

Australian Standard[®]

**The storage and handling of
non-flammable cryogenic and
refrigerated liquids**

This Australian Standard was prepared by Committee CH/9, Safe Handling of Chemicals. It was approved on behalf of the Council of Standards Australia on 18 July 1997 and published on 5 November 1997.

The following interests are represented on Committee CH/9:

Air Conditioning and Refrigeration Wholesalers Association
Australasian Railway Association
Australian Chemical Specialties Manufacturers Association
Australian Conservation Foundation
Australian Council of Trade Unions
Australian Fire Authorities Council
Australian Institute of Petroleum
Australian Paint Manufacturers Federation
Department for Industrial Affairs, S.A.
Department of Defence, Australia
Department of Minerals and Energy, W.A.
Environment Protection Authority of N.S.W.
Institution of Engineers, Australia
Melbourne Water
National Occupational Health and Safety Commission, Australia
Plastics and Chemicals Industry Association, Australia
Victorian WorkCover Authority
Work Health Authority N.T.
WorkCover New South Wales
Workplace Standards Authority, Tasmania

Additional interests participating in preparation of Standard:

Manufacturers, distributors and industrial users of cryogenic and refrigerated liquids

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This Standard was issued in draft form for comment as DR 96189.

AS 1894—1997

Australian Standard[®]

**The storage and handling of
non-flammable cryogenic and
refrigerated liquids**

Originated as AS 1894—1976.
Second edition 1997.

Incorporating:
Amdt 1—1999

PUBLISHED BY STANDARDS AUSTRALIA
(STANDARDS ASSOCIATION OF AUSTRALIA)
1 THE CRESCENT, HOMEBUSH, NSW 2140

ISBN 0 7327 1891 0

AVA Documents
Document Sharing Hub

PREFACE

This Standard was prepared by the Standards Australia/Standards New Zealand Committee CH/9, Safe Handling of Chemicals, to supersede AS 1894—1976, *Code of practice for the safe handling of cryogenic fluids*.

This Standard deals with non-flammable cryogenic and refrigerated liquids of Class 2.2 (with or without Subsidiary Risk of 5.1), as classified in the UN *Recommendations on the Transport of Dangerous Goods* and listed in the ADG Code.

The Standard has been revised in order to ensure its technical information is in accordance with international best practices, and the opportunity has been taken to arrange the document into a format consistent with other Australian Standards for the storage and handling of dangerous goods.

The revision process has led to some major changes in this new edition, which are as follows:

- (a) Separation distances have been comprehensively reviewed. Particular attention has been paid to the separation of potential sources of leakage, such as valves and connections, and to the properties of the cryogenic and refrigerated liquids being stored.
- (b) The Sections addressing operational and personnel safety, emergency management, fire protection and disposal have been aligned with the requirements specified in other Australian Standards for the storage and handling of dangerous goods.
- (c) A Section dealing with the storage and handling of non-flammable cryogenic or refrigerated liquids in portable dewars and portable pressure flasks has been developed.
- (d) The title has been changed to better reflect the contents of the Standard and align it with the range of other Australian Standards for the storage and handling of dangerous goods.

The series covering the storage and handling of dangerous goods presently comprises the following Standards:

AS

- 1940 The storage and handling of flammable and combustible liquids
- 2022 Anhydrous ammonia—Storage and handling (known as the SAA Anhydrous Ammonia Code)
- 2507 The storage and handling of pesticides
- 2714 The storage and handling of hazardous chemical materials—Class 5.2 substances (organic peroxides)
- 2927 The storage and handling of liquefied chlorine gas
- 3780 The storage and handling of corrosive substances
- 3961 Liquefied natural gas—Storage and handling
- 4081 The storage, handling and transport of liquid and liquefied polyfunctional isocyanates
- 4326 The storage and handling of oxidizing agents
- 4332 The storage and handling of gases in cylinders

AS/NZS

- 1596 Storage and handling of LP Gas
- 4452 The storage and handling of toxic substances

This Standard is a result of a consensus amongst Australian and New Zealand representatives on the Joint Committee that it be produced as an Australian Standard.

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

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

Notes that appear in the main text of this Standard are intended to provide information only.

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STANDARDS AUSTRALIA

Australian Standard

**The storage and handling of non-flammable
cryogenic and refrigerated liquids**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE This Standard sets out requirements and recommendations for the storage and handling of non-flammable cryogenic liquids at temperatures below -90°C and refrigerated liquids at or below -15°C , of Class 2.2, in quantities of at least 50 L water capacity and 50 kPa (gauge) working pressure, up to and including 200 000 L water capacity. It also provides guidelines for temporary installations.

Although carbon dioxide and nitrous oxide are not true cryogenic liquids, they are covered by this Standard. Refrigerant gases that have a halogenated hydrocarbon component are not intended to be covered by this Standard.

NOTES: The properties of low-temperature liquefiable gases covered by this Standard are outlined in Appendix A.

This Standard does not address the detailed design of vessels or equipment used for the production, transport and storage of cryogenic and refrigerated liquids, nor the precautions and equipment that might be necessary in large-scale production and processing plants.

NOTES:

- 1 Advice supplementary to that provided in this Standard might need to be sought from the supplier of the goods.
- 2 A discussion of the hazards presented by cryogenic and refrigerated liquids is provided in Appendix B.

The transport of cryogenic and refrigerated liquids is covered by the ADG Code. Requirements for road tankers for cryogenic liquids are addressed in AS 2809.6.

1.2 APPLICATION This Standard applies to the storage of non-flammable cryogenic and refrigerated liquids in pressure vessels that conform to AS 1210 or equivalent Standards. It also applies to the ancillary equipment associated with the installation.

This Standard applies in locations that are generally industrial or commercial in nature. In laboratories, the provisions of this Standard apply in addition to those of AS/NZS 2243.2 and AS 2243.10. In hospitals, the provisions of this Standard are in addition to those of AS 2896.

NOTES:

- 1 An installation can come under the regulatory control of several authorities having differing areas of responsibility, and an approval from one authority does not necessarily constitute an approval from the others.
- 2 Cognizance of the relevant requirements of the *Building Code of Australia* (BCA) is necessary for all matters relating to building works.

This Standard does not apply to home therapy, or to vessels of less than 50 L water capacity and less than 50 kPa (gauge); however, the safety precautions given in this Standard should be considered.

The requirements of this Standard apply in conjunction with, but do not take precedence over, any government regulations that apply in any area. Where it is found that compliance with the requirements of this Standard is not possible, the advice of the relevant regulatory authority should be sought.

1.3 NEW DESIGNS AND INNOVATIONS Any materials, designs, methods of assembly and procedures which do not comply with the specific requirements of this Standard or are not mentioned in it but which give performance and safety equivalent to those specified are not necessarily prohibited. Under such conditions the relevant regulatory authority may advise on the procedure for approval.

1.4 REFERENCED DOCUMENTS A list of documents referred to in this Standard is provided in Appendix C. Appendix C also includes a list of related documents.

1.5 DEFINITIONS For the purpose of this Standard the following definitions apply:

1.5.1 Ancillary equipment—pipelines, valves and all other equipment that is connected to the vessel and normally associated with the delivery of the contents in liquid or gaseous form as required.

1.5.2 Approved, approval—with the agreement of, acceptable to, and meeting the prescribed standards of the authority having jurisdiction.

1.5.3 Asphyxia—the condition that arises when the blood is deprived of an adequate supply of oxygen.

1.5.4 Asphyxiant—a gas or vapour which has no toxic properties but which, when present in sufficient concentrations, excludes oxygen and leads to asphyxia. Death can be almost immediate if all oxygen is excluded.

1.5.5 Storage vessel—a pressure vessel that is designed, constructed and protected in accordance with AS 1210, AS 2030.4 or AS 2030 Supplement 1, and has a water capacity of at least 50 L. A bulk storage vessel is one that complies with the above requirements and has a water capacity greater than 500 L.

1.5.6 Class—the number assigned to dangerous goods that exhibit a common single or most significant risk, determined in accordance with UN *Manual of Tests and Criteria* and listed in the ADG Code.

1.5.7 Combustible materials—materials of a type and quantity sufficient to constitute a significant heat-radiation hazard in the event of a fire in those materials.

1.5.8 Competent person—a person who is suitably qualified, adequately trained, and appropriately experienced for the type of work in which that person is engaged.

1.5.9 Cryogenic liquid—a liquid having a normal boiling point below -90°C at atmospheric pressure (101.3 kPa).

1.5.10 Cryogenic temperature—a temperature below -90°C .

1.5.11 Dangerous goods—substances and articles that—

- (a) satisfy the tests and criteria for determining whether they are dangerous goods as specified in the UN *Manual of Tests and Criteria* or the UN *Recommendations on the Transport of Dangerous Goods*, or are listed in the ADG Code; or
- (b) are determined to be dangerous goods by the competent authority.

1.5.12 Dewar flask—a portable, double-walled container, which is normally open-necked, free-venting and non-pressurized, and is used for storing liquefied gases at low temperature.

1.5.13 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 *Building Code of Australia* (BCA) for guidance.

1.5.14 Flammable—capable of being ignited and of burning.

1.5.15 Full gas volume—the total volume, which the gas in a nominally full vessel will occupy when expanded at 15°C and 101.325 kPa.

1.5.16 Ignition source—a source of energy sufficient to ignite a flammable atmosphere and which might include a naked flame, exposed incandescent material, an electrical welding arc, a mechanical or static spark, and electrical or mechanical equipment not approved for use in hazardous locations.

1.5.17 Inert—for the purposes of this Standard, the term ‘inert’ is defined as non-flammable and non-toxic.

1.5.18 Installation—all of those facilities on a site that are related to the storage or handling of cryogenic and refrigerated liquids.

1.5.19 Manifest—a list of the types, quantities and locations of the dangerous goods kept on the premises, intended to provide information for emergency services.

1.5.20 Material safety data sheet (MSDS)—a document that provides information on the identification, health hazards, precautions for use and safe handling of a specific chemical product, and which complies with NOHSC:2011.

1.5.21 May—implies the right to use discretion.

1.5.22 Opening (in a wall)—a break in a wall or superstructure which is permanently open or can be readily opened, e.g. a doorway, window or ventilator, and which permits the passage of gas through it and into neighbouring rooms or areas.

1.5.23 Pressure flask—a double-walled, vacuum-insulated container for the storage of liquefied gases of at least 50 L water capacity and at least 50 kPa (g) working pressure.

1.5.24 Refrigerated liquid—for the purpose of this Standard, a liquid of Class 2.2 that is stored at, and has a normal boiling point, between –15° and –90°C at atmospheric pressure (101.3 kPa).

1.5.25 Regulatory authority—the statutory authority responsible for administering the control of the storage, transport and use of Class 2.2 dangerous goods.

NOTE: More than one authority can be involved in relation to such matters.

1.5.26 Screen wall—a masonry wall that provides separation between the installation and places listed in Tables 4.1 and 5.1 and has—

- (a) an FRL of at least 120/120/120; or
- (b) an FRL of at least 240/240/240 where providing separation from liquid oxygen or liquid nitrous oxide.

NOTE: The appropriate Australian Standard for any other dangerous goods being stored may specify a greater FRL.

1.5.27 Self-contained breathing apparatus (SCBA)—a portable respirator which supplies oxygen, air or other respirable gas from a source carried by the user.

1.5.28 Separation—the isolation of dangerous goods stores from protected places, boundaries, other dangerous goods stores, filling or decanting points or other places listed in Tables 4.1 and 5.1.

1.5.29 Shall—indicates that a statement is mandatory.

1.5.30 Should—indicates a recommendation.

1.5.31 Static electricity—electrical charging of materials by such processes as physical contact, separation, electrostatic induction and the deposition of charged particles.

NOTE: Recommendations for the safe control of electrostatic charges are given in AS/NZS 1020.

1.5.32 Vapour barrier—a wall or other barrier of such material and construction so as to prevent the gas penetrating the wall and reaching any other place listed in Tables 4.1 and 5.1.

A vapour barrier need not be of masonry, e.g. it may be of corrugated iron sheet, where it provides separation from—

- (a) a road, boundary or car park;
- (b) openings of walls in adjacent buildings or structures;
- (c) areas where personnel congregate, e.g. lunch rooms or change rooms;
- (d) places of public assembly;
- (e) areas of buildings occupied by patients who are confined to bed;
- (f) electrical substations or transformers; or
- (g) openings to underground drains.

1.5.33 Water capacity—the internal volumetric capacity of a vessel.

NOTE: In this Standard, water capacity is expressed in litres.

1.6 SECURITY OF STORAGE AREAS All storage areas shall be appropriately secured against access by unauthorized persons.

SECTION 2 PORTABLE DEWARs AND PORTABLE PRESSURE FLASKS

2.1 SCOPE OF SECTION This Section sets out requirements and recommendations for the storage and handling of Class 2.2 cryogenic or refrigerated liquids in portable dewars and portable pressure flasks.

2.2 PRECAUTIONS FOR THE STORAGE AND HANDLING OF PORTABLE DEWARs AND PORTABLE PRESSURE FLASKS

2.2.1 General Only flasks that have been specifically designed for cryogenic and refrigerated liquids shall be used. Special care shall be taken to avoid bumping and jarring when using and handling the flasks (see Clause 2.2.3).

NOTE: Containers for the transport and storage of cryogenic and refrigerated liquids are designed to withstand the extremely low temperatures and rapid temperature changes encountered in use. Such containers are fragile due to the low pressure rating of the outer vessel and the minimal cross-section of the inner vessel supports.

2.2.2 Formation of frozen plug If a plug of frozen material forms beneath the lowest vent in a flask containing cryogenic liquid, it is unlikely that the vessel will be able to withstand the pressure that can build up. The formation of a frozen plug can be indicated by—

- (a) a disconnected transfer line which is known to have been connected;
- (b) an inability to insert the transfer line;
- (c) a lack of detectable boil-off; or
- (d) ice formation around the neck of the flask.

The flask should be disconnected and personnel evacuated. Any attempt to remove the plug shall only be made by a person skilled in the procedure.

2.2.3 Handling The following precautions shall be observed:

- (a) Do not drop the container.
- (b) Surround any external pipework and control valves with a structure to prevent damage during handling. Where necessary, provide an additional structure to prevent damage to the outer vessel during handling.
- (c) Lift only at designated slinging points or at specifically provided tie pockets.
- (d) ‘Tie down’ the container at designated points. Do not ‘tie down’ around the outer vessel.
- (e) Only containers that have been specifically designed for transportation shall be used.
- (f) Only trolleys that are specifically designed for moving these containers shall be used.
- (g) Cryogenic or refrigerated liquids that have a Subsidiary Risk of Class 5.1 shall not be stored or transported in open-necked dewar flasks.
- (h) Any cap supplied with the flask shall be—
 - (i) fitted when the contents of the flask are not in use; and
 - (ii) sufficiently loose-fitting so as to prevent pressure build-up.

SECTION 3 STORAGE VESSELS AND ANCILLARY EQUIPMENT

3.1 SCOPE OF SECTION This Section sets out requirements and recommendations for the location, marking, installing and commissioning of storage vessels and ancillary equipment for non-flammable cryogenic or refrigerated liquids.

3.2 APPLICATION This Section applies to storage vessels that have a water capacity of at least 50 L.

NOTE: For storage vessels of up to 50 000 L water capacity, reference may also be made to the AIGMA *Specification for cryogenic vacuum insulated storage vessels up to a maximum of 50 000 litre storage with the maximum allowable pressure up to 1900 kPa (gauge)*.

3.3 DESIGN REQUIREMENTS FOR STORAGE VESSELS Storage vessels shall be suitably designed for the function they are to perform (see also Clause 1.5.5).

If the service for which the vessel was designed is to be changed, the supplier of the cryogenic or refrigerated liquid shall be consulted before any such change is made.

NOTE: Attention is also drawn to any requirements of the relevant regulatory authority.

3.4 FOUNDATIONS AND SUPPORTS FOR STORAGE VESSELS The supporting structure and foundations shall be designed in accordance with the appropriate storage vessel design standard and the following requirements:

- (a) The design load shall be the total mass when the storage vessel is full of either water or product, whichever is the more dense.
- (b) Any storage vessel located in an area that is subject to flooding shall be anchored.
- (c) Seismic loadings shall be taken into account for any storage vessel whose water capacity exceeds 100 m³ in a Zone A or Zone 2 location, as defined in AS 1170.4.
- (d) Wind loadings shall be determined in accordance with AS 1170.2.

3.5 LOCATION OF STORAGE VESSELS

3.5.1 General The installation shall be located so as to minimize the risk to personnel, local population and property. Consideration shall also be given to the location of any potentially hazardous processes in the vicinity which might jeopardize the integrity of the storage, or on which the storage might impact. The requirements of the relevant regulatory authority shall also be met.

The location chosen for the installation shall be acceptable to both the gas supplier and the user of the cryogenic or refrigerated liquids and shall be such that it is readily retrievable or accessible for maintenance purposes. The requirements of Clause 7.2.1 shall also be observed.

Vessels containing liquid oxygen or liquefied nitrous oxide shall be located in accordance with the requirements of Section 4.

Vessels containing inert cryogenic or refrigerated liquids (see Clause 1.5.17) shall be located in accordance with the requirements of Section 5.

3.5.2 Protection against vehicular damage Storage vessels shall be protected against accidental damage from vehicles and forklift trucks by a guardrail or traffic bollards. Where a guardrail is installed, it shall be of heavy construction and installed so as to provide a clear floor area of at least 1 m all around the vessel.

Filling points shall be similarly protected.

NOTE: Suitable forms of impact protection are described and illustrated in Appendix D.

3.5.3 Outdoor installations

3.5.3.1 Level and slope Where storage vessels are to be installed on a slope, they shall be located so as to direct—

- (a) any spillage of hazardous materials, e.g. oils or flammable liquids, away from the installation; and
- (b) any spillage of cryogenic or refrigerated liquid away from locations where people are at risk, or other hazardous installations.

3.5.3.2 Service pipelines In order to avoid damage from accidental liquid spillage, bulk storage vessels and their pipelines shall be located so as to avoid other service pipelines, or be otherwise protected.

3.5.3.3 Raised installations Where storage vessels are required to be installed at high level, they shall be placed on supports, and arranged and designed with sufficient allowance to prevent accidental spillage of liquid on to adjacent structures and installations.

3.5.3.4 Protection against electrical hazards Protection against lightning is not normally required, but may be necessary in order to comply with local conditions or site regulations. Any necessary lightning protection should be installed in accordance with AS 1768.

NOTE: AS/NZS 1020 may also provide advice.

3.5.4 Indoor installations for inert cryogenic and refrigerated liquids

3.5.4.1 Location Internal siting shall only be considered after exhaustive investigation has shown that there is no suitable outdoor location. If this is the case, the vessel shall be placed on a level floor, preferably above ground level, as far away from normal work locations as is practicable. The provisions of Clauses 3.5.4.2, 3.5.4.3, 3.5.4.4 shall also be met.

Oxidizing fluids, e.g. liquid oxygen and liquefied nitrous oxide, shall not be stored indoors.

3.5.4.2 Ventilation Areas where cryogenic or refrigerated liquids are stored and or used shall be ventilated to prevent the accumulation of gas or vapour which could evaporate from the liquid.

The vessel's location shall be adequately ventilated so as to disperse the gas or vapour evaporating from any liquid spill without reducing the oxygen content of the surrounding air below 18%. This shall be provided by one of the following:

- (a) Siting the vessel against an external wall and incorporating into that wall a wire mesh, lattice or louvred opening equivalent in size to the width of the vessel being installed, and of a height from floor level to the vessel fill point. The opening shall not incorporate any means of being sealed, nor allow discharge to areas of public congregation or into any basements, pits or trenches.
- (b) Providing natural cross-ventilation by means of permanent openings of not less than 10 m² inlet and 10 m² outlet per 1000 m³ of vessel full gas volume, in close proximity to the vessel.
- (c) Providing continuous forced exhaust ventilation of a capacity not less than 10 m³/min per 1000 m³ of vessel full gas volume.

NOTE: Reference should be made to AS 1668.2 for requirements for mechanical ventilation systems.

(d) The total free space of the building shall be sufficient to ensure that the oxygen content in the atmosphere will not be reduced below 18% in the event of total evaporation of entire vessel contents. Based on the assumptions that—

- (i) the initial oxygen content is 20%; and
- (ii) the inert gas will displace an equivalent volume of air from the building (making no allowance for ventilation);

the total free space air volume in the building shall be at least 10 times the total full gas volume of the contents of the vessel.

Where the above ventilation requirements cannot be met, the space in which the vessel is kept shall be well ventilated prior to entry (see Clause 6.3.3).

Where the vessel is located in a confined space, AS 2865 shall be referred to.

NOTES:

- 1 Evaporating cryogenic or refrigerated liquids generate large amounts of vapour and gas. Gas volume ratios are given in Appendix A.
- 2 See Appendix E for background information on ventilation.
- 3 Carbon dioxide is heavier than air. Where carbon dioxide is stored, the atmosphere should be tested at ground level prior to entry (see also Clause 5.6).

3.5.4.3 Vents and relief valves Pressurized vessels for cryogenic or refrigerated liquids which are located inside a building that does not meet the ventilation requirements of Clause 3.5.4.2 shall have any vents or relief valves piped to an external atmosphere or to an external recovery system.

3.5.4.4 Mechanical ventilation When processes that generate large amounts of gas (such as food freezing, rubber deflashing, cold grinding and shrink fitting) are conducted indoors, the gas produced shall be vented by mechanical means into the atmosphere away from areas where people work or congregate, in order to ensure an acceptable atmosphere for human occupation. To prevent icing-up of the mechanical ventilation system, the exhaust gas should be mixed with ambient air or heated to a temperature above 0°C.

NOTE: AS 1668.2 should also be referred to.

3.6 IDENTIFICATION OF PRODUCT AND EQUIPMENT Storage vessels and equipment used for cryogenic and refrigerated liquids shall be clearly marked to show the liquid for which the vessel or equipment is designed and used. Marking shall be in accordance with AS 1319 and the *Worksafe Australia Guidance note for placarding stores for dangerous goods and specified hazardous substances*.

NOTE: The format of a typical placard is illustrated in Appendix F.

3.7 VALVES Valves for use in a cryogenic or refrigerated liquid system shall be selected for their suitability at cryogenic temperatures. The use of extended spindle valves is recommended to prevent seizure as a result of freezing or icing of the gland caused by the ingress of external moisture.

Colour-coding or marking of valves shall be in accordance with Table 3.1.

A supply of water shall be available at all times for thawing frozen valves.

3.8 RELIEF VALVES AND VENTS All vents and relief valves on storage vessels and pipelines shall discharge to a safe open place. They shall not impinge on any personnel, buildings, structural steelwork, airconditioning intakes or combustible materials.

Vents and relief valves on liquid oxygen systems shall be located so that their discharge cannot mix with that from any vents on systems for flammable gases or liquids.

All pressure relief devices shall be oriented so as to prevent the accumulation of water, which can result in their incorrect operation.

TABLE 3.1
VALVE COLOURS AND FUNCTIONS

Valve colour	Intended function
White	Gas
Black	Liquid
Green	Customer supply
Blue	Instrument valving
Red	Venting
Yellow	Pressure building and vapour return
Orange	Safety circuit changeover

NOTE: Reference should be made to AS 2700. Practical colour equivalents noted therein may also be used.

3.9 TRANSFER AREA

3.9.1 Location The transfer area shall be adjacent to the fill coupling of the installation and shall be positioned in such a way that, in an emergency, the tanker has a means of quick, direct and unobstructed exit. Such an area shall also be —

- (a) a designated ‘No Parking’ area on delivery days; and
- (b) level.

A road tanker, when in position for filling from or discharging to an installation, shall be—

- (i) in the open air;
- (ii) free of any enclosure from which the escape of liquid or heavy vapour is restricted; and
- (iii) provided with a positive mechanical means of preventing tow-away accidents, e.g. by the use of anti-tow-away devices or braking locks.

Tankers should have easy access to and from the installation at all times.

3.9.2 Standing on public property The transfer of liquid with the tanker standing on public property should be avoided. Where this cannot be avoided, the hazard area shall be clearly defined by using suitable warning signs, during the transfer operation. Access to this area during the transfer shall be strictly controlled.

3.9.3 Filling point An outdoor filling point shall be provided. It shall be located so as to enable connection with the filling tanker with the minimum practical single length of flexible hose (having no joints). The filling point shall also comply with the following requirements:

- (a) Remote filling points should be avoided wherever possible. Where there is no alternative, repeater vessel fill controls and instrumentation, which are essential to ensure safe filling, shall be installed at the remote fill point.
- (b) The storage vessel’s controls and instrumentation shall be clearly visible from the filling point.

3.9.4 Special requirements for liquid oxygen and liquefied nitrous oxide For liquid oxygen or liquefied nitrous oxide installations, the transfer area shall also conform with the requirements of Clause 4.4.

3.10 PIPES, HOSES AND COUPLINGS

3.10.1 General Pipes, hoses and couplings shall be selected for their suitability for the service temperature and pressure, and the particular liquid being kept.

3.10.2 Pipelines Pipelines shall be designed in accordance with AS 4041 and shall be able to cope with thermal contraction and expansion. Any section of pipework that can cause fluid entrapment and can be closed off at each end shall be fitted with a pressure relief system. Pipelines shall be labelled in accordance with AS 1319.

3.10.3 Hoses and couplings Hoses shall be stored so as to prevent contamination from oil, water or dirt. Couplings shall be loosely capped when not in use. Couplings shall not be interchangeable between liquids where contamination can create a hazard, and shall be clearly marked with their intended use.

3.11 INSTRUMENTS AND VALVES

3.11.1 Gauges All pressure gauges used for service with cryogenic or refrigerated liquids shall be of the 'safety pattern' type specified for use with high pressure gas in AS 1349.

3.11.2 Cleanliness After any maintenance, all equipment and parts for use with oxidizing gases shall be cleaned for oxygen service before being returned to use (see also Clause 4.7).

New parts shall be certified by the manufacturer, sealed in heavy polythene bags, and labelled 'Cleaned for oxygen service—use no oil'.

3.12 COMMISSIONING AND INSTALLATION Prior to the tank's first fill, the inner vessel of the tank shall be validated by a competent person to ensure that—

- (a) it is fit for its purpose for a defined period; and
- (b) the pressure system has an appropriate written scheme of examination.

The installer or commissioner of the supply system shall ensure that—

- (i) the appropriate pressure and leak tests have been carried out and documented;
- (ii) the installation conforms to the process and instrumentation diagrams;
- (iii) any backfeed from the system into the tank, e.g. from high-pressure gas cylinders, is not possible;
- (iv) liquid or gas cannot become trapped in any part of the system not protected by relief devices or reach any part of the system not designed for low temperature use;
- (v) the correct safety devices are fitted; and
- (vi) all necessary identification labels and warning signs are clearly displayed and that they are correct for the product being stored.

3.13 IN-SERVICE INSPECTION AND MAINTENANCE Vessels and their associated equipment shall be inspected in accordance with AS 3788 and maintained in accordance with AS 3873.

3.14 DECOMMISSIONING Where a vessel is taken out of service (e.g. for storage, change of service, repair, maintenance, scrapping, and similar), it shall be emptied, purged as necessary and depressurized by the supplier.

3.15 RE-EVALUATION In addition to the requirements for examination and maintenance, the vessel shall be periodically endorsed, by a competent person, as fit for continued service.

SECTION 4 SPECIAL REQUIREMENTS FOR LIQUID OXYGEN AND LIQUEFIED NITROUS OXIDE

4.1 SCOPE OF SECTION This Section sets out additional requirements for the storage and handling of liquid oxygen and liquefied nitrous oxide.

4.2 HAZARDS

4.2.1 Hazards of oxygen and nitrous oxide The special hazards associated with liquid oxygen and liquefied nitrous oxide are related to their vigorous support of combustion. Very high concentrations of oxygen support violent combustion, even of metals. Liquid oxygen and liquefied nitrous oxide in association with organic materials, especially when they are in a finely divided form, can create a risk of explosion and in some instances can detonate.

All of the precautions applicable to liquid oxygen also apply to liquefied nitrous oxide.

4.2.2 Additional hazards of liquefied nitrous oxide A further hazard of nitrous oxide is the creation of an oxygen-deficient atmosphere, owing to the displacement of oxygen by gas evaporating from the liquid. Inhalation of small amounts of nitrous oxide can produce euphoria, while large doses mixed with air or oxygen can induce anaesthesia. Very large doses can lead to asphyxiation.

NOTE: Appendix G outlines the symptoms of and treatment for asphyxia.

4.3 LOCATION OF STORAGE VESSELS FOR LIQUID OXYGEN AND LIQUEFIED NITROUS OXIDE

4.3.1 General Storage vessels for liquid oxygen or liquefied nitrous oxide shall be located in accordance with Figure 4.1 and Table 4.1. The required separation distances may be achieved by using a protective enclosure, such as that shown in Figure 4.2.

Storage vessels shall be on a non-combustible surface.

4.3.2 Separation from flammable and combustible liquids and flammable gases Storage vessels for liquid oxygen or liquefied nitrous oxide shall be separated from stores of flammable or combustible liquids or flammable gases in accordance with Table 4.2.

A screen wall may be used to achieve separation between storage vessels for liquid oxygen or liquefied nitrous oxide and stores of flammable or combustible liquids or flammable gases, as shown in Figure 4.3. Where a screen wall is used, the separation distances given in Group II, Item 5 of Table 4.1 apply.

4.4 TRANSFER AREA For liquid oxygen and liquefied nitrous oxide installations, there shall be a hard-standing area of non-porous concrete of at least 2.5 m × 2.5 m on which the tanker's pipework and couplings can stand. This area shall be kept clean and oil-free.

Materials used in expansion joints shall be suitable for use with liquid oxygen.

NOTES:

- 1 Since no concrete jointing material is totally compatible with oxygen, the design of the hard-standing area should avoid joints within 1 m of the hose couplings.
- 2 Asphalt or bitumen paving, or paving of loose pebbles which can cause sparks in movement, are not acceptable.

4.5 PERSONAL PROTECTION

4.5.1 Clothing Overalls that provide total cover shall be worn. Clothing shall be made from natural fibres and designed to minimize gas entrapment. All clothing shall be clean and oil-free. Trousers shall not have cuffs.

4.5.2 Prevention of fire and explosion Ignition sources shall not be used near storage vessels or equipment unless covered by a work permit (see Clauses 6.7.2 and 6.7.3).

4.5.3 Smoking and ignition sources Personnel shall not be permitted to smoke within 5 m of liquid oxygen or nitrous oxide vessels or equipment, and shall be warned not to smoke or approach any source of ignition for at least 5 min after working with oxygen equipment.

4.5.4 Entry into oxygen-enriched atmosphere Personnel shall not be permitted to enter an oxygen-enriched atmosphere. If entry is essential in an emergency, thorough soaking of clothing with water prior to entry will reduce the fire hazard.

NOTE: Further guidance may be obtained from AS 2865.

4.6 TOOLS All tools shall be well-maintained and kept clean and oil-free.

4.7 EQUIPMENT When selecting equipment for oxygen and nitrous oxide service, e.g. valves and pumps, the advice of the equipment manufacturer and gas supplier shall be obtained as to its suitability for this service. Vacuum pumps containing organic materials shall not be used for pumping oxygen or nitrous oxide.

4.8 CLEANING Equipment shall be cleaned and degreased only with solvents or solutions which have been recommended by the gas supplier. Flammable solvents shall not be used.

Appropriate personal protective equipment shall be used when handling cleaning agents and equipment.

Clean equipment which is not to be used immediately shall be stored in polyethylene bags. The bags should be hermetically sealed and labelled. No preservative shall be applied prior to storage.

NOTE: Documents available from gas suppliers also provide advice. In particular, CGA G-4.01, IGC 33/86/E and BS 6869 are recommended.

4.9 MATERIALS Particular care should be taken when selecting materials for use with oxygen and nitrous oxide. The advice of gas suppliers and equipment manufacturers shall be sought.

All ferrous metals can be ignited and burn fiercely in the presence of oxygen. This can also apply to stainless steels, but to a lesser degree because of their higher ignition temperature.

Plastics, natural and synthetic rubbers, jointings and lubricants can burn fiercely in the presence of oxygen. The use of such materials shall be avoided.

4.10 ELECTRICAL EQUIPMENT Care should be taken in the selection of electrical equipment for service where liquid oxygen and liquefied nitrous oxide are kept. The supplier shall be consulted regarding appropriateness of the equipment.

Electrical equipment that is necessary for the installation shall have a rating of not less than IP54 in accordance with AS 1939.

NOTE: Flame-proof and explosion-proof equipment is not essential as oxygen and nitrous oxide are not flammable.

4.11 LUBRICANTS Conventional lubricants such as oil and grease shall not be used. The equipment suppliers' advice shall be obtained and strictly observed.