

Australian Standard[®]

Gas fuel systems for forklifts and industrial engines



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- Australian Automobile Association
 - Australian Industrial Truck Association
 - Department for Premier and Cabinet, SA
 - Department for Transport, Energy and Infrastructure, SA
 - Department of Mines and Energy, Qld
 - Energy Safety, WA
 - Engineers Australia
 - Federal Chamber of Automotive Industries
 - Gas Association of New Zealand
 - International Association for Natural Gas Vehicles
 - Land Transport, New Zealand
 - LPG Association of New Zealand
 - LPG Australia
 - Motor Trade Association, New Zealand
 - Motor Traders' Association of NSW
 - Motor Trades Association of Australia
 - Roads and Traffic Authority of NSW
 - TAFE NSW
 - Victorian Police
-

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Australian Standard[®]

Gas fuel systems for forklifts and industrial engines

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PREFACE

This Standard was prepared by the Australian members of Joint Standards Australia/Standards New Zealand Committee ME-046, Gas Fuel Systems for Vehicle Engines to supersede AS 4983—2003, *Gas fuel systems for forklifts and industrial engines*.

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.

The 2009 edition of this Standard incorporates changes to LP Gas low pressure hosing not exceeding 450 kPa in Section 5. It also clarifies that this Standard does not apply to LNG fuel supply systems. It is now a requirement to fit an indexing pin to ensure correct container selection and orientation when a LP Gas container is removable. References to ‘cylinders’ have been changed to ‘containers for CNG’.

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
Gas fuel systems for forklifts and industrial engines

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE AND APPLICATION**1.1.1 Scope**

This Standard specifies requirements for liquefied petroleum gas (LP Gas) and compressed natural gas (CNG) fuel systems for engines mounted on industrial equipment, either for the propulsion of the equipment 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 equipment, and for tests, commissioning and periodic inspection.

The Standard applies to fixed installations, mobile and portable equipment such as forklifts, floor sweepers, polishers, tow tractors, elevating work platforms and industrial engines.

NOTE: For installations to industrial stationary engines connected to a reticulated fuel supply, reference should be made to AS 3814 or AS/NZS 1596 for storage and handling or AS 5601 for gas installations.

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

This Standard does not apply to Liquefied Natural Gas (LNG) fuel supply systems.

This Standard does not cover the areas where major structural modifications are to be carried out to the industrial equipment (major structural modifications are those not defined in Clause 1.6). Prior to commencement of such work, guidance should be sought from the equipment manufacturer or a professional engineer who is experienced in the relevant disciplines.

1.1.2 Application

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 designers, manufacturers, installers and regulatory authorities with technical testing, inspecting and certification requirements for LP Gas and CNG fuel systems for forklifts and industrial engines so as to provide functional, safe installations.

1.3 REFERENCED DOCUMENTS

A list of the documents 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, that 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.

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 or CNG equipment in forklifts and industrial engines.

1.5.3 Authority(ies)

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

NOTES:

- 1 In some areas, industrial equipment installations and stationary installations are under the control of different authorities.
- 2 A listing of agency information is provided in Appendix B.

1.5.4 Automatic fill limiter (LP Gas)

A provision in the filling system that 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 are met.

1.5.6 Capacity (of a container)

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

NOTE: This is also known as 'water capacity'.

1.5.7 Closed-loop system

An engine management system whereby details of the oxygen content in the exhaust gases is fed back into the management system to control the air/fuel mixture.

1.5.8 Compartment

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

NOTE: The primary function of a compartment 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.

1.5.9 CNG (Compressed natural gas)

A compressed gaseous fuel composed of natural gas of pipeline quality, as defined in AS 4564.

1.5.10 Container

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

1.5.11 Container manufacturer certificate

A manufacturer's certificate containing information including the container design information/drawing, the container Standard designation, the container model number, the rated working pressure, serial numbers, an Australian container design registration number, the expiry date (if applicable) and inspection interval.

1.5.12 Contents gauge

For LP Gas, a gauge that gives a visual indication of the liquid content of the container.

For CNG, a gauge that gives a visual indication of the container pressure.

This may be read at the container or remotely.

1.5.13 Decanting

A procedure in which the liquid phase of LP Gas is transferred from one container to another by utilizing the difference in pressure between the two containers.

1.5.14 Double non-return valve

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

1.5.15 Excess-flow valve

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

1.5.16 Factory assembling

An operation carried out by the Original Equipment Manufacturer (OEM) prior to supply of the equipment to market.

1.5.17 Fill line

Piping used for the conveyance of fuel from the filling connection to the container.

1.5.18 Fixed liquid level gauge

A gauge that indicates the maximum permitted liquid level in the LP Gas fuel container incorporating 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.

1.5.19 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.

1.5.20 Fuel injector

A device operated by an engine management system for injecting LP Gas into the engine under pressure either in liquid or gaseous form.

1.5.21 Fuel service line

Piping, other than the fill line, used for the conveyance of fuel from the container to the fuel vaporiser/regulator at a pressure exceeding 450 kPa.

1.5.22 Gas-air mixer

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

1.5.23 Hydrostatic relief valve

A valve that relieves and prevents overpressure in any fuel service line carrying LP Gas liquid.

1.5.24 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.

Forklift or industrial engines are not regarded as being an ignition source while entering or leaving the hazardous zone surrounding a fuel dispenser for refuelling purposes.

1.5.25 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, e.g. closure, reseating, pressure relief.

The perimeter of the container is taken to mean not only the surface of the container and ends, but also the outline of any boss, spigot, or nozzle welded to the container 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 definition.

1.5.26 LP Gas

A mixture of propane and butane in varying proportions with minor traces of other hydrocarbons.

1.5.27 Manifold

A component that connects multiple containers, which may contain a spring loaded non-return valve and/or a hydrostatic relief valve.

1.5.28 Maximum permitted filling level

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

1.5.29 May

Indicates the existence of an option.

1.5.30 NGV

Natural gas fuelled vehicle.

1.5.31 Non return valve

A valve that permits fuel flow in only one direction.

1.5.32 POL coupling

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

1.5.33 Pressure

Gauge pressure (as opposed to absolute pressure).

1.5.34 Pressure relief device (CNG)

One time use device triggered by excessive temperature or temperature and pressure that vents gas to protect the container from rupture.

1.5.35 Professional engineer

A person who is—

- (a) a professional engineer in the relevant discipline who has appropriate experience and competence in the relevant field; or
- (b) a Corporate Member of the Institution of Engineers Australia; or
- (c) eligible to become a Corporate Member of the Institution of Engineers Australia and has appropriate experience and competence in the relevant field.

1.5.36 Rated working pressure

The maximum pressure to which it is permitted to fill a container with CNG, measured when the container and its contents are at an equilibrium temperature of 15°C.

1.5.37 Regulator

A device used to control the delivery pressure of gaseous fuel to the engine.

1.5.38 Relief device (LP Gas)

A valve that 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.

1.5.39 Removable container

A container that is designed to be removed from the equipment for refuelling, usually in exchange for a full container.

1.5.40 Safety coupling

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

1.5.41 Safety valve (PRV-Pressure Relief Valve)

A valve that 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.

1.5.42 Service valve

A manually operated shut-off valve fitted on the container that, when operated, will open or shut-off the LP Gas or CNG supply to the engine for maintenance servicing or emergency requirements.

1.5.43 Shall

Indicates that a statement is mandatory.

1.5.44 Should

Indicates a recommendation.

1.5.45 Sub-compartment

An enclosure attached to the container, which houses the container fittings, and whose purpose is to collect any gas leakage that might occur, so that it can be discharged to open air.

NOTE: The primary function of a compartment 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.

1.5.46 Vaporiser (Converter)

A device which vaporises LP Gas liquid for delivery to the gas/air mixer or a fuel injector.

1.6 INDUSTRIAL EQUIPMENT MODIFICATIONS

Any alterations or modifications to the industrial equipment resulting from the installation of LP Gas or CNG systems shall be carried out in accordance with sound engineering practices and be approved by the manufacturer or the importer. Modifications include any alterations to the following:

- (a) *Suspension*—Including mounting locations, geometry, ground clearance axles and stub-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 equipment.

- (c) *Equipment structure*—If installation of containers is required to be on an overhead guard such installation shall require approval from the manufacturer, or the importer, and be acceptable to the relevant authority where appropriate.
- (d) *Braking system*—Including the handbrake and components.

1.7 MINOR ALTERATIONS

The weight of the LP Gas container(s) or CNG container(s) will affect the tare weight of the forklift or industrial equipment 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 equipment's critical load distribution, which affects safety considerations, be compromised.

1.8 ENGINE MANAGEMENT SYSTEM

Any alteration(s) made to the manufacturer'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 originally designed. If such alterations are made, they shall be approved by the manufacturer or their agent.

Where the industrial equipment was originally designed to operate with a closed loop engine management system, then a closed loop system shall be retained for LP Gas or CNG operation. This closed loop engine management system shall achieve at least the same exhaust emission levels for LP Gas or CNG whichever is applicable. The exhaust emission levels shall meet the industrial equipment manufacturer's requirements and shall not be inferior to the emission levels of the original system.

1.9 USE OF EQUIPMENT IN ENCLOSED SPACES

Exhaust emissions from equipment operated in enclosed spaces shall not exceed levels as specified by the relevant authority.

1.10 PREVIOUSLY USED COMPONENTS AND MATERIALS

Previously used components and materials may be transferred to other industrial equipment provided that the following conditions apply:

- (a) The component or material shall be in good condition and continue to comply with current Standards.
- (b) The LP Gas fuel container shall be subjected to the preliminary examination described in the Clause relating to 'filling' in AS 2030.1.
- (c) The CNG container(s) recertification interval shall not have expired.
- (d) Double ferrule fittings, as permitted for use with CNG, shall only be reused if the ferrules are replaced according to the manufacturer's published instructions.
- (e) The following components and materials shall not be reused:
 - (i) Any piping or hose that has been subjected to the LP Gas container or CNG container pressure.
 - (ii) Any screwed fittings other than stainless steel reusable used for the connection of pipes or hoses to components subject to container pressure which have been removed from components.
 - (iii) Any grommets or fittings used to seal piping through bulkheads.

1.11 GAS OR LIQUID FUEL WITHDRAWAL FROM INDUSTRIAL EQUIPMENT SYSTEMS

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

1.12 WORKING AREA AND SAFE PRACTICES

The working area, specialist equipment and the practices applied during installation, inspection, testing and commissioning shall comply with AS 2746.

1.13 REGULATORY AGENCIES

Nominated agencies in the States and Territories are responsible for activities relating to LP Gas and CNG vehicles.

NOTE: A list of regulating agencies is given in Appendix B.

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, compatibility and vibration. Components may be combined into multifunction units, provided that such units comply with the requirements for each function. Suitability shall be proved by testing wherever appropriate.

2.1.2 Suitability for pressure

2.1.2.1 *LP Gas*

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.

The material of any valve body that is subject to container pressure shall comply with AS 2473.

2.1.2.2 *CNG*

All components subject to container pressure, excluding the container, shall have a burst pressure of not less than four times the fuel container rated working pressure.

All other CNG components subject to gas fuel system pressure shall have a burst pressure of not less than four times their maximum operating pressure.

2.2 MOVING PARTS

LP Gas 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.

CNG components shall be approved in accordance with ISO 15500 Parts 1 to 20 or ECE R110 subject to the requirement of Clause 2.1.2.2.

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 a component shall not be made without specific approval of the manufacturer or the regulatory authority.

2.5 METALS FOR LP GAS COMPONENTS

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.

TABLE 2.1
MOVING PARTS CYCLE TEST FOR LP GAS COMPONENTS

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
Hydrostatic-relief valve	6 000
Automatic fuel shut-off device	100 000
Regulator	100 000
Filling connection	6 000
Fuel injector	6 000 000

2.6 NON-METALS FOR LP GAS COMPONENTS

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

- 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.
- 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 LP GAS CONTAINER, COMPONENTS AND FILLING SYSTEMS

3.1 SCOPE OF SECTION

This Section sets out requirements for the location, mounting, protection, venting and installation of the LP Gas container, its components and filling systems.

3.2 CONTAINER

A fuel container shall comply with one of the following Australian or Australian/New Zealand Standards and shall have a design notified or registered by the appropriate Statutory Authority and subject to the requirements of Clause 7.1(c)(ii).

- (a) AS/NZS 3509.
- (b) AS 1210 (for a design pressure of 2.55 MPa).
- (c) AS 2030.1 (for propane).

Every container shall be inspected and tested in accordance with the relevant parts of AS 2337 and certified by a gas cylinder test station registered under MP 48 prior to use.

3.3 COMPONENTS FOR REMOVABLE CONTAINERS

A container that is removed from the forklift or industrial equipment for filling shall be provided with at least the following components:

- (a) Filler connection (except where the container is filled through the service valve).
- (b) Filler cap (except where the container is filled through the service valve).
- (c) Service valve.
- (d) Excess-flow valve (except for a vapour withdrawal service outlet).
- (e) Fixed liquid level gauge or automatic fill limiter, (only if filled by monitoring volume).
- (f) Safety valve.

3.4 COMPONENTS FOR FIXED CONTAINERS

A container system that is fixed to and installed for *in situ* filling on forklifts or industrial equipment shall be specifically designed and provided with the following components:

- (a) Filler connection.
- (b) Filler cap.
- (c) Filler non-return valve system.
- (d) Automatic fill limiter.
- (e) Service valve, equipped with an automatic fuel shut off device and with a service line connection conforming to Clause 5.4(a) or 5.4(b).
- (f) Excess-flow valve (except for a vapour withdrawal service outlet).
- (g) Safety valve.
- (h) Contents gauge.

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.

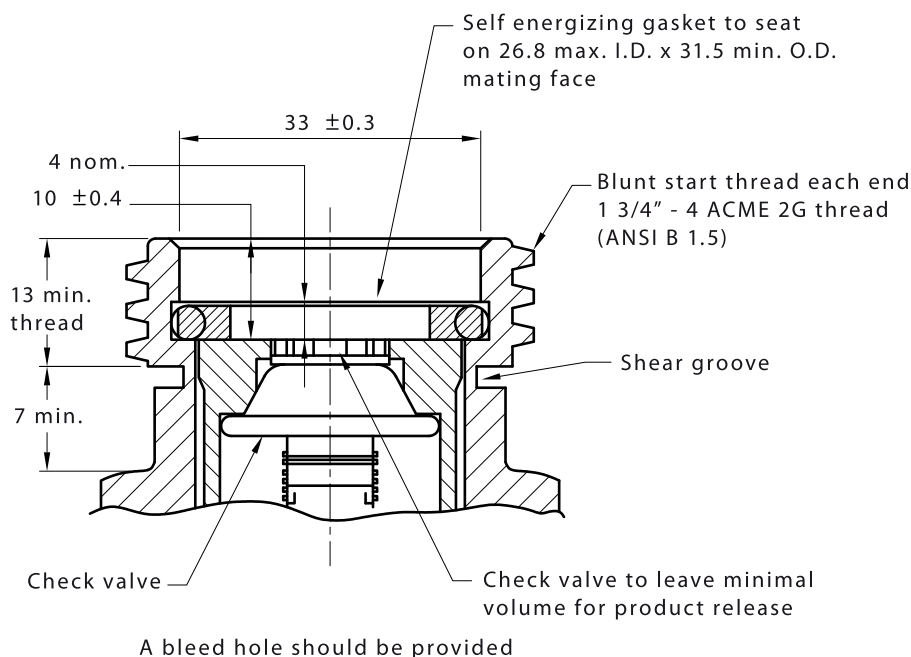
Components may be combined into multifunction units, provided that the requirements for each individual function have been satisfied.

3.6 FILLING CONNECTION

The container filling connection for containers other than removable containers shall be a 1¾ inch male ACME thread conforming to Figure 3.1. For a removable container a POL coupling or safety 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.

A remote filling system shall only incorporate 1¾ inch ACME filling connection(s) located at the filling point(s).



DIMENSIONS IN MILLIMETRES

FIGURE 3.1 1¾ inch MALE ACME THREAD

3.7 FILLER SYSTEM

3.7.1 Direct filling system

Where the container filling connection is a 1¾ inch male ACME thread, it shall incorporate a double non-return valve in which one valve at least shall be a gastight type. The filling connection may be directly mounted on the container only if the method of access to it from outside does not result in the opening of a vapour path to the interior of the equipment, thereby negating the effectiveness of a compartment or sub-compartment.

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 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.

NOTE: Certain statutory regulations further restrict the number of options permitted.

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 5.2.1(a), 5.2.2(b), 5.2.2(c) and 5.4.
- (b) The minimum size for a fill line shall be of 10 mm internal diameter tube with the minimum orifice size in any fittings or reduction in cross sectional area of 47.78 mm² between the end of the fill coupling check valve and the beginning of the AFL valve, be no less than 7.8 mm internal diameter.
- (c) Rigid piping, used as a fill line from the remote fill to the automatic fill limiter, which passes through an enclosed space need not pass through conduit, provided that the piping is protected by its location, there are no pipe joints within the enclosed space, the points of passage through the enclosure walls are sealed gastight, and they comply with the requirements of Item (a) above.

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 filler cap shall be captive, and shall be either capable of withstanding the design pressure (2.55 MPa) or designed so that pressure does not accumulate.

3.7.5 Filling point location

The filling point shall be located so that the following conditions are satisfied:

- (a) The filling connection is made from, and filling is supervised from, outside the forklift or industrial equipment.
- (b) The filling connection is protected by being located in a recess below the surface of a body panel, or by being located so that equivalent protection is provided by the construction of the equipment.
- (c) The distance between the filling connection and ground level shall be no less than 450 mm for the purpose of ease of filling and a reduction in risk of an incomplete connection being made.

3.8 AUTOMATIC FILL LIMITER (AFL)

3.8.1 Design

An automatic fill limiter 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) The AFL shall not incorporate any feature whereby the liquid level can be altered from outside the container after installation.
- (c) A type of AFL which depends for its accuracy on correct radial orientation, e.g. a screw-in type, shall incorporate a permanent provision to indicate the correct setting or position.
- (d) Where multiple container installations are involved an AFL shall be incorporated in each container.

3.8.2 Performance

When the automatic fill limiter is fitted to the container for which it is intended and that container has been correctly oriented, its performance shall be as follows:

- (a) Filling shall be shut-off before the maximum permitted filling level has been exceeded.
- (b) The filling shut-off function shall be operable at any pressure differential across it between 70 kPa and 1000 kPa. Any adjacent or inbuilt non-return valve is considered not to be part of the automatic fill limiter 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. The liquid level sensor can 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

Where a fixed liquid level gauge is fitted, it shall indicate when the liquid level is at the maximum permitted filling level.

Any opening communicating between the gauge and the interior of the container shall be internally located and not larger than 1.4 mm diameter.

A fixed liquid level gauge 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.

3.10 CONTENTS GAUGE

An electrically operated contents gauge shall be approved for use in a Zone 2 area (see AS 60079.10).

3.11 EXCESS-FLOW VALVE

An excess flow valve shall comply with the following requirements:

- (a) The valve shall be internal.
- (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.

NOTE: In order to comply with Clause 3.16(d), the excess-flow valve should be located inboard of the service valve, and is usually attached directly to it.

3.12 SERVICE VALVE

A service valve shall comply with the following requirements:

- (a) The valve shall be a manually operated shut-off valve complying with the material requirements of AS 2473.
- (b) The valve shall close in a clockwise direction.
- (c) The seal or gland-retaining nut shall be so designed that the nut cannot be unscrewed by the action of the spindle.
- (d) The direction of opening or closing of the valve shall be clearly indicated.

For a fixed container the service valve shall incorporate an automatic fuel shut off device.

3.13 AUTOMATIC FUEL SHUT-OFF DEVICE FOR FIXED CONTAINER

3.13.1 General

The automatic fuel shut-off device shall remain operative under the following conditions:

- (a) The ignition is on.
- (b) The engine is turning.

The automatic fuel shut-off device may be permitted to open for a period of up to 3 s when the ignition is first turned on, so as to allow priming of the fuel system. A maximum of 3 s of 'on period' is permitted when the engine is stalled as opposed to when the engine is turned off.

The automatic fuel shut-off device shall have a reflux (backflow opening) pressure of 0.275 MPa maximum and shall be protected with a filter located on the up stream side. Care shall be taken with the fitting of the automatic fuel shut-off device to ensure correct direction of flow.

An automatic fuel shut-off device fitted within a compartment or sub-compartment of a container shall be of the electrically encapsulated type with electrical terminals located outside of the compartment or sub-compartment.

A current limiting device or fuse shall be fitted in the positive power supply to the automatic fuel shut-off device for the purposes of protecting the automatic fuel shut-off device wiring from short circuit or over current damage. A means to deactivate the automatic fuel shut-off device shall be provided in accordance with Clause 7.9.2(k)(i) and fitted adjacent to the under-bonnet automatic fuel shut-off device.