Assets Planning and Delivery Group
Engineering

Design Standard DS 70-01

Chlorine Buildings Standard

VERSION 1
REVISION 4

FEBRUARY 2022

FOREWORD

The intent of Design Standards is to specify requirements that assure effective design and delivery of fit for purpose Water Corporation infrastructure assets for best whole-of-life value with least risk to Corporation service standards and safety. Design standards are also intended to promote uniformity of approach by asset designers, drafters and constructors to the design, construction, commissioning and delivery of water infrastructure and to the compatibility of new infrastructure with existing like infrastructure.

Design Standards draw on the asset design, management and field operational experience gained and documented by the Corporation and by the water industry generally over time. They are intended for application by Corporation staff, designers, constructors and land developers to the planning, design, construction and commissioning of Corporation infrastructure including water services provided by land developers for takeover by the Corporation.

Nothing in this Design Standard diminishes the responsibility of designers and constructors for applying the requirements of WA OSH Regulations 1996 (Division 12, Construction Industry – consultation on hazards and safety management) to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

https://www.legislation.wa.gov.au/legislation/statutes.nsf/law_s4665.html

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Head of Engineering

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REVISION STATUS

The revision status of this standard is shown section by section below:

REVISION STATUS						
SECT.	**VER./ REV.**	**DATE**	**PAGES REVISED**	**REVISION DESCRIPTION (Section, Clause, Sub-Clause)**	**RVWD.**	**APRV.**
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Design Standard DS70-01
Chlorine Buildings Standard

CONTENTS

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
EO28-70-1	Chlorine Drum Spacing Section
16097-002-011	Chlorine Facility General Arrangement

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 or 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. Section 2 applies to all chlorine buildings and Sections 3, 4 and 5 apply to chlorine containment 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.

Note: Design requirements for chlorine modules are provided in Water Corporation's module specification PTM.

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 and Spacing

The clear spacing around chlorine drums shall comply with drawing 16097-002-011 with the separation distance between pairs of drums being 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).

Access to the head of drums (.i.e. valves, ESDs, etc.) shall be in accordance with drawing EO28-70-1 in order to permit operational and emergency access (Note: the 2460 dimension in EO28-70-1 supersedes the 2450mm dimension shown in 16097-002-011).

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 rooms

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

Note: Chlorine buildings that are identified as "Containment Buildings" have additional requirements – see Section 3, 4 and 5.

2.6 Electrical equipment

(a) Shall not be installed in either the chlorine store or chlorinator rooms unless is its location in these rooms is essential for the operation of the chlorination 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** into the chlorine store room so that all the valves of chlorine containers can be visibly 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.).

Note: An exception to (a) would be the installation of cast in conduits in the floor of the chlorine storeroom between the drum head position and adjacent walls for the purpose of routing the cabling and vacuum lines associated with vacuum regulators (refer drawing 16097-02-12 as an example).

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 and other requirements of chlorine leak detectors and sensors shall comply with DS70.2 Chlorine Leak Detectors and AS2927.

3 Chlorine Containment – Design and Construction Requirements

3.1 Containment Building Size

Dispersion modelling studies undertaken for chlorine drum releases have demonstrated that chlorine buildings around 1000m^3 in volume provide significantly greater offsite risk reduction than those of 400m^3 (which was the old minimum volume for chlorine containment buildings). A building volume of 1000m^3 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 provide only a small offsite risk reduction. A building volume of 100m^3 shall therefore be the base case against which other chlorination options (including mitigation options such as 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 Truck drive-in bays

Containment buildings shall be designed to allow delivery trucks to drive in to the chlorine store room and unload chlorine containers with all external doors and roller doors closed. The "truck bay" area shall be 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.

3.3 Ventilation of chlorine stores – additional requirements

Dampers shall be provided on fan inlet 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 (of continuous operation) onsite warning 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 Access Doors

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

Vehicular access doors shall be of a roller type and be fitted with plastic or alloy runners to reduce corrosion The door(s) shall have rubber seals on the bottom to minimise air movement.

4 Chlorine Containment - Photographs of features (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 then 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 then 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 gas scrubbing, does not actually eliminate the chlorine.

The decision whether to utilise a Chlorine Containment Building or not shall be made in consultation with a Water Corporation Dangerous Goods advisor from the Engineering Business Unit, Water Treatment section.

5.1.3 Ventilation

Chlorine containment buildings need to minimise natural ventilation and hence require mechanical ventilation to meet the requirements of AS2927. However, the design of the mechanical ventilation components such as intakes and outlets needs 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

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 (outdoors). 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, etc.) shall be examined to determine whether elimination of the risk altogether is practicable.

END OF DOCUMENT

Nexus Electronic Approval Workflow Record

Document - DS 70-01 - Chlorine Buildings Workflow Routing: Concurrent

This page captures the electronic approval of the approvers that were designated for the Nexus document/object to which this page is attached.

Below is a record of the individuals who approved the document/object.

Approver	Approver Designation	Approved Time
Damon Howes	Snr Prin Eng - Water Treatment	23/02/2022 3:51PM