AS 4983—2010

Australian Standard®

Gas fuel systems for forklifts and industrial 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 16 December 2009.
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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
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- 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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Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

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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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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:

(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 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.

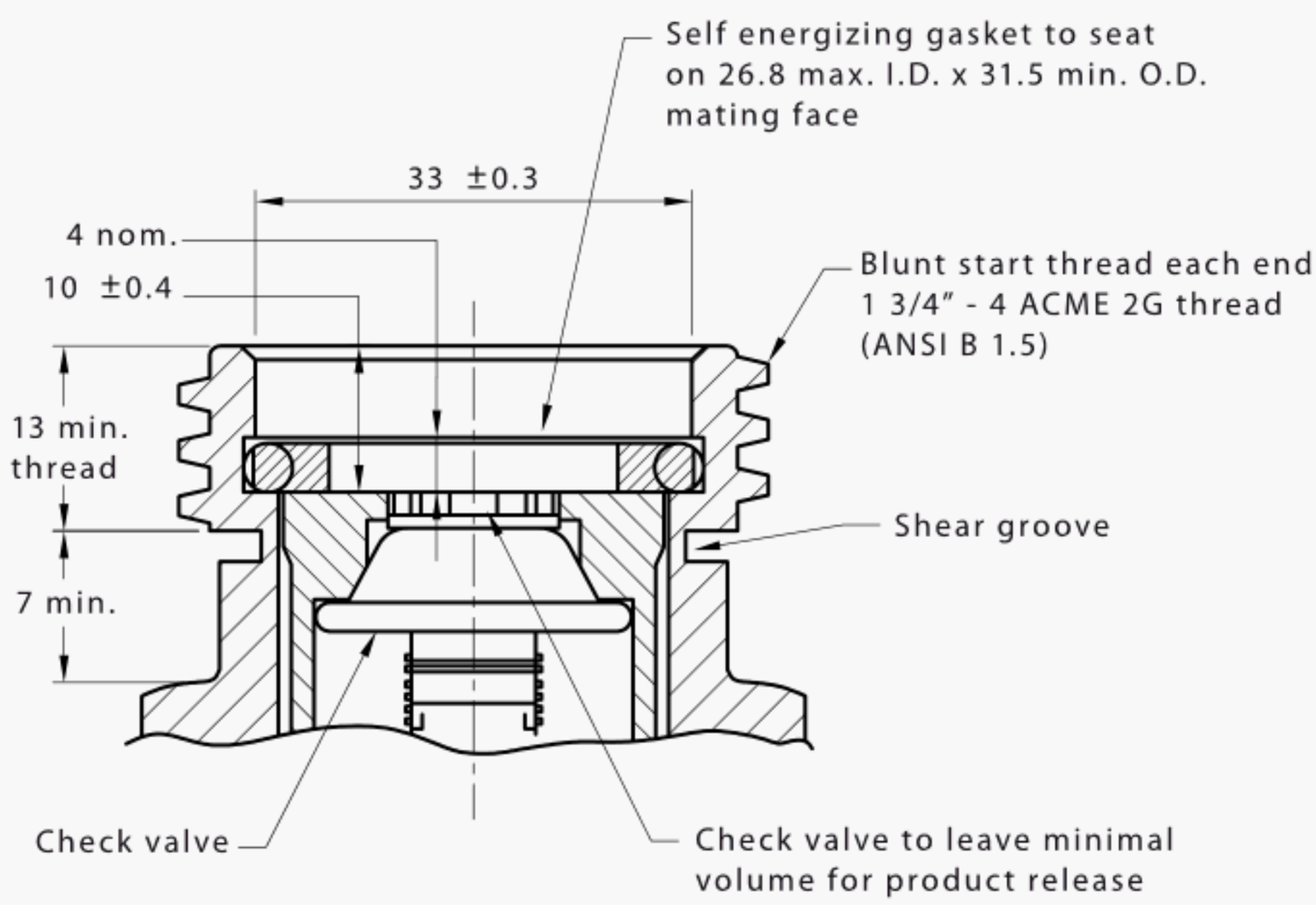
Components may be combined into multifunction units, provided that the requirements for each individual function have been satisfied.

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 mm^2 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 1*g*.

(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.

Wiring circuits, electronics and terminals provided for activation or deactivation of the automatic fuel shut-off device shall be protected so as to minimize the possibility of the control/safety shutdown feature being overridden. This protection shall be achieved by the routing of wiring away from potential voltage sources or by the incorporation of backfeed protection in the circuitry.

NOTE: This requirement does not preclude the use of combination modules comprising dual fuel selector/safety switch/fuel gauge units.

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

In all cases the automatic fuel shut-off device shall be located in a protected position. Multiple container installations shall comply with the requirements in Clause 5.7.

3.13.2 Fuel filter

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

3.14 SUITABILITY FOR HAZARDOUS ZONES

Any electrical equipment or component that is located within a compartment or sub-compartment or any associated ducting shall be suitable for use in a Zone 2 area. (See AS 60079.10.)

3.15 SAFETY VALVE

3.15.1 General

The safety valve shall comply with the following requirements:

(a) The safety valve shall be internal or adequately protected from physical damage.

(b) The safety valve shall comply with the requirements of AS 2613 or AS 1271.

(c) The design, manufacture and installation instructions shall comply with an ISO Product Certification program Level 5 and/or be UL listed.

(d) The full flow rating pressure shall be 3.3 MPa.

3.15.2 Safety valve discharge

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

(a) Discharge into a compartment or sub-compartment that complies with Clause 3.17.

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

NOTE: Fittings, piping attachments, or deflectors that are attached to the outlet of the safety valve can interfere with the action of the valve or with gas flow so as to reduce the discharge flow rate. No such attachment may be made until the installer has confirmed with the equipment supplier that the flow rate remains adequate for the installation.

3.16 LOCATION OF CONTAINER COMPONENTS

The components listed in Clauses 3.3 and 3.4 shall be installed in accordance with the following requirements:

(a) Each component shall be mounted directly on the container without any intermediate pipe or fitting.

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

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

(d) The excess-flow valve shall be arranged to control the flow of liquid through the service outlet if a downstream failure leads to an excessive flow of LP Gas liquid.

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

3.17 COMPARTMENTS AND SUB-COMPARTMENTS

3.17.1 Removable containers

A removable container is not suitable for installing in an enclosed operators cabin.

3.17.2 Internal containers

Where a container is located within an enclosed operator's cabin of the industrial equipment either—

(a) the whole of the container together with its attached components and fitting shall be enclosed in a compartment; or

(b) the valves, fittings, and pipe connections associated with or attached to the container shall be enclosed in a localized sub-compartment, attached to the container and vented to the atmosphere.

Provision shall be made for ready access to the service valve in all installation arrangements and the fixed liquid level indicator bleed valve where appropriate. (See Clause 3.18.2).

3.17.3 Construction

A container compartment or sub-compartment shall comply with the following requirements:

(a) Construction shall be such that any gas which leaks from any fittings, components, or piping cannot pass to any other enclosed compartment, operator's space or cargo space of the equipment.

(b) If struck at any point by a 5 kg steel ball dropped vertically through a height of 1 m, any resultant damage to a sub-compartment, which is attached to the container, and whilst the container is resting on a solid base, shall not be of a nature to permit leakage.

(c) When a compartment or sub-compartment has been subjected to an internal pressure of 30 kPa applied for 5 min, sealing materials or gaskets shall not be displaced or otherwise lose integrity.

(d) Hatches, covers, or construction joints that may need to be opened or dismantled during maintenance or inspection shall be capable of being opened at least 10 times without adverse effects on durability.

(e) Materials of construction, including seals and gaskets, shall be such that the enclosure will remain gastight if exposed continuously to a temperature of 100°C.

NOTE: Items (b) to (e) are intended to be the basis for type test for proof of design, rather than for quality control, which is covered by the commissioning and test procedures in Section 7.

3.17.4 Ventilation

The interior of the compartment or sub-compartment shall be vented to outside atmosphere by one or more vents whose aggregate area is not less than 500 mm^2. The location and arrangements of the vent and any associated ducting shall be such as will minimize the accumulation of gas by gravity in lower zones. The vent exit shall be at least 250 mm from an exhaust pipe or similar heat source.

Any ventilation duct or conduit necessary in order to connect to outside air shall comply with Clause 3.17.5. If piping passes through the duct or conduit, the ventilation area shall be the net area. Vent hole data is provided in Table 3.1.

TABLE 3.1

VENT HOLE DATA

Dia. mm	Area mm^2	Dia. mm	Area mm^2
6	30	30	700
8	50	35	960
10	80	40	1250
12	115	45	1590
15	180	50	1960
20	315	55	2370
25	490	60	2830

3.17.5 Conduits and ducts

Any conduit or ventilation duct required by Clause 3.17.4 shall be installed and comply with the following requirements:

(a) The thickness of the material at its thinnest point shall be not less than the following:

(i) For a material that is a composite of a fabric with an elastomer or plastics..... 0.7 mm.

(ii) For a material that is of plastics or an elastomer without reinforcement as described in Item (i) ..... 1.5 mm.

(iii) For a material that is a composite of a helical reinforcement and an elastomer or plastic ..... 1.0 mm.

(b) A sample of the duct, when placed on a flat surface and loaded with 20 kg on an applicator plate 100 mm × 100 mm, placed flat across the duct, in an ambient temperature between 15°C and 30°C, shall not crush to less than 80 percent of its diameter, and shall return to at least 90 percent of its original diameter when the load is released.

(c) A sample of the duct, arranged with both ends connected in a representative manner and plugged, and pressurized to 30 kPa, shall not exhibit a pressure drop of more than 2 kPa in 30 min.

(d) End attachments shall resist a pull-off force of 100 N.

NOTE: Certain conduit materials that feature pronounced internal spiral grooves can prove difficult to seal to spigots and should be avoided where possible, as even with considerable care in applying sealant difficulties in passing the pressure test may be experienced.

(e) The material shall conform to SAE J369 class SE/NBR.

(f) The material shall have a resistance to ultraviolet degradation.

(g) The conduit or duct shall be sealed gastight from the enclosed area, and shall be ventilated to outside atmosphere.

(h) The conduit shall be as short as practicable, commensurate with safety.

(i) The end connections shall be mechanically clamped and shall not depend on adhesives or sealing compounds to retain them in place.

(j) The holes for ventilation ducts shall be positioned not less than 40 mm from the edge of a panel or a welded joint or direct load bearing point.

3.18 MOUNTING OF FUEL CONTAINER

3.18.1 Correct orientation

The container shall be correctly orientated so that the accuracy of the contents gauge, fixed liquid level gauge, safety valve, and automatic fill limiter is not impaired. Reference should be made to the manufacturer's installation instructions, and to any orientation indicators provided.

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

When removable containers are installed, they shall be located so that the safety pressure-relief valve opening is always in communication with the vapour space (top) of the container. Where the container is mounted horizontally, this shall be accomplished by an indexing pin of a minimum diameter of 8 mm capable of being fitted with a sleeve, which correctly positions the container when it is properly installed. Any discharge from the safety valve shall be directed to minimize a potential hazard.

3.18.2 Access to valves

It shall be possible to operate the service valve for the purpose of servicing in the installed position.

Where the valve is arranged so that it can be operated from some internal area of the industrial equipment, the sealing of the compartment or sub-compartment shell shall be maintained by one of the following means:

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

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

3.18.3 Fixed industrial engines

For fuel container installations for stationary engines reference should be made to AS/NZS 1596, AS 5601 and AS 3814.

3.18.4 Attachment to mobile industrial equipment

The container shall be securely attached to the forklift or any industrial equipment to prevent slipping, rotating, and jarring loose in accordance with the following requirements:

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

  (i) clamping bands where used shall be a minimum of two flat bands as provided by calculation in Clause 3.18.4(e); round or square sections, wire, cable or material likely to localize loading shall not be used;

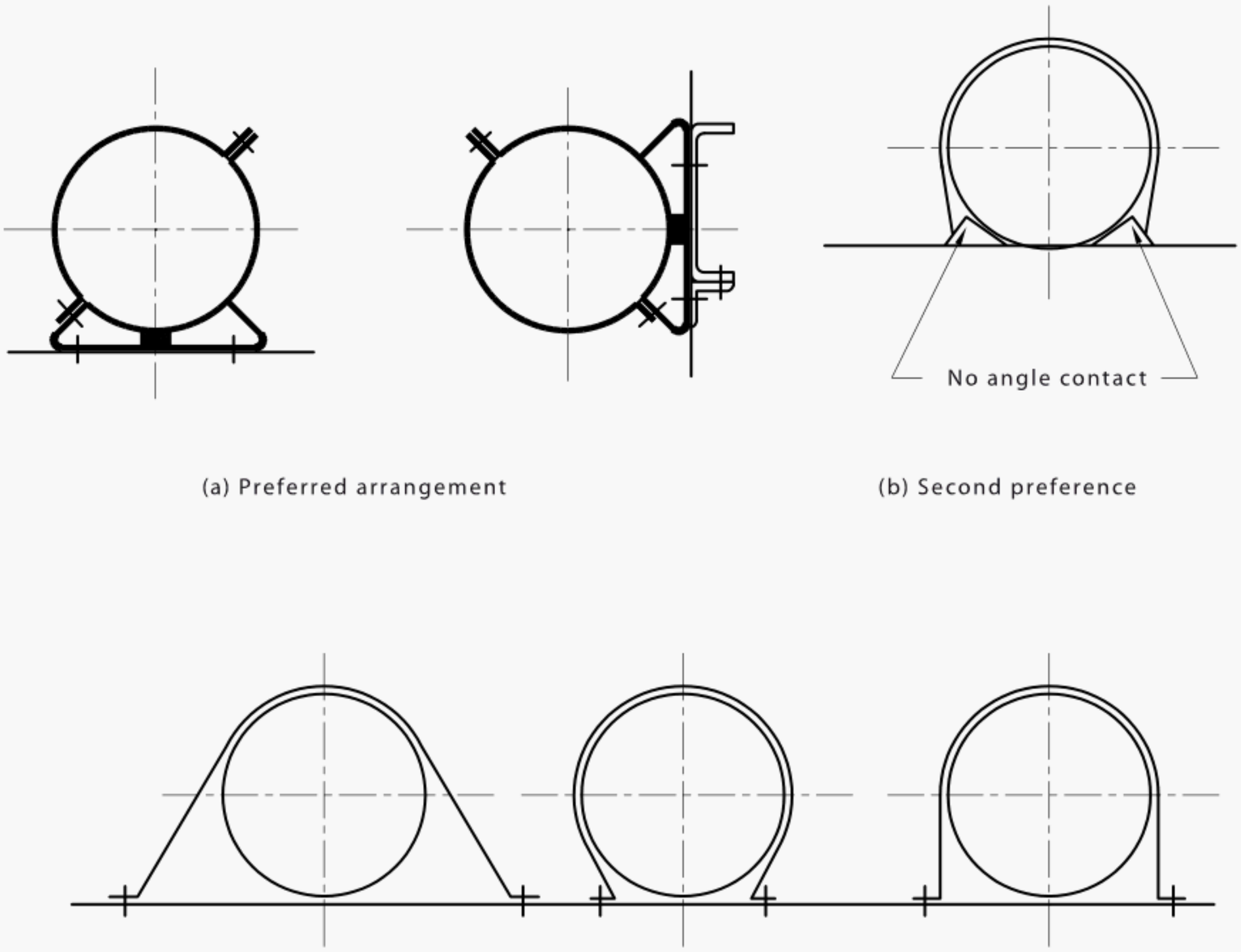
  (ii) shearing burrs on flat straps shall be arranged to be on the side remote from the shell; and

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

NOTES:

1 Corrosion of the container should be minimized by avoiding entrapment of moisture in non-draining features. Resilient materials may be interposed between the shell and a band on removable container applications.

2 Figure 3.2 illustrates designs of container mountings.



(a) Preferred arrangement

(b) Second preference

(c) Unacceptable arrangements

FIGURE 3.2 FUEL CONTAINER MOUNTINGS

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

(c) The mounting method shall not significantly weaken the structure of the forklift or industrial equipment.

(d) The area of the forklift or industrial equipment to which the container is attached shall be reinforced if necessary to ensure compliance with Item (e). (See Clause 1.7.)

(e) The force necessary to separate the container(s) from the forklift or industrial equipment in any direction shall be not less than the mass of the full container(s) times the design factor shown in Table 3.2.

TABLE 3.2

ATTACHMENT DESIGN FACTOR

Acceleration direction	Acceleration
Longitudinal	10.0*g*
Lateral	5.0*g*
Vertical	4.5*g*

NOTE: *g* is the gravitational acceleration.

Where the equipment is of the original manufactured construction, the design factor shall be as determined by the equipment manufacturer, and the above prescribed design factors are not applicable.

In all cases, fatigue factors shall be taken into account in the design of the container mounting system.

(f) The strength of the anchorages shall be established by dynamic test (deceleration over 20 ms) or static test (forces directed through the centre of mass of the container) or by calculation or, if these methods are impractical, see Clause 3.18.5.

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

NOTE: In the case of removable containers where over centre type fastening bands are used, the above requirements are deemed to be met if the bands are correctly adjusted. (An example of over centre type fastening bands is shown in Figure 3.3).

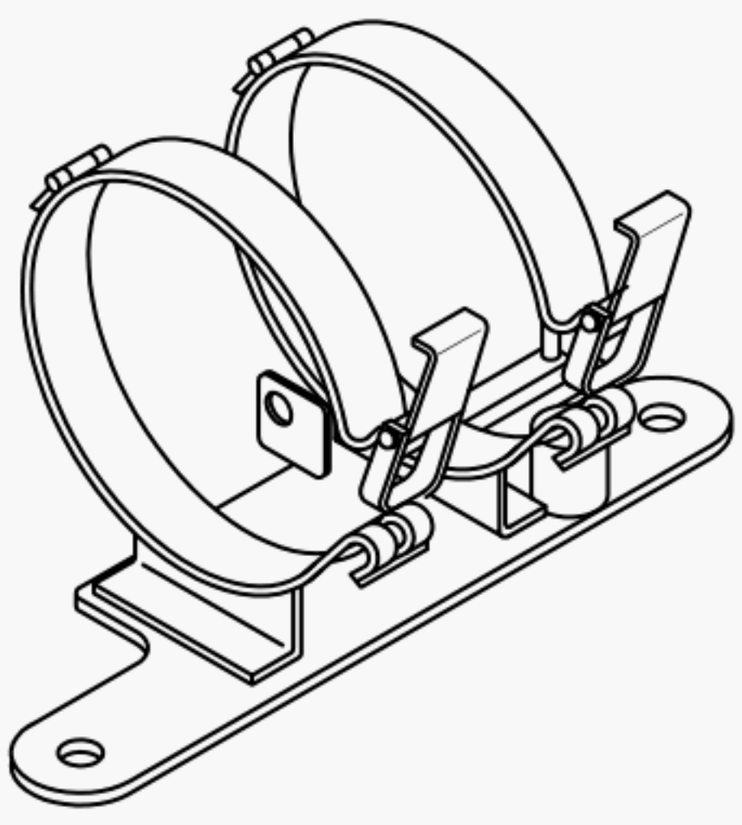


FIGURE 3.3 OVER CENTRE TYPE FASTENING

3.18.5 Alternate considerations

3.18.5.1 *General*

If dynamic testing or calculations referred to in Clause 3.18.4(f) are impracticable, the requirements in this Clause (3.18.5) shall apply.

3.18.5.2 *Attachment to sheet metal structure*

Where the container(s) is anchored to sheet metal that is an integral part of the industrial equipment structure, the following shall apply:

(a) There shall be at least four points of attachment to the structure of the forklift or industrial equipment, the distance between which shall be sufficient to ensure the stability of the container.

(b) The sheet metal shall be reinforced at each attachment point with metal plates of areas not less than 3600 mm^2 and thickness not less than 2.5 mm. Any such reinforcement plates shall be contoured to the shape of the sheet metal. It is preferred that a round washer be used but where a square plate is fitted the corners shall be radiused to 5 mm and the bolt hole shall be positioned in the centre of the plate/washer wherever possible. Where the bolt hole is not central in the plate, the nearest edge shall be bent to form an L-section for stiffening.

NOTE: Flat areas, even if ribbed, can be unsuitable for mountings without substantial reinforcement, because of flexing and fatigue. Anchoring should be to structural members wherever possible.

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

(d) Anchorage bolts, screws or studs for band or flange mountings shall have a diameter of not less than that shown in Table 3.3, and the mechanical properties shall be as follows:

(i) Fasteners with ISO metric thread .....Property Class 4.6 in accordance with AS 4291.1.

(ii) Fasteners other than ISO metric ..... shall be of a commercial grade.

(e) Where clamping bands are used, at least two steel bands shall be provided unless the container is less than 25 L. The dimensions of the bands shall be not less than those shown in Table 3.3.

(f) Where parts are joined, e.g. by welding a stud to a band, the strength of the joint shall be not less than the strength of either component.

NOTE: Cylindrical containers secured using clamping bands may require end retention features as a means of resisting longitudinal end loads on the container due to any impact.

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

Containers exceeding 150 L (water) capacity fitted to mobile equipment shall have the attachment and mountings designed by a professional engineer who shall provide a written report to the installer, stating that the mounting of the container meets the minimum strength requirements of this Standard. (See self-certification requirements of Table 3.3.) It remains the responsibility of the authorized person to retain a copy of the report.

3.18.5.3 *Attachment to forklift counterweights*

Attachments of containers to counterweights shall meet the following requirements:

(a) There shall be at least two points of attachment to the forklift counterweight, the distance between which shall be sufficient to ensure the stability of the container.

(b) Anchorage bolts, screws or studs for band or flange mountings shall have a diameter of not less than that shown in Table 3.3, and the mechanical properties shall be as follows:

(i) Fastener with ISO metric threads .....Property class 4.6 in accordance with AS 4291.1.

(ii) Fasteners other than ISO metric ..... shall be of a commercial grade.

(c) Where clamping bands are used at least two steel bands shall be provided, the dimensions of which shall be not less than those shown in Table 3.3.

(d) Where the mounting brackets for a single container includes a pivoting section, the bolts used to form the pivot shall not be less than 12 mm and the mechanism shall incorporate positive locking in its working position. The brackets shall be made of materials with adequate thickness and strength to prevent visible distortion when attached.

TABLE 3.3

DIMENSIONS OF ATTACHMENT

Container capacity L	Band dimensions mm	Minimum size of bolt mm	Number of bolts (min.)
0 to 50	30 × 3	12	2
51 to 100	30 × 3	10	4
101 to 149	50 × 6	12	4
>150	Certification by professional engineer		

3.18.5.4 *Attachment to non-integral and non-metallic panels*

Containers up to a maximum of 22 L capacity may be mounted on covers or hinged non-integral or non-metallic panels.

Containers exceeding this capacity shall have the mounting system designed in accordance with sound engineering practices.

3.18.5.5 *Attachment to roof of forklifts or industrial equipment*

Refer to Clause 1.6.

3.18.6 Multiple containers

For installations with more than one container and a common bracket, a specific design by a professional engineer shall be required for the mounting attachments.

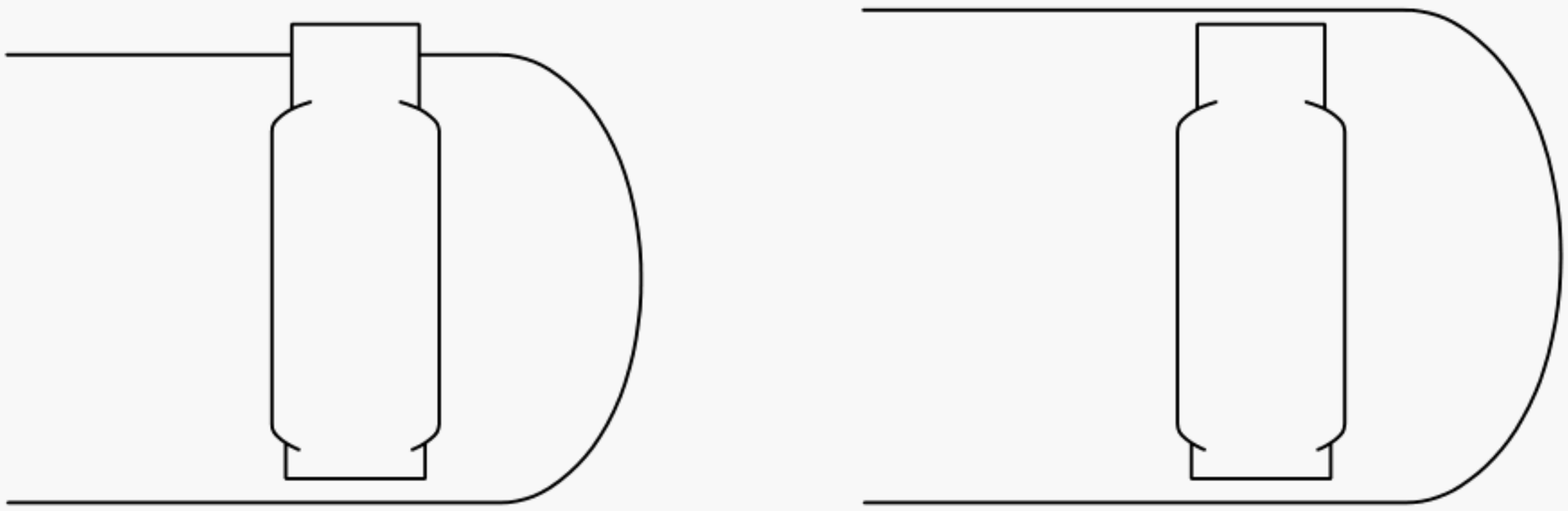
3.19 CONTAINER LOCATION

A container fitted to mobile industrial equipment shall be located in accordance with the following requirements:

(a) No part of a container shall be mounted outside the body plan of the equipment. (See Figure 3.4).

(b) No part of a container or any fittings shall be below the lowest structural member of the equipment.

(c) For forklifts, no part of a container or any fittings shall be above the mast height when in its lowest position. (See Clause 1.6(c)).



(a) Incorrect mounting (b) Correct mounting

FIGURE 3.4 MOUNTING OF LP GAS CONTAINER ON A FORKLIFT OR INDUSTRIAL EQUIPMENT

3.20 PROTECTION

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

(a) The shell of a container shall not be in contact with (or closer than 2.5 mm) to part of the equipment, a piping or any objects which could cause rubbing or the entrapment of moisture.

(b) The valves or fittings or protective guard on a container that is located longitudinally at the side of the equipment shall not project beyond the vertical plane tangential to the container shell. (See Figure 3.5).

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

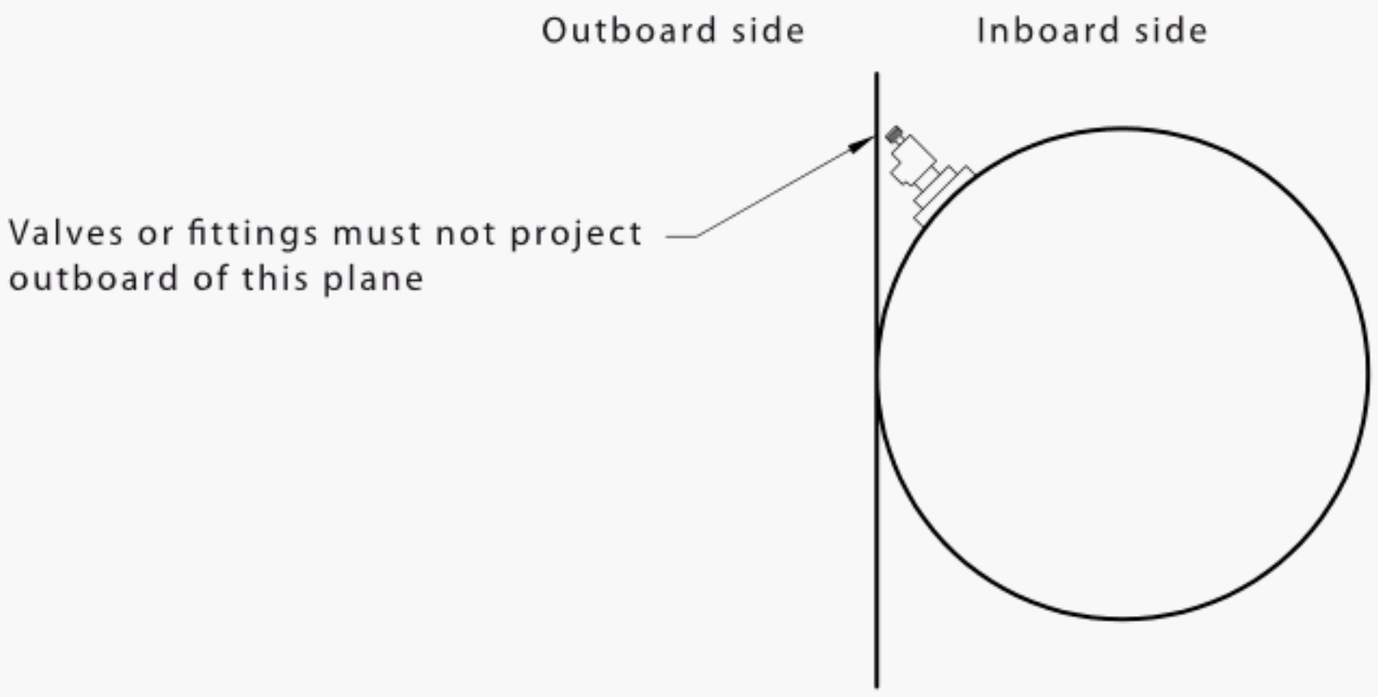


FIGURE 3.5 PROTECTION, SIDE-LOCATED LONGITUDINAL CONTAINERS

3.21 HEAT SHIELDING

Where a container, component or pipe subject to container pressure is within 150 mm of a hot object at a temperature above the normal water jacket temperature, a protective radiation shield shall be interposed. If a single sheet metal shield of sufficient dimensions to provide complete shielding is arranged not less than 15 mm from the protected item, the distance from the protected item to the heat source may be reduced to not less than 40 mm.

For composite containers, the clearance distance or heat shielding, shall ensure the surface temperature of the container does not exceed the container manufacturer's specification.

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

SECTION 4 CNG CONTAINER, COMPONENTS AND FILLING SYSTEMS

4.1 SCOPE OF SECTION

This Section sets out requirements for the components, location, mounting, protection, venting and installation of the equipment operating under CNG container pressure.

4.2 FUEL SUPPLY SYSTEM COMPONENTS

4.2.1 Components

The fuel supply system shall be provided with the following components:

(a) One or more fuel containers.

(b) Container valve or valves.

(c) A refuelling receptacle.

(d) A refuelling non-return valve.

(e) Fuel filter.

(f) An automatic fuel shut off device (see Clause 6.4).

4.2.2 Component parts

Components shall be approved in accordance with AG 805, ISO 15500 Parts 1 to 20 or ECE R110 subject to the requirements of Clause 2.1.2.2.

4.2.3 Use of combined components

The components specified in Clause 4.2.1 may be combined into multifunction units.

4.3 CONTAINER

4.3.1 General

The fuel container shall be approved for automotive CNG use, for a rated service pressure of at least 20 MPa.

The fuel container shall comply with the requirements of—

(a) ISO 11439; or

(b) ANSI NGV2; or

(c) CSA B51 Part 2; or

(d) ECE R110; or

(e) an approved equivalent National Standard.

Every container shall be inspected and tested in accordance with the relevant parts of ISO 19078 and certified by a gas cylinder test station registered under MP 48 prior to use.

4.3.2 Container identity and type

The installer shall confirm that—

(a) the serial numbers stamped or labelled on the containers are identical with those on their associated manufacturers certificates; and

(b) the container construction type is as specified by the design information/drawing given in the container manufacturers certificate.

4.3.3 Container painting

Steel containers shall be protected from external corrosion by the application of a protective anticorrosive coating.

4.4 CONTAINER VALVE(S)

4.4.1 Container valve

A container valve shall comply with AS 2473 or ANSI/AGA NGV3.1 or ISO 15500-5 unless specifically approved otherwise, and shall be mounted directly to the neck of the container.

Container valves shall—

(a) be equipped with an operating handle that is removable only with the aid of tools; and

(b) be fitted with one or more pressure relief device(s) that shall be either a combination bursting disc/fusible plug (Type BD/FP2) or a combination pressure relief valve/fusible plug (Type PRV/FP2) or a fusible plug (Type FP2) in accordance with AS 2613, ANSI PRD1, ISO 15500-13 or ECE R110.

NOTE: For composite containers and containers manufactured to ISO 11439, ANSI/AGA NGV2 and CSA B51 Part 2, the container, the container valve and the pressure relief devices need to be approved as a system.

4.4.2 Automatic fuel shut-off device at container

An automatic fuel shut-off device shall be located as close as practical to each container.

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

(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 may incorporate an internal by-pass for refuelling purposes.

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.

Wiring circuits, electronics and terminals provided for activation or deactivation of the automatic fuel shut-off device shall be protected so as to minimize the possibility of the control/safety shutdown feature being overridden. This protection shall be achieved by the routing of wiring away from potential voltage sources or by the incorporation of backfeed protection in the circuitry.

NOTE: This requirement does not preclude the use of combination modules comprising dual fuel selector/safety switch/fuel gauge units.

The automatic fuel shut-off device may incorporate a fitting between it and the manual service valve. This fitting may be a ‘T’ piece to allow filling of the container.

In all cases the automatic fuel shut-off device shall be located in a protected position.

Retrofitting of the automatic fuel shut-off device at the container shall be encouraged whenever a CNG installation inspection is undertaken.

4.5 REFUELLING CONNECTION

4.5.1 Design of connection

The refuelling connection shall meet the requirements of ISO 14469 or ANSI/CSA NGV1. The rated working pressure of the refuelling connection shall be suitable for the rated working pressure of the fuel container(s) used. Alternative designs may be used for special applications with specific approval. The receptacle (male component) shall be attached to the equipment.

4.5.2 Dust cap

Each refuelling receptacle shall be provided with a captive dust cap or plug designed to prevent the ingress of foreign material.

4.6 REFUELLING NON-RETURN VALVE

A non-return valve shall be fitted on the refuelling line to prevent the return flow of gas from the container to the refuelling connection. The non-return valve shall be located as close to the refuelling connection as practicable.

4.7 LOCATION OF REFUELLING RECEPTACLE

The refuelling receptacle shall be located so that the following conditions are satisfied:

(a) The refuelling receptacle shall not be directly mounted on the container.

(b) The engagement of the dispenser nozzle to the refuelling receptacle is made and refuelling is supervised from outside the industrial equipment.

(c) The refuelling receptacle 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 industrial equipment.

(d) The refuelling operation can be carried out without requiring the operator to kneel, crawl or lie under the industrial equipment or be otherwise subject to inconvenience, discomfort or hazard.

(e) The refuelling receptacle is located and mounted so that it can withstand any loading resulting from normal refuelling operations, and applied to the refuelling receptacle by the operator or by the refuelling hose in the course of normal refuelling procedures.

In addition, the refuelling receptacle shall be attached to a forklift or mobile industrial equipment in such a manner as to resist, without permanent deformation of the mounting attachment, 1000 N proof load applied in the forward and reverse directions of travel of the forklift or industrial equipment.

The proof load shall be applied by full engagement of the refuelling receptacle and shall be representative of attempted movement of the equipment while refuelling.

4.8 CONTAINER COMPARTMENTS AND SUB-COMPARTMENTS

4.8.1 Internal containers

Where a container is located within the body shell of a forklift or industrial equipment—

(a) the whole of the container together with its attached components and fittings shall be enclosed in a compartment; or

(b) the valves, fittings, and pipe connections associated with or attached to the container shall be enclosed in a localized sub-compartment attached to the container.

4.8.2 Pressure relief device

The pressure relief device shall be directed vertically upward, away from the industrial equipment operator's usual operating position.

Any discharge from the container pressure relief device shall be ducted to open air outside any enclosed space of the industrial equipment.

4.8.3 Construction

A container compartment or sub-compartment shall comply with the following requirements:

(a) Construction shall be such that any gas which might leak from any fitting, component, or piping cannot pass to any other enclosed compartment, passenger space, or goods space of the vehicle.

(b) Where pliable material is used as the means of enclosure, the material shall comply with the following requirements:

(i) Sufficiently strong to resist mechanical damage, preserve venting integrity, and not support combustion.

(ii) Minimum tensile strength to ISO 527-3.

Parent material ..... 14 MPa.

Material incorporating a transverse seam ..... 10 MPa.

All seams shall be lapped and Radio Frequency (RF) welded.

(iii) Minimum elongation at break to ISO 527-3 ..... 65%.

(iv) Minimum tear force to ISO 6383-1 ..... 35 N/mm.

(v) Resistance to cold cracking. The material shall withstand a bend of 180° applied within 0.5 seconds around a 6 mm diameter former at a temperature of –35°C without cracking.

(vi) Flammability. The material shall conform to SAE J369 class SE/NBR.

(vii) Resistance to ultraviolet degradation shall be incorporated in the material at manufacture.

(c) Mechanical protection shall be provided by a separate shield.

(d) The arrangement shall not create a significant thermal barrier between the container and its pressure relief device.

(e) Where the pressure relief device of the container valve is piped directly away, the container is deemed to not have a sub-compartment and the requirements of Clause 4.8.5 shall be met.

4.8.4 Ventilation

The interior of a compartment shall be vented to open air by one or more vents that comply with the following requirements:

(a) The aggregate area, taking into account any piping passing through the vent, shall be not less than 500 mm^2.

(b) The vent exit shall be at least 75 mm from an exhaust pipe or similar heat source.

(c) The location and arrangement of the vent and any associated conduit shall be such that the accumulation of gas is minimized.

If piping passes through the conduit, the ventilation area shall be the net area. Vent hole data is provided in Table 4.1.

TABLE 4.1

VENT HOLE DATA

Dia. mm	Area mm^2	Dia. mm	Area mm^2
6	30	30	700
8	50	35	960
10	80	40	1250
12	115	45	1590
15	180	50	1960
20	315	55	2370
25	490	60	2830

4.8.5 Conduits

Any conduit required by Clause 4.8.4 shall be installed and comply with the following requirements:

(a) The thickness of the material at its thinnest point shall be not less than the following:

(i) For a material that is a composite of a fabric with an elastomer or plastics..... 0.7 mm.

(ii) For a material that is of plastics or an elastomer without reinforcement as described in Item (i)..... 1.5 mm.

(iii) For material that is a composite of a helical reinforcement and an elastomer or plastic ..... 1.0 mm

(b) A sample of the conduit, when placed on a flat surface and loaded with 20 kg on an applicator plate 100 mm × 100 mm, placed flat across the conduit, in an ambient temperature between 15°C and 30°C, shall not crush to less than 80 percent of its diameter, and shall return to at least 90 percent of its original diameter when the load is released.

(c) A sample of the conduit, arranged with both ends connected in a representative manner and plugged, and pressurized to 30 kPa, shall not lose more than 2 kPa in 30 min.

NOTE: Certain conduit materials that feature pronounced internal spiral grooves can prove difficult to seal to spigots and should be avoided where possible, as even with considerable care in applying sealant difficulties in passing the pressure test may be experienced.

(d) End attachments shall resist a pull-off force of 100 N.

(e) The material shall conform to SAE J369 class SE/NBR.

(f) The material shall have a resistance to ultraviolet degradation.

(g) The conduit shall be sealed gastight from the enclosed area, and shall be ventilated to outside atmosphere.

NOTE: Certain conduit materials that feature pronounced internal spirals require considerable care in the application of sealants to ensure that they are gastight.

(h) The conduit shall be as short as practicable, commensurate with safety.

(i) The end connections shall be mechanically clamped and shall not depend on adhesives or sealing compounds to retain them in place.

(j) The edge of any holes for the conduit shall be positioned not less than 40 mm from the edge of a panel or a welded joint or direct load bearing point.

4.9 MOUNTING OF CONTAINER

4.9.1 Access to valves

It shall be possible to operate the container valve in the installed position.

The container valve may be arranged so that it can be operated from an internal area of the forklift or industrial equipment provided that the sealing of the compartment or sub-compartment is maintained. The valve-actuating device may either pass through the compartment wall or be completely enclosed within the compartment. The following requirements shall apply:

(a) If a valve-actuating device passes through the wall of a compartment or sub-compartment a gastight seal shall be provided.

(b) When the compartment or sub-compartment is of rigid construction and the actuating handle is wholly within the wall of the compartment or sub-compartment access shall be by a gastight captive hatch which can be opened without tools. Marking shall be provided giving instructions that the hatch must be kept closed except when access to the valve is necessary for maintenance or in an emergency.

4.9.2 Fixed industrial engines

For installations to stationary engines reference should be made to AS 5601 and AS 3814.

4.9.3 Attachment to forklift or mobile industrial equipment

The container shall be securely attached to the forklift or industrial equipment to prevent slipping, rotating, and jarring loose, in accordance with the following requirements:

(a) The method of attachment shall not cause unacceptable stresses in the container shell. Any attaching lugs, brackets or bolts shall be designed so that they will not rupture the container in the event of an accident.

(b) The mounting method shall not significantly weaken the structure of the industrial equipment

(c) Refer to Clause 1.6(c) for any attachment of containers to overhead guard structures of forklifts or roofs of industrial equipment.

(d) The area of the forklift or industrial equipment to which the container is attached shall be reinforced if necessary to ensure compliance with Item (b).

(e) The force necessary to separate the container(s) from the equipment in any direction shall be not less than the mass of the full container(s) times the design factor shown in Table 4.2.

TABLE 4.2

ATTACHMENT DESIGN FACTOR

Acceleration direction	Acceleration
Longitudinal	10.0*g*
Lateral	5.0*g*
Vertical	4.5*g*

NOTE: *g* is the gravitational acceleration.

Where the mobile industrial equipment is of the original manufactured construction, the design factor shall be as determined by the industrial equipment manufacturer, and the above prescribed design factors are not applicable.

In all cases, fatigue factors shall be taken into account in the design of the container mounting system.

The strength of the anchorages shall be established by either dynamic test (deceleration over 20 ms) or static test (forces directed through the centre of mass of the container) or by calculation.

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

(g) Supports shall not be welded to containers. Supports and other attachments shall not be welded to pressure vessels except during manufacture and prior to post-weld heat treatment and testing of the containers.

(h) The container manufacturer shall specify the means by which containers shall be supported for installation on mobile industrial equipment. The manufacturer shall also supply support installation instructions, including clamping force and torque to provide required restraining force but not cause unacceptable stress in the container or damage to the container surface.

4.9.4 Alternate considerations

If dynamic testing or calculations referred to in Clause 4.9.3(e) are impracticable, the following requirements shall apply:

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

(b) Where the container is anchored to sheet metal, the sheet metal shall be reinforced at each attachment point with metal plates of areas not less than 3600 mm^2 and thickness not less than 2.5 mm. Any such reinforcement plates shall be contoured to the shape of the sheet metal or chassis rail. It is preferred that a round washer be used but where a square plate is fixed the corners shall be radiused to 5 mm and the bolt hole shall be positioned in the centre of the plate/washer wherever possible. Where the bolt hole is not central in the plate, the nearest edge shall be bent to form an L-section for stiffening.

NOTE: Flat areas, even if ribbed, can be unsuitable for mountings without substantial reinforcement, because of flexing and fatigue. Anchoring should be to structural members wherever possible.

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

(d) Anchorage bolts, screws or studs for band or flange mountings shall have a diameter of not less than that shown in Table 4.3, and the mechanical properties shall be as follows:

(i) Fastener with ISO metric threads ..... Property class 4.6 in accordance with AS 4291.1.

(ii) Fasteners other than ISO metric ..... shall be of a commercial grade.

(e) Where clamping bands are used, at least two steel bands shall be provided, the dimensions of which shall be not less than those shown in Table 4.3.

NOTE: Where multiple containers are mounted together Table 4.3 does not apply.

To prevent the possibility of external corrosion where clamping bands are used, a non-moisture retaining hard rubber or equivalent material shall be provided on the inner side of the bands. Similar protection shall be provided if the container rests against other metal objects.

(f) Where parts are joined, e.g. by welding a stud to a band, the strength of the joint shall be not less than the strength of either component.

(g) Where the attachment is by means of clamping bands there shall be a positive means of resisting longitudinal end loads on the container due to vehicle impact. Each length of steel angle shall be at right angles to the longitudinal axis of the container with one leg vertical and fitted so as to provide a gap of 7 ±3 mm to the end of the container. The other leg of each angle shall be secured to the vehicle by at least two 10 mm diameter bolts.

NOTES:

1 Where suitable body or structural members of the vehicle construction are available and these components are capable of withstanding the required loadings, they may be used provided the 7 ±3 mm gap is maintained.

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

3 The friction grip of the clamping bands is not normally an acceptable means of endwise retention unless the clamping bands can be demonstrated to meet the requirement (refer Clause 4.9.3(e)). An acceptable form of retention is to secure a 200 mm length of 50 mm × 50 mm structural steel angle to the vehicle each end of the container.

TABLE 4.3

DIMENSIONS OF ATTACHMENT

Container capacity L	Band dimensions mm	Minimum size of bolt mm	Number of bolts (min.)
0 to 100	30 × 3	10	4
100 to 150	50 × 6	12	4
>150	Certification by professional engineer		

4.10 CONTAINER LOCATION AND GROUND CLEARANCES

A container fitted to mobile industrial equipment shall be located in accordance with the following requirements:

(a) No part of a container shall be mounted outside the body plan of a forklift and mobile industrial equipment (see Figure 3.4).

(b) No part of a container or any fittings shall be below the lowest structural member of the industrial equipment.

(c) For forklifts, no part of a container or any fittings shall be above the mast height when in its lowest position. (See Clause 1.6(c)).

4.11 PROTECTION

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

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

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

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

(b) With the exception of the rubber liners, gaskets or isolators of the container clamping bands, the container shall not be in contact with any part of the equipment, any piping, or any objects which could cause rubbing or the entrapment of moisture.

(c) Provision shall be made to protect a container from damage in the event of failure of any industrial equipment driveshaft if the container is less than 200 mm from the driveshaft.

(d) The container manufacturer's instructions regarding exposure to sun, water or chemicals (e.g. battery acid) shall be considered.

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

4.12 HEAT SHIELDING

Where a container, component or pipe subject to container pressure is within 150 mm of a hot object at a temperature above the normal water jacket temperature, a protective radiation shield shall be interposed. If a single sheet metal shield of sufficient dimensions to provide complete shielding is arranged not less than 15 mm from the protected item, the distance from the protected item to the heat source shall be not less than 40 mm.

For composite containers, the clearance distance or heat shielding shall ensure the surface temperature of the container does not exceed the container manufacturer's specification.

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

SECTION 5 LP GAS AND CNG FUEL SERVICE LINES

5.1 SCOPE OF SECTION

This Section sets out requirements for the LP Gas and CNG fuel service lines and associated fittings.

The requirements for a fuel service line for pressure exceeding 450 kPa are addressed in Clauses 5.2 to 5.8 and for pressure less than 450 kPa in Clause 5.9.

5.2 RIGID PIPING

5.2.1 General

Rigid metallic fuel supply piping that is subject to container or container pressure shall be one of the following:

(a) For LP Gas systems:

(i) Terne-coated copper-brazed steel tubing complying with AS 1751.

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

(iii) Seamless steel tubing complying with ASTM A53.

(b) For CNG systems:

(i) Seamless stainless steel tubing complying with ASTM A269.

(ii) Seamless steel tubing complying with ASTM A53.

(iii) Tubing complying with ISO 15500-16 or ISO 15500-20.

(iv) Tubing complying with ECE R110.

5.2.2 Suitability of rigid piping

Rigid piping shall comply with Clause 5.2.1 and shall be applied under the following conditions:

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

(b) Installer-made joints and connections shall be restricted to the connection of essential components.

NOTE: A minimum number of factory produced joints may be incorporated in the length of a service line.

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

NOTE: For CNG, coiled rigid piping (pig tail) can be used between parts that move relative to each other.

5.3 FLEXIBLE PIPING (HOSE AND HOSE ASSEMBLY)

An LP Gas hose and hose assembly shall comply with the Class D requirement of AS/NZS 1869.

CNG flexible piping and hose shall be suitable for the pressure, temperature and flexing conditions of the application and comply with AG 807, ISO 15500-17 or ECE R110.

5.4 JOINTS AND CONNECTIONS

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

(a) For copper-brazed steel tubing and seamless steel tubing, a double-wall 90-degree flare connection in accordance with AS D26 or SAE J533. A single flare provided such joints are limited to factory-assembling.

(b) For copper tubing (LP Gas installations), a 90-degree flare connection in accordance with AS D26 or SAE J533.

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

(c) A flanged joint.

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

NOTE: Brazed joints can only be used for LP Gas systems.

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

(f) A ground face union in accordance with SAE J1453.

(g) For CNG, pipe fittings in accordance with ISO 15500-19 or ECE R110.

5.5 INSTALLATION AND PROTECTION

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

(a) Fuel service lines shall follow the shortest practical route and be confined within the overall profile of the equipment.

(b) The body of the industrial equipment shall be used as protection from chance impact or collision.

NOTE: Where the fuel service line is below the industrial equipment body shell, it should be shielded by structural members of the chassis or underframe, or be otherwise adequately protected from impact or abrasion.

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

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

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

(d) Rigid piping shall be effectively secured to any rigidly mounted feature by suitable metallic or plastic clips spaced not more than 800 mm apart. In order to prevent the possibility of fretting, corrosion or erosion of the fuel service line, cushioning shall be provided to protect the rigid pipe from both the chassis/body and the clips themselves. Suitable grommets shall be provided where the rigid pipe or hose assembly passes through any body panel.

Hose assemblies shall be effectively secured to any rigidly mounted feature by suitable metallic or plastic clips spaced not more than 800 mm apart.

NOTE: Vent hose conduits may be unsupported for the length of the conduit.

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

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

(f) For stationary engine installations, fuel service lines shall be protected according to the requirements of AS 5601.

(g) The service line shall be secured to the bodywork at the point of exit from the engine compartment.

(h) All joints shall be accessible.

(i) For any mobile industrial equipment, a means of storing or retaining of the flexible service line when not in use shall be provided so as to prevent damage.

NOTE: The container end of the service line should remain unsecured to allow sufficient free movement of the container for maintenance purposes.

5.6 PIPING OR FITTINGS IN ENCLOSED OPERATOR CABINS

Rigid piping, fittings or hose assemblies shall not be located in an enclosed operator cabin except for CNG fuel containers complying with Clause 4.9.1 and LP Gas container assemblies installed in compartments that comply with Clause 3.17.2.

NOTE: A removable container is not suitable for installing in an enclosed operators cabin.

5.7 MULTIPLE LP GAS CONTAINER INSTALLATIONS

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

NOTE: A spring loaded non-return valve can form part of a container service valve.

Automatic fuel shut-off devices shall not be operated independently on a multiple container installation with a common fill point.

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

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

For multiple container installations, refer to Clause 8.4.2.

5.8 HYDROSTATIC RELIEF VALVE (LP GAS)

Any hydrostatic relief valve provided in accordance with Clause 5.7 shall be set to operate at 3.1 MPa and shall be installed in accordance with the following requirements:

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

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

5.9 LP GAS FUEL HOSES FOR PRESSURE NOT EXCEEDING 450 kPa

LP Gas fuel hose for vapour pressure, joints and connections shall be suitable for use with LP Gas and capable of sustaining five times the maximum pressure likely to be encountered in service and shall comply with Clauses 5.2.2(b) and 5.4.

LP Gas fuel hose for 7.0 kPa or less vapour pressure shall comply with either the Class B requirement of AS/NZS 1869, or meet requirements of ECE Regulation 67, Class 2 Hose.

Where the LP Gas fuel hose vapour pressure is greater than 7.0 kPa and not more than 450.0 kPa the hose shall meet requirements of ECE Regulation 67, Class 2 Hose.

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

SECTION 6 FUEL CONTROL EQUIPMENT

6.1 SCOPE OF SECTION

This Section sets out requirements for the fuel control equipment and engine management systems.

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

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

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

(c) Gas pressure regulator.

(d) Vaporiser (LP Gas liquid withdrawal only).

(e) Fuel selector, if more than one fuel system can be used.

(f) Gas-air mixer or other fuel metering device.

The components nominated may be combined into multifunction units.

The material, strength, durability and suitability requirements for components are provided in Section 2 of this Standard.

NOTE: This Clause has been drawn up on the basis of the system that is most usual for industrial equipment, it is recognized that vapour withdrawal systems, or dual vapour and liquid withdrawal systems, are possible and sometimes used, and that other systems may be developed, e.g. fuel injection, in which case variations may be arranged under Clause 1.4.

6.2 FUEL FILTER

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

6.3 AUTOMATIC FUEL SHUT-OFF DEVICE AT LP GAS REGULATOR

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

(a) The ignition is on.

(b) The engine is rotating.

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

The automatic fuel shut-off device shall open against all pressure differentials up to its rated working pressure when the valves are energized.

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

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

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

6.4 AUTOMATIC FUEL SHUT-OFF DEVICE FOR CNG SYSTEMS

A fuel shut-off device shall be installed immediately upstream of the first stage regulator and shall prevent a flow of gas to the engine unless both the following conditions exist:

(a) The ignition is on.

(b) The engine is rotating.

The 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.

6.5 LP GAS OR CNG VAPORISER/REGULATOR

Each vaporiser/regulator shall be permanently marked with—

(a) the manufacturer's name and trademark;

(b) a definitive model, mark, or series identification; and

(c) the serial number or month and year of manufacture.

6.6 REGULATING SYSTEMS

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

6.7 INSTALLATION OF LP GAS VAPORISER OR REGULATOR

The LP Gas vaporiser or regulator shall be installed as follows:

(a) It is accessible for routine maintenance, adjustment, and inspection.

(b) It is mounted as close to the engine inlet manifold as convenient.

(c) It is reasonably protected from impact in a collision.

(d) For LP Gas systems, the vaporiser is closely adjacent to or connects directly with the vaporiser automatic fuel shut-off device. Any pipe connection shall be kept as short as possible and in no case shall the line length be more than 500 mm.

(e) It allows sufficient free movement of gas and water hoses.

(f) It is securely mounted.

(g) If applicable, the coolant-circulating system shall be connected in accordance with the vaporiser or regulator manufacturer's instructions, and no flow control valve in the system can shut-off hot water flow, e.g. thermostat, heater control valve.

(h) The vaporiser or regulator shall, where necessary, be provided with the heat shielding requirements of Clauses 3.21 or 4.12 respectively.

NOTE: The vaporiser or regulator should, where possible, be no higher than the level of the top of the radiator tank as incomplete water-flooding may cause freezing immediately after starting.

6.8 FUEL METERING SYSTEM

The fuel metering system shall be securely mounted and when remotely fitted shall be suitably mounted to support its own weight.

There shall be no air filter element fitted downstream of the fuel metering system.

NOTE: Some petrol carburettors are not suitable for use with LP Gas or CNG. Reference should be made to the industrial equipment manufacturer for recommendation and advice on this matter.

6.9 FUEL SELECTION

6.9.1 General

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

Where a manual fuel selector is provided, a means to prevent inadvertent operation of the fuel selector shall be provided, either by a mechanical device or by the restriction of access.

6.9.2 Fuel changeover system

A fuel changeover system is a system equipped to operate with LP Gas or CNG and/or some other fuel (for example petrol) without further modification.

Such systems may be of two types:

(a) *Optional fuel type (bi-fuel)*—to operate either on LP Gas/CNG or some other optional fuel, e.g. petrol.

(b) *Partial substitution type (dual fuel)*—to operate on part LP Gas/CNG and part optional fuel, e.g. diesel.

6.9.3 Optional fuel type

6.9.3.1 *Shut-off device*

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

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

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

6.9.3.2 *Bypass relief device*

A bypass relief device shall be installed in the fuel pump or between the fuel pump and the shut-off device in the petrol fuel line to the carburettor on industrial equipment equipped with optional fuel systems for the use of petrol and gaseous fuel. The relief device need not be installed on fuel pumps incorporating a bypass relief device or equivalent as original equipment.

6.9.3.3 *Fuel selection control*

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

6.10 PETROL SYSTEM MODIFICATIONS

Where it is necessary to modify a petrol fuel supply system, the modification shall be such that the safety of the petrol system is not diminished. Piping, hose, seals, and connections shall be suitable for petrol service, and shall be sufficiently durable and leak-free for the purpose.

An optional fuel system shall incorporate provisions to prevent possible deterioration to the petrol fuel system as a result of sustained operation on the gaseous fuel. Such measures shall be as recommended by the original industrial equipment manufacturer.

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

6.11 ELECTRICAL WIRING

All wiring shall be properly installed, taped, clipped or contained in a loom along its length.

Suitable wiring cables shall be used in respect of the conductor cross-sectional area (determined by current flow) and insulation (determined by temperature).

All wiring must be protected from damage caused by relative movement when in contact with equipment or other components.

The electrical circuit shall be provided with a current limiting device. This equipment or fuse shall be dedicated to the alternative fuel system.

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

(a) 110% of rated current of the circuit—should not fuse.

(b) 135% of rated current of the circuit—should fuse within 60 seconds.

(c) 150% of rated current of the circuit—should fuse within 15 seconds.

A circuit breaker meeting these requirements is acceptable.

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

6.12 MINIMIZING RISK OF GAS IGNITION

The location of electrical cables and mounting of the system components shall be designed to protect against the potential ignition of leaked gas.

6.13 ENGINE MANAGEMENT SYSTEM

The performance requirements for the engine management system are provided in Clause 1.8.

6.14 CONTENTS INDICATOR

The fuel-contents indicating device(s) shall be of a type that does not require pressure piping to be located within an operator's cabin.

SECTION 7 INSPECTION, TESTING AND COMMISSIONING

7.1 SCOPE OF SECTION

This Section sets out requirements for testing and commissioning LP Gas/CNG fuel installations on forklifts and industrial equipment. The order in which this Section is arranged should not be taken to imply that any particular sequence is mandatory. However, any leakage test is invalidated if the joint tested is subsequently dismantled, requiring another leak test to be carried out.

The principal tests undertaken comprise—

(a) fixed LP Gas container assembly test (see Clause 7.7);

(b) installation test (see Clause 7.8);

(c) commissioning, inspection and test comprising (see Clause 7.9)—

(i) system check; and

(ii) container inspection and recertification by a certified gas cylinder test station.

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

7.2 USED COMPONENTS

Where previously used components are being reinstalled or transferred to other industrial equipment, the testing and commissioning procedures of this Section shall apply as if it were an installation of new components.

7.3 MODIFICATIONS AND REPAIRS

A modification or repair to an installation shall be inspected and tested in accordance with this Section, and shall comply with the relevant requirements herein. To prevent inadvertent LP Gas release whilst the fuel container is temporarily removed, the filling system shall be positively plugged.

7.4 PRECAUTIONS

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

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

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

(b) The working areas and procedures shall comply with AS 2746.

(c) When the container is being filled, the normal precautions applicable to petrol or LP Gas/CNG service or refuelling station areas shall apply, e.g. no smoking and no ignition sources within the defined hazardous area, ignition off, brake or parking provisions engaged. (See AS/NZS 1596 for a complete list of filling instructions for LP Gas refuelling stations and AS 5092 for CNG refuelling instructions.)

(d) If for any reason a LP Gas container is filled beyond the maximum permitted level, the engine shall be operated continuously for a sufficient period to consume excess fuel, or if this is not possible the excess fuel shall be removed by one of the methods for LP Gas fuel unloading described in AS 2746.

7.5 INSPECTION

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

A certified gas cylinder test station shall conduct an external examination and certify containers prior to first use.

NOTE: MP 48 gives a list of certified gas cylinder test stations in Australia.

7.6 LEAK DETECTION

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

7.7 FIXED LP GAS CONTAINER ASSEMBLY LEAK TEST

7.7.1 General

Leak testing would only be necessary if the container components had been changed or disturbed.

NOTE: If the container assembly has been tested by the container supplier, it is not intended that the installer is obliged to test again.

The test procedure and the pass/fail requirements prescribed in Clauses 7.7.2 and 7.10 shall be applied to an assembly consisting of the container shell and the following components:

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

(b) Automatic fill limiter.

(c) Contents gauge.

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

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

(f) Service valve with integral excess-flow valve.

(g) Automatic fuel shut-off device at container.

7.7.2 Leak test

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

WARNING: OXYGEN SHALL NOT BE USED FOR PRESSURIZING. COMPRESSED AIR CAN BE DANGEROUS IN ASSOCIATION WITH LP GAS. A CONTAINER THAT HAS PREVIOUSLY CONTAINED LP GAS SHALL BE PURGED THOROUGHLY IF IT IS INTENDED TO USE PRESSURIZED AIR FOR THIS TEST.

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

(b) Pressurize the container to an internal pressure of 2.30 ±0.05 MPa.

(c) Remove the pressurizing attachment.

(d) Check all joints between the container and the components for leaks (see Clause 7.6).

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

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

(g) The excess flow valve shall be tested in accordance with Clause 7.10.

(h) The container automatic fuel shut-off device shall be tested in accordance with Clause 7.9.2(k)(i).

(i) Where a leak is indicated, rectify the fault by replacement or resealing, and retest the area.

(j) Where a container component is disturbed or replaced, reinstallation procedures shall comply with the component manufacturers installation instructions.

7.8 INSTALLATION TEST

7.8.1 General

The procedures of this Clause (7.8) shall be applied after the installation has been inspected (see Clause 7.5). Any fixed LP Gas container assembly shall have passed the test in Clause 7.7. Any CNG container shall have been tested in accordance with the requirements of Clause 4.3.1.

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

7.8.2 Gastightness of compartment and sub-compartment

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

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

7.8.3 Leak testing of gas system

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

(a) *For LP Gas*:

(i) Place LP Gas in the container and ensure that the fuel lines are full of either LP Gas liquid, if it is a liquid withdrawal system, or LP Gas vapour, if it is a vapour withdrawal system.

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

(iii) Where a leak is indicated, the fault shall be rectified by first relieving any pressure and then remaking the joint, and retest the area.

(b) *For CNG:*

(i) Fill the container with CNG to the maximum filling pressure.

(ii) Check each connection, joint or seal for leakage.

(iii) Where a leak is indicated, the fault shall be rectified by first relieving any pressure, then resealing, prior to retesting the area.

7.8.4 Test of automatic fill limiter on fixed LP Gas container installations

The accuracy of the shut-off function of any fitted automatic fill limiter shall be checked in accordance with Clause 7.12.

7.8.5 Test of fuel control device

A test shall be made to ensure that the automatic shut-off device or fuel lock off valve and the fuel change over system are functioning correctly. The industrial equipment shall be operated on each fuel, and changed over several times.

7.8.6 Coolant system tests

The coolant-circulation system that supplies radiator coolant to the LP Gas vaporiser or the CNG regulator shall be pressure tested for leaks, using a conventional radiator pressure testing method.

7.8.7 Visual inspection

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

(a) the filler cap/dust cap is present and captive;

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

(c) all markings are in place and correct;

(d) necessary heat shields are fitted; and

(e) clamps and fasteners are correctly fitted.

7.9 ANNUAL INSPECTION AND TESTS

7.9.1 General

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

This Clause (7.9) deals only with the procedures and checks which are routinely applied to check the whole system. For a specific check of a fuel container that may require recertification, refer to AS 2337.1, AS 2337.2, AS 2337.3 or ISO 19078 as appropriate. Normal day-to-day running adjustments, e.g. tuning, are not addressed.

Implementation and enforcement is the responsibility of statutory authorities, and because of differences of detail from place to place it is not possible to give a complete description of national procedures. Suitable checking procedures shall be based on the following presumptions:

(a) If at any time after initial installation an LP Gas/CNG fuel installation is found to be unsatisfactory to the extent that it is potentially or actually hazardous, it will be considered that the industrial equipment has become unsafe, and the established procedure for treating any unsafe equipment shall be applied to ensure rectification.

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

7.9.2 Annual system check

The following annual checks shall be carried out:

(a) *Leakage check*

Apply the procedure of Clauses 7.6 and 7.8.3.

(b) *CNG container identity check*

Inspect the containers to confirm that:

(i) the serial numbers on the refueling information plate are the same as those of the installed containers, and

(ii) the containers have not been tampered with or modified. This may require reference to the design information/drawing provided by the container manufacturing certificate

(c) *LPG container life*

Check the container date stamp. If it will exceed the retest date before the next annual inspection, initiate the procedures for reinspection and recertification in accordance with AS 2337.2 for LP Gas.

(d) *CNG container life*

CNG containers made to CSA B51 Part 2, ANSI NGV2, ISO 11439 or ECE R110 have a specified service life. For these containers, check their life expiry date. If that date occurs prior to the next annual system check, the container shall be removed from service and disposed of in accordance with AS 2337.1 for metal containers or AS 2337.3 for composite containers.

(e) *CNG container recertification date*

Check the container date stamp. If it exceeds the retest date before the next annual inspection, initiate the procedures for reinspection and recertification in accordance with AS 2337.1, AS 2337.3, ISO 19078 or the container manufacturer's instructions, as appropriate.

If the next recertification date has passed, initiate procedures for recertification in accordance with the requirements of the appropriate inspection and certification authority.

The next recertification date shall be determined as follows:

(i) *For metal containers* The next recertification date is based on the stamped date of last re-certification and the inspection interval specified by the relevant cylinder standard.

(ii) *For composite containers* Containers that have been re-certified shall have a disc containing the next date of re-certification in accordance with AS 2337.3.

(f) *LP Gas container damage*

Inspect the LP Gas container and any fitted protection for any evidence of damage by impact or by fire. Refer the container to a certified gas cylinder test station if any of the following faults are present:

(i) A dent that does not penetrate the surface material, but whose depth exceeds 10 percent of the mean diameter of the dent, or that is located on a weld and exceeds 6.5 mm in depth.

(ii) A sharp impression or crease that does not penetrate the surface of the material, but whose length exceeds 75 mm or whose depth exceeds 25 percent of the wall thickness.

(iii) A cut or gouge that penetrates the surface material, of dimensions as in Item (ii) above.

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

(v) Fire damage.

(g) *LP Gas container corrosion*

Inspect the container for evidence of deterioration by corrosion. Pay particular attention to the drip line under the container, to areas where water could accumulate, and to the area covered by clamping bands, especially those that pass under a container or intersect the drip line. Release bands where necessary to ensure adequate examination.

NOTE: Care should be taken when releasing bands to prevent damage to any component or piping.

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

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

(ii) Any corrosion that exceeds 75 mm in length or that leaves less than 75 percent of the original wall thickness.

(h) *CNG container damage and corrosion*

Inspect the container and its mountings, pipework, compartments or sub-compartments, guards and heat shields to ensure that they have not suffered impact damage, corrosion or heating by fire or loss of integrity due to fatigue.

(i) *Container attachment*

Check for the following:

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

(ii) Tightness of and damage to fasteners, loose bands and wear under bands.

(iii) Correct orientation of fuel container, (for LP Gas installations).

(iv) Adjustment of quick release container bands, (for LP Gas installations).

(v) Cracks and metal fatigue.

(j) *Automatic fill limiter (LP Gas only)*

Check the accuracy of the automatic fill limiter (AFL), if fitted, by means of fixed liquid level gauge or a refuelling dispenser meter in accordance with Clause 7.12.

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

(k) *Safety fuel shut off system (LP Gas only)*

Test as described in Items (i) or (ii) depending upon the type of system fitted at the container.

(i) Automatic fuel shut-off device on a fixed container

Deactivate automatic fuel shut-off device at the container by isolating the power supply (see Clause 3.13.1) and run the engine until the fuel service line is empty and the engine stops.

(ii) Excess-flow valve

Deactivate automatic fuel shut-off device at the container by operating the current limiting device or removing the fuse or by open circuiting an insulated connector in the automatic fuel shut-off device wiring circuit.

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

(l) *Test of fuel control systems*

Check that the automatic fuel shut-off device(s) and the fuel change over system are present and functioning correctly.

NOTE: Where an automatic fuel shut-off device is not installed at the container (LP Gas systems), retrofitting is to be encouraged.

(m) *Manual valves*

Open and close all manual valves and test around glands and connections for leaks in both positions.

(n) *Compartment or sub-compartment*

Check for structural damage. Check around all joints, conduit connections and pipe bulkhead seals for leakage in accordance with Clause 7.8.2. Check conduits for deterioration, damage, kinking or punctures.

(o) *Refuelling connection*

Check for damage to the refuelling connection and for the presence of foreign matter, and check that the dust cap is present and captive by a chain or similar device. Check that the sealing washer is in place and in satisfactory condition. Check that the housing containing the refuelling connection is soundly attached to the industrial equipment, and that the remote fill line is not deformed or damaged by twisting resulting from a loose housing.

(p) *Hydrostatic relief valve (LP Gas only)*

Check for damage, blockage, or tampering.

(q) *Protrusions from mobile equipment*

For forklifts and mobile industrial equipment, check to ensure that any containers, flexible and rigid piping and components remain within the overall contour of the industrial equipment.

(r) *Equipment marking*

Check that all required plates and markings are present and legible.

(s) *Liquid filter(s)*

Check to ensure that the filter(s) is present, intact and clean.

7.10 EXCESS FLOW VALVE TEST (LP GAS)

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

The excess-flow valve shall be tested to ensure that it closes and reopens, by opening and then closing the service valve while the container remains under pressure following the fixed container assembly leak test. (See Clause 7.7.)

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

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

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

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

7.11 NON-RETURN VALVE TEST

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

7.12 AUTOMATIC FILL LIMITER (AFL) TEST FOR LP GAS INSTALLATIONS

The accuracy of the shut-off function of the automatic fill limiter, if fitted, shall be checked with the industrial equipment level.

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

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

7.13 TESTING OF AUTOMATIC FUEL SHUT-OFF DEVICE

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

7.14 CNG CONTAINERS

A certified gas cylinder test station shall conduct an external examination and certify containers prior to first use.

NOTE: MP 48 gives a list of certified gas cylinder test stations in Australia.

SECTION 8 CERTIFICATION, COMPLIANCE PLATE, MARKINGS AND LABELS

8.1 GENERAL REQUIREMENT

The requirements in this Section shall be complied with prior to the industrial equipment being released to the customer.

8.2 CERTIFICATION

On completion of an aftermarket installation, the owner shall be supplied with a certificate/notice of compliance with this Standard, which shall also give an installation date and the serial number(s) of any fixed container(s). The certificate/notice may be incorporated in a receipt, or may be a specific document. In all cases it shall include a certificate of compliance number.

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

8.3 INFORMATION PLATES

8.3.1 Compliance plates

An LP Gas/CNG compliance plate shall be securely attached to a permanent part of the industrial equipment and shall be clearly visible. The compliance plate shall take the form shown in Figure 8.1 and all applicable information shall be provided by the installer.

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

NOTE: Any statutory regulations on compliance procedures that differ from this clause will take precedence.

INDUSTRIAL EQUIPMENT COMPLIANCE PLATE

The installation to which this notice is affixed complies with the requirements of Australian Standard AS 4983

FUEL TYPE: .....

INSTALLATION DATE: .....

STATE: .....

COMPLIANCE NO: .....

INSTALLERS LIC. NO: .....

WORKSHOP (REP) NO: .....

EQUIPMENT SERIAL NO: .....

FIGURE 8.1 COMPLIANCE PLATE

8.3.2 Information plate for removable LP Gas container

A plate indicating information relating to a removable LP Gas container as shown in Figure 8.2, shall be located on or near the container mounting brackets and shall be permanently inscribed with the relevant information, and have the word 'LIQUID' or 'VAPOUR' deleted as appropriate.

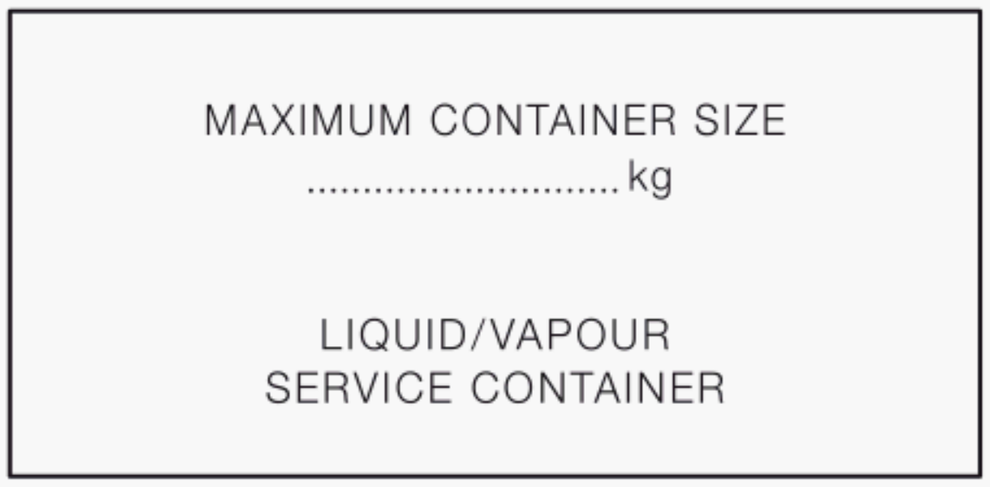


FIGURE 8.2 LP GAS CONTAINER INFORMATION PLATE

8.3.3 CNG refuelling information plate

The following information shall appear on a plate for each container that shall be installed near the refuelling connection and be clearly visible to the refueller:

(a) 'CNG'.

(b) The rated working pressure, in megapascals.

(c) The container identification numbers and the stamped date of the periodic recertification (retest) of the container(s) and the capacity of the total installation. When a container is changed or recertified, this information shall be updated.

NOTE: Figure 8.3 illustrates a typical refuelling information plate.

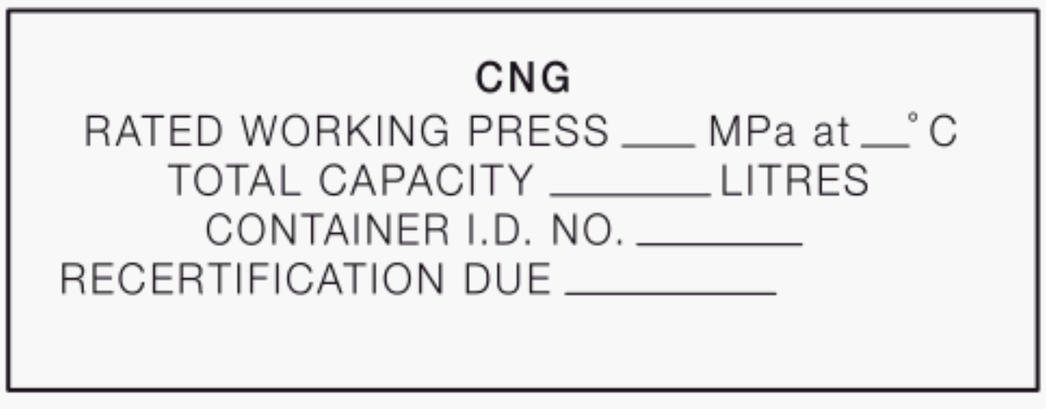


FIGURE 8.3 TYPICAL CNG REFUELLING INFORMATION PLATE

8.4 LABELS AND MARKINGS

8.4.1 Filler markings for LP Gas installations

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

STOP FILLING WHEN LIQUID APPEARS

8.4.2 Outlet markings for LP Gas installations

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

Where multiple containers are fitted, a warning label shall be attached or adjacent to each containers service valve that reads:

THE MANUAL SHUT-OFF VALVE MUST REMAIN OPEN EXCEPT DURING EMERGENCY OR SERVICING

8.4.3 Mobile industrial equipment identification

Mobile industrial equipment that uses LP Gas or CNG as a fuel shall have affixed to the rear number plate, or affixed in a visible position on the rear of the equipment if no number plate is fitted, a label that meets the following requirements:

(a) The label colour to be retroflective red, complying with AS 1743, Appendix C, Class 2.

(b) For LP Gas, the label shall be not less than 25 mm square mounted as a diamond.

(c) For CNG, the label shall be not less than a 35 mm diameter circle.

(d) The label shall only have the letters 'LP Gas' or 'CNG', depending on the installation, in white at least 10 mm in height.

8.4.4 Access hatch

Any gastight access hatch as described in Clause 3.18.2(b) shall be provided with a marking that reads:

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

8.4.5 Selector

The fuel selector shall be marked to indicate which fuel has been selected. Any written marking shall be in the English language.

8.5 OPERATING INSTRUCTIONS

The installer shall leave with the industrial equipment a set of operating instructions that shall include, but not be restricted to, the following:

(a) Refuelling procedures and precautions.

(b) Operation of fuel system selector controls, where fitted.

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

(d) Proper care and maintenance for the fuel container(s) and particularly advice that it is the owner's responsibility to have the installation inspected annually by an authorized person and to maintain the container(s) within recertification date(s).

APPENDIX A

LIST OF REFERENCED DOCUMENTS

(Normative)

AS	
1210	Pressure vessels
1271	Safety valves, other valves, liquid level gauges, and other fittings for boilers and unfired pressure vessels
1432	Copper tubes for plumbing, gasfitting and drainage applications
1572	Copper and copper alloys—Seamless tubes for engineering purposes
1743	Road signs—Specifications
1751	Copper brazed steel tubes
2030	Gas cylinders
2030.1	Part 1: General requirements
2337	Gas cylinder test stations
2337.1	Part 1: General requirements, inspection and tests—Gas cylinders
2337.2	Part 2: LP Gas fuel vessels for automotive use
2337.3	Part 3: Transportable gas cylinders—Periodic inspection and testing of composite gas cylinders (ISO 11623:2002, MOD)
2473	Valves for compressed gas cylinders (series)
2613	Safety devices for gas cylinders
2746	Working areas for gas-fuelled vehicles
3814	Industrial and commercial gas-fired appliances
4291	Mechanical properties of fasteners made of carbon steel and alloy steel
4291.1	Part 1: Bolts, screws and studs
4564	Specification for general purpose natural gas
5092	CNG refuelling stations
5601	Gas installations
D26	Tube fittings with Dryseal American standard taper pipe and unified thread for automotive and industrial use
MP 48	Certified gas cylinder test stations
AS/NZS	
1596	The storage and handling of LP Gas
1869	Hose and hose assemblies for liquefied petroleum gases (LP Gas), natural gas and town gas
3509	LP Gas fuel vessels for automotive use
60079	Electrical apparatus for explosive gas atmospheres
60079.10	Part 10: Classification of hazardous areas (IEC 60079-10:2002, MOD)

ISO	
527	Plastics—Determination of tensile properties
527-3	Part 3: Test conditions for films and sheets
6383	Plastics—Film and sheeting—Determination of tear resistance
6883-1	Part 1: Trouser tear method
11439	Gas cylinders—High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles
14469	Road vehicles—Compressed natural gas (CNG) refuelling connector (series)
15500	Road vehicles—Compressed natural gas (CNG) fuel system components
15500-1	Part 1: General requirements and definitions
15500-2	Part 2: Performance and general test methods
15500-3	Part 3: Check valve
15500-4	Part 4: Manual valve
15500-5	Part 5: Manual cylinder valve
15500-6	Part 6: Automatic valve
15500-7	Part 7: Gas injector
15500-8	Part 8: Pressure indicator
15500-9	Part 9: Pressure regulator
15500-10	Part 10: Gas-flow adjuster
15500-11	Part 11: Gas/air mixer
15500-12	Part 12: Pressure relief valve (PRV)
15500-13	Part 13: Pressure relief device (PRD)
15500-14	Part 14: Excess flow valve
15000-15	Part 15: Gas-tight housing and ventilation hose
15500-16	Part 16: Rigid fuel line
15500-17	Part 17: Flexible fuel line
15500-18	Part 18: Filter
15500-19	Part 19: Fittings
15500-20	Part 20: Rigid fuel line in material other than stainless steel
19078	Gas cylinders—Inspection of the cylinder installation, and requalification of high pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles
AG	
805	Approval requirements for natural gas vehicle (NGV) components (incorporates amendment)
807	Approval requirements for natural gas flexible hose and hose assemblies for pressures above 2.6 MPa
ANSI	
CSA NGV1	Compressed natural gas vehicle (NGV) fuelling connecting devices
AGA NGV2	Basic requirements for compressed natural gas vehicle (NGV) fuel containers
AGA NGV3.1	Fuel system components for natural gas powered vehicles
B 1.5	Acme screw threads
PRD1	Basic requirements for pressure relief devices for natural gas vehicle fuel containers

ASTM	
A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A269	Standard Specification for Seamless and Welded Austentitic Stainless Steel Tubing for General Service
CSA	
B51	Boiler, Pressure Vessel and Pressure Piping Code Part 2: High-pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles
SAE	
J30	Fuel and oil hoses
J369	Flammability of Polymeric Interior Materials—Horizontal Test Method
J533	Flares for tubing
J1453	Fitting—O-ring face seal
ECE R67	Uniform provisions concerning: I Approval of specific equipment of motor vehicles using liquefied petroleum gases in their propulsion system II Approval of a vehicle fitted with specific equipment for the use of liquefied petroleum gases in its propulsion system with regard to the installation of such equipment
ECE R110	Uniform provisions concerning the approval of: I Specific components of motor vehicles using compressed natural gas (CNG) in their propulsion system II Vehicles with regard to the installation of specific components of an approved type for the use of compressed natural gas (CNG) in their propulsion system

APPENDIX B

REGULATING AGENCY INFORMATION

(Informative)

The following information is for guidance only and may be subject to change:

Country, state or territory	Equipment installation regulator	Vehicle registration	Installer licensing	Work-area licensing
ACT	Manager, Vehicle Inspection & Technical Units Road User Services Department of Urban Services 13-15 Challis Street DICKSON ACT 2602	Manager, Vehicle Inspection & Technical Units Road User Services Department of Urban Services 13-15 Challis Street DICKSON ACT 2602	Plumbers Drainers and Gas-Fitters Board of the ACT Dept of Urban Services 16 Challis Street DICKSON ACT 2602	—
FEDERAL (new vehicles)	Administrator of Motor Vehicle Standards Department of Transport and Regional Services GPO Box 594 CANBERRA ACT 2602	—	—	—
NSW	Chief Inspector, Dangerous Goods Chemical Safety Unit WorkCover NSW Locked Bag 2906 LISAROW NSW 2252	Manager, Automotive Engineering Operations Vehicle Standards Section Roads & Traffic Authority 260 Elizabeth St SURRY HILLS NSW 2010	Motor Vehicle Repair Industry Authority 239 Great North Road FIVE DOCK NSW 2046	
NT	Chief Inspector of Dangerous Goods Dept of Industries & Business Work Health Authority DARWIN NT 0800	Manager Motor Vehicle Registry Department of Transport DARWIN NT 0800	Chief Inspector of Dangerous Goods Dept of Industries & Business Work Health Authority DARWIN NT 0800	—

(continued)

Country, state or territory	Equipment installation regulator	Vehicle registration	Installer licensing	Work-area licensing
QLD	Chief Inspector Petroleum & Gas Operations Department of Mines and Energy 41 George Street BRISBANE QLD 4000 PO Box 2454 BRISBANE QLD 4001	Manager, Motor Vehicle Registration Branch Queensland Department of Transport BRISBANE QLD 4000	Chief Inspector Petroleum & Gas Operations Department of Mines and Energy 41 George Street BRISBANE QLD 4000 PO Box 2454 BRISBANE QLD 4001	—
SA	Manager, Dangerous Substances Unit Safework SA Department of the Premier and Cabinet GPO Box 465 ADELAIDE SA 5000	Manager, Driver and Vehicle Licensing Department for Transport Energy and Infrastructure 33 Warwick Street WALKERVILLE SA 5081	Manager, Dangerous Substances Unit Safework SA Department of the Premier and Cabinet GPO Box 465 ADELAIDE SA 5000	—
TAS	Manager Chemical Safety Section Industry Safety & Mines 30 Gordons Hill Rd ROSNEY PARK TAS 7018	Registrar of Motor Vehicles Department of Transport GPO Box 936J HOBART TAS 7001	Manager Chemical Safety Section Industry Safety & Mines 30 Gordons Hill Road ROSNEY PARK TAS 7018	
VIC	Manager, Dangerous Good Unit Worksafe Victoria GPO Box 4306 MELBOURNE VIC 3001	Manager, Vehicle Safety Road Safety Division VicRoads 60 Denmark Street KEW VIC 3101	Chairman Automotive Alternative Fuels Registration Board Level 7, 464 St Kilda Road MELBOURNE VIC 3004	
WA	Chief Gas Inspector Gas Inspection Branch Energy Safety WA 303 Sevenoaks Street CANNINGTON WA 6107	Manager, Technical Section Vehicle Safety Transport, Licensing Division 2-10 Murray Road WELSHPOOL WA 6106	Manager, Regulatory Services Energy Safety WA 303 Sevenoaks Street CANNINGTON WA 6107	—

APPENDIX C

LEAK DETECTION METHODS

(Normative)

C1 SCOPE

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

C2 COMBUSTIBLE-GAS DETECTOR

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

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

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

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

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

C3 TRACE-GAS DETECTORS

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

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

C4 FOAMING AGENTS

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

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

C5 TOTAL IMMERSION

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

C6 VISUAL INSPECTION (LP GAS)

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

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