Treatment Expertise

Technical Standard

TS 0850 – Liquid Chemical Dosing

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Only the current revision of this Standard should be used which is available for download from the SA Water website.

Significant/Major Changes Incorporated in This Edition

This is the first issue of this Technical Standard.

Document Controls

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1 Introduction

This document specifies the general design and construction requirements for new or upgraded liquid chemical dosing facilities utilised at SA Water's water and wastewater treatment plants. The primary function of the chemical dosing system is to accurately dose the specified chemical to ensure the plant operates reliably and that product water quality is maintained.

There are many different types of chemicals added in the treatment process, each performing their own unique function. However, there are some common expectations regarding how a chemical dosing system should be designed to ensure the appropriate safety, performance and redundancies exist.

This Technical Standard provides SA Water's minimum requirements for the design and construction of liquid chemical storage and dosing systems. This standard is scalable to the size of the chemical application however there may be some elements that are not applicable to smaller systems. This Technical Standard applies to all liquid chemicals, with those frequently used by SA Water listed below:

- aluminium sulphate solution (alum)
- ammonium sulphate solution
- ferrous chloride solution
- ferric chloride solution
- aluminium chloro-hydrate (ACH)
- poly aluminium chloride (PACL)
- sodium hydroxide solution (caustic soda)
- sodium hypochlorite
- potassium permanganate solution
- sulphuric acid
- sodium fluoride solution
- fluorosilicic acid
- aqueous ammonia
- liquid polyelectrolytes
- sodium meta bi-sulphite (SMBS)
- citric acid
- antiscalants

Appendix A outlines additional requirements applicable for fluoride containing chemical such as sodium fluoride solution and fluorosilicic acid.

SA Water Typical Drawing TYP-08-00001_01 shall be the basis on which the Designer develops their design, noting the requirements of TS 0101 and this Technical Standard in further design development.

Any alternative materials, designs and processes that differ from the requirements of this standard but give equivalent (or better) performance outcomes to those specified herein, are not necessarily prohibited. However, these deviations will require prior written approval via a TDRF, prior to the commencement of construction.

1.1 Purpose

The purpose of this standard is to:

1) Specify requirements that ensure effective design and delivery of fit for purpose liquid chemical storage and dosing assets for best whole-of-life value with least risk to SA Water's defined levels of service standards and safety outcomes.
2) Define the minimum design life requirements for SA Water's liquid chemical dosing assets, which have been established based on the level of criticality, redundancy and accessibility of the assets defined within TS 0109 standard.
3) Establish uniformity of approach by asset designers, drafters and constructors to the design, construction, commissioning and operability of chemical dosing equipment.

1.2 Glossary

The following glossary items are used in this document:

Term	Description
AC	Alternating Current
ADG	Australian Dangerous Goods
AS	Australian Standard
AS/NZS	Australian and New Zealand Standard
BS	British Standard
DC	Direct Current
FRP	Fibre Reinforced Plastic
GHS	Globally Harmonised System
HAZCHEM	Hazardous Chemical
HAZMAT	Hazardous Material
Hz	Hertz
IP	Ingress Protection
ISO	International Organization for Standardization
LED	Light Emitting Diode
O&M	Operation and Maintenance
P&ID	Piping and Instrumentation Diagram
PAC	Powdered Activated Carbon
PE	Polyethylene
PLC	Programmable Logic Controller
PN	Pressure Nominal, Pressure Rating
PVC	Polyvinyl Chloride
RPZ	Reduced Pressure Zone
RTU	Remote Terminal Units
SA Water	South Australian Water Corporation
SCADA	Supervisory Control and Data Acquisition
SDS	Safety Data Sheet
TDRF	Technical Dispensation Request Form
TG	SA Water Technical Guideline

Term	Description
TS	SA Water Technical Standard
TWA	Time-weighted average
UV	Ultraviolet
VSD	Variable Speed Drive
WHS	Work Health and Safety
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

1.3 References

1.3.1 Australian and International

The following table identifies Australian and International standards and other similar documents referenced in this document:

Number	Title
AS 1319	Safety signs for the occupational environment
AS 1345	Identification of the contents of pipes, conduits and ducts
AS 2129	Flanges for pipes, valves and fittings
AS 2634	Chemical plant equipment made from glass-fibre reinforced plastics (GRP) based on thermosetting plastics
AS 3735	Concrete structures retaining liquids
AS 3780	Storage and handling of corrosive substances
AS 3996	Access covers and grates
AS 4775	Emergency eyewash and shower equipment
AS/NZS 3000	Electrical Installations (Australian /New Zealand Wiring Rules)
AS/NZS 3500.1	Plumbing and Drainage Part 1: Water services
AS/NZS 4452	The storage and handling of toxic substances
AS/NZS 4766	Polyethylene storage tanks for water and chemicals
BS 6374-5:1985	Lining of equipment with polymeric materials for the process industries. Specification for lining with rubbers
ISO 13823	General principles on the design of structures for durability
	Safe Work Australia - Workplace Exposure Standards for Airborne Contaminants
	Code of practice for fluoridation of drinking water supplies (Victoria)

1.3.2 SA Water Documents

The following table identifies the SA Water standards and other similar documents referenced in this document:

Number	Title
TS 0101	Safety in Design
TS 0109	Infrastructure Design
TS 0110	Durability Design (when published)
TS 0121	Installation Standards for Physical Security
TS 0132	Operations and Maintenance Manuals
TS 0204	Colour Coding of Pipework
TS 0245	Design Requirements for Ventilation and Cooling
TS 0300	Supply and Installation of Low Voltage Equipment
TS 0350	SCADA Systems
TS 0360	PLC and HMI Systems
TS 0370	Fire Detection and Emergency Evacuation Systems
TS 0720	Access Infrastructure for Water Tanks
TS 0721	Design Requirements for Storage Tanks and Associated Works (when published)
TS 0730	Stainless Steel Durability, Fabrication and Erection (when published)
TS 0800	Materials in Contact with Drinking Water
TS 112	Process and Instrumentation Diagrams
TS 18	Protection of Buried Pipework
TYP-08-00001_01	Generic Chemical Dosing Process and Instrumentation Diagram

1.4 Definitions

The following definitions are applicable to this document:

Term	Description
8-hour TWA	The maximum average airborne concentration of a substance when calculated over an eight-hour working day, for a five-day working week.
Airborne contaminant	A contaminant in the form of a fume, mist, gas, vapour or dust, and includes microorganisms. An airborne contaminant of this type is a potentially harmful substance that is either not naturally in the air or is present in an unnaturally high concentration and to which workers may be exposed in their working environment.
Corrosive Substances	Substances that, by chemical action, will cause severe damage when in contact with living tissue, or in the case of leakage, will materially damage, or even destroy, other goods or the means of transport. Such substances are listed as Class 8 corrosive substances in the Australian Dangerous Goods (ADG) Code.
Designer	The organisation responsible for designing infrastructure for SA Water whether it be a third party under contract to SA Water or a Constructor, or an in-house entity. A designer is a person who effects design, produces designs or undertakes design activities as defined in the *Work Health and Safety Act 2012 (SA)*.

Term	Description
Constructor	The organisation responsible for constructing and installing infrastructure for SA Water whether it be a third party under contract to SA Water or an in-house entity.
Design Life	Refer TS 0109.
Incompatible	Dangerous goods and other goods that are – • Likely to interact with the dangerous goods so as to increase the risk when mixed or otherwise brought into contact with the dangerous goods. • Listed in the ADG Code as being incompatible; or • Declared by the regulatory authority as being incompatible.
Responsible Discipline Lead	The engineering discipline expert responsible for TS 0850 defined on page 3 (via SA Water's Representative)
SA Water Representative	The SA Water representative with delegated authority under a Contract or engagement, including (as applicable): • Superintendent's Representative (e.g., AS 4300 & AS 2124 etc.) • SA Water Project Manager • SA Water nominated contact person
Safety Data Sheet	Document (formerly material safety data sheet – MSDS) which must be provided by a chemical supplier. It is a standard reference document for chemical information, and it provides working people and emergency service personnel essential information about: • basic physical and chemical properties of the chemical • correct safety procedures when storing, handling, transporting and disposing of the product • health hazards and impacts on the environment • what to do in accidents and emergencies. In SA Water, SDS must be stored in the site location within Chemalert which automatically maintains current versions.
Screen wall	A structurally-sound wall that – • Is impervious to liquid and vapour • Is constructed of materials that are substantially immune to attack by corrosive substances kept • May act as a shield or deflection barrier.

2 Scope

This Technical Standard:

Specifies minimum criteria requirements that assure effective design and delivery of fit for purpose liquid chemical storage and dosing assets

Establishes uniform processes to design, construct, commission and delivery of chemical dosing infrastructure.

2.1 Exclusions

This Technical Standard does not apply to the following chemical applications:

- Gas draw-off systems (e.g., anhydrous ammonia or chlorination stations)
- Powder mixing and slurry systems (e.g., powder polymer, PAC slurry or lime dosing systems).

Dry chemical feed systems (i.e., volumetric and gravimetric) and gaseous feed systems are excluded from this standard although some elements of this standard may be relevant to those types of dosing systems.

2.2 Technical Dispensation

Departure from any requirement of this Technical Standard shall require the submission of Technical Dispensation Request Form (TDRF) for the review and approval (or otherwise) of SA Water Principal Engineer, on a case-by-case basis.

The Designer shall not proceed to document/incorporate the non-conforming work before the Principal Engineer has approved the proposed action in writing via the Technical Dispensation Request Form (TDRF).

SA Water requires sufficient information to assess dispensation requests and their potential impact. The onus is therefore on the proponent to justify dispensation request submissions and provide suitable evidence to support them.

Design works that are carried out without being appropriately sanctioned by SA Water shall be liable to rejection by SA Water and retrospective rectification by the Designer/Constructor.

3 General Requirements

It is important that the general details within this Technical Standard be considered in line with specific requirements typically incorporated within the Design Basis Report. The Design Basis Report provides information that enables the Designer and Constructor to size equipment and to determine the levels of redundancy and controls necessary to meet an asset's defined levels of service and ensure safety requirements are satisfied per SA Water Technical Standard TS 0101.

3.1 Minimum Criteria

The chemical dosing system shall be designed to:

a) Meet process requirements:
   - Dose rates
   - Storage volumes.

b) Provide a minimum design life as outlined in SA Water's TS 0109

c) Account for durability and O&M considerations of TS 0110 and TS 0132 respectively.

d) Achieve required performance requirements over the designed service life, taking into account any momentary increase or decrease in plant flows

e) Comply with all relevant regulatory requirements, Standards, and Codes of Practice, including but not limited to:
   - *Work Health and Safety Act 2012 (SA)*
   - *Work Health and Safety Regulations 2012* (SA)
     - Or state alternatives for sites in NSW & Victoria
   - Managing risks of hazardous chemicals in the workplace Code of Practice 2020
   - *Dangerous Substances Act 1979 (SA)*
   - *Dangerous Substances (General) Regulation 2017 (SA)*
   - SA EPA 080/16: Liquid Storage Guidelines 2016
   - Australian Dangerous Goods Code 2018 (by National Transport Commission – Australia)
   - AS 3780 - The storage and Handling of Corrosive Substances
   - AS 4020 - Testing of Products in Contact with Drinking Water (carrier water only)
   - Australian Drinking Water Guideline 2011
   - *Safe Drinking Water Act 2011 (SA)*
   - All other reference documents in this Technical Standard

f) Not cause interruption to the normal operation of the existing SA Water's water and wastewater treatment facilities

g) Have complete chemical receiving, storage, transfer, and dosing system, and the necessary safety facilities

h) Be capable of automatic operation via SA Water's SCADA/Telemetry System

i) Be capable of local manual operation

j) Be capable of meeting the specified variations in process requirements

k) Allow for volumetric testing (required under *Safe Drinking Water Act 2011 (SA)*)

l) Contain all spills of the chemical being used.

3.2 Site Conditions

SA Water sites are normally subjected to temperate climate conditions, with ambient temperature range of -5°C to 50°C, and relative humidity of up to 100%.

Additional consideration shall be given for sites that are subjected to strong winds and saltwater spray/mist, for example, marine conditions. Thus, all equipment shall be appropriately designed to accommodate and operate satisfactorily within these weather conditions and the climate change provisions of SA Water Technical Standard TS 0109.

3.3 Materials

3.3.1 General

All materials selected or adopted in the design shall be suitable for installation in the proposed environment, including contact with the chemical being used. They shall be corrosion resistant and selected to match the relevant specified design life as outlined in TS 0109.

3.3.2 Corrosion Resistance

All internal parts in contact with the chemical substances are required to be corrosion resistant against the chemical involved, ensuring service life is achieved.

All bolts, nuts, and washers shall be made from stainless steel grade 316 or 316L, or other materials that are compatible with the chemical which is deemed to be suitable for the application.

A suitable means shall be provided for insulation of joints to prevent galvanic corrosion potential where dissimilar metals can come into contact.

3.3.3 Adhesive, Sealants, and Gaskets

All adhesives, sealants and gaskets shall be resistant to oil and water, non-supportive of microbial growth, and dimensionally stable. They shall also be resistant to chemical attack from the chemical being dosed.

Depending on the chemical, all gaskets shall be made from butyl, or Ethylene Propylene Diene Monomer (EPDM), or Viton rubber materials.

3.3.4 Pipework

Materials for pipe work shall be either uPVC Class 18, uPVC Schedule 80, polyethylene (PE), polypropylene (PP) or stainless-steel grade 316 or 316L, or other stainless-steel grade, which is deemed to be suitable for the application.

The minimum pressure rating class of all pipes and fittings shall be PN 18. Degradation of material based on ambient temperature and external stresses and loads must be accommodated to ensure appropriate pressure deratings.

All pipework selected shall be designed specifically for use in the chemical industry and resistant to chemical attack.

All pipes, including those in pipe tray and trenches, shall be painted in accordance with SA Water's TS 0204, and labelled in accordance with AS 1345.

Pipes less than 50 mm diameter, located outside of the chemical dosing building structure, shall be risk assessed for the necessity of being suitably lagged (or heated) to prevent freezing at low weather temperature (<4°C). Pipe trays located outside shall be supplied and installed with suitable covers.

Buried non-metallic pipes shall have continuous metal tape placed in the trench above the pipe to allow detection.

Pumps and ancillary equipment shall be fitted with bends, removable joints, or some other suitable method to facilitate removal. Pipe supports shall be used where required to support pipework self-weight and any installed in-line equipment such as valves, instruments, all in accordance with the manufacturer's requirements.

Stainless steel pipes shall be fabricated and handled in accordance with the requirements of SA Water Technical Standards TS 0420 and TS 0730.

All buried chemical dosing lines and hazardous chemicals dosing lines external to bunded areas (above ground or buried) shall be pipe-in-pipe (sleeved) arrangement. To assist in determination of the appropriate level of leakage containment, a risk assessment may need to be conducted. In addition to this, all chemical dosing and/or water lines passing through the chemical dosing electrical control room shall also be pipe-in-pipe (sleeved) arrangement. The arrangement of these pipes shall allow a leak to be readily identified and contained and facilitate repair or replacement of the inner pipe. The arrangement of the pipework shall allow a leak to drain into the chemical dosing bund, or a spill collection point.

All valves shall be full-bore type. These, along with other non-standard pipework fittings shall be double union type to minimise damage during repair and maintenance.

All service or process water lines coming from SA Water mains shall be provided with Reduced Pressure Zone (RPZ) valves to prevent water flowing back into the mains in accordance with AS3500.1 requirements. If water pressure control is required to support the dosing process, then a separate pressure reducing valve shall be provided. A separate RPZ or a non-return valve shall be provided on all process (reuse) water lines to prevent backflow from the chemical dosing system.

The Designer and Constructor shall ensure pipework does not pose a tripping hazard (e.g., chase into floor)

A typical chemical dosing P&ID is provided in SA Water Typical Drawing Number TYP-08-00001_01.

Refer to Section 7.2 for further requirements regarding dosing pipework.

3.3.5 Civil Works

The design and construction of the civil works shall be in accordance with the requirements contained in the National Construction Code and relevant SA Water Technical Standards including, but not limited to, TS 0600, TS 0601 and TS 0710.

3.3.6 Mechanical Works

The design and construction of the mechanical works shall be in accordance with the requirements contained in SA Water Technical Standards TS 112 and TS 0204.

Major dosing equipment such as dosing pumps, mixers, dosing lances etc shall be selected based on material compatibility with the dosing liquid, temperature ranges and required flow and pressure ranges.

Suitable dosing pump hydraulic selection shall be based on the ability of the nominated pump to achieve the dose rate and pressure ranges based on detailed hydraulic design analysis of the downstream system and available liquid pressure source upstream. Pump manufacturer restrictions on number of starts and stops over a period of time shall be provided.

Refer to Section 7.2 for further requirements regarding dosing pumps.

3.3.7 Electrical Works

The design and construction of the electrical works shall be in accordance with the requirements contained in SA Water Technical Standard TS 0300.

3.3.8 Instrumentation

All instrumentation including level transmitters, flow transmitters, pressure transmitters, flow switches and level switches shall comply with SA Water Technical Standards TS 0300 and TS 0360.

The use of liquid filled diaphragm seals between wet process connection and transmitter sensor shall be considered to protect instruments from corrosion attacks.

Online instruments should be positioned as close as possible to the point of sampling since long sampling lines introduce delays that make PLC control difficult. The diameter and length of the sample line should be minimised to avoid settling and reduce delays in feedback control loops. The time for the sample to reach the analyser should be known. Also, if practicable, sampling should be from the middle of the pipe to prevent sediment entrapment into the sample line. Consider the addition of a bypass to drain/sample tank, to reduce sampling times.

3.3.9 Telemetry and Control

The chemical dosing system shall be designed for connection into SA Water's SCADA/Telemetry System. Specific requirements of telemetry and control for the chemical dosing system are detailed in SA Water Technical Standards TS 0350 and TS 0360.

3.3.10 Services

Services to the chemical dosing system shall include water supply, electrical power, telephone/communications connection (if required), and drainage. These services are to be identified as to their location relative to the dosing unit.

Where available, process water shall be used for dilution, flushing and hosing purposes.

3.3.11 Facility and Equipment Identification and Labelling

All equipment shall have a unique identification number as per relevant P&IDs in accordance with SA Water Technical Standard TS 112.

3.3.12 Warning Signs

Warning signs shall be erected as required. These include, but not limited to the following:

- A Hazardous Chemical (HAZCHEM) warning placard with UN number and chemical class to be placed on the main site entrances if the site chemical inventory exceeds any manifest thresholds
- Information panels as per current edition of the Australian Dangerous Goods Regulation shall be placed in prominent and visible location. As a minimum, there shall be one each on the chemical storage tank, and another on the inside of the door to the bunded area
- Confined Space Entry Permit placard to be placed on the storage tank
- Capacity of the storage tank stated on the tank

Other relevant WHS signs shall be installed in accordance with AS 1319. The signs may include, but are not limited to, safety shower, eye wash station, and non-potable water tap.

An automatic fire detection system shall be installed to the requirements outlined in the SA Water TS 0370.

3.3.13 Elements of Chemical Dosing System

A chemical dosing system shall consist of the following elements:

- Chemical delivery bay within a bunded area
- Chemical dosing building, shed or similar, with a bunded area for day tanks, dosing pumps and pipe work
- Chemical storage tank(s) within a bunded area
- Electrical control panel
- SCADA RTU
- Dosing system, including day tanks, pumps, pipes, valves, instrumentation.

Specific requirements for each element of the chemical dosing system are detailed in the following sections of this Specification.

A typical chemical dosing P&ID is provided in SA Water Typical Drawing Number TYP-08-00001_01. The actual design shall be conceptually similar to it, unless approved via a TDRF.

3.3.14 Maintenance Access

The layout of the equipment for the chemical dosing facilities is such to ensure that access hatches, instrumentation, level indicators, mixers, pumps and so on, can be easily accessed by personnel for routine maintenance and operation. Walkways, stairs and handrails should be considered to enable safe access to equipment and inspection openings mounted at high level per SA Water Technical Standard TS 0720.

4 Chemical Delivery Bay

A chemical delivery bay shall be designed and constructed to provide safe arrival, parking, offloading, and departure of chemical delivery vehicles appropriate for the application, e.g., bulk chemical tanker trucks.

Consideration should also be given to ensure incompatible chemicals are not mixed across the asset (e.g., piping and drainage sumps.)

4.1 Location

The delivery bay shall be located adjacent to the Chemical Storage area. Unless otherwise specified, the Chemical Storage area shall be located on the passenger side of the tanker.

Ideally, the unloading point shall allow the chemical delivery tanker to be fully inside the delivery bay whilst unloading. If this is not possible, the chemical storage tank portion must be within the delivery bund. Considerations to the height of the delivery tanker to be included in roof design where installed. The unloading hose connection point is typically located inside the Chemical Storage area and shall be no more than 6 metres from the tanker connection point, as per Australian Dangerous Goods Code 2018.

4.2 Access

The chemical delivery tanker shall be able to access the site safely without traffic controllers.

The delivery bay and its access shall be large enough to accommodate a tanker to be reversed into the bund and exit the site in a forward direction. Alternatively, the access shall allow the tanker to drive through, make a safe turn around and exit the site in a forward direction. Please refer to AS 3780

4.3 Bund

The delivery bay shall be a concrete slab with a bunded wall, to provide containment for any spill or leaks. Relevant aspects of AS 3780 shall be complied with, where corrosive chemicals are used.

The volume capacity of the bund needs to allow for the maximum of the largest compartment of the tanker.

The bunded area shall be designed with a 1 in 75 grade towards the sump pit where possible or sufficient to fall into the sump, such that no pools of chemical will accumulate on either side of the bund.

Any humps in the roadway at either end of the tanker delivery bay bund shall be designed to allow normal passenger vehicles to enter & exit without scraping the bottom of the vehicle.

The area between the tanker bay bund and the Chemical Storage area shall be concreted, and any spills in this area must be contained and drain into the delivery bay bund.

The delivery bay and Chemical Storage area arrangement must ensure any stormwater from the surrounding roadway and ground shall be channelled away, and not flow into the delivery bay bund.

4.4 Sump and Discharge Line

A sump to collect liquid from the bunded area shall be provided. It shall have minimum dimensions of 200 mm x 200 mm x 200 mm. It shall be located within the delivery bay bund. It shall be fitted with a grate/cover, made from suitable materials and be of a trafficable class in accordance with AS 3996 (Class C or D). The weight limit shall be labelled where appropriate.

The sump shall drain by gravity (typically a 50 mm or greater diameter pipe) where feasible, to an appropriate location. This may be a Chemical Storage bunded area. In this case, the sump drainpipe outlet shall be above the full spill level in the Chemical Storage bunded area to prevent spillage into the Chemical Delivery Bay.

If more than 2 chemicals are using the same sump, they must be checked for compatibility.

Placement of the sump pump shall take into consideration any contamination that would be exposed to the maintenance and operations team.

Ensure hose connections are not placed on top of sump pump as chemical dripping will damage the pump.

4.5 Safety Equipment

The following safety equipment shall be provided:

- A safety shower and eyewash station, which complies with AS 4775-2007, located within 2 to 7 metres of the chemical unloading connection point and free of any obstructions. This is typically installed adjacent to the Chemical Storage bunded area. Long water lines to the safety shower and eyewash station that are exposed to sunlight shall be lagged, as water may be heated and therefore unsuitable for use. An anti-scald valve shall be installed on the water line.
- Safety shower installations should be fitted with flow detection and connected to SCADA for alarming.
- If sufficient pressure from the main is not available, a water booster system shall be provided to enable adequate operation of a safety shower and eyewash station.
- A UV resistant hose reel permanently attached to a water tap and capable of reaching all parts of the Chemical Storage area, including the unloading area. Process (reuse) water can be used where it is available, e.g., at a wastewater treatment plant.
- Emergency shutdown provision, hardwired via safety relay and safety contactor and capable of stopping the unloading operation, is to be provided at least 5 metres from the unloading point; and
- Sufficient lighting to enable safe work beyond daylight conditions, particularly for the chemical delivery activities.
- Digital or analogue indication of storage tank level is to be provided at fill point.
- Windsocks are to be installed for some chemicals

4.6 Tanker Power Connection Outlets

Two permanently mounted electrical power outlets are required for unloading of the dosing chemical. These power outlets are 400 VAC (32 A) and 230 VAC (20 A) and shall be interlocked with the storage tank HIGH and HIGH-HIGH level monitoring to prevent operation of the tanker unloading pump on HIGH and HIGH-HIGH levels. They shall be located within 5 metres of the unloading hose connection point.

5 Chemical Dosing Facility

A chemical dosing facility shall be designed to accommodate the chemical dosing equipment, pipework, instrumentation and control panel, along with the necessary control functions, alarms and telemetry links.

The dosing equipment shall be designed to be in the weatherproof housing on a corrosion resistant dosing platform or stand. If two or more chemicals will be used, a standalone building containing all necessary dosing equipment shall be considered.

5.1 Building Layout and Dimension

The building shall consist of a bunded dosing room for chemical dosing equipment that can collect any chemical leaks or spills. The chemical dosing equipment shall be installed on a suitable PVC (or similar) panel (skid) or in a fully enclosed cabinet in an accessible position. Should more than one chemical dosing skid be installed, the skids shall be divided by a corrosion resistant wall of sufficient size to prevent accidental mixing of the chemicals. Should the dosing pumps be mounted in the cabinet, it should incorporate a transparent polycarbonate hinged door which will allow the plant operator to view the pumps without opening the enclosure. The base of the cabinet shall also act as a drip tray and should incorporate a drain back to the bund to allow spillages and leakages to be contained. All pumping accessories such as chemical flow meters and calibration cylinders should be contained within this cabinet. Size of the cabinet should allow for future expansion.

Control panels, including any safety stops, must be located outside of the bunded area in a location where routine washdown of the equipment will not impact on the electrical installations.

A small desk area designed for a computer and paper-based documents, and a small storage area for spare parts to be provided.

The dimension of the building shall be designed to allow adequate space to work in, and regular operation and maintenance of the equipment to be carried out, without removal of the roof. As a minimum, the ceiling height shall be greater than 2.4 metres from the ground.

Normal working areas shall have immediate access to the point of safe egress. As a minimum, two personnel access doors shall be installed to provide external access into the building. The width for access and egress shall be no less than 1 m, unless specified otherwise, and be adequately weather proofed. These doors shall have a mechanism to lock them in the open position whilst the site is attended, and lockable shut when not attended. Consider the weight of the roller doors if also used for truck entry, as preferable to use automated doors.

5.2 Building Floor and Wall

The chemical dosing area inside the chemical dosing building shall incorporate provision for chemical spill collection. The floor shall be coated with suitable corrosion resistant surface treatment applicable for the concrete floor, in accordance with AS 3780.

The building internal wall shall be clad with a corrosion resistant sheeting (e.g., PVC) to provide a splash guard and corrosion resistance for the building sheeting (walls). Where appropriate, exposed internal masonry walls shall have a corrosion resistant surface treatment applied in accordance with the Manufacturer's recommendations.

The floor shall be designed with a 1 in 75 grade towards the sump pit such that no pools of water/chemical will accumulate on the floor. The floor surface shall be non-slippery.

All pipework shall be run around the perimeter of the dosing room to minimise trip hazards, and as far away from electrical wiring as practicable.

5.3 Sump and Discharge Line

To allow for the management of any chemical spills occurring in the chemical dosing building, a sump shall be provided. The fall of the building floor shall drain to this sump. The sump shall have dimensions of 300 mm x 300 mm x 300 mm or similar.

Each sump shall be fitted with level detection device to alert operations of unintended sump contents via the PLC or SCADA.

If chemical dosing equipment is installed on a vertically mounted panel / skid, the drip tray shall be installed underneath of each of such dosing panel / skid. This drip tray shall drain to a sump. The sump shall have the capacity of collecting any likely leakage or spillage occurring within the compartment and to enable disposal as appropriate. Where it is feasible, drainage from the sump shall fall under gravity (typically a 50 mm diameter or greater pipe) to the Chemical Storage bunded area. An invert of the drainage pipe outlet shall be above the full spill level of the bunded area to prevent flooding of the building.

If a gravity arrangement is not feasible, then a manually initiated self-priming pump shall be provided to empty the sump. The pump shall have a suction leg and automatic low-level trip and be installed in the sump. Alternatively, a portable pump can be used by insertion into the sump as required and with connection using flexible hosing. The pump will be used for pumping any spills to the Chemical Storage bunded area. It shall only be activated by a local stop / start station and include an automatic low-level cut-out of the power to the pump.

A suitable power outlet shall be provided for connection of the sump pump. The outlet shall be mounted on the wall inside the dosing facility.

The top of the sump shall have a corrosion resistant grate that is easily removed manually, be located where it is not subjected to loading, and such that a pump can be easily installed in a sump. The grate shall be made from lightweight materials, weighing no more than 15 kg, in accordance with AS 3996, Class A. The weight limit shall be labelled where appropriate.

5.4 Ventilation

Adequate ventilation shall be provided for ambient temperature control and to prevent condensation build-up inside the dosing building per SA Water Technical Standard TS 0245.

The building shall be provided with an industrial quality electrical exhaust fan with a capacity to meet a minimum of 6 air changes/hour. The fan shall be mounted high up on one of the walls, or on the roof of the building. To provide adequate cross flow ventilation, weatherproof louvers shall be provided low down on the opposite wall or in the personnel access doors. These louvers shall also be vermin proof.

If required, an air conditioning system shall also be considered for the electrical control equipment. Air Conditioning may also need to be required for keeping temperatures as low as possible to avoid de-gassing issues of certain chemicals such as Sodium Hypochlorite.

Where the dosing chemical is classified as airborne contaminant by Safe Work Australia (e.g., ferrous chloride / ferric chloride), the ventilation fans must be able to run continuously, and be corrosion resistant. In other dosing systems, the fan is only required to operate when plant personnel are inside the Chemical Dosing building. An automatic door switch on the Chemical Dosing building shall be provided to automatically start the fans when the doors open and stop the fans when the doors close. A visual warning indicator shall be considered to indicate that the fan is not operational.

5.5 Lighting

Internal and external lighting of the Chemical Dosing building shall be provided to allow normal work to be carried out for 24 hours a day. The external lighting shall be provided to cover the entrance door.

The lighting installation shall meet all the applicable requirements of SA Water's TS 0300, Supply and Installation of Low Voltage Equipment. Specific lighting requirements are described in the following:

1. Internal to Buildings:
    - Lighting fittings should be provided with consideration of energy consumption, longevity and serviceability (changing globes at height)
    - Battery backed emergency lighting is to be provided if deemed necessary for safe exit and/or to comply with statutory requirements.
2. External to Buildings:
    - Area lighting is generally not required for unattended automatic installations except where it is essential for emergency operations and maintenance of critical installations at night (e.g., sewage pumping stations and treatment plants). The lights should be manually controlled.
    - Light fittings should be protected from vandalism and the weather.
    - Light fittings shall be accessible by platform ladder, or on a tilt pole style design for maintenance.

5.6 Safety Equipment

Safety shower(s) and/or eyewash station(s) shall also be installed inside of the Chemical Dosing area. An additional safety shower and eyewash station shall be located within 2 to 7 metres of the chemical unloading hose connection point in the chemical unloading bay. (If the location meets requirements for both areas then additional shower not required). The safety shower and eyewash shall comply with AS 4775-2007 (e.g., adequate pressure is available).

Long water lines to the safety showers that are exposed to sunlight shall be lagged, as water may be heated up by the sun, and therefore unsuitable for shower and eyewash. Additionally, a thermo-switch valve to bleed hot water through can be considered.

A flow switch shall be installed on the safety shower water line which shall activate a SCADA alarm when flow is detected.

If sufficient pressure from the main is not available, a water booster system shall be provided to enable adequate operation of a safety shower and eyewash station.

Suitable firefighting equipment shall be provided in accordance with the relevant requirements.

Lock-Out/Tag-Out and any requirements for safe maintenance of dosing equipment shall be considered during the system design process. The lock-out devices should be able to lock out the isolation points effectively. These devices may include (but not limited to) switches with built-in locks and lockout circuit breakers, fuses and valves.

6 Chemical Storage Tank

Chemical storage tank(s) shall be provided for safe storage of the dosing chemical. They shall be located within the bunded area and satisfy requirements of AS 3780. The preferred location of the tanks is in the centre of the bunded area.

Provisions for temperature sensitive chemicals (or equipment) such as air conditioning, roof venting, carport and or western wall shielding shall be considered. It is a preference that all bulk storage sodium hypochlorite facilities are enclosed and insulated facilities. This should minimise the rate of chemical decomposition (from elevated ambient temperatures). If access roller shutters are installed, consider external lighting, and shelter over the roller shutters to be provided. Roller shutters access size needs to accommodate removal of tank if required.

The storage tank shall be designed and constructed to provide complete draining of the tank and its connections. Equipment, such as access hatches, mixers and level sensors shall be able to be easily reached from the platform ladder for ease of operation and maintenance.

Provision of roof space to be able to include safe maintenance on top of the tank.

The storage volume, or tank's capacity, shall be calculated between the top of the tank discharge line to the dosing pump, and the maximum fill level, measured at the bottom of the overflow line at the top of the tank. It is recommended that the capacity of the storage tank should be sufficient to supply a minimum of 20 days operation at the average daily rate of chemical usage. This is based on minimum fortnightly deliveries, plus a reserve capacity of 6 days in case of delays. This shall be calculated by the project team for each installation.

The storage tank is to be positioned on a plinth to bring the tank bottom slightly above the suction of the pumps to minimise dead space within the tanks.

South Australian Dangerous Substances regulations shall be reviewed to ensure adequate clearance around the tank is provided.

Other factors to be taken into consideration when determining the tank capacity should include:

- Seasonality of chemical consumption
- Maximum practical storage shelf life when considering chemical degradation for some chemicals
- Frequency of personnel attending site and the preferred frequency of chemical deliveries
- Future capacity of the plant and associated chemical usage
- Capacity of delivery tankers – the tank should be designed to accept a full tanker delivery (contact the appropriate chemical supplier to determine the tanker sizes available)
- Standard tank sizes – many manufacturers offer standard sized tanks, which may be more cost effective to purchase than custom designed tanks
- Considerations on providing a double skinned tank as a method of secondary containment shall be made on a case-by-case basis, dependant on the required chemicals and operating environment.
- For sodium hypochlorite systems consider degradation of product and usage patterns for formation of chlorates and whether a two-tank (duty/standby) arrangement is needed.

The final decision about tank capacity should be made in consultation with the project team, taking into consideration the above factors.

6.1 Material

The storage tank shall be manufactured from high-density polyethylene (HDPE), spirally wound FRP or other material suitable for the chemical specified (e.g., cross-linked polyethylene (XLPE) or low-density polyethylene (LDPE)). FRP lined or rubber lined steel tanks shall not be used without an approved TDRF, which must demonstrate how the liner and steel tank shall be maintained and/or reinstated per the requirements of TS 0110.

It shall be designed and constructed in accordance with AS/NZS 4766 when it is made from PE, AS 2634-1983 for FRP, or BS 6374-5:1985 for rubber lined steel. Where the dosing chemical is a corrosive substance, the chemical storage tank shall be resistant to chemical attack and designed and constructed in accordance with the relevant requirement of AS 3780 to meet its required design life. A minimum of 1.5 times the specific gravity of the fluid to be stored in the tank shall be assumed for calculation of wall thickness requirement.

The minimum design requirements for FRP and HDPE tanks shall be as per TS 0721.

The designer shall ensure of the following when proposing polymeric based tanks for chemical storage facilities:

- Tank materials to achieve the minimum design life specified in TS 0109.
- All polymeric tanks proposed for installation outdoors shall be adequately protected against degradation by ultraviolet (UV) light by the used UV stabilisers. The design life of the tank shall not be reduced due to exposure to UV light. This requirement shall be considered when selecting materials for construction or an external protective finish for tanks where UV is likely to be prevalent.
- The degree of damage to polymeric tanks in the event of a fire may be more significant than that of metal-based tanks (refer TS 0601).

Where applicable, all welded brackets such as hold-down lugs, pipe supports, and lifting lugs, shall be designed to allow water/chemical to drain away without pooling, to avoid external corrosion.

The tank supplied shall be fitted out with the required branches, fittings, labelling, and identification number. The labelling requirements shall include, but is not limited to, the material of construction, the name of the manufacturer and the date of manufacture.

Required testing and quality assurance for FRP and high density polyethylene tanks shall be as provided in TS 0721.

Tanks shall be provided with the required in-service inspection as part of the Operation and Maintenance manual per TS 0132, which shall incorporate the requirements of both TS 0109 and TS 0110 in what provision are made for these inspections.

6.2 Structural

The tank shall be suitably reinforced and supported to withstand all forces, including filling forces, without deforming when it is full. The tank shall be fabricated such that the top of the tank is capable of supporting the weight of maintenance personnel, or a suitable platform is to be provided to enable safe access to the top of the tank for maintenance personnel.

The tank shall be anchored and mounted on a suitable concrete plinth. Suitable lifting lugs shall be fitted.

Where the tank requires a mixer, such as when magnesium hydroxide is used as the dosing chemical, the mixer shall not be supported by the tank.

6.3 Access Hatch

For a tank with a volume capacity of 5,000 litres and under, a 600 mm diameter access hatch shall be provided on the top of the tank. If this opening cannot be achieved on a smaller tank, an opening to enable cleaning with hoses and equipment shall be provided, in conjunction with fall protection.

For any other tank, the minimum dimension of the side access hatch is 600 mm diameter. The side access hatch shall be hinged to the tank wall.

These access hatches are intended only to facilitate inspection and cleaning activities undertaken from outside the tank and shall not be used for entry purposes.

6.4 Tank Inlet and Outlet

Tank shall have the following pipework features:

- One 50 mm diameter or greater vent (breather) on the apex of the tank roof shall be supplied. The vent shall penetrate the roof and finish in a 180° bend with the open end facing downward. The end of the vent pipe shall be covered with a 1 mm mesh to prevent vermin ingress.
- One 80 mm diameter or greater overflow branch in the tank wall, 50 mm down from the roof-wall joint. The overflow line diameter should be at least 1.5 times the diameter of the filling line. The overflow line shall be located such that it prevents immersion of instruments and equipment located in the tank roof and directs chemical safely away from operators and to the bund sump by means of a downcomer pipe.
- One drain branch, with lockable valve, and with minimum diameter of 50 mm shall be provided as close to the tank floor level as practicable. The drain line should be hard plumbed to the drain sump.
- One 50 mm diameter or greater fill pipe to the top side inlet from tanker unloading point, complete with a fill valve. A suitable male camlock fitting, with lockable cover, shall be supplied and installed at the tanker filling point. The camlock fill point to be size and material specific to suit the chemical. The fill pipe shall rise vertically and then slope downwards towards the tank (1 in 100 fall). It shall enter the top of the chemical storage tank and be located above the level of the overflow pipe.
- One suitably sized bottom side outlet for dosing pump supply. It shall be located 100 mm above the tank floor.
- Hydrostatic level sensors are to be used, one or more suitably sized bottom side outlets as applicable, for level indicator installation. It shall be located at the same level with the pump supply outlet.
- Automatic cut out during filling when the tank reaches HIGH and HIGH HIGH Levels. The HIGH level alarm can be re-set by the operator to allow topping up the tank. The HIGH HIGH level alarm cannot be re-set and no further tank filling shall be allowed. Provision for the manual override by the operator could be considered.
- Isolation (stop) valves on each of the inlet and outlet connections.
- Ensure all connections are at the bottom of the tank for cleaning to avoid working at heights hazards.
- Drain valves and Outlet valves to be of Lockable Type.

6.5 Level Indicator

Two level indicators of continuous type (e.g., hydrostatic, ultrasonic, radar), to show the level/quantity of the contents inside the tank, shall be provided in a DUTY/STANDBY arrangement. Both DUTY and STANDBY transmitters shall be monitored by the system's PLC for a healthy state. Should the "healthy state" of the DUTY transmitter change, the PLC shall be able to use the STANDBY transmitter. The indicators shall be connected to the telemetry system to allow remote monitoring as specified in SA Water Technical Standard TS 0300.

In addition to the electronic level indicators, and where it is appropriate, a magnetic rotor or float contactless type level indicator shall also be provided for a visual tank level indication. The level indicator shall be oriented towards the chemical unloading bay, to indicate actual liquid level inside the tank during filling and shall be visible from the filling/transfer point. A weatherproof digital display shall also be installed at the filling transfer point, to indicate the actual level during filling. An alarm system, consisting of a beacon and a siren (optional) shall also be installed at the filling transfer point, to alarm if tank's level has reached HIGH-HIGH level during filling.

In addition, the overflow pipe shall be piped oriented towards the chemical unloading bay in such a way, that the tanker driver can view the discharge point from the pipe into the bund, to indicate if the tank is overflowing.

6.6 Digital Display

The local digital display for tank level shall be readily visible to operators at ground level and be suitable for operation with 24 VDC power supply. It shall be equipped with sunlight readable LEDs, and a minimum reading range of ten metres. It shall be suitable to display percentage values.

The digital display shall have a minimum rating of IP 56 and shall be installed with suitable mounting accessories.

6.7 Bund and Sump

The chemical storage tank shall be bunded in accordance with the requirements detailed below. The bund shall be designed as a corrosion resistant structure in accordance with AS 3780 and shall have the capability of collecting any leakage or spill which has occurred within the compartment and disposing of it as appropriate, so that leaks do not enter the storm water system.

- For chemical dosing facilities with two or more inter-connected storage tanks, the bund volume shall be at least 120% of the volume of all connected tanks in the bund. This calculated volume is the net available containment capacity and shall not include the volume occupied by foundations and other items within the bund.
- The need for high bund walls needs to be balanced against the more difficult access and emergency egress risks.
- A high level alarm (connected to SCADA) shall be installed in the bund, to alert the operator that a spill may have occurred, and to cause an automatic shutdown of the chemical dosing pump(s).
- The bund walls and floor shall be adequately coated with a coating resistant to the chemical stored and location. The floor coating system shall incorporate a non-slip finish.
- All pipework shall be run around the perimeter of the bund to minimise trip hazards, and as far away from electrical wiring as practicable.

- To allow for the management of any chemical spills occurring in the bunded area, a sump shall be provided. The bunded area shall be designed with a 1 in 75 grade towards the sump such that no pools of water/chemical will accumulate on the bund floor. The sump shall be adequately sized to house all necessary equipment and pipe entries but shall not be smaller than 600 mm long x 400 mm wide x 300 mm deep.
- Disposal of sump material to be determined and information provided to operations.
- A manually started self-priming pump shall be provided to empty the sump. The pump shall have a suction leg and automatic low-level trip and be installed in the sump. The pump will be used for pumping any spills to a discharge point fitted with a 50 mm camlock coupling. It shall only be activated by a local stop/start station, which can be operated without entering the bund, and include an automatic low-level cut-out of the power to the pump.
- A suitable power outlet shall be provided for connection of the sump pump. The power outlet shall be installed in a location to enable a safe access to it during a spill event.
- The discharge line from the chemical delivery bay spill sump shall be directed to the chemical storage bunded area (refer Section 0 of this Standard) and to be terminated as close to its sump as practical.
- To prevent injury, the top of the sump shall have a grate that is easily removed manually, be located where it is not subjected to loading, and such that a pump can be easily installed. The grate shall be made from lightweight materials, weighing no more than 15 kg, in accordance with AS 3996, Class A. The weight limit shall be labelled where appropriate.
- Steps shall be provided to allow safe access into the bund area.

Self-bunded tanks shall have level instruments to detect any leaks from the failure of the internal tank.

6.8 Electrical

All electrical wiring shall be installed above the full chemical bund level. All electrical equipment shall be capable of working when the bund is full of liquid. As both water and the dosing chemicals are electrical conductors, safety of personnel within the bund must be considered when designing the layout of electrical equipment within the building.

6.9 Chemical Manifest

SA Water's Emergency Site Information Package shall be prepared for all chemicals stored in bulk on site. The purpose of this document is to ensure that the Emergency Services are aware of the chemical hazards that they may encounter. A copy of the document template is provided in Appendix B.

A HAZCHEM sign shall be attached to the storage tank's wall appropriate for the chemical.

The new WHS Regulations introduce several changes to placard and manifest requirements compared to pre-harmonised laws. A key change is the use of hazard classes and categories under the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), instead of classes and categories of dangerous goods according to the Australian Code for the Transport of Dangerous Goods by Road or Rail 7th Edition (ADG Code).

A table containing placard and manifest quantities under the new WHS Regulations (Schedule 11) is provided in Appendix C. It shows the link between GHS classes and categories and equivalent classes of dangerous goods under the ADG Code.

If the chemical is classified as a Hazardous Chemical, and its total quantity stored on site is above the manifest quantity, then a Hazardous Material (HAZMAT) box shall be mounted just inside the chemical dosing site main entrance point. A chemical manifest shall be provided in the box and shall contain the following details:

- Date of preparation
- Name and contact details of Occupier / SA Water Responsible Person
- Contact details for two people in case of emergency
- Details of dangerous goods storages including type, location, number and volume of tanks
- Safety Data Sheet (SDS) of the chemical
- A site plan of the premises which includes:
    - Location of fire extinguisher and safety shower/eye wash facilities
    - Location of essential site services, fuel and power isolation points
    - Location of the manifest
    - Main entry and exit points
    - Location and classes of dangerous goods storages and how they are identified
    - Dosing area
    - Location of all drains on site
    - Nature of adjoining facilities
    - Location of emergency assembly area.

Also, SafeWork SA requires a licence for the storage of prescribed quantities of Class 8 corrosive substances. If required, SA Water's Health and Safety Adviser can assist in obtaining of the licence before arranging delivery of the chemical to the site (please note that SafeWork SA requires approximately 6 months' notice, and that application timelines should be adjusted accordingly).

7 Dosing System

The required dosing system shall be designed to provide a reliable, continuous dosing of metered volumes of chemical. Where more than one chemical is used, each type of chemical shall have its own dosing system. All valves, fittings, and pipework necessary for the proper operation of the dosing system shall be provided. The piping shall be suitable for the chemical conveyed and in accordance with the requirements listed in Section 3.3. The system shall be capable of operating in both automatic and local manual modes.

A typical chemical dosing P&ID is provided in SA Water Typical Drawing Number TYP-08-00001_01.

7.1 Day Tank

To minimise the risk of large quantities of chemicals from the bulk storage tank being added into the water supply in error, e.g., due to siphoning or other process control risks, a day tank can be considered.

Where a day tank is used the following principles should be adhered to:

- The workable volume of the day tank must be no more than 24 hours of storage volume at maximum flow and target dose rate. The workable volume is defined as the volume between the tank outlet and the overflow.
- The transfer of liquid chemical should be controlled by a transfer pump, can be initiated manually or automatically once a day, and stopped automatically (manual initiation can include initiation via a SCADA system). Gravity transfer must be prevented by using appropriate hydraulic design, such as an antisiphon loop.
- The refilling line should have a motorised isolation valve with position feedback. Another safeguard is to have an antisiphon and/or motorised isolation valve installed in the metering pump discharge line.
- The transfer of liquid chemical should not occur more than once in any 24-hour period.

Day tanks should be equipped with online level and weight measuring instrumentation (with an accuracy of ± 1% over the full range of the instrument) to ensure redundancy of controls is provided to prevent tank's overfilling and to measure chemical daily usage. Load cells are preferred for measuring mass changes in the day tank because they are more reliable than level sensors.

All equipment, pumps and day tanks should be located within a bunded area, and chemical spillage must be captured in a safe manner. Bulk and day tanks should be situated within separate bunds, sized to take at least 120% of the volume of the tanks.

7.2 Dosing Pumps and Pipework

The dosing system shall be located as close as possible to the dosing/day tank to avoid long suction lines, meeting dosing pump manufacturer requirements. It shall also be located to avoid long lengths of discharge pipework. The discharge point shall be at an elevation above the dosing pumps where possible, to avoid syphoning and the possibility of air entering dosing lines. Anti-syphon systems located at the injection point (e.g., pressure sustaining valves), are recommended when negative pressures are expected in the dosing line.

7.2.1 Pumps

At least two (2) identical (brand, type and capacity range) DUTY and STANDBY dosing pumps are recommended for dosing to achieve full capacity available at any one time (i.e., N + 1 configuration). The switchover to the standby pump shall be automated by default via SCADA/PLC. Automatic changeover between pump duties shall be configured on time as well as pump fault.

- Pump changeover can be a manual exercise and the operator will need to manually set the isolation valves in the correct position.

The dosing pumps shall be mechanically or hydraulically operated, electronically controlled piston diaphragm reciprocating-type, driven by an electric or stepper motor.

As sodium hypochlorite can form gas (oxygen) from solution decomposition the use of degassing type pump heads can be considered and installed where necessary.

Solenoid-driven pumps, double simplex capabilities via multiplexing, and ganging of gearboxes are not acceptable.

Turndown shall be conducted using a variable speed controller. If turndown cannot be achieved using a single pump, multiple pumps shall be used. Pumps that have no calibration below a pre-set flow are not accepted.

The manual stroke adjustment shall incorporate a calibrated dial [0 - 100%] to facilitate pre-setting and shall be capable of adjustment regardless of whether the pump is operating or not. Alternatively, the pumps are to incorporate digital indication of the set rate.

Metering accuracy of the pumps shall be better than 2.5% of the set rate at a variable suction head.

A minimum dose rate turndown ratio of 100:1 by means of stroke adjustment and variable speed control shall be provided.

Each pump shall be fitted with an external pressure relief valve with adjustable setpoint, vented back into the pump suction line to protect the pump from dead heading if there is a downstream blockage. Pumps are to be installed with local GPO connections to support isolation process without the need for an electrician. Pump speed is not to exceed 50Hz.

Dose pumps and dosing pipework need to be sized to ensure they never operate more than 80% capacity.

7.2.2 Pipework and Appurtenances

The following design requirements for chemical dosing pipework systems shall be met:

- Pipework systems shall be designed to withstand the maximum pressure experienced by the system
- The pipework layout and connections shall be simple, and all components shall be of a material that is resistant to the chemical to be conveyed. Keep pipework joints to a minimum to avoid risk of leaks (consider prefabricated chemical dosing valve modules where appropriate) Dismantling joints must be used at piping connections that do not have valves.
- Pipework components shall not pass through bund walls.
- The piping system must be resistant to internal corrosion from any associated chemical or protected by means of a suitable coating or internal lining
- Pipework must also be protected from external corrosion and mechanical impact, e.g., collision with delivery vehicles, pallet trucks, swinging doors, foot traffic, etc
- Pipework connections to tanks should be of the bolted flange type (PN16)

- All pipework (where size allows) shall be labelled with the name of chemical it conveys as well as identification of the flow direction. Refer to SA Water Technical Standard TS 0204.

Adjustable pressure sustaining valves shall be incorporated on each discharge line from the dosing pumps to maintain dosing accuracy over the range of operating depths in the storage tank, and to function as anti-syphoning protection. A second pressure sustaining valve shall be required at the dose point for dosing lines longer than 20 meters, or where the dose point level is lower than the level of the dosing pumps, to help prevent overdosing during system's idling periods.

Strainers with a maximum mesh size of one (1) mm shall be provided in each suction line to the dosing pumps to protect them from blockage by solid impurities.

7.3 Pulsation Dampeners at Pumps

Pulsation dampeners shall be provided, where appropriate, in the discharge pipework from the dosing pump and, shall be suitably sized for the displacement of the pump so that discharge pressure fluctuation does not exceed 10%. The pulsation dampeners shall have a diaphragm separating the air chamber from the liquid chamber. The air chamber shall be pressurised and be capable of re-pressurising by air pump via a Schrader valve. A pressure gauge with a protective diaphragm shall be installed on the pulsation dampeners.

7.4 De-pressurising, Flushing and Draining

Adequate provision shall be made for draining of lines for maintenance. This typically involves at least one drain valve on each of the suction and discharge sides of the dosing pump. These valves shall be piped to the sump or fitted with a camlock style fitting. The valving shall be provided to allow for flushing of the chemical dosing lines with works water without dismantling the lines.

A suitably sized male camlock style fitting constructed of a suitable material shall be provided on the chemical filling line's flushing point, and on all flushing points, if there is any, on the dosing line.

7.5 Pressure Indicator

A locally displayed pressure indicator shall be installed on the discharge side of each pump. The hydraulic oil type with a protective diaphragm shall be used for process fluids that may damage the pressure indicator. The purpose of the indicator is to enable setting of the pressure relief valve and the loading/anti-siphon (pressure sustaining) valve. Consider an additional pressure indicator and sustaining valve for lines greater than 20m.

7.6 Chemical Flowmeter

A flowmeter (magnetic and Teflon coated type preferred) shall be installed in each common dosing line. Should a pressure sustaining valve be installed on a common dosing line, the flowmeter shall be located prior to the pressure sustaining valve. It shall be sized for accurate flow rate measurements over the full range of the dosed chemical flows and be provided with sufficient upstream and downstream straight pipe run to prevent flow disturbances affecting the flowmeter. A second flowmeter shall be considered at the dose point (upstream of the pressure sustaining valve) for critical chemicals, and for dosing lines longer than 50 meters. A difference in flow rate measurements between two flowmeters would indicate a dosing line fault and would initiate shutdown of the dosing system and/or the shutdown the production at the treatment plant/dosing station for critical chemicals.

The dosing flowmeter shall be calibrated to units of litres per hour. The flow meter shall measure the flow and transmit the flow signal to SCADA. The flow meter shall display the flow rate, the total amount of the chemical dosed and any error messages.

The orientation of the flow meter tube is to be vertical mounted to minimise deposits and air entrainment and including a rodding point for cleaning to be provided.

Flow meters shall be connected using union joints, to allow easy cleaning of aperture.

7.7 Calibration Cylinder

A calibration cylinder (tube) shall be installed in each common dosing line (typically prior to the chemical dosing pumps), filled via gravity and within 2 metres of the dosing pump. The purpose of the calibration cylinder is to enable calibration of the dosing pumps locally by the operator using the chemical that is being applied. The calibration cylinder is to be sized to ensure that the volume will allow for 5 to 10 minutes of draw down and consider two tubes if flow rates vary significantly at different times of the day or year.

7.8 Water System

Where dilution water is required to meet the required process control objectives, it shall be piped from the service water system to provide a minimum dilution ratio of 20:1 of dilution water to dosing chemical.

Flow from the dilution water line shall pass through an isolation valve, flow switch, rotameter, solenoid valve(s) and non-return valve(s). The rotameter shall have a minimum length of 250 mm.

A flow switch shall be installed on the common line to provide a "dilution system failed" alarm (failsafe) as an input to the SCADA/PLC, on low flow.

A suitably sized RPZ valve shall be provided in the dilution water line for backflow prevention if connected to the drinking water supply. Only proprietary back flow prevention devices shall be used.

Where recycled water is available, it shall be used preferentially for the dilution water. Drinking water shall be used for eyewash facilities and safety showers.

A separate flushing water system is to be installed where appropriate. This is to flush the dosing lines clean of the chemical for maintenance activities.

7.9 Double Containment of Dosing Lines

A chemical risk assessment shall be used to determine the need for double containment dosing lines. The risk assessment shall consider the level of exposure and chemical type. In any event, all underground chemical dosing lines and hazardous chemical dosing lines external to bunded areas (underground or above ground) shall be of a pipe-in-pipe arrangement. The intention is to prevent a leak in the pipe contaminating the soil and groundwater, and to prevent it from accidental damage. Care must be taken with the design and installation of the outer pipe so that leaks from the inner pipe can be readily detected.

Concrete encasement of the lines when laid in ground is acceptable.

Double containment from within the bunded area through to the dosing point shall be constructed in such a way to facilitate replacement of dosing line without excavation of that section of pipe.

Rigid PE or PVC pipe or flexible PVC hose shall be considered as a material for the inner pipe, and rigid or flexible PVC conduit shall be considered for the outer pipe.

7.10 Dosing Point

The dosing point shall be designed with the following considerations:

- The use of shields to prevent splashing to nearby walls (where a corrosive chemical is used). Consider use of higher-grade materials for increased corrosion and erosion resistance of receiving duct or pipework at the dosing point. SA Water Materials group should be consulted.
- Dosing to maximise mixing with water (or wastewater) at the dosing point. Preference is to dose into a stream with turbulent flow characteristics or upstream of mixing devices, i.e., mixers, baffles etc, or upstream of transfer pumps.
- When dosed into an open to atmosphere system, e.g., open channel, the end of the dosing line shall be above the highest flow level, that is, an air gap shall be present, to avoid siphoning.
- Fully retractable dosing spears shall be used for dosing into pressurised pipelines. Chemical is to be dosed into the centre of the pipe to facilitate rapid dispersion into the water stream.

8 Instrumentation and Control

Instrumentation shall be installed within locations, environments, and conditions as recommended by the instrument manufacturer. They shall be readily visible by the operator under normal operating practices and be shielded from direct sunlight.

Sampling shall be from the middle of the pipe where practical and the probe shall be installed directly into the process stream, or onto a wet rack (preferable) that is enclosed within a suitable building and located within close proximity to the stream that is analysed (within 2 minutes travel time). Where a pumped sample stream is incorporated in the design, the response time shall be kept as short as possible, particularly for those dosing applications where high process variability is anticipated. Wet rack design shall incorporate components listed in Section 8.2.

The level of allowable instrument error is dependent on its criticality. Below is a summary of minimum expectations for each analyser.

Chemical dosing shall be flow paced to the bulk stream flowrate. Additional feed forward and/or feedback control may be required for critical applications in accordance with the requirements of the Design Basis Report.

8.1 Analyser/Instrumentation Requirements

An availability of greater than 99% is required for all analysers and other instrumentation used in the chemical dosing system such as level sensors, per the requirements of Table 1.

Table 1 - Instrumentation Requirements

Instrument	Allowable error (%)*	Display (Local, HMI, SCADA)	Units of display
Tank Height/Volume	2%	Local, SCADA	% of tank
Chemical Flow meter	5%	HMI, SCADA	L/h
Chemical Analyser	5%	Local, HMI, SCADA	mg/L, pH units, mV

** Over full scale of instrument's quantification range.*

8.2 Wet Rack Components

The wet rack shall include the following:

- A supply pipe, sized to minimise sample travel time (< 2 mins) to the wet rack and to ensure that sufficient and balanced flow is provided to all analysers.
    - The supply pipe must not be dead ended to avoid stagnation of water, particle suspension, biofilm growth and pipe fouling.
- Take off sample pipes to individual analysers, which are to be valved to enable flow to be controlled and isolated.
- The diameter of the supply pipe sized so to avoid very low or very high velocities and to minimise shear and deposition. The velocity should not be less than 0.7 m/s to prevent build-up of deposits in pipes but not too high to shear particulates (>2.0 m/s). The ideal velocity at the inlet to the supply pipe is 1.0 m/s.
- A means to obtain a grab sample from the outlet of the analyser without interfering with analyser flow or measurement must be provided. If a sample needs to be taken for microbiological compliance, the sample tap and associated pipework shall be constructed of flame-resistant material (e.g., 316 stainless steel) and installed in such a way to avoid damaging other equipment/pipework by the flaming process.

- Analyser waste water shall be directed to a drain with an associated air gap.

The sample flow at the inlet to the supply pipe should be greater than the combined flow required to the analysers. This allows excess flow to be continually discharged from the supply pipe outlet.

The discharge end of the supply pipe may be elevated above the inlet to the wet rack to provide back pressure and to keep the analyser probes flooded. Alternatively, a suitable pressure sustaining valve may be installed.

The supply pipe, valves and fittings must be constructed using suitable materials that are compliant with TS 0800.

8.3 Sample Pre-treatment and Conditioning

Physical pre-treatment prior to the analyser (and/or wet rack) may be required depending upon the sample water quality and type of analyser installed. This may include pressure reduction, straining, filtration, dissolved gas/bubble removal, pH modification and flow control.

Sample pressure may require reduction before it is delivered to the analyser, and this can be achieved using a pressure reducing valve and pressure gauge arrangement.

Non-filtered water samples may include inline strainers (typically 4 mm and 500 µm in series) to prevent particles including algae, floc, sediment and other solid material from blocking the pipework, fittings and the analyser. Strainers should be fitted with suitable isolation valves.

Gas bubbles may form in the sample pipe or measuring device, and these can interfere with sample measurement and flow. This is typically evident in reverse osmosis permeate streams where carbon dioxide and other gases exist.

8.4 Shutdown and Alarms

The dosing system shall have the capability to automatically shutdown to avoid an unsafe condition, protect equipment or have the potential to result in a water quality incident. In addition to general fault status, each analyser will provide indication of alarms per Table 2.

Table 2 - Alarm Requirements

Instrument	Alarms	SCADA / Local
Tank Height / Volume	Low Low Low High High High Out of Range	SCADA
Chemical Flow Meter	Low Low Low High High High Out of Range	SCADA
Chemical Analyser	Low Low Low High High High Out of Range	SCADA

Appendix A: Requirements for Fluorosilicic Acid & Sodium Fluoride

The purpose of this appendix is to outline additional design and installation requirements for Fluorosilicic Acid and Sodium Fluoride Solution Storage and Dosing facilities.

Fluoride is dosed to maintain optimal fluoride levels in drinking water to reduce tooth decay.

The two commonly used by SA Water Fluoride compounds for drinking water treatment are:

- Fluorosilicic Acid (also known as FSA) - H_2SiF_6
- Sodium Fluoride – NaF.

Fluorosilicic Acid is delivered to SA Water by tanker as a 20% solution and Sodium Fluoride is supplied in powdered form in 5 kg or 25 kg packaging and requires on-site dissolution in a saturator before dosing.

The relevant Australian Standard (AS3870 for Fluorosilicic Acid; AS4452 for Sodium Fluoride) and Code of Practice for Fluoridation of Drinking Water Supplies (Victoria) should be consulted, with respect to the design and construction of the chemical storage and dosing facilities.

A1 Design Criteria for all Fluoride Dosing Facilities

Fluoridation equipment must be kept separate from other water treatment plant equipment in a separate building or room (the 'fluoridation room'). The fluoridation room should be purpose designed for the type of fluoride dosing system it will house.

The dosing point should occur after any coagulation, filtration and pH adjustment to avoid substantial losses that can occur if fluoride reacts with other water treatment chemicals such as aluminium, calcium or magnesium. This can cause the fluoride to form a precipitate and thereby cease to be in solution, reducing its effectiveness.

The fluoride dosing system must have the rate of feed of the fluoride chemical paced to the flow of the water. It must not be able to operate unless water flow is detected.

A day tank shall be used to prevent overdosing. A day tank acts as a physical barrier that minimises the risk of large quantities of fluoridation chemicals from the bulk storage tank or from the saturator being added into the water supply in error. Refer to Section 0 (Day Tank) for the design principles of a day tank installation.

In addition to a day tank, the following overdosing safeguards are suggested:

- The adoption of a fluoride solution flow meter with high flow alarm
- The use of two flow meters (rather than the use of one flow meter and a flow switch) such that discrepancies in flow readings result in shutdown of the fluoride dosing system. The flow meters must record the instantaneous flow and cumulative flow over a 24-hour period
- At least one online fluoride analyser – interlocked with the dosing facility – should be provided downstream of the dosing point at a point where adequate mixing has taken place. It should provide real-time fluoride monitoring, be linked to an appropriate alarm monitoring system and automatic shutdown and must be available at all times.

Dosing pumps must be able to accurately deliver the required flow rate and be sized or capped so that they operate at their maximum output at the maximum flow of the water treatment plant. A method for verifying dose rates must be available and maintained to ensure its reliability. This is typically achieved by using a manual drawdown test cylinder.

Any risk of gravity flow or siphoning of the fluoride chemical through the dosing pump must be prevented. Pressure relief and a loading valve on the delivery side of the pump must be provided.

A2 Design Criteria for Fluorosilicic Acid Dosing Facilities

Fluorosilicic acid is corrosive and will give off acidic fumes. These fumes have the potential to increase corrosion rates of equipment in the fluoridation room and harm operator health and safety if not managed appropriately. Fumes from internal storage tanks should be minimised through sealing of the tank and extending vents outside the building. Water seals can be used on the tank overflow outlet if the bunded area is internal to the room. An exhaust fan should be installed to remove the fumes from the fluoridation room. The location of the fan and room vents should be chosen to maximise cross flow ventilation of the room. If exhaust fans are used, they should be acid-fume resistant, designed for continuous operation and vented to open air away from doors, windows and air inlets and any area that may be accessed outside the fluoridation room.

Electrical control panels should be located outside the fluoridation room to minimise deterioration due to corrosion and to minimise the need for entry into the room for operational and maintenance staff.

The control panels should be in a separate room adjacent to the room containing the fluoridation equipment. The room containing the control panels should have a separate entry door with no interconnecting door or other means by which air can pass between the two rooms. There should be a window in the common wall between the fluoridation room and the control panel room to allow operators to have a clear view of the dosing equipment when operating the control panel. Use of a suitable material for the viewing window should be considered since glass and some plastics can become etched, frosted or clouded from fluorosilicic acid fumes.

A3 Design Criteria for Sodium Fluoride Solution Dosing Facilities

A softener should be used if the hardness of the water used for sodium fluoride dissolution is greater than 75 mg/L (as $CaCO_3$) to reduce the loss of fluoride ion by precipitation of calcium or magnesium fluoride.

In a sodium fluoride solution dosing facility, if it is not practical to separate the fluoride dosing equipment from the control panels, the risks of corrosion can be managed with effective housekeeping, dust extraction and dust control measures.

Appendix B : Emergency Site Information Package

Site Street Address	*<Insert street address here>*
Site Postal Address	*<Insert postal address here or 'As Above' if same as street address>*
Head Office	250 Victoria Square ADELAIDE SA 5000
Emergency Contact Details	Operations Control Centre **P** (08) 7424 3500
	<Insert secondary contact name and number here>
Class 4 Chemicals	No Class 4.2 or 4.3 chemicals are stored at this site
Manufactured Chemicals	No Hazardous chemicals or materials are manufactured at this site
Safety Data Sheets (SDS)	Stored electronically for this site, accessible by all SA Water people. For sites only holding manifest Chlorine gas an SDS is included in the ESIP. For sites with multiple manifest quantities a copy of SAA/SNZ HB 76:2010 is included. Dangerous Goods: Initial Emergency Response Guide is to be included.

Manifest Chemicals

Insert copy of table of manifest chemicals from emergency plan, do not add extra chemicals.

Site Plans

Two A3 size laminated site plans must be attached to this document. These can be copied from the Emergency Plan.

Version History

Version	Date	Author	Comments
0.1	19/07/19	Sharon Sales	First draft
1.0	22/07/19	Health & Safety	First release

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Appendix C: Placard/Manifest Requirements (Schedule 11)

Item	Description of Hazardous Chemical		Placard Quantity *(Column 4)*	Manifest Quantity *(Column 5)*	ADG Code Classification
1	Flammable gases	Category 1	200 L	5 000 L	2.1
2	Gases under pressure	Acute toxicity, categories 1, 2, 3 or 4 Note 1—Category 4 only up to LC_{50} of 5000 ppmV	50 L	500 L	2.3 – Note 2
3		Skin corrosion categories 1A, 1B or 1C	50 L	500 L	2.3 – Note 2
4		Aerosols (including flammable aerosols)	5 000 L	10 000 L	2.1 or 2.2
5		Not specified elsewhere in this table	1 000 L	10 000 L	2.2
6	Flammable Liquids	Category 1	50 L	500 L	3 (PG I)
7		Category 2	250 L	2 500 L	3 (PGII)
8		Category 3	1 000 L	10 000 L	3 (PG III)
9		Any mix of chemicals from Items 6 – 8 where none of the items exceeds the quantities in columns 4 or 5 on their own	1 000 L	10 000 L	
10		Category 4	10 000 L	100 000 L	Note 3
11	Self-reactive substances	Type A	5 kg or L	50 kg or L	GTDTBT – Note 4
12		Type B	50 kg or L	500 kg or L	4.1 (Type B)
13		Type C-F	250 kg or L	2500 kg or L	4.1 (Type C-F)
14	Flammable Solids	Category 1	250 kg	2500 kg	4.1 (PG II)
15		Category 2	1 000 kg	10 000 kg	4.1 (PG III)
16		Any mix of chemicals from Items 12 – 15 where none of the items exceeds the quantities in columns 4 or 5 on their own	1 000 kg or L	10 000 kg or L	
17	Pyrophoric liquids and Pyrophoric solids	Category 1	50 kg or L	500 kg or L	4.2 (PG I)
18	Self-heating substances and mixtures	Category 1	250 kg or L	2 500 kg or L	4.2 (PG II)
19		Category 2	1 000 kg or L	10 000 kg or L	4.2 (PG III)

Item	Description of Hazardous Chemical		Placard Quantity *(Column 4)*	Manifest Quantity *(Column 5)*	ADG Code Classification
20		Any mix of chemicals from Items 17 – 19 where none of the items exceeds the quantities in columns 4 or 5 on their own	1 000 kg or L	10 000 kg or L	
21	Substances which in contact with water emit flammable gas	Category 1	50 kg or L	500 kg or L	4.3 (PG I)
22		Category 2	250 kg or L	2 500 kg or L	4.3 (PG II)
23		Category 3	1 000 kg or L	10 000 kg or L	4.3 (PG III)
24		Any mix of chemicals from Items 21 – 23 where none of the items exceeds the quantities in columns 4 or 5 on their own	1 000 kg or L	10 000 kg or L	
25	Oxidising liquids and Oxidising solids	Category 1	50 kg or L	500 kg or L	5.1 (PG I)
26		Category 2	250 kg or L	2 500 kg or L	5.1 (PG II)
27		Category 3	1 000 kg or L	10 000 kg or L	5.1 (PG III)
28		Any mix of chemicals from Items 25 – 27 where none of the items exceeds the quantities in columns 4 or 5 on their own	1 000 kg or L	10 000 kg or L	
29	Organic peroxides	Type A	5 kg or L	50 kg or L	GTDTBT – Note 4
30		Type B	50 kg or L	500 kg or L	5.2 (type B)
31		Type C-F	250 kg or L	2 500 kg or L	5.2 (Type C-F)
32		Any mix of chemicals from Items 30 – 31 where none of the items exceeds the quantities in columns 4 or 5 on their own	250 kg or L	2 500 kg or L	
33	Acute toxicity (Note 5)	Category 1	50 kg or L	500 kg or L	6.1 (PG I)
34		Category 2	250 kg or L	2 500 kg or L	6.1 (PG II)
35		Category 3	1 000 kg or L	10 000 kg or L	6.1 (PG III)
36		Any mix of chemicals from Items 33 – 35 where none of the items exceeds the quantities in columns 4 or 5 on their own	1 000 kg or L	10 000 kg or L	

Item	Description of Hazardous Chemical		Placard Quantity *(Column 4)*	Manifest Quantity *(Column 5)*	ADG Code Classification
37	Skin Corrosion	Category 1A	50 kg or L	500 kg or L	8 (PG I)
38		Category 1B	250 kg or L	2 500 kg or L	8 (PG II)
39		Category 1C	1 000 kg or L	10 000 kg or L	8 (PG III)
40	Corrosive to metals	Category 1	1 000 kg or L	10 000 kg or L	8 (PG III)
41		Any mix of chemicals from Items 37 – 40 where none of the items exceeds the quantities in columns 4 or 5 on their own	1 000 kg or L	10 000 kg or L	
42	Unstable explosives		5 kg or L	50 kg or L	GTDTBT – Note 4
43		Any mix of chemicals from Items 11, 29 and 42 where none of the items exceeds the quantities in columns 4 or 5 on their own	5 kg or L	50 kg or L	GTDTBT – Note 4

Notes:

1. For item 2, gases under pressure with acute toxicity category 4 only applies up to a LC_{50} of 5000 ppmV, which is equivalent to Div. 2.3 under the ADG code.
2. Division 2.3 under the ADG Code includes gases and vapours as acutely toxic (categories 1, 2 and 3) and gases which are corrosive to skin (category 1).
3. Only liquids with a flash point of up to 93°C are classified as flammable liquids under the WHS Regulations. C1 combustible liquids with flash points between 93°C and 150°C are not classified as flammable liquids under the GHS or WHS Regulations.
4. GTDTBT = Goods too dangerous to be transported.

For gases classified with Acute Toxicity, the placard and manifest quantities as defined under item 2, rather than items 33-36, should be used.