

Australian/New Zealand Standard™

The storage and handling of liquefied chlorine gas



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The following interests are represented on Committee CH-009:

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Air Conditioning and Refrigeration Wholesalers Association
Australasian Fire Authorities Council
Australian Chemical Specialties Manufacturers Association
Australian Institute of Petroleum
Australian Paint Manufacturers Federation
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National Occupational Health & Safety Commission, Australia
The New Zealand Chemical Industry Council
New Zealand Fire Service
Plastics and Chemicals Industries Association, Australia
Tranz Rail, New Zealand
Victorian WorkCover Authority
WorkCover New South Wales

Additional interests participating in the preparation of this Standard:

Australian Industrial Gas Manufacturers Association
Water Corporation Western Australia
Water authorities and corporations
Manufacturers, suppliers and industrial users of chlorine
Manufacturers and suppliers of equipment for use with chlorine

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Australian/New Zealand Standard™

The storage and handling of liquefied chlorine gas

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PREFACE

This Standard was prepared by Standards Australia/Standards New Zealand Committee CH-009, Safe Handling of Chemicals, to supersede AS 2927—1987, *The storage and handling of liquefied chlorine gas*.

This Standard incorporates Amendment No. 1 (November 2001). The change required by the Amendment is indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to promote the safety of persons and property where chlorine is stored or handled in its gaseous or liquefied forms, by providing requirements and recommendations that are based on industry best practices.

This edition has been reformatted to improve clarity and to align with the other published Standards for the storage and handling of dangerous goods. Attention has been paid to better alignment with the requirements of the various state, territory and national regulatory authorities and emergency services, as well as the various publications of the National Occupational Health and Safety Commission (NOHSC).

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

AS

1894	The storage and handling of non-flammable cryogenic and refrigerated liquids
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 agricultural and veterinary chemicals
2714	The storage and handling of hazardous chemical materials—Class 5.2 substances (organic peroxides)
3780	The storage and handling of corrosive substances
3846	The handling and transport of dangerous cargoes in port areas
3961	Liquefied natural gas—Storage and handling
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
3833	The storage and handling of mixed classes of dangerous goods in packages and intermediate bulk containers
4081	The storage and handling of liquid and liquefied polyfunctional isocyanates
4452	The storage and handling of toxic substances
4681	The storage and handling of Class 9 (miscellaneous) dangerous goods and articles

Australian and New Zealand references are separated by a slash (/).

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

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

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

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**The storage and handling of liquefied chlorine gas**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out requirements and recommendations for the safe storage and handling of liquefied chlorine gas. It also provides requirements and recommendations for vaporisers, chlorinators and other parts of systems in which chlorine is reticulated and distributed.

NOTES:

- 1 Physical and chemical data for chlorine is provided in Appendix A.
- 2 The hazardous properties of chlorine are discussed in Appendix B.

For the purposes of this Standard, quantities are expressed in kilograms (kg).

1.2 APPLICATION

The requirements of this Standard apply in conjunction with, but do not take precedence over, any government regulations that apply in any area.

NOTES:

- 1 In Australia, chlorine is classified as a workplace hazardous substance by NOHSC: 1008 and listed in NOHSC: 10005. As such, it is subject to the legislative requirements relating to workplace hazardous substances.
- 2 An installation may come under the regulatory control of several authorities, and approval from one does not necessarily constitute an approval from the others.
- 3 The relevant requirements of the *Building Code of Australia* (BCA)/*New Zealand Building Code* (NZBC) apply to all matters relating to building works.

This Standard does not apply to—

- (a) the manufacture of chlorine gas;
- (b) the chlorination of swimming pools by means of powders or liquids, e.g. calcium hypochlorite, isocyanurates or sodium hypochlorite solution.
- (c) the transport of liquefied chlorine gas, which is covered by other rules and codes, e.g. the ADG Code/NZS 5433;
- (d) the handling and transport of chlorine in port areas which, in Australia, is covered by AS 3846; or
- (e) the end use of chlorine gas.

1.3 REFERENCED DOCUMENTS

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

1.4 NEW DESIGNS AND INNOVATIONS

Any materials, designs, methods of assembly and procedures that are alternative to the requirements of this Standard are not necessarily prohibited if equivalent performance and safety can be demonstrated, e.g. by a formal risk assessment as described in AS/NZS 4360.

1.5 DEFINITIONS

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

1.5.1 Authorized

Authorized by the legal occupier of the installation.

1.5.2 Canister respirator (filtration type escape respirator)

A respiratory device incorporating filters which remove certain particles and gases or vapours from the air inhaled by the wearer for a limited period during escape from a respiratory hazard.

1.5.3 Chlorinator

Equipment that regulates the flow of chlorine gas into the user system, e.g. swimming pool, sewage effluent.

1.5.4 Chlorine

Elemental chlorine in its gaseous or liquid form.

1.5.5 Container

Any thing in which the chlorine is wholly or partly contained, including cylinders, drums, road tank vehicles and tanks.

1.5.6 Cylinder

A rigid packaging which is designed in accordance with AS 2030.1 as a portable pressure vessel for the storage of chlorine, and has only one cylinder valve, at one end, used for the withdrawal of chlorine gas.

1.5.7 Dedicated store

An area that is used solely for the storage of chlorine containers and their associated equipment.

1.5.8 Drum

A cylindrical steel container having a water capacity of 500-1000 L and which can be fitted into a protective cradle for storage and transport.

NOTES:

- 1 Drums are designed for either gas or liquid withdrawal and are not fitted with pressure relief devices.
- 2 Drums have two valves which, when vertically aligned above one another, permit gas to be drawn off from the upper valve and liquid chlorine to be drawn off from the lower valve.
- 3 In Australia, the nominal capacity of a drum is 920 kg (800 L) of liquefied chlorine.

1.5.9 Exposure standard

An airborne concentration of a particular substance in the person's breathing zone, exposure to which, according to current knowledge, should not cause adverse health effects or undue discomfort to nearly all persons. The exposure standard can take one of three forms, time-weighted average (TWA), short-term exposure limit (STEL) or peak exposure limit.

The following terms are used when calculating levels of atmospheric contaminants:

- (a) *Time-weighted average (TWA)* The average airborne concentration of a particular substance when calculated over a normal eight-hour working day, for a five-day working week.
- (b) *Short-term exposure limit (STEL)* A 15-minute TWA exposure which should not be exceeded at any time during a working day, even if the eight-hour TWA average is within the TWA exposure standard. Exposure at the STEL should not be longer than 15 minutes and should not be repeated more than four times a day. There should be at least 60 minutes between successive exposures at the STEL.
- (c) *Peak* A maximum or peak airborne concentration of a particular substance determined over the shortest analytically practicable period of time, which does not exceed 15 minutes.

NOTE: For further information, refer to NOHSC:1003.

1.5.10 Fire-resistance level (FRL)/fire resistance rating (FRR)

The grading period, in minutes, determined in accordance with AS 1530.4 (NZS/AS 1530.4)—

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

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

NOTE: Where an FRL/FRR is required, reference should be made to the *Building Code of Australia* (BCA)/*New Zealand Building Code* (NZBC) for guidance.

1.5.11 Informative appendix

Describes material which does not form an integral part of the Standard but provides additional information and which, for convenience, is placed after the body of the Standard.

1.5.12 Installation

All of those facilities on a site that are related to the storage, handling and use of chlorine.

1.5.13 Material safety data sheet (MSDS)

A document that provides information on the identification, health hazards, precautions for use and the safe handling of a specific chemical product and which complies with, in Australia NOHSC: 2011 or, in New Zealand, the *OSH Guidelines for the preparation of material safety data sheets*.

1.5.14 May

Indicates the existence of an option.

1.5.15 Nominal effective life (of SCBA)

The time for which SCBA (see Clause 1.5.27) has been designed to deliver a specified rate of life-supporting gases to the wearer under normal conditions of use, as determined in accordance with AS/NZS 1716.

1.5.16 Non-combustible

Material that does not support combustion or is deemed to be non-combustible when tested in accordance with AS 1530.1 (NZS/AS 1530.1).

1.5.17 Normative appendix

Describes material which is an integral part of the Standard but which, for convenience, is placed after the body of the Standard.

1.5.18 Opening (in a wall)

In a wall or structure, a break that is permanently open or may readily be opened, e.g. a doorway, window, or vent, and through which chlorine can pass into neighbouring rooms or areas.

1.5.19 Piping

An assembly of pipes, pipe fittings, valves and pipe accessories including associated bolting, gaskets, and pressure-retaining parts, or other components normally considered to be a part of piping.

1.5.20 Placard

Includes—

- (a) a label fixed to a bulk container, freight container or vehicle;
- (b) a label stencilled onto or printed on a bulk container, freight container or vehicle; or
- (c) an Emergency Information Panel fixed or placed in a frame that is fixed to a bulk container, freight container or vehicle;
- (d) an outer warning placard at the entrance to premises; and
- (e) composite warning placards for package stores.

1.5.21 Protected places

These are deemed to include—

- (a) a dwelling, place of worship, public building, school or college, childcare facility, hospital, theatre, or any building or open area in which people are accustomed to assemble, whether within or outside the property boundary of the installation;
- (b) a factory, workshop, office, store, warehouse, shop, or building where people who are not associated with the operation of the chlorine installation are employed;
- (c) a ship lying at permanent berthing facilities; or
- (d) any storage facility for dangerous goods that exceeds minor storage quantities and is outside the property boundary of the installation.

1.5.22 Public place

Any place other than private property, open to the public, which the public has a right to use and which includes a public road. Private car parking areas are not considered to be public places.

NOTE: In New Zealand, a 'public road' is a 'road'.

1.5.23 Regulatory authority

The statutory authority responsible for the administration of control of the storage, transport and use of chlorine.

1.5.24 Restricted area

An area to which access is available only to persons authorized by the occupier.

1.5.25 Road tank vehicle

A truck, trailer or semitrailer, or unit in a road train, incorporating a tank, or having a tank or tanks mounted thereon, either permanently or temporarily (see AS 2809 series).

1.5.26 Secured area

Premises that are—

- (a) surrounded by a chain wire fence conforming to AS 1725 and at least 2 m high; and
- (b) under surveillance at those times when the gates are not locked.

1.5.27 Self-contained breathing apparatus (SCBA)

A portable respirator which supplies air from a source carried by the user.

1.5.28 Separation

The isolation of a chlorine store from protected places, public places, boundaries or other dangerous goods stores.

1.5.29 Shall

Indicates that a statement is mandatory.

1.5.30 Should

Indicates a recommendation.

1.5.31 Tank

A container that is designed, constructed and protected, in accordance with AS 1210/NZS/BS 5500 or equivalent Standard. The term 'tank' includes any fittings and other equipment that are integral to the container.

NOTE: In Australia, a tank that is to be used for the transport of chlorine or its residues by road or rail is required to comply with the ADG Code.

1.5.32 Vaporiser

Equipment that converts chlorine from liquid to gas.

NOTE: Vaporisers are used where a relatively high rate of gas flow is required in the user system.

1.5.33 Vapour barrier

A wall or other barrier which is intended to prevent vapour passing from any one place to another.

1.6 CLASSIFICATION OF CHLORINE

Chlorine is classified by the United Nations *Recommendations for the Transport of Dangerous Goods—Model Regulations*, and listed in the ADG Code/NZS 5433 as dangerous goods of Class 2.3, Subsidiary Risk 8.

1.7 MARKING AND LABELLING OF CONTAINERS

Containers of chlorine shall be marked and labelled in accordance with the appropriate Australian State or Territory or New Zealand legislation.

NOTE: In Australia, labelling in compliance with the ADG Code and NOHSC: 2012 may be required under legislation.

1.8 SECURITY OF INSTALLATIONS

All installations shall be appropriately secured against access by unauthorized persons.

SECTION 2 MINOR STORAGE

(Australia only)

2.1 SCOPE OF SECTION

This Section specifies the criteria for 'minor storage' of chlorine in cylinders, and the requirements for such storage.

NOTE: The underlying concept of minor storage is that quantities below a certain level are so low, or are so scattered and separated, that they present little real risk, add little to a building's fire load, and are generally unlikely to play a significant part in spreading fire from place to place and in an emergency will not unduly hinder the activities of emergency personnel or contaminate the surrounding area.

2.2 CRITERIA FOR CLASSIFICATION AS MINOR STORAGE

The storage of less than 5 kg of chlorine gas in cylinders is classified as minor storage.

NOTE: AS 4332 should also be consulted.

2.3 REQUIREMENTS APPLICABLE TO MINOR STORAGE

2.3.1 General

The following requirements and precautions apply to the minor storage of chlorine in cylinders:

- (a) Areas in which cylinders are kept shall be—
 - (i) away from any artificial sources of heat, e.g. radiators, boilers to steam pipes; and
 - (ii) kept clear of combustible matter and refuse for a distance of at least 3 m.
- (b) All cylinder stores shall be provided with adequate ventilation at all times.

NOTE: Ventilation should be sufficient to maintain exposure levels to the chlorine gas below any recommended workplace exposure standards.
- (c) The base or floor on which a cylinder is kept shall be maintained in good condition.
- (d) Cylinders shall be kept in such a manner that—
 - (i) they are secured against falling; and
 - (ii) they are protected against impact damage.
- (e) Before connection to a cylinder, offtake valves and application equipment shall be checked for their suitability for use with chlorine and the pressure that is intended to be used. After connection, the offtake valves and equipment shall be checked for leaks.
- (f) Cylinder outlets shall be plugged and securely capped when not in use.
- (g) Personnel handling the cylinders shall be trained in the applicable safety regulations and safe handling procedures.
- (h) Grease and oil shall only be used on external threads, and shall not be in contact with chlorine unless a non-reactive fluorinated lubricant is used.
- (i) Cylinder valves shall not be opened more than one and a half turns, unless advised by the chlorine supplier.

2.4 OUTDOOR MINOR STORAGE

Outdoor minor stores of chlorine in cylinders shall be separated from other dangerous goods stores by at least 3 m. They shall be located at least 1 m from any door, window, air vent or duct.

2.5 INDOOR MINOR STORAGE

The indoor storage and use of chlorine cylinders shall be avoided wherever possible. Where it is impracticable to provide an outdoor cylinder and reticulation system, the following restrictions apply to chlorine cylinders indoors:

- (a) Cylinders shall not be kept in basements.
- (b) Indoor minor stores of cylinders of chlorine shall be separated from other minor stores of gases or other dangerous goods by at least 3 m.
- (c) The total capacity of chlorine kept shall not exceed one minor storage quantity per 200 m² floor area. Where the floor area exceeds 200 m², any arrangement that results in an undue concentration of cylinders shall be avoided.
- (d) The total capacity of cylinders of chlorine allowed in any particular indoor location shall include cylinders in use, spare cylinders not in use, and cylinders that are nominally empty.
- (e) The concentration of chlorine gas in the atmosphere should be monitored.
- (f) Adequate precautions shall be taken before the chlorine cylinder is opened for use, and emergency equipment, e.g. canister respirators or self-contained breathing apparatus, shall be readily available.
- (g) Nominally empty cylinders should be left containing a slight positive pressure, in order to avoid contamination with moisture or air. The cylinders should be marked 'empty' and removed from any work area as soon as practicable.

2.6 FIRST AID

A first aid kit should be provided in an accessible area.

SECTION 3 LOCATION, DESIGN AND CONSTRUCTION OF CHLORINE INSTALLATIONS

3.1 SCOPE OF SECTION

This Section specifies minimum requirements for the location, design and construction of installations for chlorine in quantities greater than minor storage.

3.2 APPLICATION

The requirements of Clause 3.3 apply to all chlorine installations greater than minor storage. Additional requirements and recommendations for outdoor installations are set out in Clause 3.4. Clause 3.5 sets out requirements and recommendations for indoor installations that are additional to those in Clause 3.3.

NOTE: To assist in the location, design and construction of chlorine installations, a qualitative risk management approach may be used.

3.3 LOCATION, DESIGN AND CONSTRUCTION OF CHLORINE INSTALLATIONS

3.3.1 Location of chlorine installations

3.3.1.1 *General*

Installations for chlorine shall be—

- (a) located in accordance with Table 3.1;
- (b) protected from direct sources of heat (e.g. steam pipes); and
- (c) separated by at least 3 m from any other dangerous goods other than gases of Class 2.2.

3.3.1.2 *Separation from public recreation areas and swimming pools*

The following separation distances shall apply:

- (a) From any area used for recreational activities to any opening in the chlorine installation—at least 3 m.
- (b) From any swimming pool or area to which the public have access (e.g. dressing rooms, toilets, first aid rooms, club rooms, foyers, kiosks, grandstands) to—
 - (i) any opening in an installation where cylinders of chlorine are stored—at least 15 m.
 - (ii) any opening in an installation where drums or tanks of chlorine are stored—at least 25 m.

3.3.1.3 *Measurement of separation distances*

Separation distances may be measured horizontally around an intervening non-combustible vapour barrier that is—

- (a) at least 1 m above the highest container; or
- (b) at least 2 m high,

whichever is the greater.

TABLE 3.1
MINIMUM SEPARATION DISTANCES FOR CHLORINE
INSTALLATIONS

Container type	Aggregate quantity, kg	Minimum distance, m		
		Protected place	Storage of combustible or flammable liquid or gas*	Public place
Cylinders not connected for use	≤2500	8	8	3
	>2500	15	15	8
Cylinders connected for use	≤250	15	15	8
	>250	25	15	15
Other containers	≤1000 kg	25	15	15
	>1000 kg	50	15	25

* Where a flammable or combustible liquid is stored near a chlorine container, bunding shall be provided in order to prevent any liquid from flowing against or beneath the chlorine container.

NOTES:

- 1 For the purpose of this Standard, any permanently closed and sealed opening in a wall is deemed to be part of the wall.
- 2 The distances specified may be reduced by half if the protected places are on the same property as the chlorine storage area, provided that leak detectors are installed and maintained.
- 3 If mechanical ventilation is provided for indoor storage areas, the specified separation distances may be reduced, e.g. 50 m to 30 m, 25 m to 15 m, 15 m to 10 m.

3.3.2 Design and construction of chlorine installations

3.3.2.1 General

The following requirements apply:

- (a) The installation shall be protected from direct sources of heat (e.g. radiators, boilers, steam pipes).
- (b) The chlorine container shall be positioned in a way that places no stress on its associated pipework during normal operations. Any wheels on the container shall be immobilized while the container is in service.

3.3.2.2 Foundations

Fixed tanks shall be mounted on concrete foundations complying with AS 3600/NZS 3101.1, or steel foundations complying with AS 4100/NZS 3404.1. Cylinders or drums shall be placed on a firm, stable, non-combustible surface.

NOTE: For the purpose of this Standard, hardwood is deemed to be non-combustible.

3.3.2.3 Access

An unobstructed path that is at least 850 mm wide, shall be maintained between the entrance to the area and the containers, for safe access and egress. A similar clearance of 850 mm shall be maintained in all parts of the area where personnel need to have access for work purposes.

Access to valves shall be clear and unobstructed, so as to allow an operator to approach them readily.

NOTE: Consideration should be given for adequate access for personnel wearing SCBA.

3.3.2.4 Electrical equipment

The following requirements and recommendations apply to electrical equipment:

- (a) Except for any electrical equipment that is necessary for the operations being carried out, any switchgear, fuse boxes or meters should not be installed in an area where chlorine is stored, handled, processed or distributed.
- (b) Any electrical equipment that is essential to the installation shall have a rating of at least IP 54 in accordance with AS 1939.
- (c) All electrical installations shall be in accordance with AS/NZS 3000.

3.3.2.5 Identification of product

Chlorine installations shall be clearly marked in accordance with regulatory requirements, Clause 6.4.1 and the NOHSC:3009/NZCIC *Warning signs for premises storing hazardous substances*, as appropriate.

NOTE: Appendix D illustrates typical safety signs and an emergency information placard (EIP) for chlorine installations.

3.4 ADDITIONAL REQUIREMENTS FOR OUTDOOR INSTALLATIONS

3.4.1 General

The following additional requirements apply to outdoor chlorine installations:

- (a) Containers shall be protected against accidental damage from vehicles and fork lift trucks. Filling points shall be protected in a similar manner.

NOTE: Where vehicles are manoeuvring at low speed, the following impact protection would be adequate:

- (a) 75 mm steel pipes filled with and set 500 mm into concrete, spaced at least 1.3 m apart, at least 1.5 m from the item being protected, and at least 1.2 m high. However, if the distance from the item being protected is 4 m or more, the pipes may be 0.5 m high.
 - (b) Highway crash barriers (e.g. 'W' guard railing) at least 700 mm high and 1.5 m from the item being protected, set into concrete or with equivalent support.
 - (c) Fenced compounds with 1.8 m high chain link fencing complete with tension wires and 50 mm diameter steel posts set in concrete.
 - (b) Containers shall be located so that any spillage of flammable or combustible liquids cannot flow against or under the chlorine container.
- NOTE: A kerb or bund may be used to achieve this requirement.
- (c) Containers and their pipework shall be located so as to avoid other service pipelines, or be otherwise protected.
 - (d) The base or floor of the installation shall be paved or constructed of suitable material that can maintain its integrity under all weather conditions.

3.4.2 Security of outdoor installations

Where it is not on a secured site, the container shall be surrounded by a chain wire fence that complies with AS 1725. Where the capacity of the container is 2000 kg or less, the fence shall have at least one gate that opens outward and can be locked. Where the capacity of the container is more than 2000 kg, the fence shall be at least 1.5 m from the vessel and shall have at least two such gates.

The fence and gates shall be maintained in good condition.

3.5 ADDITIONAL REQUIREMENTS FOR INDOOR INSTALLATIONS

3.5.1 General

The following requirements apply to indoor installations for chlorine, in addition to those already given in Clause 3.3.

- (a) The cladding or lining of any indoor installation shall be non-combustible.
- (b) The floor shall be constructed of concrete in accordance with AS 3600/NZS 3101.1.
- (c) Where chlorine is kept in a dedicated store, at least one sign (as described in Clause 3.3.2.5) shall be prominently displayed at eye level on the outside wall of the store. The sign shall remain visible when the door is open.
- (d) Where chlorine is kept in a store with other dangerous goods, the chlorine storage area shall be clearly delineated and marked by signs.
- (e) Pits, sumps or machinery wells in enclosed or underground locations or below the level of the chlorine installation shall have no unsealed openings leading into—
 - (i) the chlorine storage area;
 - (ii) any room or area where a chlorinator or vaporiser is installed; or
 - (iii) any room or area that is traversed by pipework carrying chlorine.

They shall be treated in accordance with AS 2865.

3.5.2 Doors for personnel

The following requirements apply to personnel doors to any room in which chlorine is kept and which are within 15 m of the chlorine containers and their associated equipment (e.g. chlorinators and vaporisers):

- (a) Any hinged doors shall open outwards and be fitted with devices that can keep the door open when required. Such devices shall be regularly maintained.
- (b) A sign, indicating that the door is to be kept open whenever personnel are inside, shall be displayed outside the door. The sign shall remain visible when the door is open.

Where any vehicular doors are closed, a personnel door that opens outwards shall be available.

3.5.3 Ventilation for indoor installations

3.5.3.1 Containers not connected for use

Where chlorine is stored, but not connected to a withdrawal system, ventilation shall provide a cross-draught around the containers, by either natural or mechanical means.

3.5.3.2 Containers connected for use

Where containers are connected to a chlorine withdrawal system, the following ventilation requirements shall apply:

- (a) For a total quantity of 2000 kg or less, the minimum requirement shall be either natural ventilation in accordance with Clause 3.5.3.3, or mechanical ventilation complying with Clause 3.5.3.4.
- (b) For a total quantity of more than 2000 kg, mechanical ventilation (see Clause 3.5.3.4) shall be provided.

3.5.3.3 *Natural ventilation*

At least 0.1 m^2 of ventilation opening shall be provided for each 2 m of external wall, near to floor level, in at least two opposite walls, so that there is a cross-draught.

3.5.3.4 *Mechanical ventilation*

Mechanical ventilation should be activated and operating under normal conditions whenever the storage area is occupied. A notice indicating this requirement should be prominently displayed near the store entrance.

NOTE: This may be over-ridden by the emergency plan.

A mechanical ventilation system shall comply with the following requirements:

- (a) For cylinder stores, the ventilation system shall —
 - (i) be able to provide a complete air change every minute; or
 - (ii) have a capacity of at least $15 \text{ m}^3/\text{min}$,
whichever is less, providing that the air movement is always greater than $7 \text{ m}^3/\text{min}$.
- (b) The capacity of any air extraction system for tanks and drum stores shall be at least 15 m^3 of air/min or $0.0075 \text{ m}^3/\text{sec}/\text{m}^2$ of floor space, whichever is the greater.
- (c) For a suction-type extraction system, the air intake shall—
 - (i) provide air circulation without obstruction; and
 - (ii) be located at or near floor level, so that there is substantial air flow near the valves of the chlorine containers.
- (d) A switch to activate the mechanical ventilation system shall be located—
 - (i) outside the chlorine installation; and
 - (ii) sufficiently far away that it can be operated without danger from leaking chlorine.
- (e) Where fitted, any exhaust stack shall be sufficiently tall as to permit the safe dispersal of chlorine vapours, with regard to the safety of any persons or buildings in the vicinity.

NOTES:

- 1 Reference should be made to AS 1668.2/NZS 4303 for requirements for mechanical ventilation systems.
- 2 Occupational health requirements and exposure standards also apply.

3.5.4 **Ventilation of chlorination rooms**

3.5.4.1 *General*

Where there is a dedicated room for the chlorinator, its ventilation shall be either natural (in accordance with Clause 3.5.4.2) or mechanical (in accordance with Clause 3.5.4.3).

3.5.4.2 *Natural ventilation*

Natural ventilation of the chlorinator room shall consist of either—

- (a) at least 0.05 m^2 of ventilation on each of two opposite walls, near floor level; or
- (b) at least 0.1 m^2 of ventilation in one wall, near floor level.

3.5.4.3 *Mechanical ventilation*

Mechanical ventilation shall be capable of providing at least $1.5 \text{ m}^3/\text{min}$, and shall otherwise comply with Clause 3.5.3.4. Such ventilation should operate whenever someone is in the chlorination room.

NOTE: This is to provide for the reduced likelihood of a significant chlorine leak.

SECTION 4 STORAGE AND HANDLING EQUIPMENT FOR CHLORINE

4.1 SCOPE OF SECTION

This Section sets out requirements and recommendations for containers, chlorinators, pipework and ancillary equipment.

4.2 CONTAINERS

4.2.1 Cylinders

Cylinders shall be—

- (a) fitted with valve outlet caps and with valve-protection covers, when not in use; and
- (b) securely restrained so that they are kept upright at all times.

NOTE: Upright positioning is intended to ensure that, if leaks occur at the valve, gas escapes rather than liquid.

Any pipework that is connected to the cylinder shall not be placed under tension.

Where cylinders are connected for use and are on movable scales or platforms, the wheels or rollers shall be immobilized.

4.2.2 Drums and tanks

Drums and tanks shall be—

- (a) fitted with valve-protection caps when not in use;
- (b) stored horizontally; and
- (c) prevented from moving when in storage or use.

4.3 CHLORINATORS

4.3.1 Materials of construction

Chlorinators shall be constructed of materials that are not damaged by contact with chlorine.

NOTE: A guide to the selection of suitable materials is given in Appendix E.

4.3.2 Location

Chlorinators shall be installed in either—

- (a) a chlorine storage area; or
- (b) a separate dedicated room.

Such areas or rooms shall comply with the requirements of Clauses 3.3, 3.4 and 3.5.

Where the chlorinator is in a dedicated room which has a mechanical ventilation system, the chlorinator should be positioned immediately above the air intake for the ventilation fan.

4.3.3 Pressure relief

Any pressure relief device that is fitted to the chlorinator, for the purpose of allowing chlorine to escape, shall be—

- (a) piped to an area in which dispersal can take place without danger to any person; and
- (b) accessible for test purposes; and

- (c) arranged so that the terminal point of the relief is—
 - (i) not located in any public place;
 - (ii) at least 1.5 m from any opening into any room; and
 - (iii) away from any air intakes.

4.4 VAPORISERS (EVAPORATORS)

4.4.1 Operating principle

Liquid chlorine is vaporised by heat exchange. The chlorine gas is withdrawn from above the pool of boiling liquid and delivered to the point of use.

Vaporiser systems should be designed so that the rate of vaporisation self-adjusts to the process demand.

4.4.2 Design of vaporisers

4.4.2.1 Design considerations

The main type of chlorine vaporiser is the removable jacketed shell type.

Chlorine vaporisers should be designed to deliver chlorine in excess of the peak load required by the process. The following items need to be considered:

(a) *Flooding*

Load variations should not cause flooding of liquid chlorine into the gas chlorine line.

(b) *Liquid carry-over*

Vaporisers should be designed to prevent liquid carry-over into the gas stream. Entrained liquid should be separated from the chlorine gas before discharge into the process line.

NOTE: Liquid can be formed as a result of an unpredicted temperature drop or from incomplete vaporisation due to excessive withdrawal rate from the vaporiser.

(c) *Reliquefaction*

Superheating of the vapour in the heated section above the liquid surface is desirable to minimize the possibility of chlorine reliquefying in downstream piping. The degree of superheating required is a function of the pipeline system and the precautions taken to prevent reliquefaction. A minimum of 11°C to 17°C of superheat is required.

Superheating may be achieved by—

- (i) lowering the gas pressure in the discharge line by using a pressure-reducing valve;
- (ii) using a separate superheater; or
- (iii) line insulation and/or heat tracing.

(d) *Fouling and corrosion*

Liquid chlorine can contain traces of non-volatile impurities that can accumulate and reduce the capacity of the vaporiser. The entry of moisture into the system can cause corrosion that can contribute to fouling.

(e) *Freezing*

The temperature of the chlorine in the vaporiser can be below 0°C. The design of the vaporiser should minimize the potential for water/condensate freezing, which could damage the unit.

4.4.2.2 *Heating methods*

Vaporisers can be heated with hot water, which may be supplied by—

- (a) circulating hot water through the vaporiser water jacket; or
- (b) a hot water bath.

NOTE: Chlorine can react violently with organic materials, so the use of organic-based heating media is not recommended.

4.4.2.3 *Excess pressure*

Chlorine vaporising systems shall be equipped with gas pressure relief devices to protect the system from rupture. Pressure relief valves are the preferred devices, as they limit the amount of material released, and then re-seat. The following requirements and recommendations apply to pressure relief devices:

- (a) Pressure relief devices shall not be isolated while the vaporiser is operating.
- (b) Piping should not be flow-restricted.
- (c) Where a safety relief valve is combined in series with a rupture disc or breaking pin assembly, the section of pipe between these two devices shall be equipped with a pressure alarm or other suitable indicating device to detect any leaking rupture disc or breaking pin diaphragm.
- (d) The discharge from pressure relief devices shall be vented to a safe place.
- (e) Where installed, pressure relief valves shall be inspected and tested regularly.

An expansion chamber is one device that prevents overpressure and possible hydrostatic rupture due to the thermal expansion of liquid chlorine that is trapped between closed valves.

NOTE: Schematic diagrams of expansion chambers are given in Appendix F.

4.4.2.4 *High temperatures*

In general, lower operating temperatures should be used, in order to prolong equipment life. Temperatures below 50°C shall not be used, due to the increased risk of accumulation of nitrogen trichloride, which is spontaneously explosive. Higher temperatures can lead to increased vapour pressure and more rapid rates of corrosion, and should be taken into account when designing equipment.

Temperatures above 100°C should be avoided, to prevent the accelerated corrosion of steel.

4.4.2.5 *Materials of construction*

The chlorine vaporiser should be fabricated from carbon steel, nickel, Monel or Inconel.

NOTES:

- 1 Chlorine vaporisers are generally fabricated from carbon steel, which is resistant to chlorine provided that no moisture or contaminants are present and the upper limitation temperature of 121°C is not exceeded. Nickel, Monel and Inconel are more corrosion-resistant than steel and can be used at higher temperatures.
- 2 Some steels become brittle at lower temperatures.

4.4.3 **Vaporiser controls and indicators**

4.4.3.1 *Controls and indicators for all vaporisers*

Controls and indicators shall be provided, in order to allow safe, reliable and convenient operation of the vaporiser. All vaporiser types shall be fitted with the following devices:

- (a) An automatic valve in the exit gas line, to prevent the discharge of chlorine gas if an improper condition develops. This valve shall fail to a closed position.

- (b) A gas pressure-reducing valve, to provide some superheat to the chlorine exit gas stream or to stabilize the pressure at which the chlorine gas is supplied to the process, or both.

NOTE: This valve may be provided with an automatic actuator which functions as a shut-off valve in accordance with Item (a).

- (c) Chlorine gas temperature and pressure indicators.

- (d) Reverse-flow protection on the gas outlet line.

NOTE: This is usually provided by the vacuum regulator.

4.4.4 Installing the vaporiser

The following items shall be checked:

- (a) The piping design shall be reviewed to ensure an adequate supply of chlorine liquid, as differences in elevation between the supply source and the vaporiser can reduce pressure to flash point.
- (b) The capacity of the feed pipe to back-flow liquid when the load is reduced shall also be checked, as insufficient capacity can result in over-pressuring the vaporiser and venting through the relief valve.
- (c) The length of liquid lines shall be kept to a minimum by locating the vaporiser as near as possible to the source of the liquid chlorine, in order to prevent potential flashing, degassing and back-flow.

4.5 PIPING SYSTEMS

4.5.1 General

When designing a piping system for chlorine, the following properties of chlorine shall be taken into account:

- (a) Moist chlorine is highly corrosive to most metals.
- (b) Liquid chlorine has a high coefficient of thermal expansion.
- (c) At full container pressure, chlorine gas can liquefy in cool sections of the pipe.

4.5.2 Testing

Hydrostatic pressure testing may be carried out, but it should not be conducted on the fully assembled system.

If hydrostatic pressure testing is carried out on any section of the piping, before chlorine is passed into the system—

- (a) all gaskets in the line shall be renewed; and
- (b) the line shall be thoroughly dried by passing dry nitrogen or dry air (having a dewpoint of below -40°C) through the system for at least 24 h.

Piping shall not be directly heated unless it has been purged free of chlorine.

NOTE: This is because the corrosion of chlorine piping is greatly accelerated at temperatures above 100°C .

The integrity of the system should be pneumatically tested.

Assembled pipework and valves shall be regularly inspected and tested for leaks.