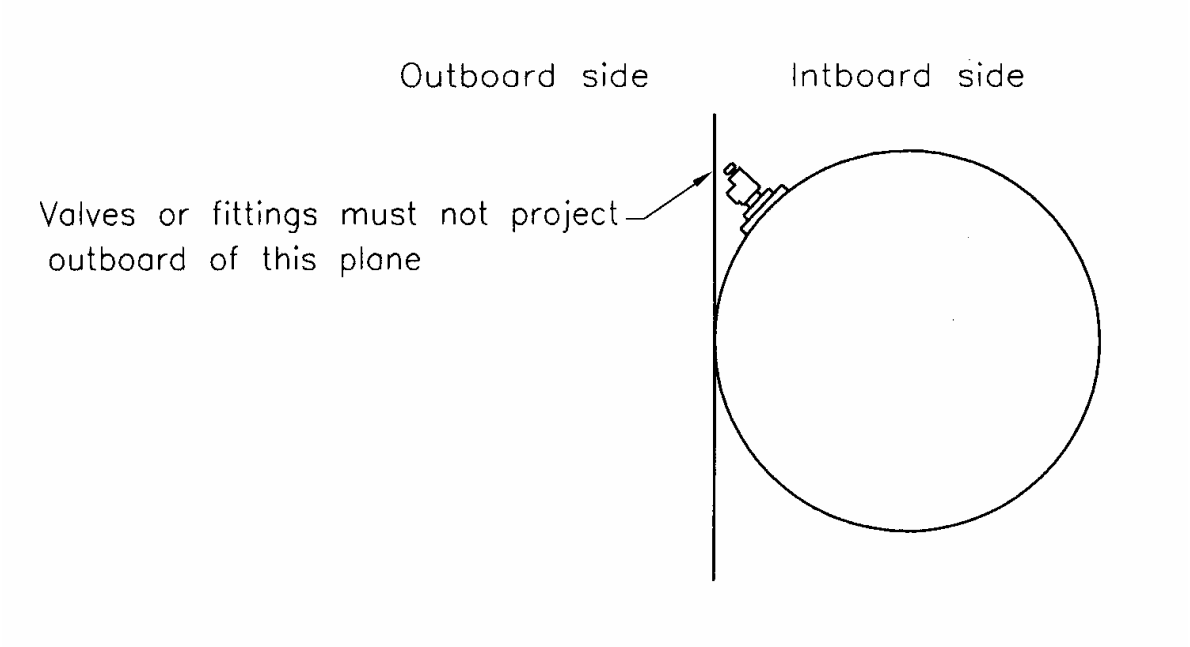

FIGURE 4 –Protection, side-located longitudinal containers

4.3.21 Heat shielding

Fuel containers shall be situated as far from the exhaust system as practicable and in no case shall the distance be less than 150 mm unless a heat shield is provided.

If a single sheet metal shield of sufficient dimensions to provide complete shielding is arranged not less than 15 mm from the protected item, the distance from the heat source to the fuel container may be reduced to not less than 40 mm.

NOTE

Exhaust systems should not be positioned below the container unless there is no practical alternative route.

4.3.2.2 Suitability for hazardous zones

Any electrical equipment or component that is located within a compartment or sub-compartment or any associated ducting shall be suitable for use in a Zone 2 area.
(See **AS 2430.1**)

4.4 Fuel service line

4.4.1 Application

This section addresses the requirements for the LP Gas fuel service line and associated fittings for pressures both exceeding 100 kPa and less than 100 kPa. The requirements for a fuel service line for pressure exceeding 100 kPa are addressed in **4.4.2** to **4.4.10** for pressure less than 100 kPa in **4.4.11**.

4.4.2 Rigid piping

4.4.2.1 General

Rigid metallic piping that is subjected to container pressure shall be one of the following:

a) Copper-brazed steel tubing in accordance with **AS 1751** or **ASTM A254**, ternecoated.

b) Copper tubing in accordance with **AS 1432** or **AS/NZS 1572** having a nominal wall thickness of not less than 0.91 mm if under 10 mm diameter, or not less than 1.02 mm if 10 mm or larger.

NOTE

*Discharge piping for safety valves is subject to specific requirements (See **4.3.15.3**) and is therefore not subject to this requirement.*

4.4.2.2 Suitability of rigid piping

Rigid piping shall comply with **4.4.2** and shall be applied under the following condition:

a) Rigid piping for the fuel service line shall be as small as possible consistent with the needs to supply the maximum requirements of the engine, and shall be not less than 6 mm outside diameter.

b) Installer-made joints and connections shall be restricted to the connection of essential components. A minimum number of factory produced joints may be incorporated in the length of a service line.

c) Rigid pipe shall not be used between parts which can move relative to each other, e.g. between a body/chassis and a flexibly mounted engine/fuel tank.

4.4.3 Flexible piping (Hose and hose assembly)

A hose and hose assembly shall comply with the Class D requirement of **AS/NZS 1869** up to a maximum of 2.6 MPa.

4.4.4 Joints and connections

Any joint for connecting or mounting a component or rigid piping or hose assembly which is subjected to container pressure shall be one of the following:

a) For copper-brazed steel tubing, a double-wall 90-degree flare connection in accordance with **AS D26** or **SAE J533**.

b) For copper tubing, a 90-degree flare connection in accordance with **AS D26** or **SAE J533**

NOTE
It is important that the correct flaring tool is used with no excessive pressure applied which could reduce the tubing wall thickness.

c) A flanged joint.

d) A welded or brazed joint, provided that such joints are limited to the factory assembling of components.

e) A screwed joint, provided that, when the thread is used as a seal, only taper-to taper threads are used.

f) A ground face union.

g) A service valve connection.

4.4.5 Installation and protection

LP Gas fuel service lines shall be installed in accordance with the following requirements:

a) Fuel service lines follow the shortest practical route.

b) The vehicle body is used as a protection from chance impact or collision.

Where the fuel service line is below the vehicle body shell, it shall be shielded by structural members of the chassis or underframe, or be otherwise adequately protected from impact or abrasion.

Although not recommended, if the fuel line has to be positioned inside wheel arches the fuel line shall be protected against impact by items which may be thrown up within the wheel arch, and the fuel line shall be positioned so as the tyre cannot rub on the fuel line under all cornering and load conditions.

c) Use of the drive shaft tunnel for fuel line location is not desirable or recommended. If such routing is the only possible practicable method of installation, the fuel line shall be positioned along the lower corner of the tunnel with the underside of the fuel service line not more than 15 mm above the intersection with the floor plan. The fuel

line should follow this route for the shortest distance possible. The fuel line shall have a minimum clearance of 40 mm with the drive shaft under all operation conditions.

This method is not applicable to vehicles where the open axle shaft passes through an enclosed tunnel.

d) Rigid piping likely to be subject to corrosion shall be effectively protected throughout its exposed length, particular attention being given to the possibility of any road corrosion.

Copper tubing shall be encased in plastic tubing throughout its exposed length to within 150 mm of each LP Gas component.

e) Rigid piping shall be effectively secured to the chassis frame or vehicle body by suitable metallic or plastic clips spaced not more than 600 mm apart. In order to prevent the possibility of fretting corrosion or erosion of the fuel service line, cushioning shall be provided to protect the rigid pipe from both the chassis/body and the clips themselves. Suitable grommets shall be provided where the rigid pipe or hose assembly passes through any body panel.

Hose assemblies shall be effectively secured to the chassis frame or vehicle body by suitable metallic or plastic clips spaced not more than 600 mm apart except in vent hose conduits where they may be unsupported for the length of the conduit.

This requirement does not preclude the running of the fuel service line within the sub-compartment vent tube where it is protected from impact and abrasion.

f) Where a rigid pipe, hose assembly, compartment or fitting is subject to container pressure and is within 150 mm of a hot object at a temperature above the normal water jacket temperature, a protective radiation shield shall be interposed. If a single sheet metal shield of sufficient dimensions to provide complete shading is arranged not less than 15 mm from the protected item, the distance from the heat source to the fuel service line may be reduced to not less than 40 mm.

NOTE
Examples of such heat sources would be parts of the exhaust system, turbochargers, and some types of refrigerant compressors.

4.4.6 Piping or fitting in enclosed spaces

Rigid piping, fittings or hose assembles that are located in enclosed spaces shall comply with the following requirements:

a) Except for containers, LP Gas components/fittings shall not enter an enclosed driver, passenger or vehicle luggage compartment.

b) Containers fitted in enclosed vehicle compartment shall have LP Gas liquid piping follow the shortest practicable route to the outside of the vehicle compartment and pass through a conduit which complies with **4.3.16.2**

c) Rigid piping and hose assembly joints shall be accessible.

4.4.7 Multiple container installations

Where more than one fuel container is installed and the liquid spaces are interconnected to a common fuel service line, a spring loaded non-return valve shall be installed between each container and the common fuel service line and the fuel service line shall be provided with a hydrostatic relief valve.

Manifolds used in multi-container applications shall be installed in a protected location.

Manifold branch pipelines shall be sufficiently flexible to prevent damage to the lines, valves and fittings due to vibration, expansion or contraction.

4.4.8. Hydrostatic relief valve

Any hydrostatic relief valve provided in accordance with **4.4.7** shall be set to operate at 3.1 MPa and shall be installed in accordance with the following requirements:

a) The direction of discharge shall be away from enclosed spaces and sources of ignition, and shall be such as to minimize the accumulation of dirt.

b) The location shall afford protection from damage and dirt, and shall be accessible for inspection and service.

4.4.9 Trailers and semitrailers

Rigid piping or hose assemblies shall not pass between a towed vehicle and its towing vehicle.

4.4.10 Previously used equipment

Previously used equipment may be reinstalled or transferred to another vehicle provided that the following components and materials are not reused.:

a) Any rigid piping or hose assembly that has been subject to LP Gas liquid.

b) Any fittings used for the connection of rigid pipes or hose assemblies to components.

c) Any grommets or fillings used to seal rigid piping or hose assemblies through bulkheads.

4.4.11 LP Gas fuel piping for pressure not exceeding 100 kPa

Joints and connection for low pressure fuel lines shall be suitable for use with LP Gas and capable of sustaining five times the maximum pressure likely to be encountered in service and shall comply with **4.4.2.2(b)** and **4.4.4**.

All LP Gas fuel hose less than 100 kPa service shall comply with either the Class B or Class D requirement of AS/NZS 1869, whichever is appropriate.

Low pressure hose shall be of sufficient length and flexibility to accommodate engine movement.

The requirements for safety valve discharge pipe work, if fitted, are nominated in **4.3.15.3**

4.5 Fuel control equipment

4.5.1 Application
This section addresses the requirements for the fuel control equipment and engine management systems.

The LP Gas fuel control equipment includes all the equipment necessary to convert LP Gas at high pressure at the service line to LP Gas-air mixture for supply to the engine and comprises the following components:

a) A fuel filter arranged to protect the automatic fuel shut-off device and the regulator.

b) Automatic fuel shut-off system (lock off).

c) A gas pressure regulator.

d) A vaporizer (Except for vapour-withdrawal systems).

e) A fuel selector, if a dual-fuel system is employed.

f) A gas-air mixer.

The components nominated may be combined into multifunction units.

The material, strength, durability and suitability requirements for components are provided in **4.2**.

NOTE
This clause has been drawn up on the basis of the system that is most usual for vehicles, i.e. fuel drawn from the container in the liquid phase, passing in succession through a water-heated vaporizer and two stages of pressure reduction in a regulator, thus providing gas at atmospheric pressure to be induced by the engine through the air/gas mixer, it is recognized that vapour withdrawal systems, are possible and sometimes used, and that other system may be developed, e.g. fuel injection, in which case variations may be arranged under ***4.1.4.***
4.5.2 Fuel filter

At the termination of every LP Gas fuel service line immediately before entry to the automatic fuel shut-off device there shall be fitted a fuel filter which is capable of removing from the fuel all matter that could cause malfunction of the automatic fuel shut-off device or pressure regulator.

4.5.3 Automatic fuel shut-off device at regulator

This device shall be fitted between the filter and the inlet of the first stage of the regulator. The device shall automatically act to prevent the flow of liquid into the vaporizer unless both the following conditions are satisfied:

a) The ignition is on
b) The engine is turning

The fuel shut-off device may be permitted to open for a period of up to three seconds when the ignition is first turned on so as to allow for priming of the system. A maximum of three seconds of 'on period' is permitted for when the engine is stalled as opposed to when the engine is turned off.

The automatic fuel shut-off device shall not be directly activated by switching to earth. Indirect switching to earth when interfacing with an electronic control module would be allowed provided that a relay is used to switch the positive power supply to the automatic fuel shut-off device. This relay shall be located as close as possible but not more than 300 mm from the electronic control module. The wiring between the electronic control module and the relay shall be suitably protected to prevent accidental short to earth conditions.

Any component of the fuel shut-off device that is subject to liquid LP Gas shall be located so as to be reasonably protected from impact in a collision.

A combination fuel filter automatic shut-off device directly coupled to the vaporizer and regulator shall be securely mounted by a bracket.

4.5.4 Vaporizer

Each vaporizer shall comply with **SLS 1208** propulsion system and be permanently marked with:

a) the manufacturer's name and trademark;
b) a definitive model, mark, or series identification; and
c) the serial number of month and year of manufacture.

4.5.5 Regulator

A regulator or regulating system shall not permit vapour to pass after the engine has stopped turning, irrespective of whether the ignition is on or off.

4.5.6 Installation of vaporizer and regulator

The vaporizer and regulator equipment shall be installed so that,

a) it is accessible for routine maintenance, adjustment, and inspection;

b) it is mounted as close to the engine inlet track as convenient;

c) it is reasonably protected from impact in a collision;

d) it is closely adjacent to or connects directly with the fuel service line automatic fuel shut-off device, to which any pipe connection shall be kept as short as possible and in no case shall the line length be more than 500 mm;

e) it allows sufficient free movement of gas and water hoses;

f) it is securely mounted; and

g) the coolant-circulating system is connected in accordance with the manufacturer's instructions, and no flow control valve in the system can shut-off hot water flow, e.g. thermostat, heater control valve.

NOTE
The vaporizer should, where possible, be no higher than the level of the top of the radiator tank as incomplete water-flooding may cause freezing.

4.5.7 Gas-air mixer

The mixer shall be securely mounted and when remotely fitted shall be suitably bracketed to support its own weight and applied working forces.

There shall be no air filter element fitted downstream of the gas-air mixer.

NOTE
Some carburetors are not suitable for use with LP Gas. Reference should be made to the vehicle manufacturer for recommendation and advice on this matter.

4.5.8 Fuel selector

4.5.8.1 General

Where alternative fuels are available but are not intended to be in use simultaneously, the selector shall prevent the supply of more than one fuel at one time.

Where a manual by-pass is provided, a means to prevent inadvertent shut-off shall be provided, either by a mechanical device or by the restriction of access.

4.5.8.2 Dual fuel change over system

A dual fuel system is a system equipped to operate with LP Gas and some other fuel without further modification.

Such systems may be of two types:

a) Optional fuel type - To operate either on LP Gas or some optional fuel (for example, petrol)

b) Partial substitution type - To operate on part LP Gas and part optional fuel (for example, diesel)

4.5.8. 3 Optional fuel type

A shut-off device shall be installed in the optional fuel system. This device shall shut-off the optional fuel supply to the engine when this fuel is not required.

Where the shut-off device is mounted remotely from the engine, flexible hose shall be used of sufficient length to accommodate engine movement. In all cases the device shall be mounted in a position reasonably protected from damage in a collision and shall be as far as practicable from high tension electrical equipment. When flexible lines are used the shut-off device shall be securely mounted.

Where flexible hose is used as part of the installation, the hose shall be a purpose made reinforced hose for the fuel type concerned. (SAE J30 specification R6, R7 or R8 or equivalent) and shall be rated for external temperatures of up to 100 °C. Metal pipe-work shall be prepared to accept the flexible hose by belling or flaring of the pipe end and the hose shall be positively retained on the pipe by suitable hose clamps. Care must be taken to ensure that the pipe end does not have sharp edges, which may cut the hose. The hose shall be routed well away from sources of heat (such as the exhaust system or engine block) or protected therefrom by suitable shielding.

4.5.8.4 By pass relief device

A bypass relief device shall be installed in the fuel pump or between the fuel pump and the automatic shut-off valve in the liquid fuel line to the carburetor on vehicles equipped with dual fuel systems for the use of gasoline and gaseous fuel. The relief device need not be installed on fuel pumps containing a by pass relief device or equivalent.

4.4.8.5 Fuel selection control

A fuel selection control shall be provided which shall have at least three positions clearly marked for the selection of each of the two fuels. The selection control shall be placed within easy reach of the driver or operator. For vehicles fitted with electronic fuel injection a two - position switch is acceptable.

4.5.9 Petrol system modifications

A dual-fuel system shall incorporate provisions to prevent the drying-out of non-metallic components in the petrol system.
Typical means are as follows:

a) Instruction to run on petrol at regular intervals.

b) Continuously recirculating petrol, where recommended by the original vehicle manufacturer e.g. for fuel injection systems.

NOTE
SAE J30 provides requirements for petrol hose. Either that Standard or the original vehicle manufacturer's specifications should be followed.

4.5.10 Electrical wiring

All wiring shall be properly installed, taped, clipped or contained in a loom along its length. Wiring cables shall comply with the requirements of **JIS C3406**, in respect of the conductor cross-sectional area (determined by current flow) and insulation (determined by temperature). The electrical circuit shall be provided with a current limiting device. This equipment or fuse shall be dedicated to the alternative fuel system.

NOTE

Where fuses are used they should be sized to conform to:

a) 110 per cent of rated current of the circuit - should not fuse.

b) 135 per cent of rated current of the circuit - should fuse within 60 seconds.

c) 150per cent of rated current of the circuit - should fuse within 15 seconds.

A circuit breaker meeting these requirements is acceptable.

Connectors and terminals shall have effectively crimped or soldered joints and shall be insulated to prevent accidental earthing during operations or routine servicing.

4.5.11 Engine management system

The performance requirements for the engine management system are provided in **4.1**.

4.6 INSPECTION, TESTING AND COMMISSIONING

4.6.1 Application

An LP Gas fuel installation in a vehicle shall comply with the associated requirements specified in **4.6**. The order in which this Section is arranged should not be taken to imply that any particular sequence is mandatory. However, any leakage test is invalidated if the joint tested is subsequently dismantled, and another leak test is necessary.

The principal tests undertaken comprise

a) container sub-assembly test (See **4.6.7**);
b) installation test (See **4**. **6.8**);
c) periodic inspection and test comprising (See **4**.**6.9**)

   (i) system check; and
   (ii) container inspection by authorized test station

NOTE

This section deals only with the testing of the complete installation and certain sub-assemblies. It is taken that any testing of individual components which may be necessary to establish suitability and individual quality has already been conducted as a component approval and control matter. The aim is to test the integrity of the various assembly joints and connections, and to test the functioning of certain control components.

4.6.2 Used equipment

Where previously used equipment is being reinstalled or transferred to another vehicle, the testing and commissioning procedures of this section shall apply as if it were an installation of new equipment.

4.6.3 Modifications and repairs

A modification or repair to an installation shall be inspected and tested in accordance with **4.6**, and shall comply with the relevant requirements herein.

4.6.4 Precautions

Where testing procedures require the handling of LP Gas, and may result in the release of LP Gas, the following requirements shall apply:

a) The earth lead of the vehicle battery shall be disconnected and stowed safely.

NOTE

The lead will need to be reconnected for certain tests involving electrically operated components.

b) The working area and the working procedures shall comply with **AS 2746**.

c) When the container is being filled, the normal precautions applicable to petrol or LP Gas service station areas shall apply, e.g. no smoking and no ignition sources within the defined hazardous area, ignition off, brake or parking provisions engaged. (See **AS/NZS 1596** for a complete list of filling instructions for service stations.)

d) If for any reason a container is filled beyond the maximum permitted level, the vehicle shall be driven without stopping the engine for a sufficient distance to consume excess fuel, or if this is not possible the excess fuel shall be removed by one of the methods for LP Gas fuel unloading described in **AS 2746**.

4.6.5 Inspection

Prior to testing and commissioning an initial inspection of the LP Gas system and components shall be carried out by, or under the supervision of, an authorized person, who shall also carry out a complete examination to ensure that the installation complies with all relevant requirements of this Standard.

4.6.6 Leak detection

The method of detecting leaks shall be one of those described in Appendix A, as appropriate. All leaks found shall be rectified and the area retested, or the item under test shall be rejected.

4.6.7 Container sub-assembly leak test

4.6.7.1 General

The test procedure and the pass/fail requirements prescribed in **4.6.7.2** and **4.6.11** shall be applied to a sub-assembly consisting of the container shell and the following components:

a) Tank filler non-return valve or valves, without any extension filler hose or pipe.

b) Automatic fill limiter

c) Contents gauge

d) Fixed liquid level gauge, if fitted, without any extension piping which might subsequently be required.

e) Safety valve, without any discharge piping, which may subsequently be fitted.

f) Service valve with integral excess-flow valve.

g) Automatic fuel shut-off device at container.

NOTE

It is recognized that the container sub-assembly is usually assembled and tested by the supplier of the container, in which case it is not intended to imply that those requirements oblige the installer to test again. This would normally be necessary only if the installer disturbed or changed a component.

4.6.7.2 Leak test

Every container sub-assembly shall be subject to a pressure test with a gas inert to LP Gas in accordance with the following procedure:

WARNING:

OXYGEN MUST NOT BE USED FOR PRESSURIZING. COMPRESSED AIR CAN BE DANGEROUS IN ASSOCIATION WITH LP GAS. A CONTAINER, WHICH HAS PREVIOUSLY CONTAINED LP GAS, MUST BE PURGED THOROUGHLY BEFORE THIS TEST.

a) Close the service valve, and the fixed liquid level gauge valve, if fitted.

b) Pressurize the container to an internal pressure of 2.3± 0.05 MPa.

c) Remove the pressurizing attachment.

d) Check all joints between the container and the components for leaks (See **4**.**6.6**)

e) Check the filler valve, the fixed liquid level gauge valve if fitted, and the service valve for leakage through the valve seats.

f) With the valve outlet plugged or capped and the valve opened, check for leaks at he valve stem seal of any valve that is normally open in service.

The excess flow valve shall be tested in accordance with **4**.**6.10**

The container automatic fuel shut-off device shall be tested in accordance with **4**.**6.13.**

g) Where a leak is indicated, rectify the fault by replacement or releasing, and retest the area.

6.8 Installation test

4.6.8.1 General

The procedures of this clause shall be applied after the container sub-assembly has passed the test specified in **4.6.7** and has been installed in the vehicle.

NOTE

It is essential that all air be purged from the container before LP Gas pressure tests commence, and it is more convenient if this purging is carried out before the container is installed.

4.6.8.2 Gastightness of compartments and sub-compartment

A compartment or sub-compartment shall be tested to ensure that it is gastight to the vehicle interior by blowing tracer gas into the compartment and testing the surrounding atmosphere for gas leakage with a gas detector. Passages between the compartment and outside air, e.g. ventilation provisions, or an access hatch or door of a permanently inbuilt compartment, shall be sealed during testing. Any leakage shall be rectified, and testing repeated.

NOTE

It may be permissible to check a compartment before installation of the fuel system, provided that nothing in the subsequent installation procedure will negate the validity of the test.

4.6.8.3 Leak testing of gas system

After all connections have been made, the LP Gas system shall be tested for leaks as follows:

a) Place propane in the container and ensure that the liquid lines are full of LP Gas liquid

NOTE

It is important that propane, not butane, be used for this test because it has a relatively high vapour pressure at the lowest temperatures likely to occur in a workshop. The pressure gauge on the LP Gas supply tank can be taken to represent the container pressure reasonably accurately, and if below 450 kPa, testing should be postponed. Under no circumstances should the container be heated to raise the pressure.

b) Test all pipe and component connections, including those on remote filling and remote ullage gauge lines, and test the filler non-return valve.

c) Where a leak is indicated, rectify the fault by remaking the joint, and retest the area.

4.6.8.4 Test of fuel automatic fill limiter

The accuracy of the shut-off function of the automatic fill limiter shall be checked in accordance with **4.6.12.**

4.6.8.5 Test of fuel control device

A test shall be made to ensure that the automatic shut-off device and the dual-fuel selector are functioning correctly.

4.6.8.6 Coolant system tests

The coolant-circulation system which supplies radiator coolant to the vaporizer shall be pressure tested for leaks, using a conventional radiator pressure testing method.

4.6.8.7 Visual inspection

The completed installation shall be subjected to a final inspection to ensure that:

a) the filler cap is present and captive;

b) the discharge arrangements for the hydrostatic relief valve, if fitted, are present;

c) where discharge piping is fitted for the safety valve, the direction of discharge is correct, the discharge closure provisions are present and in order and the pipe is not linked crushed or otherwise damaged;

d) all vehicle marking are in place and correct; and

e) ground clearances are correct.

4.6.9 Periodic inspection

4.6.9.1 General

An installation shall be re-examined from time to time during its life to ensure that it has not deteriorated to an unacceptable degree. Further, fuel containers are required by regulations to be certified before they can be put into service, and this certification has a finite life, at the end of which the certification must be renewed. Renewal is conditional on a re-examination for deterioration.

This clause (**4.6.9**) deals only with the procedures and checks which are routinely applied to check the whole system. For specific check a fuel container that may require recertification, reference to **AS 2337.2** is necessary. Normal day-to-day running adjustments, e.g. tuning, are not addressed.

Implementation and enforcement is the responsibility of statutory authorities, and because of differences of detail from place to place it is not possible to give a complete description of national procedures. However, this clause is based on a fairly common arrangement, which uses the 'roadworthy' system to locate vehicles and subject them to a checking procedure. The checking procedures are based on the following presumptions:

a) If any time after initial installation and LP Gas fuel installation is found to be unsatisfactory to the extent that it is potentially or actually hazardous, it will be considered that the vehicle has become unroadworthy, and the established procedure for treating an unroadworthy vehicle is applied to ensure rectification. Minor operating faults such as an out-of-tune condition are not considered to be in this class of fault.

b) Discovery of the condition might arise from an owner's observation or from a random check, but a scheduled check at set intervals is considered necessary in case a deteriorating condition goes unnoticed.

c) Two levels of inspection procedure exist. The first, described in **4.6.9.2,** is an on-vehicle inspection of the overall installation. This may be done at any time it is considered necessary, but is basically designed as a scheduled routine check to enable reissue of a roadworthy pass. It is within the scope of activity of an installation workshop.

d) The second level of inspection involves the fuel container in greater details, and takes place at scheduled longer intervals, or may be applied when damage has been discovered. In some circumstances this may be done on the vehicle, in others the container may need to be removed if it is to be inspected thoroughly. The inspection shall be made by an authorized container test station, licensed under the terms of Motor Traffic Act and following the procedures of **AS 2337.2.**

4.6.9.2 System check

The following checks shall be carried out at intervals as specified by the Authority and at every roadworthiness inspection for the renewal of vehicle registration:

a) **Leakage check :** Apply the procedure of **4**.**6.6** and **4**. **6.8.3**

b) **Fuel container life :** Check the container date stamp. If it will be more than ten years old before the next periodic vehicle inspection, initiate the procedures for reinspection and restamping in accordance with **AS 2337.2**

c) **Container damage :** Inspect the container for any evidence of damage by impact or by fire. Refer the container to a test station if any of the following faults are present:

(i) A dent which does not penetrate the surface material, but whose depth exceed 10 per cent of the mean diameter of the dent, or which is located on a weld and exceed **4.6.5** mm in depth.

(ii) A sharp impression or crease which does not penetrate the surface of the material, but whose length exceeds 25 per cent of the wall thickness.

(iii) A cut or gouge which penetrates the surface material, and whose length exceeds 25 per cent of the wall thickness.

(iv) Bulging, to the extent that the circumference varies by more than 1 per cent.

(v) Fire damage.

d) **Container corrosion :** Inspect the container for evidence of deterioration by corrosion. Particular attention should be paid to the drip line under the container, to areas where water leaking into or thrown up by a vehicle could accumulate, and to the area covered by clamping bands, especially those that pass under a container or intersect the drip line. Bands should be released where necessary to ensure adequate examination.

Refer the container to a test station if any of the following faults are present:

(i) A pit which reduces the wall thickness by 50 per cent or more of the original or which leaves less than 1.1 mm of metal remaining. Adjacent pits less than 85 mm apart shall be treated as general corrosion.

(ii) Line corrosion which exceeds 75 mm in length or which leaves less than 75 per cent of the original wall thickness.

(iii) General corrosion, which exceeds 75 mm in length or which leaves less than 75 per cent of the original wall thickness.

e) **Container attachment:** Check for the following:

(i) Rust, corrosion, abrasion, or impact damage.

(ii) Tightness and locking of nuts, evidence of necking of bolts, loose bands, wear under bands, and incompatible band materials.

(iii) Correct orientation of fuel container

f) **Automatic fill limiter :** Check the accuracy of the automatic fill limiter (AFL), if fitted, by means of fixed liquid level gauge or a refueling dispenser meter in accordance with **4.6.12.**

If there is no AFL fitted retrofitting of an AFL shall be encouraged.

g) **Fuel containment system:** Test as described in Items (I) or (ii) below depending upon the type of system fitted at the container.

(i) *Automatic fuel shut-off device at container:* Deactivate automatic fuel shut-off device at the container by operating the current limiting device or removing

the fuse (See **4 .3.13**) and run the engine until the fuel service line is empty and the engine stops.

(ii) *Excess-flow valve:* Shut off the service valve and run the engine until the fuel service line is empty. It may be necessary to attempt to restart the engine after another half minute or so, to ensure that all residual LP Gas has been cleared. Open the service valve and listen for the sound of the excess-flow valve operating. If it is not closed, close the service valve, disconnect the fuel service line at the engine end, and recheck the excess-flow valve.

NOTE
If the fuel service line is to be disconnected, first remove the battery and take steps to ensure that discharging gas does not become a hazard.

h) **Test of fuel control systems:** Check that the automatic fuel shut-off device(s) and the dual-fuel selector are present and functioning correctly.

NOTE
Where an automatic fuel shut-off device is not installed at the container, retrofitting is to be encouraged.

(i) **Manual valves :** Open and close all manual valves and test around glands and connection for leaks in both positions.

j) **Compartment or sub-compartment :** Check for structural damage. Check around all joints, conduit connections and pipe bulkhead seals for leakage in accordance with **6.8.2** Check conduits for deterioration, damage, kinking or punctures.

k) **Filler connection** : Check for damage to the coupling and for the presence of foreign matter, and check that the cap is present and captive by a chain or similar device.
Check that the sealing washer is in place and in satisfactory condition. Check that the housing containing the filler valve is soundly attached to the vehicle, and that the remote fill line is not deformed or damaged by twisting resulting from a loose housing.

I) **Hydrostatic relief valve (if fitted)**: Check for damage, blockage, or tampering.

m) **Safety valve system:** Check for damage or blockage to the discharge pipe if fitted, and for correct direction of discharge, and check that the protective cap is present and functioning.

n) **Liquid filter(s)** : Check to ensure that the filter(s) is present and intact and clean.

o) **Ground clearance**: Check to ensure that the ground clearance still complies with this Standard.

p) **Vehicles identification**: Check that the 'LP Gas Vehicle' identification markers **7.4** are present on the number plates.

4.6.10 Excess flow valve test

The excess-flow valve shall be tested at initial inspection and after any servicing of the valve itself or following container removal and reinstallation in the vehicle of a permanently mounted container.

The excess-flow valve shall be tested to ensure that it closes and reopens, by opening and then closing the service valve while the container remains under pressure following the container sub-assembly leak test. (See **4.6.7**).

The excess-flow valve should function before or as soon as the service valve is fully open. Function of the excess-flow valve is indicated when the initial escape of gas suddenly drops to the small flow permitted by the bypass in the closing disc of the excess-flow valve.

This test may be carried out with the fittings downstream of the service valve removed.

Where an automatic fuel shut-off device is integral with the excess-flow valve and service valve, fittings downstream of this combined valve may be removed for the excess-flow valve test.

Where multiple containers are installed, each excess flow valve shall be tested separately.

4.6.11 Non-return valve test

The function of each non-return valve shall be tested by pressurizing the valve and testing for leaks.

4.6.12 Automatic fill limiter test

The accuracy of the shut-off function of the automatic fill limiter, if fitted, shall be checked with the vehicle standing on level ground and the tyres correctly inflated.

The container shall be emptied of LP Gas liquid and then filled by a pump-meter unit. The meter reading at which the AFL cuts off shall be within +2 per cent of the maximum permitted filling volume.

NOTE

The accuracy of the contents gauge may be checked at the same time. A fixed liquid level gauge may also be used for checking but is less accurate.

4.6.13 Testing of automatic fuel shut-off device

The automatic fuel shut-off device at the container shall be tested for leakage in the unpowered condition.

4.7 Certification, compliance plate, markings and labels
4.7.1 Application

The requirements in this section shall be complied with prior to the vehicle being released to the consumer.

4.7.2 Certification

On completion of an after - market installation, the installer shall supply the owner with a certificate/notice of compliance with this standard, which shall also given an installation date and the fuel container serial number. The certificate/notice may be incorporated in a receipt, or may be a specific document and shall include a certificate of compliance number.

NOTE
Any statutory regulations on certification procedures that differ from this requirement will take precedence.

4.7.3 Compliance plate

An LP Gas compliance plate for each container shall be securely attached to the vehicle body work in the engine bay in a clearly visible location. The compliance plate shall take the form shown in Figure **5** and all applicable information shall be provided by the installer.

The information shall be permanently inscribed, where applicable, and clearly legible.

Where a container is changed or retested the appropriate parts of the plate shall be reinscribed.

LIQUEFIED PETROLEUM GAS COMPLIANCE PLATE

The auto gas installation to which this notice is affixed complies with the requirements of SLS…….
INSTALLATION DATE …… PROVINCE ……
COMPLIANCE NO ……
INSTALLED BY:
NAME …… LIC NO. ……
WORKSHOP NO ……(REP.NO.)

VIN NO. ……..
CONTAINER SERIAL NO. ……
CONTAINER TEST STATION STAMP DATE……

FIGURE 5 – Compliance plate

4.7.4 Labels and markings

4.7.4.1 Filler markings

A permanent and mechanically attached filling instruction shall be provided on any removable container that is filled by volume, i.e one having a fixed liquid gauge but not an automatic fill limiter. The notice shall be displayed adjacent to the gauge and shall state:

'STOP FILLING WHEN LIQUID APPEARS'

4.7.4.2 Outlet markings

Where both liquid and vapour are withdrawn from the same container, a marking shall be provided adjacent to each service valve clearly indicating whether the valve is for vapour withdrawal or liquid withdrawal.

4.7.4.3 Vehicle identification

The vehicle, to indicate that it is equipped to use LP Gas as a fuel, shall carry, affixed to the front and rear of the vehicle, an approved, permanently attached, external steel plate 1 mm thick and a label complying at least with the following requirements:

a) The plate and label size to be not less than 25 mm square mounted as a diamond.

b) The label colour to be retroreflective red, complying with **AS 1743**, Appendix **A**, Class 2

c) The label shall have only the letters LPG in white at least 10 mm in height.

The plate and label shall be affixed to the registration plate and or they shall be affixed as close as possible to the registration /number plate.

Where a vehicle is fitted with dual containers the vehicle shall carry an additional plate and label as above.

4.7.4.4 Controls

Dual-fuel selector devices which are visible to the driver seated in the notmal driving position shall be marked to indicate the selected fuel.

4.7.4.5 Access hatch

Any gastight access hatch as described in **4.3.17** shall be provided with a marking, which reads:

WARNING: KEEP CLOSED AND GASTIGHT EXCEPT WHEN THE SERVICE VALVE MUST BE OPERATED.

NOTE

AS/NZS 3509 *requires that, for a system that incorporates a multivalve, this information be provided on a label on the fuel container.*

4.7.5 Operating instructions

The installer shall leave with the vehicle a set of operating instructions which shall include amongst other things the following:

a) Refueling procedures and precautions.

b) Operation of fuel system selector controls.

c) Procedures to follow in the event of various faults or emergency situations.

APPENDIX A
LEAK DETECTION METHODS
(Normative)

A.1 SCOPE

This Appendix describes a variety of leak detection methods for LP Gas and indicates advantages or disadvantages that may be significant.

A.2 COMBUSTIBLE-GAS DETECTOR

Combustible-gas detectors are suitable for testing for leaks after fuel gas has been introduced to the system, and are particularly useful for checking assembly joints after installation.

Care in interpretation is necessary, as the detectors can respond to the presence of any of several vapours that are combustible, some of which may not be LP Gas, such as oil smears and jointing compounds. Detectors can also detect residual LP Gas vapour that is present for reasons other than leakage.. Residual LP Gas vapour detected shall be cleared before a valid test for leakage is made. If a leak is present, a detector will signal its existence, but not its size, and will indicate a general location, but may not be able to locate it exactly, so a follow-up or providing check with foams is often desirable.

The combustible-gas detector shall be capable of detecting 40 parts per million (p.p.m) of LP Gas in air. Exhaust gas analyses are not suitable for leak detection.

The system under test is purged to LP Gas, and all likely leak points are checked.

It is important to keep the sensing element in contact with the surface of the part being tested, and that the test be carried out under still air conditions.

A.3 Trace-gas Detectors

Trade-gas detectors are suitable for checking the gastightness of the construction joints in a compartment or sub-compartment, conduit connections or similar, particularly when it is impracticable to apply much internal pressure.

The basic method is to plug or blank of openings such as vents, and inject a trace gas under such pressure as is practicable. The gas used may be any convenient gas for which a suitable gas detector is obtainable, e.g. halogenated hydrocarbons, carbon dioxide, or the like. The gas detector should be capable of detecting 25 p.p.m in air, and should not be of the continuous sample-aspiration type.

A.4 Foaming agents

Foaming agents are more effective for detection of small leaks; large leaks tend to blow the solution away from the leak without forming a bubble. Care in applying the solution slowly with a brush will provide easier detection of large leaks.

The foaming agent should be a proprietary leak test solution, formulated specifically for the purpose. Fresh solution should be used and the whole of the surface to be tested is coated and time allowed for bubbles to form. All areas under test should be able to be observed during the test.

A.5 Total immersion

Total immersion may not always indicate very small leaks, or leaks which may be inhibited by the head of water. Good illumination and an ability to manipulate the item while submerged are important. A wetting agent is desirable, provided that foaming does not result.

A.6 Visual inspection

Because LP Gas is a refrigerant, a leak, particularly of liquid, will often cause a frost to form on surrounding surfaces, even when the rate of leakage is too small to be readily detectable by immersion or foam method. Visual checks for signs of such frost patches are particularly appropriate for the welded seams of container.

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