

Australian Standard™

LP Gas fuel systems for marine engines

This Australian Standard was prepared by Committee ME-046, Gas Fuel Systems for Vehicle Engines. It was approved on behalf of the Council of Standards Australia on 30 April 2002 and published on 10 May 2002.

The following interests are represented on Committee ME-046:

Australian Automobile Association
Australian Chamber of Commerce and Industry
The Australian Gas Association
Australian Industrial Truck Association
Australian Liquefied Petroleum Gas Association
Box Hill Institute of TAFE
Department of Administrative and Information Services, S.A.
Department of Mines and Energy, Qld
Department of Industries & Business, N.T.
Department of Industry, Science and Resources (Commonwealth)
Department of Transport, S.A.
Department of Urban Services, A.C.T.
Federal Chamber of Automotive Industries
Institution of Engineers, Australia
Motor Traders Association of N.S.W.
Motor Trades Association of Australia
Office of Energy, W.A.
TAFE, N.S.W.
Victoria Police
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Additional interest participating in the preparation of this Standard:

Waterways Authority, N.S.W.

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This Standard was issued in draft form for comment as DR 00085.

Australian Standard™

LP Gas fuel systems for marine engines

First published as AS 4732—2002.

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Published by Standards Australia International Ltd
GPO Box 5420, Sydney, NSW 2001, Australia

ISBN 0 7337 4508 3

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee ME-046, Gas Fuel Systems for Vehicle Engines, to provide a Standard for the installation, inspection, testing, commissioning and certification of LP Gas fuel systems for marine engines.

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee ME-046. After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

This Standard was based on AS/NZS 1425:1999, *LP Gas fuel systems for vehicle engines* and has been modified to meet the needs of marine engines.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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STANDARDS AUSTRALIA

Australian Standard LP Gas fuel systems for marine engines

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE AND APPLICATION

1.1.1 Scope

This Standard specifies the requirements for liquefied petroleum gas (LP Gas) fuel systems for marine engines for either the propulsion of the craft or for powering auxiliary engines.

This Standard is not intended to override any requirements of IMO (International Marine Organisation), SOLAS (Safety Of Life At Sea) or any classification society rules.

This Standard does not apply to LP Gas systems for appliances.

NOTE: State and Territory marine and energy supply authorities may specify additional requirements relating to the LP Gas as the source of fuel.

1.1.2 Application

This Standard shall be read as defining the minimum requirement of acceptability.

The relevant authority having jurisdiction may determine the extent of application of this Standard.

1.2 OBJECTIVE

The objective of this Standard is to provide requirements for the design and construction of component parts, and for their installation in marine craft, and for tests, commissioning, and periodic inspection.

1.3 REFERENCED DOCUMENTS

A list of the Standards referred to in this Standard is given in Appendix A.

1.4 NEW DESIGNS AND INNOVATIONS

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 given equivalent results to those specified, may be acceptable. Under such conditions the regulatory authority can give advice on the procedure for approval.

1.5 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.5.1 Approved, approval

Approved by or approval of the regulatory authority.

1.5.2 Authorized person

A person qualified, authorized or licensed by the relevant Australian or State body to install or service LP Gas equipment in marine craft. (See also Clause 1.5.23.)

1.5.3 Authority

The authority having regulatory powers to control the design, manufacture and installation of equipment described in this Standard in the State or Territory in which the craft is registered.

NOTE: A listing of agency information is provided in Appendix B.

1.5.4 Automatic fill limiter (AFL)

A provision in the filling system which automatically terminates filling when a predetermined liquid level in the container has been reached.

1.5.5 Automatic fuel shut-off device

A provision for automatically shutting off the fuel supply unless certain essential conditions exist.

1.5.6 Bilge

The lowest portion of a craft's hull interior.

1.5.7 Capacity (of a container)

The total internal volume of the container, expressed in litres.

NOTE: This was previously known as 'Water Capacity' (W/C).

1.5.8 Container

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

1.5.9 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.

1.5.10 Craft

A vessel intended for use on inland or offshore waters and includes ships, boats, barges, pontoons, houseboats and any other similar craft.

1.5.11 Double non-return valve

Two non-return valves arranged in series to provide dual security against backflow.

1.5.12 Excess-flow valve

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

1.5.13 Fixed liquid level gauge

A gauge which indicates the maximum permitted liquid level in the fuel container.

1.5.14 Fuel filter

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

1.5.15 Fuel service line

Piping used for the conveyance of LP Gas from the filling connection to the fuel container or from the fuel container to the LP Gas vaporizer.

1.5.16 Fuel system

The way in which LP Gas is delivered to the engine. This can include the following configurations:

- (a) Mono fuel LP Gas (operates solely on LP Gas).
- (b) Bi-fuel (operates on LP Gas or another fuel, i.e. petrol).
- (c) Dual fuel (operates on LP Gas plus another fuel, i.e. diesel).

NOTE: All of the above can be supplied LP Gas with either a liquid or vapour withdrawal system.

1.5.17 Galvanic compatibility

Metals or alloys that are close in order of their potential as measured in relation to a reference electrode when immersed in sea water.

1.5.18 Gas-air mixer

A device for introducing gaseous fuel to the induction air of the engine.

1.5.19 Gas detector system

An approved system of detectors, and shut off valves interlocked together to automatically detect the presence of gas.

1.5.20 Hydrostatic relief valve

A valve whose purpose is to relieve and prevent overpressure in any fuel service line carrying LP Gas.

1.5.21 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 craft is not regarded as being an ignition source while it is entering or leaving the hazardous zone surrounding a fuel dispenser, for refuelling.

1.5.22 Internal (component)

A fitting or component constructed with its significant working parts within the container perimeter so that any damage to exposed portions will not prevent effective safe functioning of the component.

NOTE: The perimeter of the container 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.

1.5.23 Licensed installer

A person who has successfully completed an authorized training course and is registered or endorsed with the relevant authority.

1.5.24 Locker

A structure which encloses the whole of the container and its fittings, whose purpose is to collect any gas leakage which might occur.

NOTE: The primary function of a locker or sub-compartment is leakage collection and discharge, not physical protection. This is a separate need, which may equally well be provided by some other means.

1.5.25 LP Gas

A hydrocarbon fluid composed predominantly of any of the following hydrocarbons, or mixtures of all or any of them: propane, propylene, butane, butylenes.

NOTE: Unless specifically stated otherwise, any reference to propane, butane, etc. means the commercial grade of that product.

1.5.26 Maximum permitted filling level

The level of the liquid in a container when the liquid contents are 80% of the total available internal volume of the container.

1.5.27 Machinery space

Any compartment housing an internal combustion engine.

1.5.28 Non return valve

A valve which permits fuel flow in only one direction.

1.5.29 POL coupling

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

1.5.30 Pressure

Gauge pressure (as opposed to absolute pressure).

1.5.31 Professional engineer

A person who is a registered professional engineer in the relevant discipline who has appropriate experience and competence in the relevant field.

1.5.32 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.

1.5.33 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.

1.5.34 Removable container

A container which is removed from the craft for refuelling, usually in exchange for a full container.

1.5.35 Safety coupling

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

1.5.36 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.

1.5.37 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.

1.5.38 Shall

Indicates that a statement is mandatory.

1.5.39 Should

Indicates a recommendation.

1.5.40 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.

NOTE: The primary function of a locker or sub-compartment is leakage collection and discharge, not physical protection. This is a separate need, which may be provided equally well by some other means.

1.5.41 Vaporizer

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

1.5.42 Vented compartment

A structure to house components that is vented to open air.

1.5.43 Ventilation (forced)

Either a forced draft or induced draft fan designed to ventilate fuel vapours from ducts, conduits, lockers or machinery space.

1.5.44 Ventilation (natural)

A draft induced by differential pressure between internal and external atmosphere.

1.6 CRAFT MODIFICATIONS

Any alterations or modification to any craft resulting from the installation of LP Gas equipment shall be carried out in accordance with sound engineering practices and in compliance with the relevant marine standards.

The installation of LP Gas containers may adversely affect the stability of the craft. Consideration shall be given to the location of the containers.

In no circumstances shall the craft's critical load distribution which affects safety considerations be compromised.

1.7 APPROVED EQUIPMENT

Only equipment suitable for a marine environment and acceptable to the relevant body shall be used.

1.8 PREVIOUSLY USED EQUIPMENT

Used equipment may be reinstalled provided that—

- (a) the equipment is in good condition and continues to comply with relevant Standards;
- (b) the fuel container has been subjected to the preliminary examination described under 'Filling' 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.

1.9 LP GAS WITHDRAWAL FROM MARINE SYSTEMS

A marine 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.

SECTION 2 COMPONENTS

2.1 GENERAL SUITABILITY

2.1.1 General

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

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 procedures, 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.

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 2.1.

TABLE 2.1
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 only)	6 000
Liquid level sensor, whether a part of a filling shut-off valve or of another contents gauge	100 000
Safety valve and hydrostatic-relief valve	6 000
Automatic fuel shut-off device	100 000
Regulator	100 000
Filling connection	6 000

2.3 SUITABILITY FOR INSTALLATION

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

2.4 MODIFICATION

Modifications to an approved component shall not be made without specific approval of the manufacturer or their agent.

2.5 METALS

Metals used in valves on the container shall be those specified in AS 2473. Aluminium alloys may be used for other components except piping and pipe fittings. Metallic materials having a melting point lower than 500°C shall not be used in any application where failure could result in gas escape.

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 2.2 after immersion in hexane or pentane at 20°C for 70 h.
- (b) The part shall not show visible evidence of deterioration after exposure to oxygen at 2 MPa and 20°C for 96 h.

TABLE 2.2
IMMERSION TEST LIMITS

Nature of change	Maximum permissible change, percent	
	Diaphragms	Other parts
Volumetric swelling	25	25
Volumetric shrinking	10	1
Loss of mass	15	10

SECTION 3 CONTAINER

3.1 APPLICATION

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

3.2 CONTAINER

3.2.1 General

A fuel container shall comply with one of the following Australian or Australian/New Zealand Standards and shall be suitable for use in a marine environment:

- (a) AS/NZS 3509.
- (b) AS 1210.
- (c) AS 2030.1.
- (d) AS 2470.

3.2.2 Use of fixed containers

All liquid withdrawal LP Gas systems shall employ fixed containers.

3.2.3 Use of removable containers

Containers which are removed for refuelling shall only be used in accordance with Clause 6.4 of AS/NZS 1596:1997 and be used only in the following applications:

- (a) For the fuel supply to an auxiliary engine.
- (b) For the fuel supply to a small outboard engine to a maximum of 19 kW.
- (c) For the fuel supply to a diesel engine employing a dual-fuel system.

3.3 COMPONENTS FOR FIXED CONTAINERS

A container system that is installed for *in situ* filling on a craft 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.

3.4 COMPONENTS FOR REMOVABLE CONTAINERS

A container that is removed from the craft 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.
- (f) Safety valve.
- (g) Automatic fuel shut-off device.

3.5 COMPONENT SUITABILITY

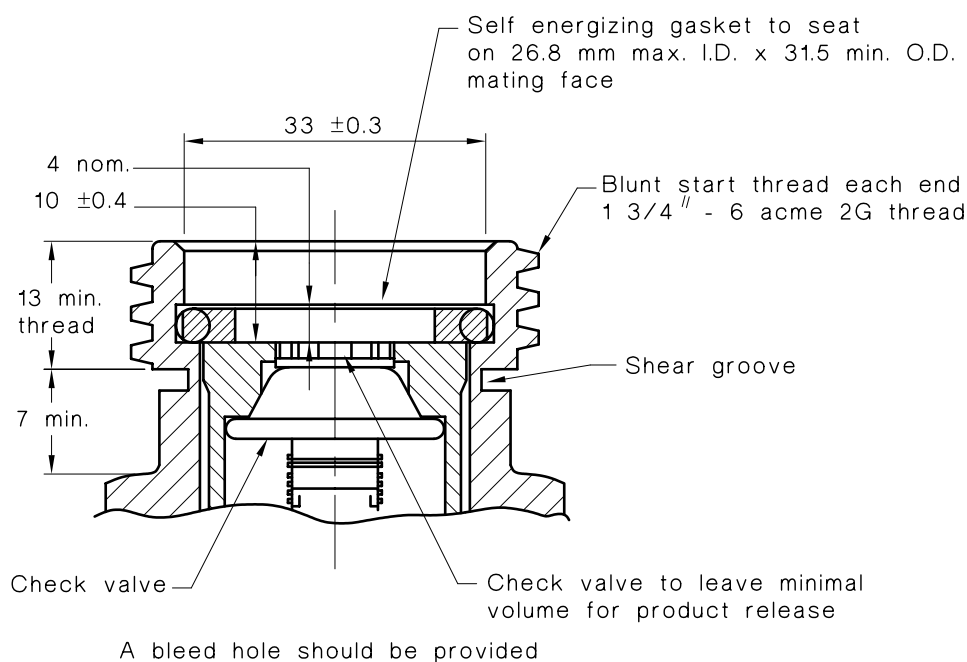
Container components other than those makes and models nominated by the container manufacturer or professional engineer for use with that particular container shall not be fitted.

Components may be combined into multifunction units, provided that the requirements for each individual function have been satisfied.

3.6 FILLING CONNECTION

The container filling connection shall be a 1¾ inch male Acme thread conforming to Figure 3.1, except that for a removable container a POL coupling may be used.

A remote filling connection shall incorporate a provision to prevent it from rotating when the mating dispenser nozzle is connected or disconnected.



DIMENSIONS IN MILLIMETRES

FIGURE 3.1 1¾ INCH ACME FILLING CONNECTION

3.7 FILLER NON-RETURN VALVE SYSTEM

3.7.1 Direct filling system

Where the filling connection is on the container, it shall incorporate a double non-return valve in which one valve at least shall be a gastight type.

3.7.2 Remote filling system

3.7.2.1 Filling connection

Where the filling connection is remote from the container, the backflow prevention system shall be one of the following:

- (a) A single gastight non-return valve at the filling connection plus a double non-return valve at the container of which one element at least shall be gastight.
- (b) A single gastight non-return valve at the container, plus a double non-return valve at the filler connection of which one element at least shall be gastight.
- (c) Double non-return valves at both the container and the filling connection of which one element at least of each valve shall be gastight.
- (d) A single gastight non-return valve at the filling connection, plus a manual shut-off valve together with a gastight non-return valve at the container.

3.7.2.2 Fill line

The fill line shall meet the following conditions:

- (a) Rigid piping, fittings or hose assemblies used as a fill line shall comply with Clauses 4.2.1, 4.3, 4.4 and 4.5.
- (b) The minimum size for a fill line shall be of 8 mm nominal internal diameter with a minimum number of elbows.
- (c) Rigid piping which passes through a compartment or void need not pass through conduit, provided that—
 - (i) the piping is protected from mechanical damage by its location;
 - (ii) there are no pipe joints within the compartment; and
 - (iii) the points of passage through the compartment are sealed gastight by approved means.

3.7.3 Internal non-return valve

At least one of the non-return valves in the backflow prevention system shall be of such a type that damage to the assembly external to the container will not impair the operation of the valve.

3.7.4 Filler cap

The filling connection shall be provided with a filler cap that meets the following conditions:

- (a) The filler cap shall be captive.
- (b) The filler cap shall be capable of withstanding the system design pressure.
- (c) The filler cap shall be capable of providing a weather-tight seal.

3.7.5 Location of fill point

The filling point shall be located so that the following conditions are satisfied whilst the craft is afloat:

- (a) The filling connection is made from outside the craft.
- (b) The filling connection can be supervised from open deck of the craft.
- (c) The filling connection is protected from mechanical or corrosive damage by its location.
- (d) The filling connection is located so that any spillage will not enter the interior of the craft.

3.8 AUTOMATIC FILL LIMITER (AFL)

3.8.1 General

An automatic fill limiter shall be fitted to every fixed container and shall comply with the following requirements:

- (a) The operation of the shut-off action shall not depend on a bleed of LP Gas to the atmosphere.
- (b) It shall not incorporate any feature whereby the liquid level can be altered from outside the container after installation.
- (c) A type that depends on correct radial orientation for its accuracy, e.g. a screw-in type, shall incorporate a permanent provision to indicate the correct setting or position.

Where the option of an AFL is used for a removable container (see Clause 3.4(e)) it shall comply with all of the above requirements.

3.8.2 Performance

The AFL shall be correctly oriented and its performance shall be as follows:

- (a) The shut-off shall be before the maximum capacity of 80% has been exceeded.
- (b) The shut-off function shall be operable at any pressure differential between 70 kPa and 1000 kPa. Any adjacent or inbuilt non-return valve is considered not to be part of the AFL for this requirement.
- (c) The leakage rate into the container after shut-off shall be such that the liquid volume does not increase by more than 5 percent of the total container volume in 8 min.

3.8.3 Durability

The AFL shall continue to comply with Clause 3.8.2 subsequent to testing as follows:

- (a) The cycling and function test specified in Clause 2.2 shall be carried out using either air or water at a pressure of 700 kPa.
NOTE: 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 1g.
- (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 its normal working attitude 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.

3.9 FIXED LIQUID LEVEL GAUGE

3.9.1 General

Where a fixed liquid level gauge is installed it shall not be used or activated whilst the container is onboard the craft.

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 of the fixed liquid level gauge.

3.9.2 Gas-bleed type

A fixed liquid level gauge that 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.

3.10 CONTENTS GAUGE

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

3.11 EXCESS-FLOW VALVE

3.11.1 Liquid

The following requirements apply:

- (a) For a fixed container the valve shall be internally located within the container.
- (b) The nominal closing flow rate shall not exceed 215 mL/s of LP Gas liquid.
- (c) The bypass flow rate when the valve is shut shall not exceed 3.3 mL/s of LP Gas liquid at 350 kPa differential pressure.
- (d) The valve shall re-open automatically when the excess flow condition has ceased.

3.11.2 Vapour

The following requirements apply:

- (a) For a removable container the valve shall be located within the container sub-compartment.
- (b) The nominal closing flow rate shall not exceed 56.5 mL/s of LP Gas vapour.
- (c) The bypass flow rate when the valve is shut shall not exceed 4.0 mL/s of LP Gas vapour at 700 kPa differential pressure.
- (d) The valve shall re-open automatically when the excess flow condition has ceased.

3.12 SERVICE VALVE

A service valve shall be a manually operated shut-off valve complying with the material requirements of AS 2473.

3.13 AUTOMATIC FUEL SHUT-OFF DEVICE AT CONTAINER

3.13.1 General

The automatic fuel shut-off device (container) shall automatically act to prevent the flow of LP Gas to the service line unless the following conditions are simultaneously satisfied:

- (a) The ignition is on.
- (b) The engine is turning.
- (c) The gas detection system, as required by Clause 6.2, does not indicate the presence of gas.