

Vehicle Standards Bulletin 14

**NATIONAL CODE OF PRACTICE
for
LIGHT VEHICLE CONSTRUCTION
and
MODIFICATION**

**SECTION LM
FUEL SYSTEMS**

Version 2.0 November 2009

Vehicle Standards Bulletin 14

National Code of Practice for Light Vehicle Construction and Modification (VSB 14)

Important Information for Users

Users of VSB 14 need to be aware that this document needs to be used in conjunction with the appropriate administrative requirements of the jurisdiction in which they wish to either register a vehicle or to obtain approval for a modification for an already registered vehicle. *Administrative requirements* include, amongst other things, processes for vehicle registration, obtaining exemptions, obtaining modification approvals, vehicle inspections, preparation and submission of reports and the payment of appropriate fees and charges.

If unsure of any of the requirements specified in VSB 14, or if more information is needed for any other issues concerning the administrative requirements, users should contact their relevant Registration Authority **prior** to commencing any work.

While VSB 14 provides advice on the construction of ICVs and the execution of modifications, it is not to be taken to be a design manual. Determination of component strength, performance, suitability and functionality must be either calculated or determined on a case by case basis by suitably qualified personnel experienced in each matter under consideration.

Users of VSB 14 also need to ensure that they refer to the most recent version of the relevant Section/s when working on a project. The version is identified by the version number and date on the face page of each Section. The version and date is also located in the footer of each page in each Section. On the website the version number is specified in the Section file name for easy identification.

If a project is taking a long time to complete, check the currency of the version you are using.

Users must be familiar with the provisions stated in the Preface and Introduction. These two Sections provide the necessary background information to assist users in understanding how VSB 14 is administered by Registration Authorities across Australia, on how it is structured, and the meaning of the types of modification codes specified in VSB 14. If not already done so, users should download them for study and reference.

Understanding these requirements is important to ensure that the correct processes are followed thereby reducing the likelihood of having work rejected by Registration Authorities.

Many of the Sections refer to other Sections within VSB 14 for further information or additional requirements. Users must read and apply all relevant Sections.

If in doubt about any issue concerning or contained in VSB 14, users should seek clarification from the appropriate state or territory Registration Authority.

Please do not contact Vehicle Safety Standards (VSS) of the Federal Department of Infrastructure, Transport, Regional Development and Local Government in Canberra about VSB 14. VSS provides the website as a service only.

Document Amendments by Version

Version

Version 2.0

Published February 2009

Amendments

Reference to *CNG* has now been replaced with the more generic *NG* except where reference to *CNG* is specifically required.

Checklist LM2 has been completely replaced with a new version to better reflect the contents of AS/NZS 1425. It now also references the clauses in the standard that apply to each checklist question.

This document has also a number of editorial amendments that have had no affect on its technical content.

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1 SCOPE

Section LM outlines the minimum design, installation and fabrication requirements for light vehicle modifications involving fuel systems.

It does not apply to Australian Design Rule (ADR) Category L-group vehicles and motorcycles.

The term *modify/modification* used in the Section also means *install/installation* and *convert/conversion* as appropriate.

1.1 BASIC MODIFICATIONS NOT REQUIRING CERTIFICATION

The following modifications may be performed without certification:

- Fitting replacement fuel lines;
- Fitting additional fuel filters;
- Fitting alternative fuel pumps; and
- Fitting a manufacturer's optional fuel system.

1.2 MODIFICATIONS THAT MAY BE CERTIFIED

The following modifications may be performed under the Section LM Codes:

- Fitting an additional or replacement fuel tank and associated componentry;
- Fitting a surge tank;
- Installing a Liquefied Petroleum Gas (LP Gas) fuel system; and
- Installing a Natural Gas (NG) fuel system.

The design installation and fabrication requirements for all of the above modifications are contained in sub-section 2 *General Requirements* and also in the relevant sub-sections 4 and 5.

Note: Codes LM2 and LM3 are not utilised in Queensland.

2 GENERAL REQUIREMENTS

This subsection applies to all light vehicles and must be read and applied in conjunction with all the LM Codes applicable to the proposed modifications.

Modified vehicles must continue to comply with the ADRs to which they were originally constructed, except as allowed for in the Australian Vehicle Standards Rules (AVSR). These modified vehicles must also comply with the applicable in-service requirements of the AVSR.

Modified pre-ADR vehicles must continue to comply with the AVSR.

Compliance with the AVSR also means compliance with the equivalent regulations of a State or Territory of Australia.

2.1 FUEL LINES

This clause refers to any fuel hose, pipe or tubing used in a vehicle's fuel system, irrespective of the fuel type used.

The material used for fuel lines must be compatible for both the type of fuel and fuel system to be used and must comply with all applicable standards.

Fuel lines must be securely fastened. Push-on type hose connections must be fitted with a positive means of retention to reduce the possibility of fire due to leakage or fuel hoses coming adrift and spraying fuel over electrical components or hot exhaust components. Where hose

clamps or clips are used the end of the mating pipe must have provision to aid the retention of the hose.

Fuel lines must be well clear of extremely hot components such as the exhaust system or turbocharger (if fitted). Fuel lines must be adequately supported and where under a vehicle, must be protected from road debris and damage either by chassis/body members or shielding.

Fuel lines must be adequately protected from chafing or damage where they pass through panels, bulkheads or chassis members.

2.2 FUEL TANKS (Other than LP Gas/NG Containers)

Fuel system modifications, replacement fuel tanks and *drop tanks* must meet the following requirements:

- The vehicle must have a minimum ground clearance of 100mm and meet the minimum ground clearance requirements as defined in ADR 43;
- No part of any fuel tank or fuel system component must lie below a plane created as a component of that vehicle's Departure Angle¹;
- Any fuel tank or fuel system component must be at least 100mm inboard of the OEM permanent body work (excluding the filler neck and assembly);
- Any fuel tank or fuel system component with a ground clearance of 200mm or less must be adequately protected by shields or adjacent vehicle components;
- In the event of any tyre being deflated, no parts of the fuel tank or fuel system must contact the road surface;
- If a replacement tank of a 125% or larger capacity than the original uses the original mountings, their strength must be checked and shown to be adequate by a Signatory;
- Replacement fuel tanks must not adversely affect the suspension travel, controllability, handling or road holding of the vehicle;
- The fuel filler inlet and cap should be located outside of the vehicle. Where an inlet is located inside a vehicle, it must not be inside the passenger compartment and the inlet must be separately sealed from the rest of the vehicle to ensure fumes do not enter the passenger cabin and that provisions are made to ensure any fuel spills are localized and drain outside the vehicle;
- The fuel tank and filler shall be so arranged that any overflow or leakage of fuel cannot accumulate nor contact the exhaust or electrical systems; and
- Any apertures created to allow for the installation of the fuel tanks must be suitably sealed to prevent the entry of exhaust, road or petrol fumes into the cabin of the vehicle.

Additional Requirements for Vehicles fitted with Evaporative Emission Control Systems

- All of the fuel tank evaporative controls for ventilation of the tank must be installed and operational to prevent hydrocarbon emissions entering the atmosphere;
- If the replacement fuel tank has a greater capacity than the largest optional fuel tank available for the vehicle, an additional or larger canister of sufficient capacity must be fitted to vehicles equipped with evaporative emission control systems; and
- Vehicles originally fitted with fuel tanks with expansion/vapour spaces must continue to provide these facilities. (e.g. modified fuel tanks must have vapour spaces proportional

¹ Departure Angle is the greatest angle between the horizontal plane and the plane from the static loaded rear tyres to the lowest, rearmost extremity of the Original Equipment Manufacturer's (OEM) permanent body work.

to their new capacity). Vehicles originally equipped with independent liquid/vapour separators must have either an additional separator or that provision built into the new tank.

2.3 FABRICATION

All work must be performed in accordance with recognised engineering standards. Cutting, heating, welding or bending of components should be avoided by choosing unmodified production components wherever possible.

Welding, Fasteners and Electroplating

Mandatory requirements and guidance on the above items are contained in Section LZ *Appendices*.

- For the use of fasteners refer to Appendix A *Fasteners*;
- For welding techniques and procedures refer to Appendix C *Heating and Welding of Steering Components*; and
- For electroplating refer to Appendix D *Electroplating*.

3 AUSTRALIAN DESIGN RULES

A modified vehicle must continue to comply with the ADRs to which it was originally constructed, except as allowed for in the AVSR.

Outlined in Table LM1 below are requirements and/or components of the vehicle that may be affected by the modifications and that may require re-certification, testing and/or data to show continuing compliance for the modified vehicle. This is not an exhaustive list and other modifications may also affect ADR compliance.

Table LM1 Summary of items that if modified, may detrimentally affect compliance with applicable ADRs

ADRs	DETAIL
ADR 26, 27x	Vehicle Engine Emission Control
ADR 37, 37/...	Vehicle Emission Control
ADR 40	Light Duty Vehicle Emissions Control
ADR 41, 41/...	Mandatory Operation on Unleaded Petrol, Evaporative emission controls..
ADR 42/...	General Safety Requirements, The requirements for positioning of exhaust outlets.
ADR 43/...	Vehicle Configuration and Dimensions (Includes provisions for ground clearance).
ADR 44/...	Specific Purpose Vehicle Requirements (Includes provisions for LP Gas installation).

ADR 79/...	Vehicle Emission Control. This vehicle standard is applicable to all M and N category vehicles with a Gross Vehicle Mass (GVM) less than or equal to 3.5 tonnes and with an engine that operates on petrol, diesel, liquefied petroleum gas or natural gas.
ADR 80/...	Emission Control for Heavy Vehicles. (This ADR applies to vehicles of the M and N ADR categories, with a GVM greater than 3.5 tonnes.)

To determine the ADRs that apply to the vehicle in question, refer to the Applicability Tables in Section LO. Vehicles manufactured on or after 1 January 1969 and prior to 1 July 1988 need to comply with the Second Edition ADRs whilst vehicles manufactured after this date need to comply with the Third Edition ADRs. Section LO has separate applicability tables for each edition.

Alternatively, ADR applicability tables for individual vehicle categories may be referenced on the Department of Infrastructure, Transport, Regional Development and Local Government *RVCS* website at the following address and under the section titled *ADR Applicability tables*:-

<http://rvcs.dotars.gov.au/>

The ADRs apply according to the vehicle's category and date of manufacture. It is the responsibility of the signatory to refer to the appropriate ADR applicable to the vehicle.

4 BASIC MODIFICATIONS NOT REQUIRING CERTIFICATION

The following modifications may be carried out provided they do not affect compliance with the ADRs, compliance with regulations including applicable vehicle standards and provided they meet the following general safety requirements.

4.1 FUEL LINES

The fitting of alternative or replacement fuel lines may be performed without certification, provided that:

- the installation is in accordance with good engineering practice
- all components used are unmodified
- the fuel lines are secured, properly supported and shielded against heat, abrasion and impact damage and
- the fuel lines do not leak.

4.2 FUEL FILTERS AND PUMPS

The fitting of additional fuel filters and/or alternative or replacement fuel pumps may be performed without certification, provided that:

- the installation is in accordance with good engineering practice
- all components used are unmodified
- the alternative/replacement fuel filter and/ or fuel pump are secured, properly supported and shielded against heat, abrasion and impact damage, and
- the alternative/replacement fuel filter and/ or fuel pump do not leak.

5 MODIFICATIONS THAT MAY BE CERTIFIED UNDER THE LM CODES

This section specifies particular requirements and covers limitations on work that may be carried out under individual LM Codes.

Each Code is supplemented with a checklist. (Refer Table LM2)

Table LM2 LM Code Directory

LM Codes		Page
LM1	Fuel Tank Alteration	10
	Checklist	12
LM2	Installation of Liquefied Petroleum Gas (LP Gas) Fuel Systems and Gas Containers	15
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FUEL TANK ALTERATION

CODE LM1

SCOPE

Code LM1 covers the installation of alternative fuel tanks and the installation of surge tanks in light motor vehicles other than ADR category L-group vehicles and pre-ADR motorcycles and motor tricycles.

MODIFICATIONS COVERED BY CODE LM1

The following is a summary of the modifications that may be performed under Code LM1:

- Fitting an alternative fuel tank.
- Fitting a surge tank.

MODIFICATIONS NOT COVERED BY CODE LM1

Modifications not covered under Code LM1:

- Fitting an alternative fuel system (this is covered by Code LM2 or LM3).

COMPLIANCE WITH REGULATIONS

Modified vehicles must continue to comply with the ADRs to which they were originally constructed, except as allowed for in the AVSR. These modified vehicles must also comply with the applicable in-service requirements of the AVSR.

Modified pre-ADR vehicles must continue to comply with the AVSR.

Compliance with the AVSR also means compliance with the equivalent regulations of a State or Territory of Australia.

Outlined below in Table LM3 are areas of the vehicle that may be affected by the modifications and that may require re-certification, testing and/or data to show compliance for the modified vehicle. This is not an exhaustive list and other modifications may also affect ADR compliance.

Table LM3 Summary of items that if modified, may detrimentally affect compliance with applicable ADRs

ADRS	DETAIL
ADR 26, 27x	Vehicle Engine Emission Control
ADR 37, 37/...	Vehicle Emission Control
ADR 40	Light Duty Vehicle Emissions Control
ADR 41, 41/...	Mandatory Operation on Unleaded Petrol, Evaporative emission controls.
ADR 42/...	General Safety Requirements, The requirements for positioning of exhaust outlets.
ADR 43/...	Vehicle Configuration and Dimensions (Includes provisions for ground clearance).
ADR 44/...	Specific Purpose Vehicle Requirements (Includes provisions for LP Gas installation).

ADR 79/...	Vehicle Emission Control. This vehicle standard is applicable to all M1 and N1 category vehicles with a GVM less than or equal to 3.5 tonnes and with an engine that operates on petrol, liquefied petroleum gas or natural gas.
ADR 80/...	Emission Control for Heavy Vehicles. (This ADR applies to vehicles of the M and N ADR categories, with a GVM greater than 3.5 tonnes.)

Note: Any modifications to the vehicle that involve structural changes may affect compliance with seat belt and child restraint anchor points.

CHECKLIST LM1
FUEL TANK ALTERATION
CODE LM1

(N/A= Not Applicable, Y=Yes, N=No)

1.	GENERAL			
1.1	Are all fuel lines used suitable for the fuel and fuel system?		Y	N
1.2	Are all fuel lines securely fastened with clamps or clips?		Y	N
1.3	Has the circuit been checked for leaks and any leaks have been repaired?		Y	N
1.4	Are fuel lines at least 100mm from the exhaust and any other dangerous ignition sources?		Y	N
1.5	Are fuel lines well protected from possible road damage?		Y	N
1.6	Are lines adequately protected from chafing, road damage or crushing?		Y	N
1.7	Does the location of the tank meet the vehicle's requirements?		Y	N
1.8	Are the fuel tank and components at least 100mm inboard of OEM permanent bodywork?		Y	N
1.9	Is adequate shielding provided for fuel tanks if ground clearance less than 200mm?		Y	N
1.10	Has the fuel tank installation been checked to ensure that no part of the fuel tank contacts the road should a tyre become deflated?		Y	N
1.11	If a replacement tank is of a larger capacity (25% or more) than the original and uses the original mountings, has their strength been checked and shown to be adequate by a Signatory.	N/A	Y	N
1.12	Does the replacement fuel tank have no adverse affect on the controllability, handling or stability of the vehicle when road tested?		Y	N
1.13	Are the fuel filler inlet and cap located outside of the vehicle?	N/A	Y	N
1.14	Where the inlet is located inside the vehicle, is it not inside the passenger compartment and is the inlet separately sealed from the rest of the vehicle?	N/A	Y	N
1.15	Is the fuel tank and filler so arranged that any overflow or leakage of fuel cannot accumulate nor contact the exhaust or electrical systems?		Y	N

(N/A= Not Applicable, Y=Yes, N=No)

1.16	Are all apertures created to allow for the installation of the fuel tanks suitably sealed so as to prevent the entry of exhaust, road or petrol fumes into the cabin of the vehicle?		Y	N
2.	ADDITIONAL REQUIREMENTS FOR VEHICLES FITTED WITH EMISSION CONTROL SYSTEMS.			
2.1	Are all of the fuel tank evaporative controls for ventilation of the tank installed and operational?		Y	N
2.2	If the replacement fuel tank has a greater capacity than the largest optional fuel tank available for the vehicle, has an additional or larger canister of sufficient capacity been fitted to vehicles equipped with evaporative emission control systems?	N/A	Y	N
2.3	If the vehicle was originally equipped with an independent liquid/vapour separator has either an additional separator been fitted or that provision built into the new tank?	N/A	Y	N
3.	WORKMANSHIP			
3.1	Is all work including welding performed in accordance with recognised engineering standards?		Y	N
4.	ADR COMPLIANCE			
4.1	Does the converted vehicle continue to comply with applicable ADRs?		Y	N
5.	INSPECTION			
5.1	Has an inspection been carried out on the installation and all modified components and found to be satisfactory?		Y	N
6.	RECORDS			
6.1	Have complete records of vehicle conversion/modifications details been retained in a manner suitable for auditing as requested by the Registration Authority?	N/A	Y	N

Note: If the answer to any question is **N (No)**, the modification cannot be approved under Code LM1.

CERTIFICATION DETAILS																
Make						Model						Year of Manufacture				
VIN																
Chassis Number (If applicable)																
Brief Description of Modification/s																
Vehicle Modified By																
Certificate Number (If applicable)																
Vehicle Certified By (<i>Print</i>)																
Signatory's Employer (If applicable)																
Signatory's Signature										Date						

INSTALLATION OF LIQUEFIED PETROLEUM GAS (LP GAS)

FUEL SYSTEMS AND GAS CONTAINERS

CODE LM2

SCOPE

Code LM2 provides for the installation of Liquefied Petroleum Gas (LP Gas) fuel system in light motor vehicles other than ADR category L-group vehicles and pre-ADR motorcycles and motor tricycles. Code LM2 also provides for dual fuel systems that include LP Gas and petrol or LP Gas and diesel.

MODIFICATIONS COVERED UNDER CODE LM2

The following modifications may be performed under Code LM2.

- Installing an LP Gas fuel system;
- Converting an engine to operate on LP Gas or dual fuel, (*Dual fuel* may be either LP Gas and petrol or LP Gas and diesel); and
- Replacing the original LP Gas container with one of larger capacity or with a fibreglass or fibre-reinforced plastic (FRP) container.

MODIFICATIONS COVERED UNDER CODE LM2

The following is a summary of modifications that may not be performed under Code LM2:

- Fitting a natural gas (NG) fuel system (this is covered by Code LM3); and
- Fitting replacement or modified fuel tanks (these are covered by Code LM1).

Note: Code LM2 is not utilised in Queensland

COMPLIANCE WITH REGULATIONS

Modified vehicles must continue to comply with the ADRs to which they were originally constructed, except as allowed for in the AVSR. These modified vehicles must also comply with the applicable in-service requirements of the AVSR.

Modified pre-ADR vehicles must continue to comply with the AVSR.

Compliance with the AVSR also means compliance with the equivalent regulations of a State or Territory of Australia.

Outlined below in Table LM4 are areas of the vehicle that may be affected by the modifications and that may require re-certification, testing and/or data to show compliance for the modified vehicle. This is not an exhaustive list and other modifications may also affect ADR compliance.

Table LM4 Summary of items that if modified, may detrimentally affect compliance with applicable ADRs

ADRS	DETAILS
ADR 26, 27x	Vehicle Engine Emission Control
ADR 37, 37/...	Vehicle Emission Control
ADR 40	Light Duty Vehicle Emissions Control
ADR 41, 41/...	General Safety Requirements, The requirements for positioning of exhaust outlets.
ADR 42/...	Vehicle Configuration and Dimensions (Includes provisions for ground clearance).
ADR 43/...	Specific Purpose Vehicle Requirements (Includes provisions for LP Gas installation).
ADR 79/...	Vehicle Emission Control. This vehicle standard is applicable to all M1 and N1 category vehicles with a GVM less than or equal to 3.5 tonnes and with an engine that operates on petrol, liquefied petroleum gas or natural gas.
ADR 80/...	Emission Control for Heavy Vehicles. (This ADR applies to vehicles of the M and N ADR categories, with a GVM greater than 3.5 tonnes.)

Note: Any modifications to the vehicle that involve structural changes may affect compliance with seat belt and child restraint anchor points.

To determine the ADRs that apply to the vehicle in question, refer to the Applicability Tables in Section LO. Vehicles manufactured on or after 1 January 1969 and prior to 1 July 1988 need to comply with the Second Edition ADRs whilst vehicles manufactured after this date need to comply with the Third Edition ADRs. Section LO has separate applicability tables for each edition.

Alternatively, ADR applicability tables for individual vehicle categories may be referenced on the Department of Infrastructure, Transport, Regional Development and Local Government *RVCS* website at the following address and under the section titled *ADR Applicability tables*:-

<http://rvcs.dotars.gov.au/>

The ADRs apply according to the vehicle's category and date of manufacture. It is the responsibility of the signatory to refer to the appropriate ADR applicable to the vehicle.

SPECIFIC REQUIREMENTS

The safe use of LP Gas requires strict safety standards to be followed for system design and installation.

The regulations allow the continued use of vehicles that were modified to comply with previous versions of AS/NZS 1425.

1. NEW LP GAS INSTALLATION REQUIREMENTS

LP Gas installations must comply with *Australian Standard AS/NZS 1425 LP Gas Fuel Systems for Vehicle Engines*. This Standard provides the technical requirements for the installation of LP Gas fuel systems for motor vehicles in Australia.

Only a licensed technician or installer is allowed to carry out the installation or repair of automotive LP Gas equipment. The installer must fit an identification plate to certify that the LP Gas system meets the requirements of the current version of AS/NZS 1425 when it was installed.

In all States and Territories in Australia the Administration of regulations relating to LP Gas installations is usually the responsibility of more than one department. As a result, certain technical requirements may vary and installation plates may vary in appearance. Please check with your local jurisdiction if you need additional information. In the majority of cases the licensed technician or installer will be able to offer advice.

As stated above, the installation requirements are specified in AS/NZS 1425 and as a consequence these requirements will not be repeated in this document. However a number of issues which affect the consumer directly are specified below for information purposes.

2. LP GAS COMPLIANCE or IDENTIFICATION PLATES

Vehicles with LP Gas systems installed by a licensed LP Gas installer

Only a licensed LP Gas equipment installer is permitted to install automotive LP Gas equipment. Following the completion of each installation, the installer must fix an LP Gas *Compliance Plate* to the vehicle to verify that the installation has been performed in accordance with AS/NZ1425. . The LP Gas *Compliance Plate* must be securely attached in the engine bay in a clearly visible location and must include information such as installation date, state of origin, licence number of installer, Vehicle Identification Number (VIN), container serial number and test date.

3. LP GAS IDENTIFICATION LABELS

Vehicles built or converted to run on LP Gas must have red retroreflective labels (refer Figure LM1) fixed to the front and rear registration plates.

AS/NZS 1425 specifies that these labels:

- (a) shall be affixed to a metal plate not less than 1mm thick;
- (b) size shall not be less than 25mm square mounted on the number plate as a diamond;
- (c) colour shall be retroreflective red complying with AS/NZS 1906.1 Class2; and
- (d) shall have only the letters LPG in white and at least 10mm in height.

These labels are available from licensed LP Gas installers and should be used on all new installations. These labels may also be used to replace existing labels.



Figure LM1 LP Gas Operating Label

Note: The AVSR allows LP Gas vehicle installations performed under previous versions of the Australian Standard to continue to display labels that were appropriate at that time and complying with the provisions shown below:-

- (2) *A vehicle equipped to run on LPG must have fixed conspicuously to the front and rear number plates a label that is:*
 - (a) *made of durable material; and*
 - (b) *at least 25 millimetres wide and 25 millimetres high; and*
 - (c) *reflective red conforming to Australian Standard AS 1742-1975 Manual of Uniform Traffic Control Devices, Appendix C, Class 2; and*
 - (d) *marked 'LPGAS' or 'LPG', or with words or acronyms to similar effect, in capital letters at least 6mm high.*

4. LP GAS FUEL SYSTEMS

Petrol vehicles that are converted to operate on LP Gas can be equipped to run alternatively on LP Gas or petrol, or on LP Gas only. There are also diesel gas vehicles converted to run on a mixture of diesel and up to approx 25% LP GAS concurrently.

The four main component parts fitted to the vehicle are, (refer Figure LM2):

- fuel container for storing the liquefied LP Gas
- fuel lock valve (or filter lock) which prevents the flow of fuel when the engine stops
- vaporiser regulator (or converter) which vaporizes LP Gas liquid (Liquid injection systems do not have a traditional style vaporiser/regulator but instead rely on fuel pump, rail, injectors and pressure regulator, similar to petrol system)
- an air/gas mixer that blends air and LP Gas for delivery to the engine or a vapor injection system interfacing with the original petrol injection system – or liquid injectors.

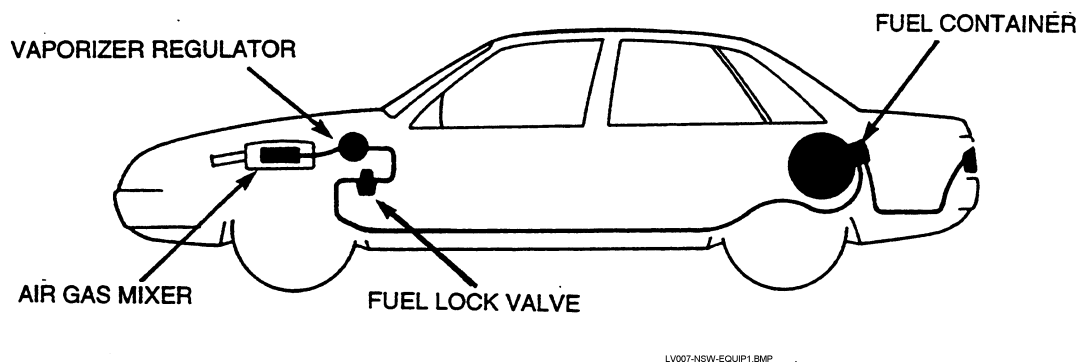


Figure LM2 Equipment for LP Gas vehicles

5. LP GAS FUEL CONTAINERS

The LP Gas fuel container is a certified pressure vessel that is designed and constructed in accordance with Australian Standards. During manufacture it is subjected to controlled heat treatment and stress relief to the weld affected areas. Therefore it is imperative that no welding, soldering, brazing or extreme heating of the cylinder takes place after the manufacture of the vessel.

Internally mounted containers must be encapsulated and vented to the outside of the vehicle (i.e. to atmosphere), in accordance with AS/NZS1425, so that any leaking gas may not pass into any other enclosed space such as the boot or passenger compartment and create a fire hazard

Periodic inspections of LP Gas Containers

All pressure vessels (including LP Gas containers) must bear a stamp that indicates the date on which the containers were last inspected.

Steel or alloy LP Gas containers must be removed from the vehicle and inspected by an authorised test station at least every 10 (ten) years. Non-metallic or FRP containers must be checked every 3 (three) years.

When the inspection and testing of an LP Gas container is required, the owner must enlist the services of a certified gas cylinder testing station. Contact details of certified testing stations may be obtained from the Australian LPG Association at <www.lpgaustralia.com.au> or from the latest version of *MP 48 Certified gas cylinder test stations* which can be obtained from Standards Australia.

6. EMISSION CONTROL EQUIPMENT

Vehicles converted to run on LP Gas only

A vehicle can be converted to operate on LP Gas only (single fuel) providing the following conditions are met:

- For vehicles built between 1 July 1976 and 1 February 1986 and originally operating on leaded petrol, there are no emission requirements other than the maximum carbon monoxide exhaust concentration at engine idle speed must not exceed 4.5% and any engines that were originally fitted with exhaust gas re-circulation valves (EGR) and associated equipment must continue to be fitted with this equipment and the equipment must be operational.
- Catalytic converters and associated engine emission control systems fitted to any vehicle originally operating on unleaded petrol should remain operational after the modifications are completed. For vehicles that were built to complying with ADR 79 or ADR 80, catalytic converters and associated engine emission control systems originally fitted to the vehicle must remain operational.
- Vehicles converted to operate on LP Gas only are not required to retain the evaporative emission control system (carbon canister etc).
- A vehicle originally designed to operate with a closed loop engine management system, must have an LP Gas compatible closed loop management system installed that results in exhaust emission levels for LP Gas that meet the ADR requirement applicable to the vehicle.
- Vehicles built to comply with ADR.79/-- must continue to comply with that standard irrespective of the fuel type used. If a certified (gas installation) kit known to comply with the ADR for that make/model vehicle is not fitted or only partially fitted, then the vehicle must be tested and shown to comply.

Vehicles converted to run on both petrol and LP Gas

An engine can be converted to operate on either petrol or LP Gas provided that when the vehicle is operated on petrol it complies with the petrol related regulations. All emission control systems, fuel emission systems and devices and engine control and management systems, including catalytic converters and oxygen sensors, if originally fitted, must remain operational on all such vehicles. On vehicles dated after 2003 LP Gas systems fitted must also comply with the emission test requirements of AS/NZS 1425: A list of such emission compliant vehicle kits can be obtained from the LP GAS industry body LP GAS Australia on:

< www.lpgautogas.com.au >.

Allowances are made for minor air cleaner and carburetion/injection modifications required for the conversion. The heated air intake system can be removed and replaced by a new unit if it is compatible with and recommended by the system manufacturer.

All passenger vehicles manufactured to comply with an emission ADR, must meet the exhaust emission limits applicable to the vehicle when the vehicle is operating on the original fuel. Where a vehicle was originally designated 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 that meet the ADR requirement applicable to the vehicle.

7. STRUCTURAL ALTERATIONS

Where the installation of LP Gas equipment involves major structural alterations such as the removal of portions of a subframe, floorpan or roof support pillar, it is possible that the vehicle structural strength may have been reduced. In such cases, the modifications must comply with the requirements of Code LH Body Modifications. Reduction in structural strength may have an adverse affect on the strength of seat, seat belt and/or child restraint anchor points.

CHECKLIST LM2

INSTALLATION OF LIQUEFIED PETROLEUM GAS (LP GAS)

FUEL SYSTEMS AND GAS CONTAINERS

(N/A= Not Applicable, Y=Yes, N=No)

[CL refers a clause within to AS/NZS 1425]

1.	LICENSED INSTALLER			
1.1	Has the installation been performed by a licensed installer?		Y	N
2.	LP GAS COMPLIANCE PLATE			
2.1 <i>CL 7.3</i>	Has the licensed installer fitted an LP Gas Compliance plate that complies with the provisions of AS/NZS 1425 that confirms that all LP Gas work has been carried out according to the provisions of AS/NZS 1425?		Y	N
3.	LP GAS IDENTIFICATION LABEL			
3.1 <i>CL 7.4.3</i>	Do the front and rear registration plates have an LP Gas Identification label attached as required by AS/NZS1425?		Y	N
4.	EMISSION CONTROL EQUIPMENT			
4.1	Where a vehicle has been converted to bi-fuel, is the emission control system still connected as per the original installation?	N/A	Y	N
4.2 <i>CL 5.9.1</i>	If more than one fuel is used and not intended to be used simultaneously does the selector prevent the supply of more than one fuel (gas/petrol switch)?	N/A	Y	N
4.3 <i>CL 1.8</i>	If the vehicle is fitted with an oxygen sensor in the exhaust, has a closed loop LP Gas management system been fitted? (Vehicles manufactured from 2004 onwards are required to have a certified LP Gas emission exhaust kit fitted, see Appendix D of AS 1425).	N/A	Y	N
5.	WORKMANSHIP			
5.1	Is all work including welding performed in accordance with recognised engineering standards and to the satisfaction of the Inspector?		Y	N
5.2 <i>CL 1.6</i>	Are vehicle modifications in accordance with sound engineering practises? (e.g. vehicle structure and spare wheel mounting).		Y	N
6.	FASTENERS			
6.1	Are high tensile bolts used on all new critical joints and mountings except container mounting requirements defined by AS/NZS1425?	N/A	Y	N

6.2	Are self-locking nuts used on all new critical joints and mountings?	N/A	Y	N
6.3	Are all replacement fasteners equivalent to or better than original? strength and quality?	N/A	Y	N
7.	ADR COMPLIANCE			
7.1	Does the vehicle comply with applicable ADRs?		Y	N
8	BODY MODIFICATIONS			
8.1	Have all body modifications been performed in accordance with Section LH?	N/A	Y	N
8.2	Have all the checklists required under Section LH been signed and submitted?	N/A	Y	N
9.	INSPECTION			
9.1	Has an inspection been carried out on the installation and all modified components and found to be satisfactory?		Y	N
9.2 CL 7.5	Have the operating instructions been provided including; (a) Refuelling procedures and precautions? (b) Operation of fuel system selector controls? (c) Procedure to follow in the event of various faults?	N/A	Y	N
10.	FUEL COMPONENTS			
10.1 CL 3.2.1	Is an acceptable fuel container fitted and date stamped? Are fuel container components protected in sub-compartment?	N/A	Y	N
10.2 CL 3.18, CL 3.19, CL3.20	Is fuel container mounting position and protection acceptable? (eg ground clearance, tangential angle, container protection) Are under-slung containers mounted to structural members unless approved by a signatory? Are containers over 150 litres water capacity certified by a signatory?	N/A	Y	N
10.3 CL 3.3 – 3.4	Are fuel container components acceptable components for: <u>Fixed Containers</u> <input type="checkbox"/> <u>Removable Containers</u> <input type="checkbox"/>			
10.4 CL 3.7.4	(a) Filler cap?	N/A	Y	N
CL 3.6	(b) Filler connection?	N/A	Y	N
CL 3.7	(c) Filler non-return valve system?	N/A	Y	N

CL 3.8	(d) Automatic fill limiter fitted?	N/A	Y	N
CL 3.11	(e) Excess flow valve?	N/A	Y	N
CL 3.10	(f) Contents gauge?	N/A	Y	N
CL 3.12	(g) Service Valve?	N/A	Y	N
CL 3.15	(h) Safety valve?	N/A	Y	N
CL 3.13	(i) Automatic fuel shut-off device <u>not required on removable container</u>	N/A	Y	N
10.5 CL 3.17.2	Is the construction of container compartment or sub-compartment such that any gas leak cannot pass to any other enclosed compartment, passenger space or luggage space of the vehicle?		Y	N
10.6 CL 3.17.3	(a) Is the compartment or sub-compartment suitably vented to outside atmosphere (clamp tight and caps secured and sealed). (b) Vent exit to be a minimum of 250mm from any heat source.		Y	N
10.7 CL 3.17.4	Are the conduits, ductwork and their fixings acceptable?		Y	N
11.	VALVES			
11.1 CL 3.18.2	Are all valves accessible? Is it possible to operate the service valve for the purpose of servicing or filler shut off valve if fitted, in the installed position without the need for tools?		Y	N
11.2 CL 3.15.2	Safety valve discharge. Discharging gas will not impinge directly on the container, on by-standers, or adjacent vehicles. It will not discharge directly into the passenger compartment.		Y	N
11.3 CL 3.13	Is there an automatic fuel shut off device fitted to the fuel container? (May be fitted directly to fuel container or within 1 metre of it)		Y	N
11.4 CL 3.7.5	Fill point location: (a) Direct mounted when filling is supervised from the outside of the vehicle? (b) Is fill connection protected by being located in a recess below the surface of a body panel, or is equivalent protection provided by the construction of the vehicle? (c) Is the distance between the filling connection and ground level no less than 450mm ?		Y	N
CL 3.7.4	Is a captive filler cap fitted?		Y	N
12.5 CL 4.5	Is the piping protected from corrosion, heat and impact, is it secured every 600mm, are suitable grommets and sleeves etc fitted?		Y	N

11.6 CL 4.7	If more than one container is installed, is there a hydrostatic relief valve fitted and if a common service pipe is used is there a spring-loaded non-return valve fitted?	N/A	Y	N
11.7 CL 3.13	Do automatic fuel shut-off device(s) (AFSOD) only open when the engine is turning and the ignition is on? Is a fuse, a current limiting device or a means of disconnection Installed as a means of electrical isolation for the rear AFSOD and is it installed in the engine bay, adjacent to engine bay AFSOD?		Y	N
11.8 CL 5.6	(a) Is the vaporizer\convertor\regulator installed so that; (b) It is easily accessible? (c) Is it mounted as close to the engine inlet track as is practicable? (d) It is reasonably protected from impact in a collision? (e) It is as close to as is practicable, or connected to the automatic shut off valve? (Any pipe connection to be as short as possible - in no case more than 500mm). (f) Is there sufficient free movement of gas and coolant hoses? (g) It is securely mounted. (h) Is the coolant circulating system connected in accordance with the manufacturer's instruction so that no flow control valve in the system can shut off hot coolant flow? e.g. Thermostat heater control valve. Also should not where possible be higher than the radiator top tank?		Y	N
CL 6.8.3	Is the LP Gas installation free of gas leaks?		Y	N

Note: If the answer to any question is **N (No)**, the modification cannot be approved under Code LM2.

CERTIFICATION DETAILS																	
Make					Model					Year of Manufacture							
VIN																	
Chassis Number (If applicable)																	
Brief Description of Modification/s																	
Vehicle Modified By																	
Certificate Number (If applicable)																	
Vehicle Certified By (Print)																	

Signatory's Employer (If applicable)			
Signatory's Signature		Date	

NATURAL GAS (NG) FUEL SYSTEM INSTALLATIONS AND MODIFICATION

CODE LM3

SCOPE

Code LM3 provides for the conversion of light vehicles to be powered by natural gas. *Natural Gas* (NG) is now used as the generic name for the two physical states of commercially available natural gas, i.e. Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG). Except where specifically required, the generic term will be used within this document.

Code LM3 also provides for dual fuel systems that include LP Gas and petrol or LP Gas and diesel.

Code LM3 does not apply to ADR category L-group vehicles and pre-ADR motorcycles and motor tricycles.

MODIFICATIONS COVERED BY CODE LM3

Modifications that may be performed under Code LM3:

- Installing a CNG fuel system;
- Converting an engine to operate on CNG or dual fuel;
- NOTE: Dual fuel could be either CNG & petrol or CNG & diesel, and
- Replacing the original CNG container with one of larger capacity or with a fibreglass or fibre-reinforced plastic (FRP) container.

MODIFICATIONS NOT COVERED BY CODE LM3

The following is a summary of the modifications that may not be performed under Code LM3:

- Fitting a liquefied petroleum gas fuel system (this is covered by Code LM2);
- Fitting replacement or modified fuel tanks (these are covered by Code LM1); and
- Fitting an LNG fuel system. (Refer to the appropriate vehicle Registration Authority for details of how to obtain approval).

Note: Code LM3 is not utilised in Queensland.

COMPLIANCE WITH REGULATIONS

Modified vehicles must continue to comply with the ADRs to which they were originally constructed, except as allowed for in the AVSR. These modified vehicles must also comply with the applicable in-service requirements of the AVSR.

Modified pre-ADR vehicles must continue to comply with the AVSR.

Compliance with the AVSR also means compliance with the equivalent regulations of a State or Territory of Australia.

Outlined below in Table LM5 are areas of the vehicle that may be affected by the modifications and that may require re-certification, testing and/or data to show compliance for the modified vehicle. This is not an exhaustive list and other modifications may also affect ADR compliance.

Table LM5 Summary of items that if modified, may detrimentally affect compliance with applicable ADRs

ADRS	DETAILS
ADR 26, 27x	Vehicle Engine Emission Control
ADR 37, 37/...	Vehicle Emission Control
ADR 40	Light Duty Vehicle Emissions Control
ADR 41, 41/...	General Safety Requirements. The requirements for positioning of exhaust outlets.
ADR 42/...	Vehicle Configuration and Dimensions - (Includes provisions for ground clearance).
ADR 43/...	Specific Purpose Vehicle Requirements (Includes provisions for LP Gas installation).
ADR 79/...	Vehicle Emission Control. This vehicle standard is applicable to all M and N category vehicles with a GVM less than or equal to 3.5 tonnes and with an engine that operates on petrol, liquefied petroleum gas or natural gas.
ADR 80/...	Emission Control for Heavy Vehicles. (This ADR applies to vehicles of the M and N ADR categories, with a GVM greater than 3.5 tonnes.)

Note: Any modifications to the vehicle that involve structural changes may affect compliance with seat belt and child restraint anchor points.

To determine the ADRs that apply to the vehicle in question, refer to the Applicability Tables in Section LO. Vehicles manufactured on or after 1 January 1969 and prior to 1 July 1988 need to comply with the Second Edition ADRs whilst vehicles manufactured after this date need to comply with the Third Edition ADRs. Section LO has separate applicability tables for each edition.

Alternatively, ADR applicability tables for individual vehicle categories may be referenced on the Department of Infrastructure, Transport, Regional Development and Local Government *RVCS* website at the following address and under the section titled *ADR Applicability tables*:-

<http://rvcs.dotars.gov.au/>

The ADRs apply according to the vehicle's category and date of manufacture. It is the responsibility of the signatory to refer to the appropriate ADR applicable to the vehicle.

SPECIFIC REQUIREMENTS

The following are the requirements applying to vehicles that are converted to run on NG:

1. INSTALLATION REQUIREMENTS

A licensed gas fitter can only carry out work on a NG installation. The work for which a licence is needed includes installing a NG system to a motor vehicle or repairing or adjusting any NG equipment that has already been fitted to a vehicle. All NG related work must comply with the provisions of AS/NZS 2739: *Natural gas (NG) fuel systems for vehicle engines*.

After a NG installation is fitted to a vehicle the installer must: provide the owner of the vehicle a Certificate of Compliance confirming that the installation is in accordance with AS/NZS 2739.

NG COMPLIANCE PLATE

A compliance plate must be securely attached to the body of the vehicle in a conspicuous position in the engine bay.

NG IDENTIFICATION LABELS

The installer must attach labels to the outside of the vehicle, in conspicuous places at both the front and back. Usually, the labels are fitted to the vehicle's registration plates.

The labels must be at least 25mm square, be red in colour and have white lettering at least 10mm high showing the letters *NG*. (Refer Figure LM3).

However the current standard, AS/NZS 2739: specifies that the label:

- (a) shall be affixed to a metal plate not less than 1mm thick and mounted to the number plates;
- (b) size shall not be less than a 35mm diameter circle;
- (c) colour shall be retro-reflective red complying with AS/NZS 1906.1 Class2, and
- (d) shall have only the letters *CNG* in white and at least 10mm in height.

These labels are available from all licensed NG installers and should be used on all new installations. These labels may also be used to replace existing labels.

An identification label is required for each tank fitted to the vehicle - i.e. if two or more tanks are fitted, two labels must be attached to each number plate.



Figure LM3 NG Vehicle Identification

2. EMISSION REQUIREMENTS FOR NG FUELLED VEHICLES

Vehicles converted to run on NG only

A vehicle can be converted to operate on NG only (single fuel) providing the following conditions are met:

- For vehicles built between 1 July 1976 and 1 February 1986 and originally operating on leaded petrol, there are no emission requirements other than that the maximum carbon monoxide concentration at engine idle speed must not exceed 4.5% and any engines that were originally fitted with exhaust gas re-circulation valves (EGR) and associated equipment must continue to be fitted with this equipment and the equipment must be operational;
- Catalytic converters and associated engine emission control systems fitted to any vehicle originally operating on unleaded petrol should remain operational after the modifications are completed. For vehicles that were built to complying with ADR 79 or

ADR 80, catalytic converters and associated engine emission control systems originally fitted to the vehicle must remain operational; and

- Vehicles converted to operate on NG only are not required to retain the evaporative emission control system (carbon canister etc).

Vehicles Converted to Run on Both Diesel (or Petrol) and NG

An engine can be converted to operate on both diesel (or petrol) and NG provided that when the vehicle is operated solely on diesel (or petrol) it complies with the diesel (or petrol) related regulations. All emission control systems, fuel emission systems and devices and engine control and management systems, including catalytic converters and oxygen sensors, if originally fitted, must remain operational on all such vehicles.

Allowances are made for minor air cleaner and carburetion/injection modifications required to fit the conversion. The heated air intake system can be removed and replaced by a new unit if it is compatible with and recommended by the system manufacturer.

CHECKLIST LM3

NATURAL GAS (NG) FUEL SYSTEM INSTALLATIONS AND MODIFICATION

CODE LM3

(N/A= Not Applicable, Y=Yes, N=No)

1.	LICENSED INSTALLER			
1.1	Has the installation been performed by a licensed installer?		Y	N
2.	NG COMPLIANCE PLATE			
2.1	Has the licensed installer fitted a NG compliance plate that complies with the provisions of AS/NZS 2739 that confirms that all NG work has been carried out according to the provisions of AS/NZS 2739?		Y	N
3.	NG IDENTIFICATION LABEL			
3.1	Do the front and rear registration plates have a NG identification label attached?		Y	N
4.	EMISSION CONTROL EQUIPMENT			
4.1	Where a vehicle has been converted to dual fuel, are all the original emission control systems still connected as per the original installation?		Y	N
5.	WORKMANSHIP			
5.1	Is all work including welding performed in accordance with recognised engineering standards and to the satisfaction of the Inspector?		Y	N
6.	FASTENERS			
6.1	Are high tensile bolts and self-locking nuts used on all new critical joints and mountings?	N/A	Y	N
6.2	Are all replacement fasteners equivalent to or better than original in strength and quality?	N/A	Y	N

[Continued overleaf]

(N/A= Not Applicable, Y=Yes, N=No)

7.	ADR COMPLIANCE		
7.1	Does the converted vehicle comply with applicable ADRs?		Y N
8.	INSPECTION		
8.1	Has an inspection been carried out on the installation and all modified components and found to be satisfactory?		Y N
9	BODY MODIFICATIONS		
9.1	Have all body modifications been performed in accordance with Section LH?	N/A	Y N
9.2	Have all the checklists required under Section LH been signed and submitted?	N/A	Y N

NOTE: If the answer to any question is **N (No)**, the modification cannot be approved under Code LM3.

CERTIFICATION DETAILS													
Make				Model				Year of Manufacture					
VIN													
Chassis Number (If applicable)													
Brief Description of Modification/s													
Vehicle Modified By													
Certificate Number (If applicable)													
Vehicle Certified By (<i>Print</i>)													
Signatory's Employer (If applicable)													
Signatory's Signature								Date					