Assets Planning and Delivery Group
Engineering

DESIGN STANDARD DS 79

Design of Chemical Systems
- Legislative Requirements and General Principles

VERSION 3
REVISION 5

APRIL 2024

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 the Western Australia's Work Health and Safety (General) Regulations 2022 to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

Overview of Western Australia’s Work Health and Safety (General) Regulations 2022 (dmirs.wa.gov.au)

Enquiries relating to the technical content of a Design Standard should be directed to the Senior Principal Engineer, Water Treatment, Engineering. Future Design Standard changes, if any, will be issued to registered Design Standard users as and when published.

Head of Engineering

This document is prepared without the assumption of a duty of care by the Water Corporation. The document is not intended to be nor should it be relied on as a substitute for professional engineering design expertise or any other professional advice.

Users should use and reference the current version of this document.

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Any interpretation of anything in the Standards/Specifications that deviates from specific Water Corporation Project requirements must be referred to, and resolved by, reference to and for determination by the Water Corporation's project manager and/or designer for that particular Project.

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.**
1	2/0	30.10.17	8	Section 1.2 revised	NH	DH
1	3/0	8.09.20	9-13	Standards and definitions updated	NH	DH
1	3/2	03.22	11	New WC standards added	NH	DH
1	3/3	30.10.22	9, 12, 13	Minor changes & updates, including referencing, from OSH to WHS regulations	SZ	BM
2	2/0	30.10.17	12-13	Section 2 – minor wording changes	NH	DH
2	3/0	8.09.20	14-15	Section 2 minor edits	NH	DH
2	3/3	30.10.22	14	Minor changes	SZ	BM
3	2/0	30.10.17	14-15	Sections 3.1 and 3.3 amended	NH	DH
3	3/0	8.09.20	16-18	Section 3 – major amendments to buffer definitions and use	NH	DH
3	3/2	03.22	17	Note 2 augmented	NH	DH
4	2/0	30.10.17	16-18	Sections 4.2.1, 4.2.2 and 4.5 amended	NH	DH
4	3/0	8.09.20	19-23	Section 4 numerous clarifying edits	NH	DH
4	3/2	03.22	18,20	S4 – requirement for environmental risk assessment S4.5 – 5m separation distance added in line with WC WHS requirements	NH	DH
4	3/3	30.10.22	19, 21	S4.2.1 Updated ventilation considerations for different chemicals and their properties. S4.5 U-PVC req's included	SZ	BM
4	**3/5**	**03.04.24**	**18-21**	**S4.2.4 and s4.5 revised. S4.7 removed and transferred to s6.12.**	**NH**	**BM**
5	2/0	30.10.17	23,25,35	Sections 5.1.2&5.4.2 valving requirements changed, Section 5.5.1 amended to cover tank material selection. Section 5.9 added	NH	DH
5	3/0	8.09.20	24-44	Section 5 numerous clarifying edits and updates. Double walled/skinned tanks explicitly prohibited from use.	NH	DH

REVISION STATUS						
SECT.	VER./ REV.	DATE	PAGES REVISED	REVISION DESCRIPTION (Section, Clause, Sub-Clause)	RVWD.	APRV.
				New Section 5.10 added		
5	3/2	03.22	23, 24-26, 28, 37, 39, 41-47	Old S5.11 deleted – now covered in DS79-05. New S5.9 added. S5.1, S5.1.2, S5.3, S5.6.1, S5.6.5, S5.7, S5.8.2.2, S5.9, S5.10, S5.11.1.3, S5.11.2.3 revised	NH	DH
5	3/3	30.10.22	25, 27, 32, 36	Minor changes	SZ	BM
5	3/3	30.10.22	25, 44, 46	s5.4.3 – change to angle of load-in connection point; drip leg isolation valve now has a spring. s5.1.2 updated bund sump instrument selection guide New section 5.11.1.6 Caustic conductivity settings	SZ	BM
5	3/4	27.02.24	44	s5.11.2.1 – 75mm coupling size for Sulphuric clarified re Coogee feedback	SZ	BM
5	**3/5**	**03.04.24**	**23,25,29,30, 36, 40, 42-44**	**Changes to s5.1.2, 5.2, 5.4.3, 5.5.3.1, 5.6.7, 5.9, 5.11**	**NH**	**BM**
6	**3/5**	**03.04.24**	**48-51**	**New Section**	**NH**	**BM**
7	1/1	31.07.14	34	New Section	ST	NH
7	2/0	30.10.17	35	Page number altered	NH	DH
7	3/0	8.09.20	44	Major update to address Diesel systems	NH	DH
7	3/1	4.11.20	46	S6.2.3 added	NH	DH
8	3/0	8.09.20	All	New Section to reference DS79.4	NH	DH
App 1	1/0	1.08.12	All	New Standard	ST	NH
	2/0	30.10.17	36	Updated to reflect organizational changes	NH	DH
	3/0	8.09.20	45	Page number altered and updated to reflect organizational changes	NH	DH
App 2	1/0	1.08.12	All	New Standard	ST	NH
	2/0	30.10.17	37-38	Minor changes to wording	NH	DH

	3/0	8.09.20	46	Page number altered and minor changes to wording	NH	DH

DESIGN STANDARD DS 79

Design of Chemical Systems - Legislative Requirements and General Principles

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1 INTRODUCTION

1.1 Purpose

The purpose of this document is to summarise the Legislative requirements concerning the design of chemical systems and the general principles that the Water Corporation expects its staff, consultants and contractors to consider. The standard supports other Water Corporation design standards and does not over-ride the specific requirements of any other standard.

1.2 Background Information

Water Corporation currently has chemical specific design standards for Chlorine, Fluorosilicic Acid, Sodium Hypochlorite and Lime dosing systems.

This standard has been written to improve the design of chemical storage facilities that have in the past been deficient from a risk exposure and risk management perspective. It should be read in conjunction with the design standard for chemical dosing systems (DS78).

Also included is this document are text boxes titled "Commissioning Plan Information", which provide non-design information relating to construction or commissioning activities. This information should be included in the Commissioning Plan.

1.3 Regulations and Standards

This design standard makes reference (directly or indirectly) to the following legislation and standards:

1.3.1 Department of Mines, Industry Regulation and Safety

1.3.1.1 Dangerous Goods Division

Legislation and Compliance requirements as contained at the website:

http://www.dmp.wa.gov.au/Dangerous-Goods/Dangerous-Goods-258.aspx

Dangerous Goods Safety Act 2004

Dangerous Goods Safety (Storage & Handing of Non-explosives) Regulations 2007

1.3.1.2 WorkSafe Division

Legislation and Compliance requirements as contained at the website:

https://www.commerce.wa.gov.au/worksafe

Work Health Safety Act 2020

Work Health Safety (General) Regulations 2022

1.3.2 Health Department of Western Australia

Medicines and Poisons Act 2014

The Poisons Standard 2019 - Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP)

Memorandum of Understanding (MOU) for Drinking Water: https://nexus.watercorporation.com.au/otcs/cs.exe/link/58586927

Schedule 7 of MOU - Chemicals Approved for Addition to Drinking Water: http://ww2.health.wa.gov.au/~/media/Files/Corporate/general%20documents/water/PDF/MaterialsSubstancesDrinkingWater.pdf

1.3.3 Water Corporation Standards

DS 20	Design Process for Electrical Works
DS 22	Ancillary Plant & Small Pump Stations – Electrical
DS 24	Electrical Drafting
DS 26	Type Specifications - Electrical
DS 28	Water and Wastewater Treatment Plants - Electrical
DS 30-02	General Design Criteria - Mechanical
DS 31-01	Pipework - Mechanical
DS 31-02	Valves and Appurtenances - Mechanical
DS 33	Water Treatment Plants - Mechanical
DS 35	Ancillary Plant - Mechanical
DS 40	SCADA Standards
DS 40-07	Electrically Actuated Valve Control
DS 40-08	Standard for the Control of Chemical Dosing
DS 40-09	Field Instrumentation
DS 62-01	Site Security Treatments
DS 70-01	Chlorine Buildings
DS 70-02	Chlorine Leak Detectors
DS 70-03	Emergency Shutoff Devices for Use on Chlorine Containers
DS 70-20	Small Chlorination Systems (Water) – Control Function Description
DS 70-25	Chlorine Sequenced Vacuum System – Control Function Description
DS 70-30	Small Chlorination Systems (Wastewater) – Control Function Description
DS 71-01	Fluorosilicic Acid Storage and Dosing System - Basis of Design
DS 71-02	Fluorosilicic Acid Storage and Dosing System – Control Functional Specification
DS 72-01	Lime Storage, Mixing and Dosing System – Basis of Design
DS 72-02	Lime Storage, Mixing and Dosing System – Control Function Specification
DS 73-01	Sodium Hypochlorite Storage and Dosing System – Basis of Design
DS 73-02	Sodium Hypochlorite Storage and Dosing System – Control Functional Specification
DS 73-10	Small Sodium Hypochlorite Dosing Systems
DS 78	Chemical Dosing
DS 79-02	Emergency Safety Showers and Eyewash Stations
DS 79-03	Chemical Barrier Protection
DS 79-04	Chemical Signage, Labelling and Markers
DS 79-05	Small Chemical Dosing Systems
DS 80	WCX CAD Standard

DS 81	Process Engineering
DS 95	Standard for the Selection, Preparation, Application, Inspection and Testing of Protective Coatings on Water Corporation Assets
DS 100	Suspended Flooring (Grid Mesh and Chequer Plate)
HA-ST-02	Hazardous Area Classification Standard
CR5	Application of Chemical Resistant Protective Coating on Concrete Bunds in Water and Wastewater Treatment Plants
	Strategic Products Register
SPS497	GRP Chemical Storage Tanks
SPS498	Polyethylene Chemical Storage Tanks

1.3.4 Australian Standards

AS 1940	The Storage and Handling of Flammable and Combustible Liquids
AS 2022	Anhydrous Ammonia - Storage and Handling
AS 2927	The Storage and Handling of Liquefied Chlorine Gas
AS 3780	The Storage and Handling of Corrosive Substances
AS 4332	The Storage and Handling of Gases in Cylinders
AS 4452	The Storage and Handling of Toxic Substances

1.4 Abbreviations and Terminology

ADG Code	Australian Dangerous Goods Transport Code
Buffer	The separation distance between a chlorine or ammonia facility, and a neighbouring land use.
Bulk DG	DG Storage in a container > 500 kg or L
Bulk (tank)	For this standard, means storage vessels with individual capacities in excess of 2 kL (i.e. not including bulki-boxes)
Class	A Dangerous Goods allocation for a substance listed in the ADG Code (e.g. Corrosives are Class 8)
Corrosive Chemicals	For this standard, chemicals that include any of the following health statements on their Safety Data Sheet (SDS): H314, H315, H318, H319.
Dangerous Goods	Dangerous Goods are materials classified by the ADG Code, on the basis of immediate physical or chemical effects such as fire, explosion, corrosion and poisoning as having the potential to affect people, property or the environment.
Division	A Dangerous Goods allocation for a substance listed in the ADG Code (e.g. Chlorine is Division 2.3)
DG Regs	The Dangerous Goods Safety (Storage & Handing of Non-explosives) Regulations 2007
DMIRS	The Department of Mines, Industry Regulation and Safety (the Dangerous Goods Regulator)
FRP	Fibre Reinforced Plastic
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
Hazardous Chemical	Are materials classified, according to the GHS, on the basis of health effects, whether immediate or long term (e.g. corrosives, poisons)
Package DG	Storage in a container < 500 kg or L (e.g. cylinders, 200L drums)

Packing Group	Materials that are classified according to the ADG Code by the degree of danger they present: PGI - high danger; PGII - medium danger; PGIII - low danger
PCV	Pressure Control Valve (e.g. pressure sustaining or pressure reducing)
PSV	Pressure Safety (relief) Valve
Public Place (Access) Buffer	The land requiring public access to be prevented due to the level of risk posed by a facility.
Sensitive Developments	Defined by AS 2927 to include facilities such as hospitals, schools, childcare centres, aged care housing and other community facilities where large numbers of people may be located, and which may be difficult to evacuate.
SLOD	Significant Likelihood of Death (SLOD) – defines an outdoor distance at which 50% of persons located there, and unable to move away, would die, should the modelled release event occur under specific atmospheric conditions. An output of risk consequence modelling.
SLOT	Significant Level of Toxicity - defines an outdoor distance at which 50% of persons located there, and unable to move away, would require some form of medical attention, should the modelled release event occur under specific atmospheric conditions. An output of risk consequence modelling.
Subsidiary Hazard	An additional allocation(s) (for a substance listed in the ADG Code) to a class or division: e.g. Chlorine is a Division 2.3 Toxic Gas, with the subsidiary hazards allocated Division 5.1 Oxidizing Agent and Class 8 Corrosive.
Tank	Any storage vessel – includes bulk tanks and bulki-boxes
Tank working volume	The volume of the tank between the low-low level alarm and the high level alarm
Tank design capacity	The volume of the tank from its base to the invert of the overflow
WHS	Work Health Safety Regulations 2022

2 LEGISLATIVE REQUIREMENTS

The storage and handling of chemicals is managed through these three Acts and their associated Regulations:

1. Work Health Safety Act 2022
2. The Dangerous Goods Safety Act 2004
3. The Medicines and Poisons Act 2014

All chemicals that possess hazardous qualities fall within the scope of the Work Health Safety Act, with a subset of these falling within the Dangerous Goods Safety Act (i.e. are defined as Dangerous Goods under the ADG Transport Code). A lesser number fall within the Medicines and Poisons Act (i.e. are classified as Scheduled chemicals in accordance with The Poisons Standard 2019).

It should also be noted that the Environmental Protection Act 1986, through the Environmental Impact Assessment process requires the risk posed by chemicals (including dangerous goods) to be considered. This process is not covered within this standard.

The use of chemicals in contact with drinking water is covered by a Memorandum of Understanding (MOU) between the Department of Health (WA) and Water Corporation. Schedule 7 of the MOU outlines the chemicals that are approved for addition to drinking water. Schedule 8 covers chemicals and procedures used to maintain water treatment and distribution systems, whilst Schedule 5 covers materials approved for use in contact with drinking water. All new requests to use chemicals which may contact drinking water must be directed to Water Corporation's Water Quality Business Unit who has the process accountability for approving such chemicals.

2.1 Licensing - Overview

The WA Work Health Safety Act 2022 does not include any requirements for licensing of hazardous chemicals as it just sets out requirements for the design of systems and the handling of chemicals.

The Dangerous Goods Safety Act 2004 does include requirements for licensing of Dangerous Goods above defined quantities (known as Manifest quantities) in accordance with Schedule 1 of the Dangerous Goods Regulations. The quantities vary according to the type of chemical. A Dangerous Goods license is site specific and is required **before site construction commences**. The Dangerous Goods Safety Act calls upon the requirements of the Dangerous Goods Safety (Storage & Handing of Non-explosives) Regulations 2007 and various Australian Standards.

The Medicines and Poisons Act 2014 requires a permit to be obtained, for Scheduled chemicals, **before they can be stored on site**. Each Water Corporation Region or Alliance maintains a Poisons Permit that they simply add new additional sites to (or amend the quantities at existing sites).

2.2 Dangerous Goods Licensing - Requirements

2.2.1 Major Hazard Facility Notifications

As part of Dangerous Goods Licensing, a proponent is required to submit a Major Hazard Facility (MHF) Notification to the Dangerous Goods Regulator (the Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)), when a site is intending to store Dangerous Goods more than specified threshold quantities. Liquefied Chlorine Gas is currently the only MHF Schedule chemical used by WC and its threshold for notification is 2.5 tonnes. The Regulator will then decide whether the site will be classified as a MHF and what further risk mitigation requirements will need to be incorporated for the site.

Design Managers shall prepare a Major Hazard Facility Notification, in conjunction with the Senior Principal Engineer - Water Treatment, **at the end of Concept Design stage.** Part of the notification process will entail developing a chlorine buffer drawing.

2.2.2 Dangerous Goods License Applications

The Department of Energy, Mines, Industry Regulation and Safety, requires Dangerous Goods License applications to be developed by accredited licensing consultants, a list of whom can be found on their website. The license application includes an Emergency Response Plan, Emergency Services Manifest and Dangerous Goods Risk Assessment. These three documents are all prepared by the Chemical Safety Specialists in Water Treatment section.

License applications should be submitted to DEMIRS at the **end of Engineering Design stage.**

Note: For sites below Manifest/Licensing quantity, Dangerous Goods cannot be brought on site until an Emergency Response Plan and Emergency Services Manifest have been prepared.

2.3 Poisons Permits

As indicated earlier, the Medicines and Poisons Act requires a permit to be obtained, for Schedule 7 chemicals, **before they can be stored on site**. Currently, the only Schedule 7 chemicals used by the Water Corporation are Chlorine and Fluorosilicic Acid – these are found in Schedule 7 of The Poisons Standard 2019. The Design Manager should arrange with their Chemicals Advisor for the existing Poisons Permit to be updated for the Region or Alliance in question.

3 WATER CORPORATION REQUIREMENTS

During the design process, Water Corporation has two internal requirements concerning the storage of chemicals, as follows:

- Procurement & Property Business Unit (Chemical Contract Officer) shall be **notified by the Design Manager** of the chemical quantities being proposed for a new or upgraded site **before the end of Concept Design stage**,
- A chlorine/ammonia buffer drawing shall be **developed by the Design Manager** in conjunction with the Senior Principal Engineer - Water Treatment **before the end of Engineering Design stage.**

A list of Legislative and Water Corporation Requirements is in **Appendix 1: Design Manager Actions.**

3.1 Estimating Chlorine Buffers

As per the requirements of S224 Defining, Securing, Protecting and Managing Buffers, there is a need to identify and secure the buffer requirements of chlorine facilities. Water Corporation has adopted SLOD distances for identifying its buffer distance requirements. Specifically, the SLOD distances for 6mm liquid leak scenarios under atmospheric stability class F1 are used to determine the buffer distance. SLOD distances are outputs of consequence assessment modelling which is increasingly being used as part of risk consequence assessment by regulators as it provides useful information in understanding the potential health impacts at calculated distances for specific chlorine leak scenarios.

The SLOD distances that shall be used for chlorine facilities are as follows:

Cylinder site (33kg or 70kg) – 60m

Drum site (uncontained) – 265m

Note: The Australian Standard for chlorine, AS 2927, includes a separation distance table (6.1) which provides risk-based distances for various chlorine system configurations and land uses. As the distances are risk-based, however, they don't factor in the responsiveness and capabilities of local emergency responders, who in remote locations are likely to be volunteers.

In remote regional locations, where land use is unlikely to change, the Water Corporation purchases a 30m Public Access exclusion buffer and is required to notify surrounding land-owners within the SLOD buffer. In locations where land use might change, however, Water Corporation policy (as per S224) is to secure the SLOD buffer in some way. This is organised by the Project Manager and Procurement & Property Business Unit.

3.2 Ammonia Buffers

Where gaseous ammonia is stored onsite (typically for chloramination), the site buffer sought shall take its risk impact into account (the ammonia risk levels are cumulative with the chlorine risk levels).

3.3 Buffer Risk Mitigation Options

Risk mitigation options might be considered to either reduce chlorine or ammonia buffers, or to reduce the consequences of a leak. The following are typical reasons for incorporating risk mitigation measures over and above standard designs:

- The chlorine and/or ammonia buffer does not meet or is marginal with respect to meeting SLOD buffer requirements
- Sensitive developments are near the facility (150m for cylinders, 400m for drums).

Typical risk mitigation options include:

- Use of a containment building incorporating a truck drive through delivery area within the building
- Relocation of the chlorine or ammonia facility, or substitution of chlorine with sodium hypochlorite or Electro-chlorination
- Inclusion of a solid media emergency gas scrubber

Note 1: As per DS70-03, Emergency Shut-off Devices (ESDs) are mandatory for Water Corporation chlorine and ammonia facilities.

Note 2: Based on the above risk analysis Water Corporation does not apply the functional requirements of AS61508/AS61511 to the design of its chlorine and ammonia installations as a possible risk mitigation option (risk reduction approach) due to the complexities in managing Functional Safety Systems/Safety Instrumented Systems. The use of other mitigation options is used instead to achieve ALARP risk.

Section 5 of DS70-01 contains additional information concerning chlorine containment buildings.

4 DESIGN PRINCIPLES – RISK MANAGEMENT

The design of chemical facilities is not just about satisfying the requirements of the DG Regulations and Australian Standards. It is about **Risk Management**. The WHS Regulations make this particularly clear (e.g. Hierarchy of Risk Controls), with designers having to provide **Safety in Design** reports which are intended to brief the construction, commissioning, operations and maintenance personnel about hazards associated with the design during their activities.

Chemicals that may pose a risk to the environment shall be risk assessed to determine what controls (e.g. bunding as per section 5.1) need to be incorporated.

The following section addresses the general design principles associated with corrosive chemicals. Chlorine is specifically addressed through the DS70 design standards.

4.1 Housing of Corrosive Chemical Facilities in Buildings

From a risk management perspective, housing of chemical facilities in buildings includes the following advantages:

- It provides an additional level of separation of the hazardous chemical from staff (operations and maintenance) and visitors to site;
- It provides an additional level of security;
- Protects equipment from UV degradation, which might initiate early failure;
- Reduces the impact of extreme ambient temperature fluctuations that could cause operational problems (e.g. hypo – loss of strength, caustic – freezing);
- Provides protection from wind loadings and from bush fires.

Buildings do, however, have a substantial capital cost. This cost must be weighed against the costs of a suitably engineered outdoor facility with a risk profile acceptable to the Asset Delivery Representative.

Note 1: An outdoor facility will not have the same risk profile as a housed facility because of the advantages that a building provides, but, if it has been determined to be the most economical solution, it must be engineered with an acceptable risk profile in line with the User Requirements.

Risk treatment of outdoor facilities has historically been poorly undertaken and under-costed. It has also tended to rely on operations/maintenance, PPE Use and Administrative Controls, which do not conform to the risk management philosophy of the WHS Regulations Hierarchy of Risk Controls.

Note 2: Housed chemical facilities also include the benefit of excluding rainfall from the bund, which eliminates the need to size the bund with additional capacity for rainwater and the capital and operating costs associated with regularly having to keep the bund level low.

Note 3: Housed chemical facilities also include the benefit of shielding chemicals from extreme temperature fluctuations that could cause operational problems (eg hypo – loss of strength, caustic - freezing).

4.2 Design Features of Housed Chemical Facilities

4.2.1 Ventilation

The building ventilation system design shall comply with the requirements of AS1668 and/or any other relevant Australian Standard. Chemicals emitting fumes classifiable as “Type A effluents” (refer AS1668) shall be provided with a combination of natural and mechanical ventilation. Ventilation design shall also consider the properties of the chemical, which includes:

- Containment philosophy versus avoiding explosive atmospheres – consider whether, to mitigate off-site risks, it is important to minimise rate of discharge of toxic gas from the storage room such as for chlorine or if the gas can accumulate to explosive levels (such as for ammonia) then provide a high degree of ventilation to prevent this.
- density of gas relative to air – impacts on location of the largest vents.
- Safety risks – odourless gases (such as carbon dioxide) rely on high degree of ventilation to minimise hazard to personnel rather than their sensory perception providing warning of high concentrations.

4.2.2 PPE and First Aid Storage

The facility shall include generous room to store the PPE and first aid equipment that is required for use in the chemical store and/or dosing room. This space may be provided in a room such as a control room, but it shall be near the chemical store and/or dosing room.

4.2.3 Personnel Doors

The location of access doors to the room shall be selected to maintain the required separation and segregation distances outlined in the Western Australian Dangerous Goods Safety Act 2004 and its associated regulations and codes of practice. Consideration should be given to the potential inclusion of exit only doors where personnel undertaking activities may not be able to access the usual route of entry/exit. If the floor area is greater than 25m2 then two means of access are required. Consideration should be given to the potential inclusion of exit only doors where personnel undertaking activities in the storage and dosing room may not be able to access the usual route of entry/exit.

Personnel doors shall be designed to meet the required fire rating and shall be fitted with crash-bars for use as emergency exits (or shall alternatively be designed to be held in the open position when personnel are inside). They shall open outwards, and the travel path of the doors shall not be restricted by external features on the building or any other structure. External doors shall be metal-faced to provide weather resistance but insulated at the same time to prevent heat transmission into the room. They shall have pull handles and retaining hooks for holding them in the open position when required. A hydraulic-operated door anti-slam closer/dampener shall be provided for each door leaf. Appropriate signs shall be fitted on the doors.

4.2.4 Layout and Design

The internal layout shall be as uncluttered as possible with all piping to be located either around the periphery of the building, under grid-mesh or attached to the ceiling, to give a smooth tidy arrangement which leaves adequate access to all components. The internal walls of the room shall be designed to minimise the number of protrusions and thereby provide as much flush wall space as possible to facilitate running of piping and cable trays around walls. The piping shall also be appropriately located to allow easy access to equipment and pipes and facilitate unobstructed cleaning of the work areas. Ramps over the drops in floor levels should be included at appropriate locations for easy moving of equipment in and out of the building.

The building, inclusive of doors, windows and ventilation openings shall be designed to better withstand bushfire attack in accordance with the most recent version of AS3959 (including any amendments).

The building shall also be designed to exclude wildlife, insects and vermin. Measures shall include door seals, tropical midge mesh on ventilation openings, and brush-ware around the edges of the roller shutter to impede ingress of insects through the doorway when the roller shutter is in the closed position.

The building shall be designed so that storage tanks can be removed and replaced. The order of preference is that tank removal be through doorways (e.g. roller doors), or by using removable wall panels, or having a roof specially designed with a lift-out section such that the structure retains integrity when the roof section is removed. For facilities with two or more storage tanks, the design shall allow for replacement of any tank while the others remain in operation.

4.3 Design Features of Outdoor Chemical Facilities

As noted in section 4.1, outdoor facilities are subject to multiple issues that need to be addressed through substitution, elimination or engineering controls. The design of outdoor facilities must not rely on operations/maintenance, PPE Use and/or Administrative Controls as these do not conform to the risk management philosophy of the WHS Regulations' Hierarchy of Controls.

4.3.1 Consideration of Operational Activities

Consideration needs to be given to operational activities that may occur in the vicinity of an outdoor storage, as personnel should not be reliant on PPE Use or Administrative Controls when undertaking routine tasks – e.g. checking instrument readings, taking samples, moving from one area of plant to another, etc.

Maintenance activities are normally not an issue as plant is typically taken off-line to allow work to be performed. If this is **not** the case, however, then the design should incorporate risk mitigation measures (e.g. separate dosing panel enclosures for each dosing pump) so that personnel are not solely reliant on PPE Use or Administrative Controls.

4.4 Lighting

Internal lighting, external entry lighting and lighting on internal roads shall be provided, all with easy and safe access for lamp maintenance. These lighting levels and other characteristics shall be designed so as to conform to the requirements of DS28. Internal lighting shall be on backup power supply (e.g. UPS) unless specifically not required in the project User Requirements. The building shall be equipped with internal emergency lighting that has battery backup.

4.5 Chemical Pipework – Risk Management

Consideration should be given to dilution of chemicals within the storage bund to reduce the hazard that they present to personnel, but it is accepted that process reasons can preclude this, and that it is impractical to dilute some chemicals below hazardous levels. Regardless of whether this occurs or not, all chemical pipework shall be designed with risk treatment and run in such a way as to prevent any spillage from impacting people or the environment.

Factors that will influence the risk treatment design include:

- The proximity of the chemical line/pipework to areas frequented by operational/maintenance personnel (at least 5m separation).
- The degree of hazard presented by the undiluted or diluted chemical; and
- The height of the pipework, etc.

Note: Some diluted chemicals still present a significant hazard in the event of a leak and so their pipework should be subject to high levels of risk mitigation treatment.

Chemical pipework running within a bund or containment area shall therefore be subject to the following types of risk treatment:

- Surrounded by containment piping that drains to the chemical bund sump or viewing/catch pots at low points.
- Run in an enclosure (such as a duct) that prevents spraying of any chemical leak. DS79-3 provides further detail on requirements.

Outside a bunded or containment area, chemical pipework shall conform to one of the following risk treatments:

- Surrounded by containment piping that drains to a chemical bund sump or viewing/catch pots at low points.
- Run in an enclosure (such as a duct) that prevents spraying or leakage of any chemical.
- Run without protection where there is minimal risk of environmental pollution or injury arising as a result of a leak.

Dosing pump panels shall be housed in an enclosure which complies with DS79-03 Chemical Barrier Protection Standard that allows ready maintenance access, but which will prevent a chemical jet from spraying personnel or equipment.

It should be noted that in some cases there may be less risk and cost in running a pipe tube within a PE pipe, compared to running a double-contained PVC pipe. The expected life of the tube in contact with the chemical, the length of the tube and the number of bends (a key source of risk) that a PVC pipe might have to navigate will all be key inputs into the option assessment.

4.6 Materials of Construction Issues

Selection of materials of construction shall consider the impacts of fumes emanating from the chemical in question, as well as its properties when undergoing dilution (including heat of dilution). Water Corporation mechanical design standards shall be complied with where applicable.

5 DESIGN PRINCIPLES – STORAGE CONSIDERATIONS FOR LIQUID CHEMICALS

5.1 Chemical Storage Bunding

A bund designed and constructed in accordance with the DG Regulations and AS 3780, shall extend beneath the storage tank, the load-in panel (for bulk tanks) and all dosing equipment. There shall be no penetrations through the bund wall or floor, other than the drain pipework for the bund sump. The bund shall be separated from Protected Places and Public Places in accordance with the DG Regulations and AS 3780.

Where a bund is to be located outdoors, provisions shall be made for managing the ingress of rain, leaves and debris.

5.1.1 Bund Volume and Geometry

Bund volume shall be at least 110% of the design capacity of the largest tank in the bund (not to be confused with the tank working volume). This calculated volume **shall not include the volume occupied by foundations and other items within the bund**. If tanks are cross connected and operated together, rather than as duty and standby, then the bund shall be sized to hold 110% of the total design capacity of both tanks.

The bund wall height and position relative to the chemical storage tanks shall be such that:

- the bund wall shall be at least 1000 mm from any storage tank containing dangerous goods to allow for clear access; and
- no portion of the tank shall lie outside of any line drawn from the top inside edge of the bund wall at an angle of 26.5 degrees to the vertical (this is equivalent to a rise of 2 metres for every one horizontal metre – the tan theta/crest locus limit rule of AS3780). This is to prevent liquid squirting over and outside the bund wall.

For facilities with more than one tank, the minimum separation distance between the tanks is 600mm (AS3780 5.3.2.2), however for ease of access for maintenance and operation 1000mm is preferred.

The bund floor shall have a minimum slope of 1 in 50 falling towards its sump which shall be in a corner that is readily accessible by maintenance personnel. Note that this grade has been deliberately selected to be greater than typical tolerances for unformed surfaces to avoid ponding.

Commissioning Plan Information
As part of construction quality assurance or Factory Acceptance (in the case of modules), the bund floor slope shall be checked to confirm that requirements have been satisfied. A test shall be conducted for ponding.

5.1.2 Bund Sump and Valves

The bund shall include a sump of sufficient size to provide ample access and volume for neutralisation or dilution of small spills and to hold all equipment, instruments and pipework terminations:

- float valve (for wet sumps),
- high level switch,
- conductivity or pH sensor,
- overflow lines,
- drain lines, etc.

A toroidal conductivity sensor in a dry sump is generally the preferred instrument for leak[1] detection because they have low maintenance requirements as they do not require frequent calibration. However, a wet sump shall be used if the neat chemical will release fumes[2] (except a wet sump is not recommended where reaction of the neat chemical with water is strongly exothermic, such as sulphuric acid).

For wet sumps, a conductivity sensor or pH sensor shall be used with the choice being based on Regional preference.

Where there is a need to use a wet sump, it shall include a float-operated water supply valve to maintain a fixed water level in the sump. As this valve is crucial for the effective functioning of the wet sump, the float operated valve must be of durable, high-quality construction. The robust, heavy duty type valve shall have a reliable control mechanism that requires minimal maintenance. Valve components shall be constructed with materials that are corrosion-resistant and suitable for the chemical environment. An accessible isolation valve shall be provided upstream of the float valve.

The bund sump shall be adequately sized to house all necessary equipment, instruments, and pipe entries. From past project experience the recommended minimum sump dimensions are: 1200 long x 800 wide x 300 deep. This arrangement provides adequate volume for spill neutralisation and sufficient water depth for operation of a float valve and immersion of a pH sensor[3]. Clear access for maintenance of the valves and equipment located in and adjacent to the sump shall be provided.

A DN50 PVC drain outlet pipe positioned flush with the floor of the sump shall lead to an exterior valve pit outside the building. The bund drain valve pit shall contain:

- a DN50 manual bund outlet valve; and
- a DN50 motorised 3-way bund outlet diverter valve.

Drawing GT36-060-83.1 illustrates the requirements. The recommended minimum valve pit dimensions are 1200 long x 600 wide to enable easy access for the installation and maintenance of these valves.

The design of the valve pit shall ensure that:

- chemical (spills) cannot enter the pit.
- it does not present any trip or fall hazards when the pit cover is in place. This may necessitate the inclusion of a removable cover[4].
- any water that inadvertently enters the pit does not accumulate and cannot result in the valve or actuator becoming submerged.
- The pit and cover have appropriate load rating for personnel and/or vehicles relevant to its location.

The motorised 3-way valve shall be operated from a local operator interface panel (LOIP) and shall be interlocked with sump conductivity or pH to prevent inadvertent discharge of chemical from the bund. An override shall be available from the LOIP to allow this interlock to be overridden by the operator on site, only once they have confirmed that the contents of the sump are safe for disposal to site drainage. The override shall be time limited to 30 minutes (i.e. valve will then close) in order to prevent the valve accidentally being left in the drainage position.

A motorised three-way valve shall be used to direct the bund contents to either a waste holding tank or the sludge drying bed/drainage system. Normally the valve is closed to prevent the discharge of chemical. This also normally provides a double isolation in the bund sump drain line as the motorised bund outlet valve is also normally closed. However, when the contents of the internal bund sump are known to not be contaminated with chemical, such as may be the case during a routine bund hose down, the valve is operated to direct this uncontaminated water to the sludge drying beds or drainage system.

[1] When selecting alarm setpoints, note that if the chemical weakly dissociates (i.e. providing only a small change to conductivity) such as citric acid, ammonium hydroxide, and sodium hydroxide, then it will be difficult to distinguish between water and chemical.
[2] An issue particularly following chemical delivery when small amounts report to the bund sump.
[3] Note that the toroidal type of conductivity sensor can operate dry, and so does not require immersion.
[4] To provide easy/ergonomic access the pit cover shall be lightweight unless its location requires it to be trafficable.

The three-way isolation valve shall be in an exterior valve pit which shall have a removable cover5, allowing ready access to the bund outlet valve and isolation valves when the bund is full.

Any valves below gridmesh or ground level (e.g. exterior valve pit) shall be supplied with securely supported extension spindles and handles located just below the FRP gridmesh where applicable in order to allow manual operation without sump entry. The valve tag numbers, description along with open and closed positions shall be clearly marked on each valve.

Any rainwater collected in this external sump will be directed to a local soak or the load-in apron sump by a DN100 PVC drain line.

An additional collection chamber, sump pump and delivery line shall be provided if gravity flow to the drying beds and waste holding tank cannot be achieved from the sump. This system can be common with other compatible chemical bund sump drains.

5.1.3 Bund Linings and Coating

A chemical proof (or resistant) coating shall be provided for the bund. Coatings for concrete bunds shall comply with Water Corporation Coating Specification CR5.

The bund floor, sump, walls (and building walls where these are within the crest locus limit of the tank and therefore acting as a bund wall) and tank plinths shall be coated. The grouting at the interface between supports or equipment shall also be coated to the same standard as the rest of the bund. The floor coating system shall incorporate a non-slip finish.

Full PVC lining with joined PVC sheet is very expensive and not believed necessary given the vast array of relatively inexpensive polymer and epoxy-based acid resistant surface coatings now available. Experience has also shown that PVC bunds can be susceptible to cracking at the joints.

To achieve effective water-tight sealing of the bund, proper application of coatings is essential especially around the bund drain pipe which passes through the bund wall- no other bund penetrations shall be made. Strict specifications for products to be used and the methods of application should be in place to ensure that this is achieved.

Commissioning Plan Information
A 24-hour hydrostatic leak test shall be conducted on a bund prior to the filling of its associated storage tank(s) with chemical. Confirm the absence of any bund floor or wall penetrations other than the bund drain as such penetrations have been the cause of several chemical leak incidents.

5.2 Platforms and Stairways

An FRP gridmesh platform is to be provided over the bund to give access around the tank if there are any valves in the bund that require operation. Cut-out sections with removable covers shall be provided to allow easy access for likely operational activities (e.g. to allow removal of valves, neutralisation activities, etc.) and to comply with DS100 (s3.5.2 is particularly relevant).

Sufficient gridmesh area is required to accommodate the load-in and dosing panel(s) and associated equipment. The height of the platform is to suit the height of the load-in connection (refer to section 5.4.3 for further detail), but shall be above the flood level of the bund. All platforms and stairways shall be designed in accordance with DS30-02, DS100, AS1170.1 and AS1657 and shall have the necessary kickplate and handrails. All structural components of the floor, stairs and handrail system shall also be FRP.

There shall be a stairway from the platform down to the bund floor for access to the bund sump. All stairways from platforms where work might be undertaken (e.g. on nearby instruments, valves, etc.) shall be equipped with automatic self-closing gates. The gates shall close in such a way as to prevent

[5] To provide easy/ergonomic access the pit cover shall be lightweight unless its location requires it to be trafficable.

people from falling down stairs. Stairs and platforms shall be sized to accommodate the movement of personnel wearing fully encapsulated protective suits and SCBA sets.

The FRP grating selected for the platform shall:

a) Be resistant to the chemical;

b) Be a moulded type with square mesh pattern to provide bi-directional strength;

c) Have a non-slip grit top surface;

d) Have a layout which enables access to pipework, valves and equipment by incorporating readily removable sections;

e) Be fastened in place using 316 SS clips to prevent sliding and overturning; and

f) Have any shop or field cuts coated with resin to provide maximum corrosion resistance.

Various grades of FRP grating are available, so it is important to ensure that the FRP grating selected and supplied for a chemical storage room is resistant to the chemical and its fumes. Each manufacturer has its own means of designating grating types, whether it be specific colours to indicate acid resistance or cast-in identification threads, so suitability will need to be confirmed with the individual FRP manufacturer when a grating is being considered for use.

The design should minimise the number of valve spindles to be extended above grating level and provide cutouts to allow use of a tool to operate below the grating valves (operators shall not be required to have to kneel and/or extend their hands below grating level. **Cutouts shall not create a tripping hazard or obstruct access/egress ways**. Where cut outs are required in the FRP grating, for raised valve spindles or to accommodate equipment, then proper strengthening and support of the modified grating shall be carried out by qualified designers and installers to ensure its integrity is not compromised. The open hole in the grating that results from the cut out shall be covered with a removable cut-to-shape FRP grating panel securely supported and clipped. All modification work to the grating shall comply with the relevant WHS requirements for safe access of Grid Mesh Landings.

Equipment and valve spindle end shall not protrude out of the FRP grating where it could pose a tripping hazard.

The design of the FRP platform supports shall:

a) Meet the design loading requirements;

b) Allow for access to pipework and equipment;

c) Take into account the direction of fall across bund floor; and

d) Keep the number of concrete embedment's to a minimum.

Structural FRP members shall be secured to the concrete floors and walls using 316 SS chemical anchors. The concrete to base plate interface shall be grouted (30 mm nominal) to prevent liquids and debris collecting underneath. Unless resistant to the chemical, the grout shall be coated to the same standard as the bund.

5.3 Accessibility

A minimum clearance of 1m shall be provided around all sides of equipment that require maintenance access, with consideration given to a greater clearance where maintenance activities require it.

All valves, pumps, ancillary equipment, and instruments shall be accessible without having to enter the bund and located above bund wall height. This requirement has an additional benefit of allowing the bund integrity to be tested through filling of the bund to wall height.

5.4 Bulk Delivery Requirements

5.4.1 Delivery Sizes

Delivery truck sizes for project locations shall be checked with Procurement & Property Business Unit (Chemical Contract Officer). Tanks shall be sized so that delivery volumes can be accommodated in the volume contained between the high alarm and low alarm levels.

The power supply, delivery hose length and turning circle requirements for the proposed delivery truck shall be identified early in engineering design stage – Procurement & Property Business Unit (Chemical Contract Officer) should again be contacted to obtain these details.

Where required, a permanently mounted, external weatherproof electrical power outlet conforming to the following specifications shall be provided for truck-mounted pumps:

a) Power outlet to be located away from the delivery hose connection point, but, within 7.5 metres of the road tanker;
b) IP56 rated combination switch and 4-pin plug socket for 3-phase, 415 Volts, 50 Hz at 20 Amp rating with earth leakage protection (e.g. Clipsal 56 Series);
c) Equipment rated for starting a “x” kW motor;
d) Earthing point close to plug outlet and earth leakage protection;
e) The installation is to be in accordance with AS 3000 and power supply authority regulations including appropriate labelling.

The power outlet shall incorporate a device to cut off the power supply when the storage tank high high level alarm is initiated.

Early in the design phase the designers shall confirm what type of deliveries will be received and design the load-in facilities accordingly.

5.4.2 Load-in apron

A 200 mm thick reinforced concrete load-in apron shall be provided adjacent to the chemical storage room and be 4.5m wide. The length is dependent upon the delivery truck type, although the truck cab does not need to be contained within the load-in apron. The load-in apron shall be located nearest to the load-in panel door opening as the length of flexible transfer hose is 4m.[6] The apron shall have a small trafficable lip ramped 30-50mm in height above the roadway around the perimeter for the containment of spills.

The load-in apron shall be graded to a sump from where its contents drain to either a soak well/site storm water drainage, or a waste holding tank via an actuated 3-way valve. Under normal conditions, this valve is opened to discharge to the soakwell/site drainage so that rainwater is not collected on the apron. During a delivery it is part of the tanker truck driver’s procedures to open the door in front of the load-in panel. At sites where the security system is not linked to the load-in system, the opening of this door shall automatically initiate the 3-way valve to open to the waste holding tank (and close to site drainage) in anticipation of any potential spillage. At the end of the load-in process, the door to the load-in panel would be closed activating the switch to revert the valve back to its normal state of ‘open to site drainage’ and ‘closed to the waste holding tank’.

The actuated 3-way valve shall have limit switches to indicate valve position on the HMI, OIP and load-in panel displays. It shall have manual override with securely supported extended spindles all housed in a valve pit with removable cover. In the event of valve failure or power outage, the valve shall automatically fail to the “open to the waste holding tank”/“closed to site drainage” position.

[6] As provided by. Coogee Chemicals Pty Ltd “Bulk Storage Installation Guide”. Maximum allowable hose length from AS3780 Cl 5.8.3 (a) is 6m.

The sump shall be fitted with a suitable level switch to provide warning when the content in the sump has reached a set high level. The sump high level alarm shall be enunciated on the load-in panel and on the OIP/HMI.

For multi-chemical facilities, the designer should consider the risk due to spills of incompatible chemicals (e.g. acid and sodium hypochlorite) mixing in the waste holding tank and associated pipework.

Road access to the load-in apron shall be designed to include a drive-through route. If this is not possible, as may be the case on brown field sites, a turning circle shall be incorporated. This is to enable the delivery truck to be driven clear of the facility without the need to reverse[7].

A safety shower shall be provided at apron level between 2 and 7m from the transfer point, primarily for the use of the delivery driver, and a 600 mm wide clear access route to this shower shall be always maintained. Any platform or stairs projecting onto the load-in apron shall be designed so that access to the safety shower is not restricted, especially when the truck is parked up for unloading. See also section 5.8.2.

5.4.3 Load-in Panel and Transfer Point

Chemicals are transferred from the delivery truck into the storage tanks via a transfer point on the load-in panel. The load-in connection shall be located at a height such that the flexible hose will drain back to the delivery tanker (2.2m height above road level is typical, but should be checked for the chemical tanker in question). Sodium Hydroxide and Sulphuric Acid connection points shall always be at high level to allow hose drainage back to the delivery tanker due to the difficulties in managing these very corrosive chemicals as waste.

5.4.3.1 High Delivery Connections

The acceptable range for high connection points is 1.9 – 2.2 metres relative to road level where the delivery tanker parks. High delivery connections provide the most opportunity to drain the chemical delivery hose back to the tanker and thereby prevent chemical being released to the bund, which can cause corrosion of the bund sump. The connection can be at either 90 degrees to the vertical or a slight angle (22.5 degrees below the horizontal) in a downwards direction. This allows free drainage back down the delivery hose once the delivery is completed and because of the slight angle can in some cases eliminate extra hose support. The preferred angle is 90 degrees to the vertical because this is a simpler arrangement.

5.4.3.2 Deliveries at or below 1.2 metres

A delivery hose connection of around 1200mm is best with a 90-degree load-in connection (this may require the inclusion of a platform to achieve this). This allows the hose to have no dead legs and enables the driver to freely lift the hose to drain all remaining product left in the hose at the completion of the delivery. Low delivery connections shall not have an angle in a downward direction because it makes it impossible for the driver to drain the hose completely.

Note: for sodium hydroxide installations with a low delivery point, a small double diaphragm pump shall be incorporated at the load-in transfer point to assist with the residual chemical waste that remains after a delivery has occurred. An example of this is illustrated on drawing 12410-70-031.1 & 12410-60-668.3. It shall be located at a safe and ergonomic height for connection and disconnection - 1m above floor level is recommended (this normally requires the inclusion of a platform to achieve this).

5.4.3.3 Load-in connection requirements

The load-in connection shall meet the following requirements:

[7] AS3780 Cl 5.5.7 (d) iii requirement.

- It shall be located at least 5m from any protected places or the plant boundary8.
- The design shall allow for a delivery hose of 4m in length (between the tanker and load-in camlock).
- If using a 22.5deg bend, then it shall be fitted to the panel using a flanged fitting, for ease of replacement (glue not to be used). The 22.5 deg bend and camlock are high wear components and are regularly damaged or broken-off. For ease of replacement, a flanged joint shall be used to connect the 22.5° fitting to the piping instead of solvent welding. The flanged joint shall be enclosed in a removable Perspex box to minimise the impact of a gasket failure. Screw fittings shall not be employed in accordance with AS3780.
- It shall have a safety shower and eye wash compliant with DS79-02, located between 2 and 7m from the transfer point and on the same level (no stairs or other obstacles along route). A 600mm wide clear access route to this shower shall be always maintained. Any platform or stairs projecting onto the load-in apron shall be designed so that access to the safety shower is not restricted or impeded, especially when the truck is parked up for unloading. Where a platform is provided, a safety shower and eyewash shall also be provided at that level.
- It shall be a type A camlock coupling with matching type DC dust cover (polypropylene is typically used as it is compatible with most chemicals, but this should be confirmed by the designer). The coupling size and configuration to be used shall be confirmed with Procurement & Property Business Unit (Chemical Contracts Officer).
    - It shall have a spring-to-close valved drip leg, which is used to check that the delivery line has drained completely prior to disconnection of the hose. The spring-to-close valve automatically shuts when the Operator releases grip on the manual actuator, thereby preventing risk that the drip leg valve mistakenly gets left open during chemical deliveries.
    - All flanged fittings shall be enclosed in a removable Perspex box to minimise the impact of a gasket failure.

The load-in panel shall be located inside the bunded area. Where possible the FRP gridmesh covering the bund within the chemical room shall also be at the same level as the elevated platform. A roller shutter door complete with thermal insulation shall be provided to gain access to the load-in panel for the tanker hoses. Outside the building, there shall be a continuation of the platform in front of the roller shutter door (refer to the below Figure 5-1 for an example of this configuration), and a stairway shall give access to this external platform from ground level. Drawing GT36-070-083-1 provides an illustration of this arrangement for information.

[8] AS3780 Cl 5.5.7 (c) requirement.

Figure 5-1: Continuation of raised platform outside roller door

The load-in panel shall be constructed from PVC sheet (nominally 12 mm thick) with FRP frame and supports. It shall have a drip tray which runs the full length of the panel and extends well clear of the valves and transfer point mounted on the panel to collect any drips. The tray shall have additional side and bottom supports to prevent cracking of PVC welds due to the weight of the hose and operator. The front of the tray shall have a rolled over reinforced edge to act as an intermediate support for the transfer hose. The drip tray shall be graded towards a drain that is piped to the bund sump and made from material compatible with both the delivered strength and diluted strength of the chemical (e.g. Sulphuric Acid is a particular issue due to heat of dilution as well as change in corrosivity).

Along with the camlock, the load-in panel shall have the following valves and equipment mounted on it:

- tank filling line isolation valves;
- drip leg valve;
- large sized tank level indicators;
- high level visual alarm;
- high level visual and audible alarms;
- alarm acknowledge pushbuttons;
- manual alarm (light/siren) test pushbutton; and
- tank/bund pump out connection point;
- load-in apron sump drain valve position indicator lights;

- load-in apron sump high level indicator light; and
- a drip tray.

The tank/bund pump out connection point is usually a DN50 type B or D polypropylene camlock coupling with matching type DP dust plug which is used to remove chemical from the bund sump or directly from the tanks in the event of a significant spill or for maintenance. A valved water inlet point for flushing and priming of the pump-out piping shall be also provided.

The displays, lights and sirens shall be mounted on the load-in panel to be as far apart as is practical from the load-in point to minimise corrosion of the instrumentation. The manual alarm (light/siren) test pushbutton is provided so operators and maintainers can simply and routinely check alarm light and siren operation without having to first generate or simulate an alarm condition. Similar to the safety showers, the alarm light and siren should be tested every time before unloading chemical into the tanks.

The digital readout display of the tank level indicators shall be clearly legible to the delivery driver during unloading, who would likely be standing next to the transfer pump control on his truck a few metres away. The digital readout display shall therefore have a minimum character height of 38 mm with a sunshade fitted on top to prevent glare.

All valves and equipment mounted on the panel shall be mounted at an easily accessible level (no higher than 1.8m above floor level is preferred) and shall be clearly labelled with an engraved traffolyte tag number (red tags for critical safeguards, white tags for all other equipment) and functional description e.g. VA83110 TANK 1 FILL VALVE. Other signage which shall appear on the load-in panel includes the maximum fill level label.

The purpose of the maximum fill level label is so the Operator and Delivery Driver can check that there is sufficient storage space in the tanks to accept a whole delivery load prior to commencement of the unloading. The units used on the maximum fill level label and on the tank level indicators shall be litres.

All pipework and connections shall be rigidly fixed by pipe supports fastened to the load-in panel. All fixings on the panel shall be 316 SS.

An example of a load-in panel arrangement illustrating these requirements is shown in drawing GT36-070-083-09.

5.5 Bulk Storage Systems

5.5.1 Storage Tank design

The choice of storage tank material shall be based upon the whole of life cost, based on a design life of 25 years. GRP tanks shall comply with SPS498. Polyethylene tanks shall comply with SPS497. Other tank materials shall comply with a relevant design code/standard. Rotationally moulded polyethylene tanks are not considered to provide the required 25-year life and therefore shall not be used for bulk storage of corrosive chemicals. Tanks for storing sodium hydroxide and sulphuric acid shall also comply with the requirements of section 5.12. The use of double skinned/walled tanks is generally prohibited because they do not obviate the need for bunding, and the Water Corporation does not have confidence that the penetrations between the tank walls will deliver the required asset life. For the rare occasions where it is identified that they may offer a site/project specific benefit, the approval of the Senior Principal Engineer Water Treatment is required for their use.

All tanks shall comply with the process requirements set out in the following sections.

Consideration shall be given to the operational and maintenance benefits of using two tanks instead of one larger tank. Storage tanks shall have a working volume storage capacity of at least 2 weeks during peak (not to be confused with the tank design capacity).

Each tank shall include as a minimum the following fittings:

- one (1) flanged scour outlet nozzle either on the bottom of the tank, or the side if provision is made to ensure that the scour can drain the entire tank – e.g. inclusion of a false floor;
- one (1) flanged tank overflow outlet nozzle with overflow pipework supports. The invert level of this outlet shall be specified;
- one (1) flanged tank fill point inlet nozzle on the tank lid. For sulphuric acid, an inlet pipe shall extend within the tank and terminate 300mm above the top of the overflow in order to prevent chemical from running down the tank walls and thereby cause erosion-corrosion;
- one (1) flanged process outlet nozzle on the side of the tank (to supply chemical to dosing panels);
- one (1) flanged tank vent nozzle connection in the tank lid;
- two (2) flanged nozzles, vertically in line with each other, on the side of the tank (for mounting of a magnetic level gauge);
- sufficient lifting lugs;
- one (1) flanged nozzle on the side of the tank for connecting to a pressure transmitter;
- one (1) flanged side entry inspection port of diameter 600mm, to allow camera-based inspection of the tank interior or entry of a hose for flushing purposes. The inspection port needs to be airtight when closed. (Port not required for tanks below 5kL in capacity)[9].

Each tank shall have an integral non-removable roof. The base of the storage tank should be graded towards the scour outlet where practicable to ensure that the tank can be drained completely. A false floor may be required to achieve this requirement.

Each tank shall be designed for the following criteria:

a) Operating & Design Temperature: range appropriate to the site

b) Operating & Design Pressure: atmospheric and hydrostatic

c) Roof Live Loading: 1.25kPa

Adequate fixings at the base of each tank shall be provided to resist all seismic and wind loads as appropriate for the area.

All nozzles shall be flanged, reinforced and of size DN50 minimum, except the overflow nozzle which shall be at least 1.5 times the filling line diameter of the inlet line, so the minimum size of this nozzle shall be DN80[10]. In accordance with DS38-02 all flanges shall be Class 16 to AS 4087, unless a different flange standard has been adopted for the site for consistency. All flange bolt holes shall straddle the centre line.

All nozzle isolation valves shall be hard flanged to the tank nozzles and shall be sized according to the respective nozzle flange size, not the outgoing pipe size if it happens to be smaller than the nozzle. Ensuring no other fitting between each isolation valve and the tank minimises the risk of potential leakage on isolation.

The designer shall provide drawings to the tank supplier that clearly show the desired location and size of all connections and fittings on the tank(s).

A permanently affixed corrosion resistant compliance plate shall be provided on the outside of the tank[11]. This plate is best located at eye level and positioned so it can be read without stepping down into the bunded area.

[9] Although an inspection port is provided, Water Corporation asset management philosophy is to minimise tank inspections due to the cost of emptying and decontaminating tanks.

[10] AS3780 Cl 5.7.7 (b) requirement.

[11] AS3780 Cl 5.7 requires certain information concerning tank details to be available to a DEMIRS inspector.

The characters shall be at least 5 mm high and it shall contain the following information:

- Manufacturer’s name or Registered Trademark
- Date of Manufacture (Year of completion)
- Serial Number
- Tank Identification number or Tag Number
- Design Capacity (Volume kL and Weight kg)
- Design pressure and temperature
- Design liquid specific gravity
- Material of manufacture and grade
- Design Code/Standard

Commissioning Plan Information
Prior to delivery to site all tanks shall be hydrostatically tested using clean water filled to the overflow level at the workshop. The full static head is to be held for a minimum of 12 hours.Once installed, the tanks should be hydrostatically tested again to check for any damage which may have occurred during transportation or installation. All tanks shall be transported to site with blind flanges fixed to all nozzles to prevent dust, moisture and vermin entering vessels. If a crane is required to install PE & GRP tanks then soft sling rigs shall be used on the shackles so as not to cause damage. Note1: SPS498 contains greater detail on packaging, transport, installation and testing. Note 2: For some chemicals such as 98% Sulphuric Acid for which water testing may be problematic, this requirement should be replaced by an alternative quality assurance method.

5.5.2 Tank Plinth

A concrete plinth or tank stand shall be provided for each storage tank so that its base is at least above the 110% bund fill level. The bund floor shall be designed to support the tank plinth or stand with a tank full to the top of its wall.

The benefits of an elevated plinth include the following:

- Tank valves and associated control cabling are precluded from inundation,
- Associated dosing pumps are provided with a guaranteed minimum net positive suction head and can therefore be mounted at bund wall height.

5.5.3 Tank Level Measurement

An externally mounted level transmitter shall be provided to measure chemical level in each storage tank. The signal from the level transmitter shall be used to calculate the amount of chemical in the tank and to generate high level and low level alarms. This quantity shall be displayed locally at the load-in panel as well as on the Local Operator Information Panel and Human Machine Interface. The tank level indication on the Local Operator Information Panel and Human Machine Interface shall be % and litres. The load-in panel digital read-out shall show litres. The maximum fill level shall also be shown as text on the load-in panel, magnetic level gauge, Local Operator Information Panel and HMI in litres.

The high level alarm generated by the level transmitter shall isolate the GPO used by the tanker (if provided) and activate a flashing light on the load-in panel to alert personnel that a high level in the tank has been reached and there is the potential for a tank overflow if the unloading operation is not terminated. The high level alarm is termed the "Maximum Fill Level" and shall be set at a level which corresponds to 2 minutes (~1000L depending on the transfer pump) before a tank would commence overflowing during a filling operation.

The low level alarm generated from this instrument is used to notify the operator that the chemical re-order level has been reached and should be set at a level which corresponds to the tank being sufficiently empty to receive a full delivery of chemical without triggering the high level alarm.

The low level alarm shall be set at just above the invert level of the tank process outlet and is used as a trigger to shutdown the chemical dosing system to prevent the dosing pump from running dry (and initiate changeover to the standby tank & dosing system if project requirements/specification specify this configuration). The volume of the tank between the low level and low-low level alarms should equate to approximately 5 days of consumption at peak use.

5.5.3.1 Level Transmitter Selection

Level measurement using radar level transmitters has the advantage of direct measurement of fluid level and not being in contact with corrosive chemical fumes or potentially explosive atmospheres if mounted above the tank roof (i.e. above a blank flange). Consideration needs to be given to the minimum range (deadband) that the sensor can detect and the beam angle. By not being exposed to the tank atmosphere, the radar level sensor will have negligible maintenance requirement and be operated to failure with no need to access the tank roof for maintenance. Requirement to work at heights may be further reduced by installing the transmitter at ground level with only the sensor installed at the top of the tank.

Ultrasonic sensors have the disadvantage(s) of more frequent maintenance requirement due to exposure to chemical fumes inside the tank (and, if there is potential for explosive atmospheres, then specified as intrinsically safe), plus they have the disadvantage of working at heights (though may be considered for tanks less than ~2 metres in height).

Level measurement using a pressure transmitter has the advantage of avoiding working at heights, but disadvantage of inferring level which is reliant on calibration with the specific gravity of the solution. Working at heights may not be a significant consideration for small volume tanks if they have low height where a radar level transmitter is preferred. A disadvantage of pressure transmitters is the risk of exposure to chemical solution during maintenance.

The pressure transmitter shall be installed on side-mounted tank connections, complete with isolation valves, scour valve and flushing facilities as shown on the P&ID to permit safe calibration and testing. The pipework which connects the pressure transmitter to the tank shall be as short as practicable to minimise the amount of chemical which needs to be drained away and flushed to gain access to the transmitter for maintenance. A diaphragm seal with an appropriate material shall be incorporated in the pressure transmitter installation to protect the transmitter components from contact with chemical.

Pressure transmitters are generally preferred to ultrasonic level detectors because:

- they minimise access requirements to top of tank, thereby avoiding work health and safety issues associated with working at heights;
- have lower capital cost because no stairway and platform are required on top of tank; and
- calibration is simple using simulated injection of pressure, whereas calibration of an ultrasonic level device requires either manual handling of the sensor or raising levels in the tanks to known levels.

Where pressure transmitters are used to derive a level in the tank, it is important that the specific gravity of the chemical is known when setting up and calibrating the pressure transmitters and level indicator.

Commissioning Plan Information
Confirm accurate calibration of the tank level indication from the pressure transmitter for the specific gravity of the chemical to be stored in the tank. Confirm high and high-high level alarms initiate well before the tank overflows.

5.5.3.2 Tank Magnetic Coupled Level Gauge

In addition to a level transmitter (radar, ultrasonic or pressure), each storage tank shall be fitted with a magnetic coupled level gauge. The magnetic coupled level gauge provides a simple, continuous and positive indication of the tank contents and thus a cross-check of the electronic (pressure) transmitter. This reduces the need to periodically spot check calibration of the electronic indicator. It also provides a back-up level measurement device in the event of power failure.

Each tank magnetic coupled level gauge shall be of bar graph indicator type with a red/white (flip/flop) display that is visible from the tanker unloading apron. Shuttle types are not acceptable as they can lose linkage to the float. A level of float positive buoyancy shall be acquired against the lowest possible specific gravity to ensure the float remains in position for all normal and abnormal operations.

A high high magnetic sensing level switch shall be added to the magnetic coupled level gauge to provide protection against tank overflow, independent of the pressure transmitter generated alarms. The high high level switch shall initiate an alarm on SCADA as well as audible and visual alarms on the load-in panel. It shall also be interlocked to isolate power to the chemical load-in GPO. The high-high level switch shall be set at a level which corresponds to 20 secs before tank overflow.

Each magnetic coupled level gauge shall be plumbed to side connections on the storage tank complete with isolation, scour and flushing facilities (FSA standard P&ID GT36-060-083-1 provides an example). The valves allow the gauge to be removed without having to drain the tank. The float chamber shall be constructed of materials suitable for contact with the chemical.

5.6 Bulk Storage System Pipework

5.6.1 Filling Line

The chemical storage tank filling lines shall be DN50 minimum (80mm for Sulphuric Acid and Sodium Hydroxide). The roof mounted fill line into the tank shall be located diametrically opposite the outlet pipe to minimise the possibility of any air entrainment during filling from interfering with the operation of the dosing pump. The fill line shall enter the tank above the overflow level, and for sulphuric acid, include a termination inside the tank, 300mm above overflow level that prevents spraying of walls that could cause erosion-corrosion.

Apart from a small section of fill pipework which is mounted on the load-in panel, the filling line shall be sloped to drain back to the tank. The onboard tanker pumps used for delivery are typically capable of pumping up to 10 m head, therefore the height of the filling line (relative to the chemical delivery vehicles tank) should not exceed this height.

Commissioning Plan Information
Prior to the first delivery of chemical, the filling line shall be hydrostatically pressure tested in accordance with AS 4041 to 1.5 times the operating pressure of the tanker pump and held for a minimum of 30 mins. Written proof of this test will be requested by the chemical Supplier and shall be made available to them. Note: The tank shall not be subject to the test pressure as it is only rated for the static head up to the overflow level.

5.6.2 Vent Line

Each tank shall have a vent line to allow venting of fumes during tank filling and vacuum relief during tank emptying. The vent line shall be sized to ensure adequate air flow out of the tank during a filling operation (including air purging) and adequate air flow into the tank whilst the dosing pump is operating or the tank is being drained without exceeding the maximum allowable operating stresses of the tank. As a rough rule-of-thumb the vent size should as a minimum be 1.5 times the fill or scour line diameter (whichever is largest).

For non-hydroscopic chemicals, the vent line shall discharge outside the building at about 500 mm above the site finished surface level, which is high enough to observe any potential dripping, but low enough that it is unlikely that any drips will fall on personnel. The vent discharge point shall be weather-proofed and shall be fitted with a “tropical midge wire” insect screen. Hydroscopic chemicals need to be considered on a case-by-case basis as they will require a desiccant unit to be included to prevent moisture being sucked back into the tank during dosing. The desiccant unit shall be located such that it is readily accessible for inspection and can be safely maintained (i.e. preferably maintained from ground level rather than atop the tank).

The vent outlet shall be located so that it is safe to gain access to it for maintenance purposes, and shall be located at least 4 m away (greater preferably) from the location where the load-in operator and driver stand during tank filling. The vent pipework shall be configured so that condensation of vapours is directed back into the tank.

5.6.3 Scour Line

There shall be a DN50 minimum scour outlet from the bottom of each tank which is plumbed to the bund sump, to allow complete emptying of the tank. The scour piping shall be interconnected between the bund sump and the pump-out connection, to enable the contents of the tank to be directly loaded to a truck without firstly dumping it into the bund sump.

A DN50 minimum manual valve shall be installed as close to the nozzle flange as possible to isolate the tank in the event of an emergency or downstream leak. The instrument drain line shall tee into the scour line in accordance with Section A on drawing GT36-070-083-05.

The scour valves are required to be operated without the operator entering the bund, and so the scour outlet should be located at the edge of the FRP grating or removable cut outs shall be provided in the grating to access these valves. Securely supported extension spindles to bring the valve handles to a comfortable height for ergonomic operation shall be provided.

Tanks shall be fabricated to allow the entire tank including any sludge that may have settled on the tank floor to be drained out completely. Provision of a sloping false floor inside the tank is one way to ensure complete emptying of the tank.

5.6.4 Process Line

The process line supplies chemical from each tank to the duty dosing pump located at the dosing panel. The diameter of each tank process outlet nozzle and valves should be at least equal to the tank inlet diameter, typically DN50. The process line from each tank interconnects at a tee before proceeding to the dosing panel on a common pipeline. The diameter for the common process pipeline after the tee fitting may be reduced to achieve a higher flow velocity (say 0.5m/s) if required.

Where a chemical is inclined to form bubbles (e.g. sodium hypochlorite), the process line to the dosing pump shall be kept as short as possible and the piping from the storage tank graded downward to allow gases in the solution to be released back into the tank. At the dosing panel, the piping shall be graded up towards the calibration tube which acts as a vent tube to purge any gas bubbles prior to entering the dosing pump.

The manual tank outlet valve of each tank shall be flanged directly to the process outlet nozzle and be easily accessible so flow of chemical from the tank can be shut off in the event the motorised tank outlet isolation valve fails. The handles of these valves shall be located above the bund wall level so that they would not be submerged if the bund was to be filled to the 110% fill level and they shall be accessible without having to enter the bund.

The actuated tank outlet isolation valves (VA82137/VA82147) are normally open but in the event of high sump level alarm occurring in conjunction with a high sump conductivity alarm, or when the tanks are nearing empty (LALL82115/LALL82125 activated), an automatic closure of these valves shall be triggered which leads subsequently to the shutdown of the chemical dosing systems. It is not considered to be critical for these isolation valves to be specified to fail-closed as the chance of a major leak during a power failure is low, and even if it had occurred, the spillage would still be contained in the bund.

HDPE tank walls tend to bulge and flex during filling and emptying cycles, and this has caused cracking failures on the tank and process outlet piping in past installations. To allow movement and help reduce stress on the tank and piping, a flexible connection (e.g. bellow) shall be installed after the manual outlet valve.

Detail 1 on drawing JD71-070-082-05 provides an example of the process outlet pipework arrangement. As the process line is likely to have a low section between the tank and the dosing panel, where it runs beneath the gridmesh, it is necessary to provide a manual drain valve along this line to facilitate its complete emptying prior to maintenance. These drain valves shall be DN15 ball valves with securely supported extension spindles so their handles are located just below the gridmesh grating for ease of operation (using an extension spindle). As these valves have the potential to drain the chemical storage tanks, their open/close position along with their purpose shall be clearly marked with appropriate signage and their handles shall be lockable to prevent accidental or inadvertent incorrect operation.

5.6.5 Overflow line

Each tank shall have an overflow pipe sized at not less than 1.5 times the filling line diameter, which shall discharge 200 mm above the bund sump. The overflow line shall have a fillable seal bend (with appropriate fittings) to prevent fumes from being released and a sight tube that is visible from the load-in panel (see photo in Figure 5-2 as an example). For sulphuric acid tanks, the seal pot shall be ergonomically designed to permit filling with silicone oil.

Sturdy supports must be provided for the overflow piping to avoid excessive loading on the tank nozzle. No valves or equipment which could potentially cause blockages shall be installed in the overflow lines. Care shall be taken on the design to ensure that the sump water cannot be drawn into the tank under any conditions.

Figure 5-2: Overflow line with a transparent fillable seal pot visible from load-in panel

5.6.6 Dosing line

The dosing line from the dosing panel to the dosing point shall be chemical barrier protected in accordance with DS79-03.

If the dosing line is buried, then permanent pipe markers shall be installed to warn operators or others working in the area. These buried chemical signs shall be positioned at every change of direction or at maximum intervals of 50m.

Depending on the dosing point location and whether it is above ground, or below ground in a pit, the pipework layout and design shall include joints and fittings to enable the removal of the spears.

Where the dose point back-pressure is elevated (i.e. above 10m head), a non-return valve shall be installed just prior to the dose point-main isolation valve to ensure that failure of the dose line does not result in a catastrophic release of recipient main water (the residual risk is limited to the section of dose pipe between the non-return valve and dose point-main isolation valve. Where back flushing of the chemical dose line is necessary (usually required for most chemicals), a bypass shall be provided around the non-return valve. The bypass pipework and bypass valve shall be at least DN40 minimum to provide mechanical robustness and to not create a pipe section even more prone to failure.

5.7 Waste Holding Tank

As discussed in the sections above, a waste holding tank, based on drawings FQ18-6-17,-6-24.1, 6-24.2, -6-27 and 6-28, with a minimum storage capacity of 1000L[12] shall be provided at each site for the collection of chemical waste. A larger tank should be provided if the tanker pump rate is greater than 7 L/s or where other site-specific considerations or risks exist – e.g. location is near a river or other water body. At wastewater treatment plants, however, for some chemicals it may be possible to return spills to the head of the plant, but this will require the approval of the Asset Delivery Representative.

The tank shall be fitted with a suitable float type level switch to warn the operator when the waste has reached a high level and to arrange for disposal. The design shall ensure that the switch can be easily accessed without the use of special equipment (e.g. cranes, scaffolding, etc.). A vent with insect screen shall be provided for the tank.

The tank shall be housed within a concrete liner to protect it from ground forces and to allow its easy removal at end of life. Joins in the concrete liner shall be sealed with Sika Tank to ensure that the concrete liner can act as secondary containment if chemical were to leak from the waste holding tank. To minimise cost of small holding tanks, consider installing the polyethylene/GRP tank inside a pre-fabricated concrete well liner, rather than a custom-designed concrete pit.

The main purpose of this tank is to stockpile the small quantities of chemical and neutralised waste generated in either the storage room or load-in apron during normal operational duties. When sufficient waste is collected in the tank, a tanker truck can be arranged to pump out and transport the waste off-site for proper disposal. If the waste holding tank is not located near to the load-in apron, road access to the tank shall be provided for the tanker.

The waste holding tank shall be fabricated from a material suitable for the long-term storage of waste chemical, such as polyethylene or GRP, as it may be expected to hold waste (undiluted or diluted) for well over a year depending on the waste production volumes. It is normally located below ground or at a level lower than the bund sump and load-in apron sump, so waste can gravitate to this tank. The tank shall be housed within a concrete liner to protect it from ground forces and to allow its easy removal at end of life. Joins in the concrete liner shall be sealed with Sika Tank to ensure that the concrete liner can act as secondary containment if chemical were to leak from the waste holding tank. The design of the tank shall withstand any buoyant forces when empty, particularly if natural groundwater levels can flood the concrete liner.

[12] A 1000L tank capacity would be sufficient to contain a load-in chemical spillage volume of 840L calculated from pumping at a rate of 7L/s for two minutes before emergency shutoff. As a side note, requirement of AS3780 Clause 5.8.4.2 for capacity of spillage control system to be the greater of 9000L or largest tanker compartment is only intended for loading of chemical into tankers, not unloading from tankers as is the case at load-in facility. This was clarified by DMIRS in 2010 (ref. Meeting minutes dated 3 June 2010 Nexus ID #53022606).

5.8 Ancillaries

5.8.1 Wash Trough

A single wash trough shall be provided for the washing of pump components, valves and other equipment prior to removal from the chemical store room. The wash trough shall be constructed of a material compatible with the chemical. The wash trough shall be located at a height convenient for operator use and shall drain into the bund sump.

5.8.2 Safety Showers & Eyewash Units

5.8.2.1 Number and Location

At least two safety showers and eyewash units shall be provided. One safety shower/eyewash unit shall be provided at ground level outside the chemical building between 2m and 7m horizontal distance from the tanker hose connection point and the load-in panel. Others shall be identified through risk assessment. The second safety shower shall be provided adjacent to the Dosing Panels, on the same level, in the storage/dosing room.

All safety showers shall comply with the requirements of DS79-02.

5.8.2.2 Safety Shower Water Supply

Potable water shall be used to supply the safety showers and eyewash units. Where a dedicated potable water supply is not available, the safety shower supply off-take from the potable water system on site shall be located upstream of a reduced pressure zone device (RPZD). Any water usage connections associated with any chemical such as dilution or flushing of chemical, shall be located downstream of the RPZD to protect the safety shower supply from potential contamination due to backflow of chemical. Hydraulic design shall ensure that there is sufficient water pressure and flow available for the safety shower and eyewash to operate when other normal services are in operation.

Backflow prevention devices and their installation shall be in accordance with the current revision of AS3500.1 Plumbing and Drainage – Water Services and shall be installed by a qualified plumber.

5.8.3 Hose Reels

Retractable wash down hose reels shall be provided and located such that all areas of the load-in and storage facility can be accessed with the hose. This typically means that at least two hose reels are required, one inside the storage room near to the dosing panels and one outside the building for use to hose down the load-in panel and apron. Hose shall be minimum 19mm diameter and 20m in length.

5.9 Dosing Pumps and Pressure Relief

Each pump shall be mounted on a PVC plinth attached to the dosing panel and so that the pump can be adequately accessed from all sides for adjustment and servicing.

Digital diaphragm dosing pumps have advanced features capable of smooth continuous dosing with flow measurement that can be integrated in a Profibus DP network whilst having the ability to detect and automatically push out air bubbles from the dosing head. If this type of pump demonstrates these capabilities across the operating range, then some of the auxiliary equipment on the dosing panel such as pulsation dampener and flow meter may be omitted, if approved, where this type of “smart” pump is installed.

Especially for chemicals prone to gassing off, pumps shall be set up for auto-degas and autoflow adaption where those features are available.

An external pressure relief circuit (i.e. pressure shall relieve to the suction side of the pump) shall be provided unless the dosing pump has an internal pressure relief system and relief alarming. The pressure safety (relief) valve shall be set to open on failure (i.e. fail open).

Note also use of an external pressure relief circuit together with a digital dosing pump using Flow Control Measurement (FCM) may have the effect of confounding the FCM i.e. the maximum pressure on the DDA-FCM control variant must be set below the setting of the pressure relief valve.

5.10 Dosing Point Considerations

Where practicable, dosing points should be located above ground in order to eliminate confined space and access/egress issues and improve maintainability. Above ground dose points will need to be assessed for chemical barrier protection in accordance with DS79-03.

Duty and standby dosing diffusers shall be provided. Recipient water mains greater than 750mm in diameter with high flows and pressures normally require a full bore dosing sparger with locating spigot for support. For recipient water mains less than 750mm in diameter a dosing spear (open ended pipe projecting half way into the main) should be adequate to provide good mixing. The holes on the dosing sparger should face away from the direction of flow (be on the downstream side of the sparger) and the flow direction should be marked on the flange of the sparger.

Blockage of pipework and sparger orifices caused by scaling shall be addressed if it is possibility - especially if the recipient water or carrier/dilution water (for small system with low dose flow) contains sufficient levels of alkalinity and hardness.

Design of the dosing diffusers and/or mixing devices are site-specific and reference shall be made to DS78 Chemical Dosing Standard for guidance.

Dosing spears should pass through a gate valve so that the recipient water main can be operated even when the spear is not in place. Non-return valves shall be provided on the dosing line near to the dosing spear to ensure the recipient water does not back-feed up the dosing line when the spears are not in operation. Isolation ball valves shall also be provided to enable the individual spears to be isolated from the chemical and removed for maintenance whilst the other spear is in operation. Some systems may require removable dosing spears or spargers so this potential requirement should be considered in design.

For dosing lines more than 10m in length, a suitable pressure sustaining valve (PCV) and pressure gauge (PI) shall be installed near to the dosing diffuser[13] to provide stable control of the dosing especially during high throughputs. The PCV will also help prevent overdosing of the mains water due to "siphoning" of the long pipeline of chemical into the recipient water during periods of idling when the dosing pump is not operating and the mains water is not flowing.

The PCV and pressure gauge shall be constructed of materials suitable for contact with chemical similar to those provided at the dosing panels.

5.11 Dosing System Considerations

5.11.1 Chemicals Prone to Gassing

The design of dosing systems for chemicals that are prone to gassing shall take note of the de-gassing provisions contained in DS73 Sodium Hypochlorite design standard and in section 6 below.

[13] Similar installations have been provided for FSA at Gwelup GWTP and hypochlorite at Hamilton Hill CDP. PSV typically set at 50kPa above maximum line pressure (KWS Investigation Report with drawing notes Rev 8 by P. Hanley).

5.11.2 Dosing Line

The dosing line from the dosing panel to the dosing point shall be barrier protected in accordance with DS79-03. Where installed, any double containment piping system shall have viewing catch pots that can be drained at low points for visual detection of any leakage in the pipeline.

If the dosing line is buried, then permanent pipe markers shall be installed to warn operators or others working in the area. These buried chemical signs shall be position at every change of direction or at maximum intervals of 50m.

The dosing line between the metering pump and the application point should be kept as short as possible to minimise delay time. Where redundancy of the external dosing lines is installed, provision shall be made to allow any one of the dose lines to be used by either of the dosing pumps to convey chemical to the dosing points. Cross-connection of the piping shall be provided downstream of the dosing panels.

Depending on the dosing point location and whether it is above ground, or below ground in a pit, the pipework layout and design shall include joints, fittings and valves to enable the removal of the dosing spears.

The dosing system shall be designed in accordance with DS78 (which covers mixing and loop time considerations).

5.12 Specific Design Features for Sodium Hydroxide and Sulphuric Acid Systems

The following sections outline the specific design features required for Sodium Hydroxide and Sulphuric Acid Systems. These requirements have been drawn from Water Corporation’s chemical supplier.

A permanently mounted external weatherproof electrical power outlet within 7.5m of the road tanker shall be provided and conform to the following:

- Located away from the delivery hose connection point
- IP56 rated combination switch and 4-pin plug socket for 3-phase, 415 volts, and 50Hz at 20 amp rating (e.g. Clipsal 56 series). GPOs at 32 amp are acceptable, as all Coogee Chemicals-operated prime movers are equipped with 32-10 amp voltage-reduction boxes
- Either HRC fuses or circuit breakers rated for direct on-line starting for a 5.5kW induction motor
- Earthed metal close to plug outlet (e.g. conduit, water-pipe, steel structure, etc.) and earth leakage protection

5.12.1 Sodium Hydroxide (50%)

5.12.1.1 Tanks

Tanks shall be provided with the following materials of construction:

- Carbon steel to AS1548, AS1594 for plate and ASTM A106.B for pipe. All carbon steel welds and bends shall be stress relieved, or
- Stainless steel to ASTM A240TP316L (plate) and ASTM A312TP316L (pipe)
- HDPE tanks designed in accordance with SPS497

Thermoplastics (such as UPVC and Polypropylene) and GRP shall not be used.

5.12.1.2 Tank Cooling Issues (Insulation and Heating)

Where ambient temperatures drop below 10°C, sodium hydroxide liquors above 35% w/w require heating to prevent solidification. This problem shall be addressed by any of the following methods:

- Inserting electric elements compatible with Sodium Hydroxide in a bulk tank. Electric elements shall be controlled with a thermostat.
- Using 30% sodium hydroxide
- Lagging of the tank – this is effective where nighttime temperatures are the primary cause for concern.

5.12.1.3 Pipework

All storage pipework shall be flanged carbon steel; screwed joints shall not be employed. Full penetration butt-welding shall be undertaken. Design code ASME B31.3 shall be used for design of piping systems.

The following material standards shall be used for carbon steel pipe and fittings:

- For pipe (seamless): ASTM A106.B for pipe;
- For butt-weld fittings: ASTM A234WPB;
- For flanges: ASTM A105 (for ASME and AS2129)

Pipes shall be sized to avoid velocities exceeding 1m/s to avoid the risk of erosion.

Pipes shall be provided with electric heat tracing and insulation if temperatures less than 15.5 C are possible for a significant part of a 24-hour period. Heat Tracing and insulation shall be segmented to allow easy removal and replacement if necessary. Flanges do not have to be insulated if they are barrier protected in accordance with DS79.3 – this is to ensure easy access to flange bolting.

Designs shall use 80mm fill pipework and valving where tanks are greater than 10kL. Below this tank size, the pipework and valve sizing shall comply with chemical supplier requirements, but not be less than 50mm.

Where sodium hydroxide at 50% strength is diluted to a lower concentration, stainless steel shall be used for 10 pipe diameters upstream of the dilution point and 20 pipe diameters downstream before transition to any other suitable material occurs. Approval shall be sought from the Senior Principal Engineer Water Treatment before varying the above distances.

5.12.1.4 Valves

The use of ball valves is not permitted due to their tendency to lock up due to solid deposition/crystallisation.

Diaphragm or butterfly valves shall be used up to 50mm diameter (inclusive). Lugged butterfly valves shall be used for sizes greater than 50mm diameter. Materials shall comply with the Water Corporation's Strategic Product Register Section D.

Commissioning Plan Information
Gasket material to be used with steel pipework in 50% sodium hydroxide service should be a compressed fibre non-asbestos type. Examples are Uniflon 50, Tesnit BA Unit, Klinger SIL C-4500 and Garlock Gyon 3510.

5.12.1.5 Sumps

Wet sumps shall be used for sodium hydroxide to allow dilution of any small leaks and thereby protect coatings from chemical-temperature attack. Bunds composed entirely of plastic (e.g. HDPE) do not require wet sumps because small spills will be absorbed using a suitable spill kit.

5.12.1.6 Bund Sump Conductivity Settings

Sodium Hydroxide conductivity sensors shall have the follow settings:

- High – 25 mS/cm (indicating water leak)
- High High – 100 mS/cm (indicating chemical leak)

5.12.2 Sulphuric Acid (98%)

5.12.2.1 Tanks

Tanks shall be provided with the following materials of construction:

- Carbon steel to AS1548, AS1594 for plate and ASTM A106.B for pipe. All carbon steel welds and bends shall be stress relieved, or
- Stainless steel to ASTM A240TP316L (plate) and ASTM A312TP316L (pipe)

Thermoplastics (such as UPVC, HDPE and Polypropylene) and GRP shall not be used.

A desiccant unit shall be included on the tank vent to prevent moisture being sucked back into the tank during dosing. The desiccant unit shall be located such that it is readily accessible for inspection and can be safely maintained– refer dwg AJ87-13-68-02 as a general arrangement example. The desiccant unit shall be sized to manage the air displaced during tank filling.

Note: The performance of existing desiccant units supports a 12-year interval between desiccant material changes as being a reasonable design basis.

Designs shall use 80mm fill pipework and valving, with a 75mm male camlock coupling where tanks are greater than 10kL. Below this tank size, the pipework and valve sizing shall comply with chemical supplier requirements, but not be less than 50mm.

5.12.2.2 Pipework

All pipework shall be flanged carbon steel or stainless steel – screwed joints shall not be employed. Full penetration butt-welding shall be undertaken. Design code ASME B31.3 shall be used for design of piping systems.

The following material standards shall be used for carbon steel pipe and fittings:

- For pipe (seamless): ASTM A106.B for pipe;
- For butt-weld fittings: ASTM A234WPB;
- For flanges: ASTM A105 (for ASME and AS2129)

Pipes shall be sized to avoid velocities exceeding 1m/s to avoid the risk of erosion.

Where sulphuric acid at 98% strength is diluted to a lower concentration, PTFE lined steel or PTFE lined stainless steel shall be used for a minimum of 10 pipe diameters upstream of the dilution point and 20 pipe diameters downstream before transition to any other suitable material occurs. Approval shall be sought from the Senior Principal Engineer Water Treatment before varying the above distances. Dual PTFE lined check valves shall be installed in the chemical line as close as is practical to the mixing tee and the length of chemical line between these check valves and the mixing tee shall also be PTFE lined steel or PTFE lined stainless steel. The diameter of the chemical line from the PTFE lined check valves through to the mixing tee shall be as small as possible to reduce the rate of diffusion of water back into the line when not flowing. Reducing this rate of diffusion will reduce the temperature rise that occurs in this section of line due to the heat of dilution.

5.12.2.3 Valves

Ball valves shall be used up to 50mm diameter (inclusive). Lugged butterfly valves shall be used for sizes greater than 50mm diameter. Materials shall be as per the Water Corporation's Strategic Products Register Section D.

Note: Steel body ball valves shall be used downstream of dosing pumps unless approved by the Senior Principal Engineer, Water Treatment who will require a case to be presented that the elevated temperatures cannot occur at the location of the valve in question or that the temperature de-rated pressure rating is satisfactory for the expected system pressure.

Commissioning Plan Information
Gasket material to be used with steel pipework in 98% sulphuric acid service should be a compressed fibre non-asbestos type. Examples are FKM and PTFE.

5.12.2.4 Sumps

Dry sumps shall be used for sulphuric acid to avoid heat of dilution effects impacting protective coatings.

6 PIPEWORK AND VALVES

6.1 Pipe Materials

All pipework (except where noted such as in section 5.12) shall be Schedule 80 PVC-U in accordance with ASTM D-1785. Water Corporation has adopted this standard rather than PN18 PVC-U – Series 1 (AS/NZS 1477) in recognition of the pipework typically supplied by contractors and the desire to standardise on one pipe standard. Schedule 80 PVC-U pipe is a superior product in terms of mechanical strength, impact resistance and UV degradation.

Each piping component pressure rating shall be determined with consideration of the piping manufacturers design guidelines for temperature de-rating plus any applicable pipe or joint de-rating factors that may be applicable for the intended chemical service. The Design Pressure of chemical pipework shall not exceed the lowest pressure rating of any piping component after all applicable de-rating factors have been applied. Where multiple de-rating factors apply to a piping component or joint, normally the manufacturer specifies that these are cumulative.

6.2 Pipe Sizes for Chemicals Prone to Gassing

Pipe sizes for pump dosing should ideally be selected to maintain the chemical flow velocity as high as possible but under 2 m/s, to sweep bubbles along and minimise gas accumulation. A velocity higher than 2 m/s may contribute to a shearing effect that will separate the chemical into alternating slugs of gas and liquid, affecting the accuracy of downstream dosing whereas a velocity slower than 0.5 m/s may contribute to gasification and crystallisation.

6.3 Pipe Fittings

At least 120mm clearance space shall be provided to allow hand access to o-ring unions and flanges. Support brackets and electrical conduits have historically been the reason for this space requirement being breached.

O-ring unions shall be provided at sufficient locations to allow easy disassembly of equipment such as flow meters, pumps etc.

6.4 Pipework Jointing & Solvent Cements

All PVC-U pipework joints and fittings shall be solvent welded except the tank to pipework connections and some pipework to equipment connections which shall be flanged. The use of screwed fittings shall be avoided wherever possible, but will probably be necessary for the installation of the pulsation dampeners and pressure gauges. If threaded connections must be used, threads must be new, sharp and secured with a high quality caustic resistant Teflon tape.

To ensure leak-free pipework, the solvent welded pipe joints shall be made with care and strictly as per the manufacturer's installation instructions and WS-2 Welding and Jointing specification. Over-applying the solvent to the joints should be avoided as excess glue can reach the interior of the pipe and restrict flow.

The solvent cement used for these joints shall be Tangit DTX solvent cement (use together with Tangit Cleaner). Tangit DTX is a gap filling cement, ideally suited to the larger clearances in schedule 80 PVC piping system fittings. Many other solvent cements / jointing compounds have limited gap filling properties and require a complex jointing methodology, often demanding multiple solvent applications when applied to schedule 80 piping systems. The inability to carry out this complex methodology successfully has led to joint failures at some Water Corporation sites. Tangit DTX has been the preferred solvent cement for jointing PVC pipes carrying chemicals at Water Corporation.

6.5 Pipework Supports

PVC pipework shall be supported at specific intervals depending on the pipe wall temperature, the density of the flow medium, the pipe diameter and wall thickness, and the stress loading on the pipeline. The pipe manufacturers typically provide published data in their design guides and will be able to advise on spacing of supports.

All supports shall be constructed of materials suitably resistant to the dosed chemical such as PVC, FRP, PE, 316 stainless steel pipe tray, brooker rod and unistrut. Mild steel supports shall not be used unless approval is granted otherwise (they would only be considered if coated with a suitable corrosion resistant coating and where contact with chemical or fumes is not likely).

6.6 Hoses and Tubing

Where used, pump suction and discharge flexible hose material shall be compatible with the chemical. The preferred hose type is braided clear PVC minimum PN16 hose (e.g. 6 mm ID/12 mm OD by Rehau Rauiflam-E). Hoses shall be protected from direct sunlight.

Where there is a need to use hoses outdoors, approval shall be sought from the Senior Principal Engineer, Water Treatment who will require information concerning temperature de-rating, material compatibility and sun shading as a minimum.

6.7 Pipework Identification and Labelling

Commissioning Plan Information
All above ground PVC pipework shall be painted in accordance with Water Corporation Standard DS95 (Appendix 3, Coating Specification K1). Paint on pipes located outdoors shall be UV-resistant. Where the pipes are in an aggressive environment, a chemical resistant paint may be required. The manufacturer/paint supplier will need to be consulted regarding the suitability of the paint on PVC. Chemical pipework shall be identified and labelled in accordance with DS79-04 Chemical Safety Signage, Labelling and Markers Buried pipework or pipework installed in culverts (not exposed to UV) does not require painting, but shall be labelled for identification purposes.

6.8 Pipework Testing

Commissioning Plan Information
All pressure pipework shall be hydrostatically pressure tested in accordance with AS 4041 before being commissioned. Unless specified otherwise the pipework should be tested to 1.5 x the maximum design pressure. Care shall be taken to remove or isolate equipment from the lines which cannot be safely tested to the same pressure as the pipework.

6.9 Valves

All valve components including handles, actuators, balls, ball seals and O-rings shall be constructed of materials suitable for contact with the chemical.

Valves shall have tags to indicate whether they are “normally open” or “normally closed”. For critical valves, a sign should also be displayed alongside. Safety critical valves shall use red coloured tags.

The ball valve inherently has a cavity between the body and the ball inside the valve where chemicals prone to gassing can be trapped when it is in the closed position. Gases released from the trapped chemical can increase the pressure inside the valve potentially to the point of catastrophic failure. Crystallisation of some chemicals can likewise cause valves to jam making them difficult to operate.

To avoid this situation, ball valves with a pre-drilled small-diameter vent hole on the upstream side of the ball shall be used for gassing applications. This modified ball effectively vents the gases while keeping inner valve surfaces constantly wetted, eliminating the conditions required for gas accumulation and crystallisation. The vent hole should be drilled and deburred by the valve manufacturer or a competent person as rough burrs left on the hole will damage the valve seat when the valve is later operated.

6.10 Flanges & Gaskets

All flanges shall be drilled in accordance with AS/NZS 4087 for pressure class PN16, unless a different flange standard has been adopted at the site for consistency. All flanges shall be provided with galvanised steel backing plates and 3mm full face gaskets at the flanged interfaces. The backing plates shall be hot dipped galvanised in accordance with AS/NZS 4680.

Gaskets shall be of a material compatible with the chemical. Typical materials used by Water Corporation include FPM (also known as FKM and Viton®) material stabilised with carbon black[14] , natural rubber, EPDM, Nitrile and Buna N (NBR).

6.11 Fasteners

All fasteners shall comply with AS 1111.1 and AS 1112.3. Fasteners and anchorage bolts shall be hot dip galvanised in accordance with AS 1214.[15]

6.12 Pressure Control (Sustaining) Valve and Pressure Safety Valve Settings

The pressure sustaining valve at the dosing pump discharge (in the dosing pump enclosure) shall be set at the greater of:

- The minimum dosing pump discharge pressure that is specified by the dosing pump manufacturer, or
- A pressure that ensures the minimum dosing pump differential pressure that is specified by the dosing pump manufacturer.
- A pressure equal to 100kPa above the maximum normal operating pressure at the dose point.

A pressure gauge shall be provided in the vicinity of any PCV (immediately upstream of a pressure sustaining valve and immediately downstream of a pressure reducing valve) to allow ready checking of their performance. This is particularly important where a PCV is remote from the dosing panel.

Commissioning Plan Information
The "as designed" pressure setting of Pressure Control Valves and Pressure Safety (Relief) Valves shall be recorded on their valve tags (as critical safeguards, PSVs shall use red tags).

[14] DS 33 Clause 15.6.3
[15] 316 stainless steel fasteners are considered to have no advantage over galvanised steel fasteners due to risk of stress corrosion cracking and problem with galling.

7 FLAMMABLE AND COMBUSTIBLE MATERIALS

7.1 Storage and Handling Systems

Storage and handling systems shall comply with AS 1940-2017.

7.2 Diesel Tank Systems

Main diesel tanks shall meet AS 1940 including Clause 5.9 for self-bunded tanks. Day or service tanks, pipework between tanks or leading to generators, and generators, shall have secondary containment. All secondary containment shall prevent water ingress, have an inspection hatch, and be fitted with a float switch and alarm linked to SCADA.

Systems shall meet the following requirements:

- Tanks shall not be installed in low-lying areas that may be prone to flooding.
- Underground storage tanks shall not be used for the storage and supply of fuel.
- The maximum volume of fuel that can be stored at each site (e.g. individual bores) shall not exceed 5,000 L (5 kL) in a PDWSA.
- Fuel tanks shall be placed, as far as practicable, away from the production bores, if there is no alternative to placing the tank outside of the Well Head Protection Zone (WHPZ) or Reservoir Protection Zone (RPZ). Water Quality Business Unit shall be contacted to provide advice on the PDWSA category and WHPZ or RPZ separation requirements.
- Non-earthen bunding shall be provided for tanks in accordance with AS1940. This applies whether a tank is single or double skinned because double skin tanks without external bunding are vulnerable to theft and vandalism. This is of particular concern in PDWSAs. Bunds shall include a float switch and hydrocarbon sensor with alarms linked to SCADA.
- Secondary containment shall be provided around all pipes and fittings that may contain fuel, including those conveying fuel to the generator(s), as these are most likely to fail or cause spillages (e.g. locate pipes and fittings either within the bund or have appropriate containment installed around all pipework and fittings).
- Underground pipework shall not be used in Public Drinking Water Areas (PDWSAs).
- Secondary containment shall also be provided for mobile diesel storage options and generators with internal tanks. Portable type bunds are commercially available.
- In accordance with AS 1940: 2017, fill points shall be provided with appropriate spill capture. Such a spill capture area shall be provided at the load-in point in order to catch and contain any minor spill during re-filling of a tank.
- Tanks shall be designed to prevent overfilling (i.e. fitted with auto shut-off and high level alarms). Refer to Section 5.5.3 for general guidance.
- Where multiple tanks are to be located on-site, sufficient space shall be provided for emergency vehicle access, bearing in mind that the maximum volume of fuel stored on site shall not exceed 5,000 L (5 kL) in a PDWSA.
- Limit switches shall be provided on tank hatches/lids/doors for security reasons, with alarms linked to SCADA.
- Hydrostatic level sensors shall be used to measure diesel volume in large tanks.

7.2.1 Stormwater Management

To mitigate stormwater ingress within the bund, and thereby reducing the containment capacity of the bund, the design shall:

- Include an enclosure or roofed structure. Roof structures without walls shall extend at least 1 m past the edges of containment compound/bund.
- Include pump-out facilities to allow the ready removal of stormwater that may be contaminated (such water must be appropriately disposed outside of any PDWA).
- Ensure that uncontaminated stormwater from roofs (where roofing exists) and clean hardstand areas is directed away from potentially contaminated areas and bund capture zones.

7.2.2 Management of Fire Water from Site Emergencies

The site design shall address the issue of containment of fire water resulting from the management of a site emergency. Contaminated fire water shall be contained within the site to enable proper safe clean-up of this effluent. Contaminated fire water/effluent shall be disposed of appropriately.

7.2.3 Fuel Storage and Transfer System – Drawings and FCD

Although the fuel system is typically documented as a vendor package, process design drawings and a Functional Control Description meeting the requirements of DS81 shall be provided and a HAZOP conducted.

7.3 Hazardous Area Classification

Where flammable materials (e.g. liberation of flammable gases, vapours, liquids or dusts) can be reasonably expected to occur in normal and abnormal situations, hazardous area classification shall be undertaken in accordance with Water Corporation Standard HA-ST-02 “Hazardous Area Classification Standard”.

8 SIGNAGE, LABELLING AND MARKERS

Chemical facilities shall be provided signage, labelling and markers in accordance with DS79-04 “Chemical Safety Signage, Labelling and Markers” and regulatory requirements. Colour coding shall be in accordance with drawing EG71-1-1.

9 APPENDIX 1: DESIGN MANAGER ACTIONS

Note: The Design Manager shall ensure that each of the items listed below are addressed, although, they will require the support of others (e.g. Senior Principal Engineer - Water Treatment, design consultant, project manager, etc.) to close a number of them out.

Activity	***Support***	***Stage***
Major Hazard Facility Notification and Chlorine Buffer Drawing	SPE - Water Treatment	Before end of Concept Design Stage
Advise Procurement & Property (Chemical Contract Officer) of Chemical Quantities	Procurement and Property	Before end of Concept Design Stage
Discuss truck sizes, turning circle and power configuration with Procurement & Property (Chemical Contract Officer)	Procurement and Property	Early Engineering Design Stage
Obtain approval for use of chemical not covered by WC's MOU with Department of Health	Drinking Water Quality	Early Engineering Design Stage
Chlorine Buffer Drawing (non-drum sites)	SPE - Water Treatment	Before end of Engineering Design Stage
Dangerous Goods License Application, ERP, Manifest and DG Risk Assessment	SPE - Water Treatment	End of Engineering Design Stage
Hazardous Area Classification	SPE - Mechanical and Electrical	Detailed Design
Pressure Vessel Registration	SPE - Mechanical and Electrical	Detailed Design
ERP, Manifest and DG Risk Assessment (non-license sites)	SPE - Water Treatment	Prior to Chemical Commissioning
Poisons Permit Updated	SPE - Water Treatment	Prior to Chemical Commissioning
DG Site Compliance review	SPE - Water Treatment	Prior to Chemical Commissioning
Chemical Supplier Inspection	Procurement and Property	Prior to Chemical Commissioning

10 APPENDIX 2: COMMISSIONING PLAN ISSUES LIST

Commissioning Plan Information
As part of construction quality assurance or Factory Acceptance (in the case of modules), the slope shall be checked to confirm that requirements have been satisfied. A test shall be conducted for ponding.

Hazard: Damage to assets, injury to personnel.

Commissioning Plan Information (Commissioning)
A 24-hour hydrostatic leak test shall be conducted on a bund prior to the filling of its associated storage tank(s) with chemical. Confirm the absence of any bund floor or wall penetrations other than the bund drain as such penetrations have been the cause of several chemical leak incidents.

Hazard: Environmental impact due to failure to contain a leak.

Commissioning Plan Information (Commissioning)
Prior to delivery to site all tanks shall be hydrostatically tested using clean water filled to the overflow level at the workshop. The full static head is to be held for a minimum of 12 hours. Once installed, the tanks should be hydrostatically tested again to check for any damage which may have occurred during transportation or installation. All tanks shall be transported to site with blind flanges fixed to all nozzles to prevent dust and vermin entering vessels. If a crane is required to install PE & FRP tanks, then soft sling rigs shall be used on the shackles so as not to cause damage. Note: For some chemicals such as 98% Sulphuric Acid which water testing may be problematic, this requirement should be replaced by an alternative quality assurance method.

Hazard: Damage to assets or injury to personnel.

Commissioning Plan Information
Confirm accurate calibration of the tank level indication from the pressure transmitter for the specific gravity of the chemical to be stored in the tank. Confirm high and high-high level alarms initiate well before the tank overflows.

Hazard: Overfilling of chemical tank due to incorrect level indication.

Commissioning Plan Information (Commissioning)
Prior to the first delivery of chemical, the filling line shall be hydrostatically pressure tested in accordance with AS 4041 to 1.5 times the operating pressure of the tanker pump and held for a minimum of 30 minutes. Written proof of this test will be requested by the chemical Supplier and shall be made available to them. Note 1: The tank shall not be subject to the test pressure as it is only rated for the static head up to the overflow level. Note 2: For some chemicals such as 98% Sulphuric Acid, for which water testing may be problematic, this requirement should be replaced by an alternative quality assurance method.

Hazard: Equipment failure resulting in injury to personnel and damage to equipment.

Commissioning Plan Information
Gasket material to be used with steel pipework in 50% sodium hydroxide service should be a compressed fibre non-asbestos type. Examples are Uniflon 50, Tesnit BA Unit, Klinger SIL C-4500 and Garlock Gyon 3510.

Hazard: Equipment failure resulting in injury to personnel and damage to equipment.

Commissioning Plan Information
Gasket material to be used with steel pipework in 98% sulphuric acid service should be a compressed fibre non-asbestos type. Examples are Uniflon 50, Klinger SIL C-8200 and Garlock Gyon 3510.

Hazard: Equipment failure resulting in injury to personnel and damage to equipment.

Commissioning Plan Information (Construction)
All above ground outdoor pipework shall be painted in accordance with Water Corporation Standard DS95 (Appendix 3 Coating Specification K1). Paint on pipes located outside the building shall be UV-resistant. Where the pipes need to be in a more aggressive environment, a chemical resistant paint may be required. The manufacturer/paint supplier will need to be consulted regarding the suitability of the paint on PVC. Chemical pipework shall be identified in accordance with DS79-04. Buried pipework or pipework installed in culverts (not exposed to UV) does not require painting, but shall be labelled for identification purposes.

Hazard: Personnel being unable to identify correct pipework to work on.

Commissioning Plan Information (Construction)
All pressure pipework shall be hydrostatically pressure tested in accordance with AS 4041 before being commissioned. Unless specified otherwise the pipework should be tested to the lesser of 1.5x the design pressure or 1.25x the PN rating of the piping component with the lowest pressure rating. Care shall be taken to remove or isolate equipment from the lines which cannot be safely tested to the same pressure as the pipework. Note: For some chemicals such as 98% Sulphuric Acid which water testing may be problematic, this requirement should be replaced by an alternative quality assurance method.

Hazard: Equipment failure resulting in injury to personnel and damage to equipment.

Commissioning Plan Information (Construction)
The as designed pressure setting of Pressure Control Valves and Pressure Safety (relief) Valves shall be recorded on their valve tags (as critical safeguards, PSVs shall use red tags).

Hazard: Equipment failure resulting in injury to personnel and damage to equipment.

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