Asset Delivery Group
Engineering

Design Standard DS 70-01

Chlorine Buildings Standard
FOREWORD

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Head of Engineering

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<table>
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## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preliminaries ................................................................. 8</td>
</tr>
<tr>
<td>1.1</td>
<td>Scope .................................................................................. 8</td>
</tr>
<tr>
<td>1.2</td>
<td>Standards ........................................................................... 8</td>
</tr>
<tr>
<td>1.3</td>
<td>Definitions .......................................................................... 8</td>
</tr>
<tr>
<td>1.3.1</td>
<td>Chlorine ............................................................................... 8</td>
</tr>
<tr>
<td>1.3.2</td>
<td>Container ........................................................................... 8</td>
</tr>
<tr>
<td>1.3.3</td>
<td>Cylinder ............................................................................... 8</td>
</tr>
<tr>
<td>1.3.4</td>
<td>Chlorine Containment .......................................................... 8</td>
</tr>
<tr>
<td>1.3.5</td>
<td>Chlorine Store ................................................................. 9</td>
</tr>
<tr>
<td>1.3.6</td>
<td>Drum .................................................................................. 9</td>
</tr>
<tr>
<td>1.3.7</td>
<td>Installation ......................................................................... 9</td>
</tr>
<tr>
<td>1.3.8</td>
<td>Non-combustible ................................................................. 9</td>
</tr>
<tr>
<td>1.3.9</td>
<td>Placard ................................................................................ 9</td>
</tr>
<tr>
<td>1.3.10</td>
<td>Self-Contained Breathing Apparatus (SCBA) ......................... 9</td>
</tr>
<tr>
<td>1.3.11</td>
<td>Sensitive Uses (as per AS2927 definition) ............................ 9</td>
</tr>
<tr>
<td>1.3.12</td>
<td>Shall .................................................................................. 9</td>
</tr>
<tr>
<td>1.3.13</td>
<td>Should ............................................................................... 9</td>
</tr>
</tbody>
</table>
2 Design and Construction Requirements - General ................................................................. 10
  2.1 Application ......................................................................................................................... 10
  2.2 Room Layout ..................................................................................................................... 10
  2.3 Access .................................................................................................................................. 10
  2.4 Ventilation for chlorine stores ............................................................................................ 10
  2.5 Ventilation of chlorination ................................................................................................. 10
  2.6 Electrical equipment ........................................................................................................... 10
  2.7 Signage/Placarding ............................................................................................................. 10
  2.8 Fire control ......................................................................................................................... 11
  2.9 Chlorination room – wall space .......................................................................................... 11
  2.10 Viewing window for personnel .......................................................................................... 11
  2.11 Personnel and Vehicular Doors ......................................................................................... 11
  2.12 Sealing of buildings .......................................................................................................... 11
  2.13 Safety showers and eyewash stations ............................................................................... 11
  2.14 Chlorine leak detectors ..................................................................................................... 12
3 Design and Construction Requirements – Chlorine Containment .................................. 13
  3.1 Containment Building Size ............................................................................................... 13
  3.2 Buildings with truck drive in bays ....................................................................................... 13
  3.3 Ventilation of chlorine stores – additional requirements .................................................. 13
  3.4 Personnel and Vehicular Doors ......................................................................................... 13
4 Photographs of the major features in chlorine containment buildings (taken at Mirrabooka GWTP) 14
5 Chlorine Containment Building Philosophy ...................................................................... 17
  5.1 Chlorine Containment Building Design Requirements ..................................................... 17
     5.1.1 Application ................................................................................................................... 17
     5.1.2 When to use Chlorine Containment Buildings ............................................................. 17
     5.1.3 Ventilation .................................................................................................................. 17
     5.1.4 Drive in Delivery Bays and Gantry Cranes ................................................................. 17
     5.1.5 Extra Large Buildings, Catastrophic Rupture Proof Buildings and Scrubber Systems .... 18
1 Preliminaries

1.1 Scope
This Design Standard identifies the key design parameters/requirements associated with chlorine buildings.

1.2 Standards
This Design Standard makes reference (directly or indirectly) to the following current Standards:

AS/NZS
3000 Electrical Installations (known as the Australian/New Zealand Wiring Rules)

AS
1319 Safety signs for the occupational environment
1668.2 Part 2: Mechanical ventilation for acceptable indoor-air quality
1939 Degree of protection provided by enclosures for electrical equipment
2927 The storage and handling of liquefied chlorine gas

WATER CORPORATION STANDARDS
DS70.2 Chlorine leak Detectors
DS79 Design of Chemical Systems – Legislative Requirements and General Principles
DS79.02 Emergency Safety Showers and Eyewash Stations
DS79.04 Chemical Safety Signage, Labels and Markers

1.3 Definitions

1.3.1 Chlorine
Elemental chlorine in its gaseous or liquid form.

1.3.2 Container
Anything, in which the chlorine is wholly or partly contained, including cylinders and drums.

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

1.3.4 Chlorine Containment
A design philosophy which aims to minimise the leakage of chlorine from a chlorine building in the event of a vessel or equipment failure.
1.3.5 **Chlorine Store**

An area that is used for the storage of chlorine containers and their associated connection equipment (i.e. where connection and disconnection of containers occurs).

1.3.6 **Drum**

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

1.3.7 **Installation**

All of those facilities on a site that are related to the storage, handling and use of chlorine, including connected and standby containers and associated piping and equipment, but not including separate storage areas (where cylinders or drums are simply stored).

1.3.8 **Non-combustible**

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

1.3.9 **Placard**

Refers to signs that provide a primary warning of the location and type of hazardous chemicals stored.

1.3.10 **Self-Contained Breathing Apparatus (SCBA)**

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

1.3.11 **Sensitive Uses (as per AS2927 definition)**

Sensitive uses include establishments and other uses where vulnerable people are concentrated such as schools, hospitals, aged persons’ accommodation and child care facilities (including creches).

When considering sensitive uses, the possibility of easy evacuation by the people using the area should be considered. This might mean that for example, doctors’, dentists’ or other medical surgeries that provide specialist care to vulnerable people should be considered to be sensitive uses.

When considering large establishments, the actual use of the buildings and areas within the defined separation distance should be evaluated. For example, in a large school or hospital surrounded by a garden or playing field or car park, the required distance should be maintained from the school or hospital buildings and places of regular occupancy. However, the garden or playing field or car park should be considered as sensitive if vulnerable people are normally present in these areas.

1.3.12 **Shall**

Indicates the statement is mandatory, and thus must be carried out.

1.3.13 **Should**

Indicates the statement is a recommendation/strong preference.
2 Design and Construction Requirements - General

2.1 Application
This Design Standard details the requirements and considerations involved in the design and construction of chlorine buildings. The standard shall not be used as a substitute for AS2927. Its purpose is to highlight those aspects of AS2927 that have not been generally been well adhered to by designers in the past and to highlight Water Corporation specific requirements over and above AS2927.

2.2 Room Layout
Chlorine building installations shall be designed to include a dedicated electrical room. Separate chlorine store and chlorinator rooms shall be employed (this improves asset life by reducing the exposure of chlorination equipment to the effects of chlorine gas attack).

2.3 Access
All designated walkways around and between containers shall be of at least 850mm width to permit ready movement of personnel wearing SCBA. The separation distance between pairs of drums shall be 150mm where it is not to be used as an access way (this distance is small enough to discourage use as a walkway but large enough to prevent a drum being moved by crane from striking a neighbour).
Also a 1000mm access distance shall be provided between container valves and header manifold piping to permit ready drum connection/disconnection activities by personnel wearing SCBA.

2.4 Ventilation for chlorine stores
Mechanical ventilation shall be provided (in accordance with AS2927) to provide substantial flow through the chlorine containment building, across the header arrangement. Ducting for ventilation shall exit the building through the ceiling rather than via wall penetration, in order to ensure the safe dispersal of chlorine vapours.

Note: Containment Buildings have additional requirements – see Section 3.

2.5 Ventilation of chlorination
Mechanical or natural ventilation shall be provided for the chlorinator rooms in accordance with AS2927.

Note: Containment Buildings have additional requirements – see Section 3.

2.6 Electrical equipment
(a) Shall not be installed in either the chlorine store or chlorinator rooms unless is it essential for the operation of the system.
Instrumentation such as chlorine and fluoride analysers may be located in the chlorinator room. Chlorine leak detector control units should be located in the electrical/control room.

(b) That is located in either the chlorine store or chlorinator rooms shall have a rating of at least IP 54 in accordance with AS 1939.

2.7 Signage/Placarding
Chlorine installations shall be clearly marked in accordance with DS79.04 Chemical Safety Signage, Labelling and Markers and regulatory standards.
2.8 Fire control

The following fire control requirements apply.

(a) The lining of an indoor installation shall be non-combustible;
(b) The floor shall be constructed of concrete in accordance with AS 3600;
(c) Heaters should not be employed unless absolutely necessary. Electric bar heaters shall not be employed.

2.9 Chlorination room – wall space

This room is usually dedicated for the chlorinators, although ejector pumps are frequently also co-located.

The wall space in this area shall be designed to allow:

(a) uncluttered positioning of instrumentation (e.g. analysers);
(b) the operator to have a full range of motion;
(c) effective ventilation (the configuration of the room will usually dictate mechanical ventilation due to an inability to get good cross draught through the room); and
(d) the installation of a viewing window that provides a view of the drum valves, where it is not practical for the window to be located in an electrical/control room - see 2.10.

2.10 Viewing window for personnel

A viewing window should be provided to allow an adequate view from the control room of the chlorine store room, so that all the valves of chlorine containers can be checked for leaks without walking into the storage room. If an electrical/control room is not a viable location for the window, then the chlorination room is an adequate alternative. The window shall be made of glass, such that it is not discoloured by trace amounts of chlorine.

2.11 Personnel and Vehicular Doors

The following description applies to doors into the chlorine store and chlorination room:

All hinged doors shall open outwards and be fitted with devices that keep the door open when occupied. Hinged doors shall also be designed so their travel path is never impeded by the external building design (e.g. overhanging eaves/roof). Personnel doors shall be fitted with crash bars to allow personnel to speedily exit the building. The travel of vehicular doors shall take into account the prevailing wind conditions.

Note: Containment Buildings have additional requirements – see Section 3.

2.12 Sealing of buildings

The following requirements apply to all buildings.

(a) Flooring shall not include pits, ducts, sumps or machinery wells; and
(b) There shall not be any unsealed openings between rooms (e.g. cable ducts, conduits etc.).

2.13 Safety showers and eyewash stations

Chlorine building installations shall be designed with fixed safety shower and eyewash stations in accordance with Water Corporation’s DS79.02 Emergency Safety Showers and Eyewash Stations standard and regulatory requirements.
2.14 Chlorine leak detectors

Chlorine building installations shall be designed for leak detection in both the chlorine store and chlorinator rooms.

Two leak sensors/cells shall be provided for the chlorine store as the risk of a chlorine gas leak/release in this room is relatively high and sensor redundancy is an ALARP consideration.

One leak sensor/cell shall be provided for the chlorination room as the risk of a leak in this room is relatively lower with a chlorine solution leak/release being the most likely risk scenario.

Locations of sensors shall comply with DS70.2 Chlorine Leak Detectors and AS2927.
3 Design and Construction Requirements – Chlorine Containment

3.1 Containment Building Size

Dispersion modelling studies undertaken for chlorine drum releases have demonstrated that chlorine buildings around 1000m³ in size have significantly greater risk reduction than those of 400m³ (which was the old minimum figure for Containment Building volume). A building volume of 1000m³ shall therefore be the base case against which other chlorination options are assessed against in terms of financial and community risk, bearing in mind the Regulator’s requirement for risk to be reduced as low as reasonably practicable (ALARP).

Dispersion modelling studies undertaken for chlorine cylinder releases have demonstrated that chlorine buildings around 40m³ in size have only a small risk reduction. A building volume of 100m³ shall therefore be the base case against which other chlorination options (including gas scrubbers) are assessed against in terms of financial and community risk, bearing in mind the Regulator’s requirement for risk to be reduced as low as reasonably practicable (ALARP).

3.2 Buildings with truck drive in bays

Buildings designed to allow delivery trucks to drive in and unload within shall be designed so that the “truck bay” area is at least 14m in length and the roller door shall possess a width of at least 3.6m and a height of at least 4.3m.

Truck unloading should be accomplished using a “gantry” type crane that allows non-restrictive movement during loading and unloading of chlorine containers from the truck, thereby reducing the need for drums to be moved over the top of one another.

Note: A chlorine risk assessment will determine the need for a truck drive-in bay.

3.3 Ventilation of chlorine stores – additional requirements

Dampers shall be provided on fan inlets and outlet ducts in order to minimise air passage whilst fans are not operating.

Ventilation fans shall be interlocked with the 5ppm alarm signal from a chlorine leak detector such that they lose their permission to run signal. Fans shall also be equipped with a 55 minute operation onsite alarm and a 60 minute automatic shutdown interlock in accordance with Water Corporation standard design drawings (drawing series EO28).

Ventilation fans shall be interlocked with the 5ppm alarm signal such that they will not operate, except via use of an approved emergency over-ride system, e.g. a password protected OIP start button or key start.

3.4 Personnel and Vehicular Doors

Personnel doors shall be equipped with a 55 minute door open onsite alarm and a 60 minute offsite alarm in accordance with Water Corporation standard design drawings.

Vehicular doors shall be of a roller type and be fitted plastic or alloy runners to reduce corrosion and rubber seals on the bottom of the doors to minimise air movement.
4 Photographs of the major features in chlorine containment buildings (taken at Mirrabooka GWTP)

Figure 1: View of drum room from control/electrical switchroom
Figure 2: View of emergency exit door

Figure 3: View of chlorine drum room ventilation (extraction) system
Figure 4: Truck drive-in facility roller door and gantry crane access

Figure 5: Full view of chlorine containment room (taken from the truck drive through bay)
5 Chlorine Containment Building Philosophy

5.1 Chlorine Containment Building Design Requirements

5.1.1 Application

This section outlines the key conceptual design issues for chlorine containment buildings and provides a rationale to the Water Corporation’s philosophy.

5.1.2 When to use Chlorine Containment Buildings

The Dangerous Goods Regulations (Storage and Handling) and OSH Regulations require organisations to reduce risk to as low as reasonably practicable (ALARP)”.

Where chlorine drum facilities are to be located within 400m of Sensitive Uses or residences consideration shall be given to the use of a chlorine containment building.

Where chlorine cylinder facilities are to be located within 100m of Sensitive Uses or residences, consideration shall be given to the use of a chlorine containment building if other forms of risk mitigation are not considered to be adequate to minimise off-site risk.

Factors to be considered include; population density, type of land use, chlorine consumption rate and the amount of chlorine to be stored. The rationale for adoption/non-adoption of a chlorine containment building shall be documented (e.g. Preliminary Design Report).

Studies undertaken by consultants on the Water Corporation’s behalf have demonstrated the beneficial effects of the use of chlorine containment buildings in mitigating the consequences of a chlorine release. Containment’s primary advantage is that it is an inherently reliable method of mitigating the effects of a chlorine leak (no power required, no moving parts etc.) but unlike measures such as scrubbing, does not actually eliminate the chlorine.

5.1.3 Ventilation

Chlorine containment buildings need to minimise natural ventilation and hence require mechanical ventilation to meet the requirements of AS2927. The design of the mechanical ventilation components such as intakes and outlets needs however to minimise natural ventilation when the fans are not in use (e.g. through use of dampers etc.).

A well-sealed chlorine containment building typically experiences 1 to 3 air changes per hour (ACH). Risk modelling work undertaken by consultants suggests that reduction of air changes below 1 ACH does not yield any significant benefit as the reduction in chlorine leak rate appears to be offset largely by the higher concentration of gas leaking from the building (due to the decreased air dilution). Hence, unless the building is completely sealed, 1 to 3 ACH is an effective target for natural ventilation.

5.1.4 Drive in Delivery Bays and Gantry Cranes

Where additional risk reduction is warranted, the use of gantry cranes and drive in delivery bays has been shown in risk modelling to make significant reduction in risk levels.

The benefit is threefold:

1) The use of gantry cranes eliminates the need to move drums over one another, thereby eliminating the drum (edge) penetrating another drum scenario.

2) The inclusion of a drive in delivery bay results in a larger containment volume being available and this has a notable risk reduction effect on all types of chlorine facilities (from small drum vacuum systems through to large drum liquid systems).
3) The inclusion of a drive in delivery bay results in drum drop scenarios (apart from catastrophic rupture) being modelled as contained chlorine leaks rather than as uncontained. This has a notable effect on risk for small drum facilities that have high delivery frequencies.

5.1.5 Extra Large Buildings, Catastrophic Rupture Proof Buildings and Scrubber Systems

Where further additional risk reduction is warranted, the use of Extra Large Buildings (>4x min containment volume), Catastrophic Rupture Proof Buildings and/or Scrubber Systems are options to be considered. Given their expense, however, the use of an alternative disinfectant/oxidant (such as electrolytic chlorination, sodium hypochlorite, ozone etc.) shall be examined to determine whether elimination of the risk altogether is practicable.
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