



The storage and handling of liquefied natural gas



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-

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Australian Standard®

The storage and handling of liquefied natural gas

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PREFACE

This Standard was prepared by the Standards Australia Committee ME-070, Liquefied Natural Gas Storage and Handling, to supersede AS 3961—2005.

The objective of this Standard is to provide requirements for the design, construction and operation of installations for the storage and handling of liquefied natural gas (LNG), covering installations of atmospheric-type tanks for supplying marine terminals, pipeline peak shaving, and pressure tanks.

The LNG industry has developed considerably since the previous editions and this edition draws upon this experience. Requirements that were modelled on the storage of LP Gas and flammable liquids have been rewritten to reflect the properties and usage of LNG.

Changes have included the following:

- (a) Removal of requirements for pressure storages of less than 5 m³ as small storages are not in use in the industry and the cryogenic properties of LNG are such that small storage is generally not practical.
- (b) Reinforcing the containment and separation aspects of firefighting as the use of water sprays can exacerbate a fire situation.
- (c) Removing requirements that are in the scope of other standards and are adequately covered in those standards. Examples are pressure vessel requirements in the scope of AS 1210, *Pressure vessels*, and transport requirements in the scope of the ADG Code and AS 2809, *Road tank vehicles for dangerous goods*, Parts 1 and 6.
- (d) Revision of the fill coupling requirements to align with International Standards and allow for the use of dry-break couplings.

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard.

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 provides information and guidance only.

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STANDARDS AUSTRALIA

Australian Standard

The storage and handling of liquefied natural gas

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE AND APPLICATION

1.1.1 Scope

This Standard specifies requirements for the design, construction and operation of installations for the storage and handling of liquefied natural gas (LNG).

1.1.2 Application

This Standard applies to two basic types of installation, being—

- (a) installations of atmospheric tanks for marine terminals, pipeline peak shaving, and the like; and
- (b) pressure tanks, which are usually a part of a distribution system for LNG by road tanker.

1.1.3 Where this Standard does not apply

This Standard does not apply to or deal with—

- (a) the functional design of liquefaction equipment;
- (b) frozen-ground storage techniques;
- (c) aspects of natural gas distribution and use that are covered by other Standards and publications such as pipeline and reticulation codes, appliance and vehicle installation codes, and the like;
- (d) any transport operations that are covered by the ADG Code;
- (e) the transport of LNG by ship; or
- (f) any aspect of transport or piped distribution outside the perimeter of the static storage installation.

1.2 REFERENCED DOCUMENTS

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

1.3 DEFINITIONS

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

1.3.1 ADG Code

The Australian Dangerous Goods Code.

1.3.2 Atmospheric tank

A tank which operates at a nominal vapour pressure not exceeding 50 kPa or, for a pressure vessel, less than the pressure specified in AS 1210.

1.3.3 Authority

The authority having statutory (legal) control of the installation.

1.3.4 Automotive refuelling station

A place where vehicle fuel tanks are filled from dispensers while on the vehicle.

1.3.5 Boil-off gas

Gas resulting from evaporation close to its equilibrium condition.

1.3.6 Boundary

The perimeter of the whole of the site under the same occupancy as the installation.

1.3.7 Bund

An embankment or wall which may form part or all of the perimeter of a compound.

1.3.8 Capacity (of a tank)

The total volume of the space enclosed within the tank for a pressure tank, or the total volume of the space up to the maximum permitted filling level for an atmospheric tank.

1.3.9 Combustible liquid

A flammable liquid as defined in the ADG Code.

1.3.10 Compound

An area bounded by natural ground contours or by a bund, and intended to retain spillage or leakage.

1.3.11 Design spillage

The quantity of liquid that a compound is designed to contain in the event of spillage or leakage.

1.3.12 Emergency shutdown system

A system of controls and components that complies with specific requirements of this Standard, which facilitates safe shutdown in an emergency.

1.3.13 Excess-flow valve

A normally open valve which closes automatically when a predetermined flow rate in a particular direction has been exceeded.

1.3.14 Fire resistance level (FRL)

The grading period, in minutes, determined in accordance with AS 1530.4 for—

- (a) structural adequacy;
- (b) integrity; and
- (c) insulation,

and expressed in that order (e.g. 60/60/30).

NOTE: Where an FRL is required, reference should be made to the *National Construction Code* (NCC) for guidance.

1.3.15 Firewall

A wall or other barrier constructed and placed with the object of preventing the spread of fire or the radiation of heat from any place to some other place.

1.3.16 Flammable liquids

A flammable liquid as defined in the ADG Code.

1.3.17 Flash gas

Vapour generated from sudden evaporation at non-equilibrium conditions.

1.3.18 Holding time

The time that will elapse before the pressure of the contents, initially saturated at one atmosphere, will rise to a pressure at which the safety valve will commence to open.

1.3.19 Ignition source

A source of energy sufficient to ignite an explosive atmosphere. Such sources include but are not limited to flames, incandescent material, electrical sparks, hot surfaces and mechanical impact sparks.

1.3.20 Installation

All of the facilities on a site used for storing or handling LNG.

1.3.21 Liquefied natural gas (LNG)

A hydrocarbon fluid composed predominantly of methane (CH₄), refrigerated to the liquid phase.

NOTE: See Appendix B for characteristics of LNG.

1.3.22 Maximum filling level

The highest liquid surface level permitted in a tank, taking into account the liquid temperature at the time of filling. It provides an allowance for any expansion of the liquid due to temperature changes after filling.

1.3.23 Mobile refuelling

The use of a tanker or other transportable vessel for the purposes of refuelling a vehicle fuel tank.

1.3.24 Non-return valve (check valve)

A valve which permits flow in one direction only.

1.3.25 Pressure tank

A tank within the scope of AS 1210.

1.3.26 Protected place

Any of the following:

- (a) A dwelling, place of worship, public building, school or college, hospital, theatre or any building in which persons are accustomed to assemble, whether it is within or outside the property boundary of the installation.
- (b) A factory, workshop, office, store, warehouse, shop or other building where people are employed, that is outside the property boundary of the installation.
- (c) A ship lying at permanent berthing facilities.
- (d) Any storage facility for dangerous goods outside the property boundary of the installation, except those defined as minor storages in other standards or regulations.

1.3.27 Public place

Any place other than private property, open to the public and including a street or road. Parking areas for commercial and public buildings are not considered public spaces.

1.3.28 Restricted area

An area to which access is limited to specific or authorized persons, or to which restrictions on activities apply. It may be all or part of the area within the boundaries, and may contain within the restricted area nominated non-restricted zones.

1.3.29 Safety valve

A type of pressure relief valve intended for the release of excessive vapour pressure.

NOTE: Such valves are defined in AS 1210 and AS 1271.

1.3.30 Tank

A container designed for the storage of LNG (see also Clauses 1.3.2 and 1.3.25).

A tank may be one of the following types:

- (a) *Static storage tank* A tank intended to remain permanently in place once installed.
- (b) *Portable tank* A tank intended for semi-permanent static installation, but which incorporates additional features which allow it to be transported to the site, or transferred to another site, filled or partly filled with LNG.
- (c) *Tank container* A tank fitted with frames to international freight container dimensions in accordance with ISO 1496-3 (also known as an ISO Tank).

1.3.31 Tanker

A road tank vehicle complying with the relevant part of AS 2809.

1.3.32 Transfer connection

The coupling for connecting a storage tank to a tanker. It may be—

- (a) a direct connection, located at the tank shell, or
- (b) a remote connection, which is at a distance from the tank being filled and is connected to it by fixed rigid piping.

1.3.33 Trycock

A gauging device for a pressure tank, which indicates when the liquid surface in the tank has reached the maximum allowable filling level.

1.3.34 Vapour barrier

A wall or other barrier constructed and placed with the object of preventing the passage of vapour from one place to another.

NOTE: This should not be confused with another use of the term common in the cryogenics industry, to mean a barrier to prevent icing and breakdown of thermal insulation.

SECTION 2 GENERAL INSTALLATION REQUIREMENTS

2.1 SCOPE OF SECTION

This Section specifies the design and installation requirements for the storage and handling of LNG. It applies in addition to either Section 3 or Section 4, which give additional requirements specific to the two main types of storage.

2.2 TANKS

2.2.1 General tank design

The design of all tanks shall take into account the following:

- (a) Any structural provisions for supporting the tank shall be designed to support the loading when in service or any site testing.
- (b) Any portion of the outer surface area of a tank or associated piping or fittings which could be accidentally exposed to low temperatures shall be suitable for such temperatures or shall be otherwise protected from the effects of such exposure.
- (c) The effect of stratification should be considered with a view to prevent roll over.

2.2.2 Tank data plate

In addition to the markings required by AS 1210 or API 620, the tank data plate shall include the following:

- (a) Capacity in cubic metres.
- (b) Minimum temperature for which the tank was designed.

2.3 PRESSURE AND VACUUM RELIEF

2.3.1 Relief devices for tanks

Safety valves or pressure-vacuum vents shall be provided as required by the design Standard applicable to the tank, i.e. AS 1210 or API 620, with the following qualifications:

- (a) A safety valve or a pressure-vacuum vent shall communicate with the vapour space in the tank.
- (b) There shall be no valve or restriction of any type between the pressure-relief or vacuum-relief device and the vapour space of a tank, except where reserve reliefs are provided to permit servicing without depressurizing. In such a case the valve system used to isolate any individual relief device shall be designed so that it is not at any time possible to operate the system with less aggregate relief capacity than that required for the tank.
- (c) The option of gas admission through a vacuum vent as provided in API 620 shall not be permitted.
- (d) Materials shall not be subject to self-adhesion, and in particular soft-seated valves shall not be prone to seat adhesion to such an extent that the start-to-discharge pressure will increase to beyond 110% of the design pressure after a period of service.
- (e) Safety valves shall be arranged so that the possibility of tampering is minimized. Any externally located pressure-setting adjustment shall be provided with means of sealing or locking, or both, after setting.

2.3.2 Other equipment including vacuum jackets

Any component which could be subject to vacuum shall be designed to withstand such vacuum, or protected by vacuum-relief provisions.

A sealed or vacuum annular insulation space shall be provided with a pressure-relief device, set to release before any internal pressure exceeds the internal or external pressure capability of the outer and inner shells respectively. The discharge area of this device shall be at least 0.34 mm^2 for each litre of capacity of the inner vessel but need not exceed 8000 mm^2 for any size tank.

2.3.3 Discharge from relief devices

The location of the discharge point and the direction of discharge from a safety valve or other pressure-relief device shall be such that hazards from venting vapours are minimized. Vapour impingement on tanks or piping shall be prevented. The direction of discharge shall be vertically upwards except where another direction is necessary to comply with this Clause, e.g. to avoid impingement.

A safety valve and any associated discharge piping shall comply with the following requirements when installed:

- (a) The size of any discharge piping shall be sufficient to ensure that the required discharge capacity of the safety valve is achieved. Refer to AS 1271.
- (b) Irrespective of any provisions for recycling vapour discharges from pressure-relief and pressure control devices, the design shall ensure that the required discharge capacity of a safety valve will be released without restriction in an emergency.
- (c) The outlet shall not be vulnerable to physical damage.
- (d) Provision shall be made to prevent the accumulation of rain, dew, or foreign matter within the safety valve in such a manner as to cause backpressure or render the valve defective. For pressure tanks, the point of discharge shall have a self-closing device designed so that no parts become separated if a discharge occurs. Where a weep hole or drain is provided in order to comply with this requirement, the overall design shall be such that any ignited discharge cannot impinge on the tank, adjacent tanks, piping, or equipment. A deflector or a drainage discharge pipe may be provided; any such piping shall not incorporate a valve.

2.4 GAUGES AND CONTROLS

2.4.1 Reserve instrumentation

Where it is not acceptable to operate without continuously functioning instrumentation, so that alternative instrumentation is provided, any provision for isolating one instrument for service shall be such as to ensure that the alternative instrumentation is not also isolated at the same time.

2.4.2 General failsafe requirement

Instruments and control systems should be designed so that if power, air, hydraulics or the like for operating instruments fail, the system shall go into a safe condition that can be maintained until appropriate action can be taken either to reactivate or to secure the system.

2.4.3 Vacuum jacket gauges

Vacuum-jacketed equipment shall be equipped with instruments or connections for checking the absolute pressure in the annular space.

2.4.4 Leak detection

All sites shall have a fixed, continuously operating gas-leak detection system.

2.5 PLANT EMERGENCY SHUTDOWN SYSTEMS

2.5.1 Where required

An emergency shutdown system shall be incorporated into any installation that—

- (a) includes an atmospheric tank; or
- (b) exceeds 300 m³ total capacity; or
- (c) includes LNG pumps, compressors or liquefaction plants; or
- (d) involves the loading of LNG into tankers.

When operated, such a system shall isolate, shut down, or otherwise make safe any equipment whose continued operation could add to or continue an emergency.

2.5.2 Principles of design

An emergency shutdown system shall be designed to fail to a safe condition. The system shall be designed, installed, located or protected so as to minimize the possibility of becoming inoperative in the event of an emergency or failure of the normal control system.

2.5.3 Actuation

The initiation of the emergency shutdown system shall be both manual and automatic, the extent of either being determined by evaluation of the specific needs. Manual actuators shall be located in areas accessible in an emergency, and shall be distinctly and conspicuously marked with their designated function. At least one such manual actuator shall be protected from radiant heat either by shielding from, or being located at a distance from, a potential fire.

2.5.4 Monitors and alarms

Monitors and alarms shall be provided for installations described in Clause 2.5.1, located where an abnormal condition of a potentially hazardous nature is likely to occur.

Any such systems shall comply with the following requirements:

- (a) Continuously monitored low-temperature sensors or flammable-gas detection systems shall initiate an alarm at the plant site and at a constantly attended location if the plant site itself is not continuously attended. Flammable-gas detection systems shall initiate this alarm at not more than 25% of the lower explosive limit of the gas or vapour being monitored.
- (b) Fire detectors shall initiate an alarm at the plant site, and at a constantly attended location if the plant site itself is not continuously attended. In addition, if deemed necessary by an evaluation in accordance with Clause 7.2.5, fire detectors may activate appropriate portions of the emergency shutdown system.
- (c) Portable flammable-gas indicators shall be available.

2.6 LOCATIONS

2.6.1 General

Where the aggregate capacity of LNG storage exceeds 300 m³, the location of the tanks and associated equipment in relation to any aspect of the site shall be determined from a formal risk assessment in accordance with Clause 2.6.2. Otherwise the installation shall comply with Clause 2.6.3.

NOTE: Regulations or other site factors may require a risk assessment to be performed.

2.6.2 Risk assessment

A formal risk assessment shall comprise an analysis of the specific features of the site and the installed equipment. The analysis shall include at least the following:

- (a) A maximum design spillage, based on a 10 min escape period for any equipment rupture. This spill shall be modelled on the largest connection with the maximum design pressure as the initial condition.
- (b) The dispersion of vapour from the maximum design spillage.
- (c) Heat radiation levels resulting from the ignition of an escape, sufficient to cause the following maximum allowable received levels of radiation heat:
 - (i) Outdoor off-site areas for public use or assembly where the average daily congregation is 20 people or more, e.g. sports grounds, beaches, meeting or recreation areas: 5 kW/m².
 - (ii) Buildings of timber or similar combustible materials: 10 kW/m².
 - (iii) Unshielded storage of flammable liquids, other dangerous goods, LNG vessels, pressure vessels in any service, or the like: 10 kW/m².
 - (iv) Non-critical or fire-resistant structures: 10 kW/m².
 - (v) Streets, highways, and other roads: 20 kW/m².
- (d) Features specific to the particular installation, including the following:
 - (i) The location of equipment in relation to the surroundings, taking into account particularly any protected places, adjacent population densities, and possible interaction with materials on neighbouring sites.
 - (ii) The nature and dimension of any likely fire, as affected by tank type, compound area, potential spillage area, rollover of contents, or possible involvement of extraneous materials on site.
 - (iii) The type, quantity and location of sensors for the detection and control of fire, leakage or spillage of LNG, or potential fires in other processes or installations.
 - (iv) The design of the emergency shutdown system, the location of the sensors and remote actuators to initiate shutdown, and the extent of the equipment and processes protected by it, and the extent of any depressuring provisions.
 - (v) The means provided to protect equipment and structures from exposure to heat.
 - (vi) The firefighting equipment, and its purpose, capabilities, and limitations.
 - (vii) The extent of the training in emergency procedures and of the responsibilities of plant personnel.
 - (viii) The availability of external emergency services, their training, and their response time.

2.6.3 Tank location and spacing

Tanks that are not within the scope of Clause 2.6.2 shall be located in accordance with the distances shown in Table 2.1, with the following qualifications:

- (a) Any tank shall be at least 1.5 m from a boundary.
- (b) Tanks may be arranged in groups of up to six tanks separated in accordance with Table 2.1, Column 2. In such cases, the following requirements apply:
 - (i) The distance from one such group to another tank or group shall be not less than 15 m except that, where no tank in either group exceeds 2 m diameter, the distance may be reduced to 10 m minimum.

- (ii) Tanks shall not be stacked one above another.
 - (iii) The optimum alignment is for the longitudinal axis of horizontal tanks in a group to be parallel and directed away from any nearby storages of hazardous, flammable or combustible liquids or gases. Where another arrangement is unavoidable, i.e. where a tank is in line with the axis of another tank, the distance between the end of any tank and the end or shell of another tank shall be not less than 3 m or twice the diameter of the larger tank, whichever is the greater.
- (c) Where a number of inner vessels are enclosed within a single outer shell, the distance between any two such inner tanks may be reduced to 1 m, with the following requirements applying:
- (i) The outer shell shall be a vapour barrier.
 - (ii) The space within the outer shell shall contain an inert gas.
 - (iii) For all other purposes, the combination shall be treated as a single pressure tank of a capacity equal to the aggregate capacity of the contained inner tanks.

2.6.4 Liquefaction equipment

The separation distance between the perimeter of any liquefaction equipment and any storage, protected place, public place, or ignition source shall be that for a tank having a capacity equal to the maximum liquid content of the liquefaction unit.

2.6.5 Vaporizers

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

- (a) A vaporizer which incorporates an ignition source shall be located so as to comply with Clause 2.6.8.
- (b) The distance of a vaporizer from protected places and public places shall be not less than that required for the tank which it serves, except that where the associated storage exceeds 300 m³, Clause 2.6.2 shall apply.
- (c) Air intakes for any burners shall be located to avoid the induction of any likely leaked gas.

2.6.6 Changed site conditions

Where alterations on the installation site or adjoining property result in a breach of the requirements for separation distances, the tank or tanks affected shall be moved so as to restore compliance, or any affected tanks shall be taken out of service.

2.6.7 Storage of materials other than LNG

An LNG tank and any other dangerous goods or combustible liquids shall not be in the same compound. Where there is no compound, the separation between an LNG tank and any such storage shall be as follows:

- (a) Cryogenic liquids in tanks or vessels: in accordance in AS 1894.
- (b) Compressed gases in cylinders: 3 m.
- (c) LP Gas in tanks or cylinders: in accordance with AS/NZS 1596.
- (d) A tank, or package storage, or filling area, or filling point, for flammable liquids: 6 m.
- (e) The centre-line of the bund for any compound for flammable or combustible liquids: 3 m.
- (f) Except where liquid nitrogen is used as a sacrificial refrigerant the separation to the liquid nitrogen tank may be reduced to 1 m.

2.6.8 Ignition sources

An ignition source shall not fall within a Zone 0, 1, or 2 hazardous area, as defined in AS/NZS 60079.10.1 and illustrated in Appendix C of this Standard.

Where an opening into a building intersects a hazardous area, the whole of the interior of the building shall be taken to have assumed the same zone.

Where a pit, trench or duct has an opening into a hazardous area, the zone shall be determined as follows:

- (a) If the potential gas escape will be vapour only, an open trench or pit is unzoned, and an enclosed drain assumes the same zone as that which it intersects.
- (b) If the potential escape is liquefied natural gas, the duct, drain, pit, or the like becomes Zone 1 over its length, irrespective of whether it is open or closed.
- (c) The whole of the interior of any duct containing a pipe joint becomes the same zone as that for the vicinity of the joint.

2.6.9 Use of vapour barriers and firewalls

Separation distances may be measured in a horizontal plane around the end of any intervening vapour barrier or firewall complying with Clause 2.6.11 or Clause 2.6.12 provided that—

- (a) the top of the vapour barrier shall extend above the hazardous area;
- (b) the clearance between the vapour barrier and the tank shall comply with Clause 2.6.13(b); and
- (c) where the separation distance under consideration involves a protected place, the vapour barrier shall also be a firewall (see Clause 2.6.11).

2.6.10 Construction of vapour barriers

A vapour barrier shall comply with the following requirements:

- (a) The vapour barrier shall be impervious to gas over the whole of the area of the barrier around which a separation distance is to be measured.
- (b) The vapour barrier shall be made of material that is non-combustible and the construction shall be sufficiently durable to remain functional as a vapour barrier for the life of the installation.

2.6.11 Construction of firewalls

A firewall shall comply with the requirements for vapour barriers, and in addition shall have an FRL at least FRL 240/240/240.

2.6.12 Use of existing construction

Existing building walls or fences may be used as vapour barriers or firewalls provided that they comply with the appropriate requirements.

2.6.13 Ventilation and access

The installation site for storage shall comply with the following requirements for ventilation and access:

- (a) Storage tanks shall be in the open air outside buildings.
- (b) Nearby construction, fences, walls, vapour barriers or the like shall permit free access around and cross-ventilation for the tank.

Any construction that is not higher than the bottom of the tank shall not be treated as being a ventilation obstruction.

TABLE 2.1
LOCATION OF STORAGE TANKS

1	2	3
Capacity of the tank	Minimum distances from the tank to a public place, or a railway line	Minimum distance from the tank to protected place
m ³	m	m
5	5	8
8	6	10
10	7	11
15	8	14
20	9	15
50	10	17
100	11	20
200	12	25
300	15	30

NOTES:

- 1 Distances for intermediate tank sizes may be interpolated.
- 2 The boundary of adjacent private property is not considered to be a protected place. This implies that a separation distance may be measured across a boundary to the nearest protected place (if any) on an adjacent site. It should be borne in mind that Clause 2.6.6 imposes a condition, which is a potential penalty should the adjoining property be further developed.
- 3 The separation distance is determined individually for each tank, and is assessed on the basis of its own particular capacity, and not on any aggregation with the capacity of any adjacent tank.

2.7 POTENTIAL FLAME IMPINGEMENT

Any filling or withdrawal connection, pump, shear point, safety valve outlet, or any other feature that is a potential source of leakage and possible flame shall be located and directed to minimize the likelihood of flame impingement on LNG piping, components or tanks.

Aspects of design that should be determined include the following:

- (a) The location of pumps, and particularly the direction of any potential seal leakage, in relation to a tank.
- (b) The orientation of piping at any shear point so that any discharge is in a safe direction.
- (c) The orientation of piping at transfer connections.
- (d) The location and orientation of flanges or other mechanical joints.

2.8 ROAD AND RAIL TANKER TRANSFER INSTALLATIONS

2.8.1 Tank filling connection

The filling connection for a tank shall comply with the following requirements:

- (a) The filling connection shall be a remote connection.
- (b) All tanks over 20 m³ capacity shall be designed to permit filling into both the liquid and the vapour space.

2.8.2 Tanker-loading connection

A tanker-loading connection shall be a remote transfer connection.

2.8.3 Remote transfer connection

Remote transfer connection provisions for liquid, vapour, or vapour return service, for either filling or withdrawal, shall comply with the following requirements:

- (a) The appropriate valve system as specified in Clause 3.3.2 shall be provided at the tank.
- (b) An anchorage shall be provided for the remote filling point, of sufficient strength to ensure that the piping and valves between the anchorage and the tank will not be damaged before the drive-away protection fails or releases.
- (c) Drive-away protection complying with Clause 2.8.4 shall be provided between the point of connection and the anchorage, as close as possible to the anchorage.
- (d) The piping between the tank and the remote transfer connection shall be provided with a connection to a blow-down line arranged to discharge at a safe place. Control shall be by means of a valve and a flow restriction equivalent to an 8 mm orifice.
- (e) A non-return valve shall be located as close as practical to the anchorage. Where outflow is required, an emergency shutdown system with excess flow protection shall be provided.

2.8.4 Drive-away protection

A transfer connection shall be provided with shear points or the equivalent, designed in conjunction with the support to ensure that if the tanker is driven away without disconnecting, break-away can be relied on to occur at that shear point before valves or piping are damaged.

2.8.5 Emergency shutdown for transfer facilities

Where an LNG transfer facility is required to be provided with an emergency shutdown system as defined in Clause 2.5.1, the following requirements shall apply:

- (a) The system shall incorporate a shut-off valve that can be shut off by manual action, and will shut off automatically in the event of fire.
NOTE: Sensors may also be used to react to other fault conditions, e.g. leakage.
- (b) The fire-sensing provisions shall cause the valve to shut in the event of fire at the transfer connection and at the valve or valves.
- (c) The system shall incorporate at least two provisions for initiating valve closure from a position that is not at the valve. Remote initiating devices shall be located as follows:
 - (i) One shall be readily accessible from any transfer connection, and from a vehicle fuel dispenser. Another shall be located at least 5 m from a transfer connection.
 - (ii) At least one shall be located in a direction of ready egress from the installation, and at least one shall be protected from radiated heat by shielding or by distance.
 - (iii) The system shall require manual action to re-open the valves to resume operation.
- (d) Any emergency shutdown system for a liquid transfer system shall incorporate a provision to ensure that flow is shut off at the tanker side and the static side of the transfer hose at the same time.

- (e) Every actuating point for the emergency shutdown system, except the provision on the valve itself, shall be provided with a sign—
 - (i) marked **EMERGENCY STOP** in red letters at least 40 mm high;
 - (ii) having a white background; and
 - (iii) giving instructions on how to actuate the system, in red or dark lettering, at least 20 mm high.

2.8.6 Separation distances

Unless otherwise determined by a risk assessment, a transfer connection for road and rail tankers shall be located to afford at least the following separation distances:

- (a) *To a tank*—4.5 m.
- (b) *To a public place or protected places*—3 m.
- (c) *To an ignition source*—as required by AS/NZS 60079.10.1.

The arrangement of the installation shall permit compliance with requirements for tanker location during transfer (see Section 6).

2.9 PIPING, VALVES AND ACCESSORIES

2.9.1 General design

Piping, valves and accessories shall comply with AS 4041 or ASME B31.3. Particular attention shall be paid to the fire resistance of any gaskets that are located between a tank and an emergency shut-off valve.

2.9.2 Tank connections

Any joint in piping between the tank shell and the primary shut-off valve shall be welded, or screwed and seal-welded or brazed. A screwed joint may be used to connect a safety valve of 20 mm nominal size or less.

2.9.3 Piping joints

Pipe joints shall comply with the Standard nominated for the application. The following requirements also apply:

- (a) Where the nominal bore of the pipe exceeds 50 mm, screwed joints shall not be used unless unavoidable, e.g. for the mounting of essential auxiliary equipment having screwed connections.
- (b) Welded joints shall be used to the maximum possible extent.
- (c) Flexible connections shall not be used, unless unavoidable. Where used, they shall not comprise telescopic slip-type joints or packed glands, applied as a permanent connection.

2.9.4 Interconnected tanks

Where two or more tanks are so piped that liquid or vapour can pass from one to the other, the piping system shall be designed to ensure that no one tank can become liquid-full as the result of filling, operating, or temperature conditions.

2.9.5 Underground piping

Underground piping shall comply with AS 4041 or ASME B31.3, and its installation and any coating or cathodic protection system shall comply with AS 2832.1.

2.9.6 Liquid lines between valves

Where piping can be shut off between valves when liquid-full, that piping shall be provided with a hydrostatic pressure relief valve in accordance with the following requirements:

- (a) The setting shall not be higher than the maximum safe working pressure of the weakest pipe or component in the system being protected.
- (b) The discharge from the relief valve shall not terminate within a building, and shall not impinge on any tank, fitting, other equipment, or on the ground.

The relief valve should not be installed on the discharge side of a pump if the same degree of protection could be obtained on the inlet side.

2.9.7 Piping drain or bleed valves

Where a piping system is provided with a bleed valve whose only purpose is for venting a pipe during maintenance, a means for limiting the rate of discharge shall be provided. The design and location of the discharge provisions shall be such as to ensure that discharge is made safely.

NOTE: A valve or restriction equivalent to a 6 mm orifice would be a suitable means of limiting the rate of discharge.

2.9.8 Support of piping

All exposed aboveground piping shall be adequately supported. Particular attention shall be paid to the support or protection of piping that passes from the withdrawal point of a tank to the ground or to adjacent structures, to vulnerability to impact, to possible use as a hand-support, to movement and distortion due to temperature changes and differentials, and the like.

2.9.9 Cold-contact hazards

Human contact with cold piping shall be prevented by protective insulation wherever possible, otherwise by limiting access or by providing guards or protective clothing.

2.9.10 Piping within buildings

Liquefied natural gas shall not be piped into, through, or under a building.

2.9.11 Identification of pipes

Piping should be identified according to its contents where both liquid and vapour phase gas are present, or where some pipes on the installation carry materials other than LNG. The contents of each pipe shall be identified by printing, stencilling, or attaching a label at important locations, e.g. adjacent to connections.

If it is desired to use a colour code in addition to the above identification, it should comply with AS 1345.

The identification system used shall be consistent throughout the one installation.

2.9.12 Transfer hoses

Transfer hoses shall be suitable for the pressure and temperature conditions applicable during transfer, and shall be protected against external damage from impact and abrasion during normal handling.

2.9.13 Transfer hose coupling

The transfer hose coupling for road or rail transfer shall comply with an International Standard for LNG transfer connections such as ISO 12617; CGA LNG-30 or other industry standard. Preference should be given to dry-break style couplings.