Assets Planning and Delivery Group
Engineering

DESIGN STANDARD DS 73-10

Small Sodium Hypochlorite Storage and Dosing Systems Basis of Design

VERSION 1
REVISION 0

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FOREWORD

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

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

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

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

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

Head of Engineering

DISCLAIMER

Water Corporation accepts no liability for any loss or damage that arises from anything in the Standards/Specifications including any loss or damage that may arise due to the errors and omissions of any person. Any person or entity which relies upon the Standards/Specifications from the Water Corporation website does so that their own risk and without any right of recourse to the Water Corporation, including, but not limited to, using the Standards/Specification for works other than for or on behalf of the Water Corporation.

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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	1/0	29/11/21	All	New Version/Revision	DH	DH
2	1/0	29/11/21	All	New Version/Revision	DH	DH
3	1/0	29/11/21	All	New Version/Revision	DH	DH
4	1/0	29/11/21	All	New Version/Revision	DH	DH
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6	1/0	29/11/21	All	New Version/Revision	DH	DH
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DESIGN STANDARD DS 73-10

Small Sodium Hypochlorite Storage and Dosing System - Basis of Design

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1 INTRODUCTION

1.1 Purpose

The purpose of this document is to explain the reasoning behind the Water Corporation's design and installation requirements for its small sodium hypochlorite storage and dosing facilities and to provide specific information relating to the Corporation's preferences and best practices which have evolved over years of experience.

1.2 Scope

This document is primarily intended for small sodium hypochlorite storage and dosing facilities that are used for drinking water disinfection although most of it is also relevant to sodium hypochlorite facilities for wastewater treatment or other treatment purposes. It is particularly applicable to sodium hypochlorite dosing plants that have small storage tanks that receive supply of sodium hypochlorite in plastic packages (20L), drums (200L), or IBCs (1,000L) delivered in trucks or utility vehicles. For dosing design downstream of the dosing panel including dosing spears, mixing of chemical, and dilution/carrier water of chemical, reference should be made to design standard DS78 - Chemical Dosing.

This standard also applies to temporary or mobile installations – whilst it might not be feasible to apply all requirements to such installations, any deviations should be identified, risk assessed and recorded.

1.3 Background Information

Sodium Hypochlorite (NaOCl) solution is a corrosive and strong oxidiser and is mainly used in water treatment as an alternative disinfectant to chlorine gas. Although chlorine gas is highly effective as a disinfecting agent and relatively inexpensive, it has inherent risks. Safety concerns associated with potential gas leaks makes chlorine gas unsuitable where there is insufficient separation to residential and public access areas. Sodium hypochlorite solution is less hazardous and easier to handle, and is a viable alternative to gaseous chlorine.

Sodium hypochlorite has historically been supplied to Water Corporation facilities as 12.5% to 13.5% (weight/volume available chlorine) solution with a specific gravity of 1.18 at 20°C. It is now also available1 as 4.5% w/v solution (specific gravity 1.05). The weight/volume (w/v) percent is equivalent to grams of available chlorine per 100mL of solution.

Sodium hypochlorite disassociates in water to form hypochlorite ions (OCl^-) and hypochlorous acid (HOCl) according to the following equations:

$$NaOCl_{(aq)} \leftrightarrows Na^+_{(aq)} + OCl^-_{(aq)}$$

$$OCl^-_{(aq)} + H_2O_{(l)} \leftrightarrows HOCl_{(aq)} + OH^-_{(aq)}$$

The hypochlorite ion (OCl^-) exists in equilibrium with hypochlorous acid (HOCl). The relative concentration of these two disinfectant species depends on pH.

[1] Available, for example, from Environex International Pty Ltd of Wangara.

Figure 1 illustrates this equilibrium. Hypochlorous acid is the stronger disinfecting species. The equilibrium favours hypochlorous acid at pH less than 7.5.

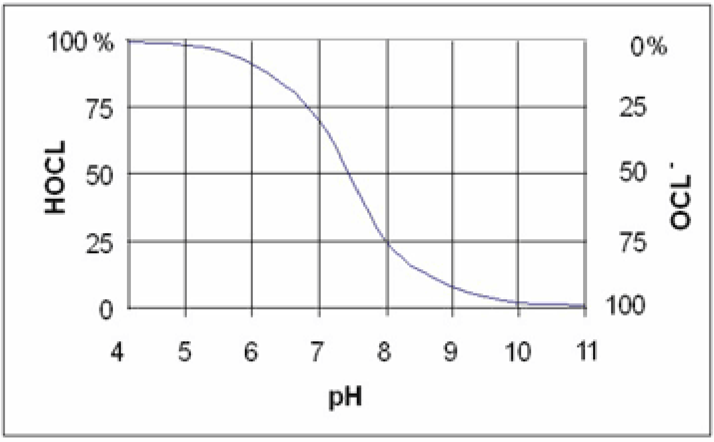

Figure 1-1 - Equilibrium of Hypochlorite Ion & Hypochlorous Acid

Transport cost for sodium hypochlorite tends to be high compared to chlorine gas because it is delivered in solution which adds weight. This additional weight also limits manual handling options. Its' caustic properties make it highly corrosive to skin and eyes, so operators require appropriate PPE when handling opened packages.

Sodium hypochlorite is not without its problems. It is highly corrosive to most metals and also oxidises many plastics and elastomers. It is relatively unstable over time and has the potential to crystallise in delivery lines, form scale on water system components, and releases gas which may cause "gas locking" and which may rupture piping and valves. These problems may be mitigated by good engineering design and correct material selection, and by using dilute sodium hypochlorite (i.e. below 5%), which is one of the design principles used in this Standard. Sodium hypochlorite degrades over time reducing the available chlorine content and producing undesirable by-products such as sodium chloride, sodium chlorate, and oxygen. Factors that influence the rate of sodium hypochlorite degradation include solution strength, pH, temperature, UV light exposure, contaminants in solution, and contact with many metals.

Material selection for sodium hypochlorite service is critically important. For piping and valves, typically plastics such as uPVC (alternative is ECTFE) are used. It is recommended that gaskets, o-rings and elastomeric seals be made of FPM (also known as FKM and Viton). Water Corporation no longer permits the use of peroxide-cured EPDM due to past instances of sulphur-cured EPDM being inadvertently used and then subsequently failing causing leaks.

Another factor that complicates material selection is that some metals offer good corrosion resistance but cause accelerated decomposition of sodium hypochlorite. When sodium hypochlorite decomposes it produces oxygen gas which can cause significant problems with vapour-locking of dosing pumps or achieving consistent control with dosing systems. Past experience has shown that a seemingly minor detail, such as the wrong metal spring in a pressure sustaining valve or dosing pump check valve, can result in a dosing system failure. Direct exposure to stainless steels, duplex stainless steels and Hastelloy results in rapid decomposition of sodium hypochlorite solution and causes equipment failure.

Sodium hypochlorite solutions react vigorously with most acids to release toxic chlorine gas. In general, sodium hypochlorite must not be mixed with other chemicals or any organic compounds, including oils, fuels, and grease, unless known to be compatible.

1.4 Related Drawings

The Piping & Instrumentation Diagrams (P&IDs) associated with this Basis of Design document can be found in the Corporation's Drawing Management System and have the following drawing numbers:

P&ID drawings JD71-060-082-05 through to JD71-060-082-09

1.5 Water Corporation's Level of Service (LOS)

Two separate designs for two levels of service (High LOS and Low LOS) were initially suggested for the sodium hypochlorite dosing design standards. A Low LOS design standard which was less complex and could be built at lower cost was proposed for re-chlorination facilities. However, this is now thought to be unacceptable due to the risk of upstream primary chlorination failure. Provision of High LOS is necessary for small sodium hypochlorite storage and dosing facilities and involves two dosing panels supplied from a single tank which avoids potential interruptions to chlorination.

1.6 Design Philosophy

1.6.1 Delivered Chemical Concentration

It is anticipated that most new small hypochlorite facilities will use dilute (4.5% m/v) hypochlorite solution because it resolves the problems of gas-locking and significantly reduces the rate of strength degradation.

Sodium hypochlorite is available as neat solution (approximately 12.5% m/v) or dilute solution (4.5% m/v). Use of dilute solutions is generally practical for the small hypochlorite systems considered by this standard. This is because the volume of chemical used is relatively small and thus the impact of three-fold dilution (reduced to 4.5% from 12.5%) makes minimal difference to considerations such as ability to fit the storage tank within the dosing module, and the overall cost of operating the dosing facility.

1.6.2 Continuity of Dosing

The disinfection treatment process is critical and mandatory to the production of safe drinking water, and typically is critical for disinfection of treated wastewater if the consequence of disinfection outage is an interruption of the sole disposal method (i.e. the primary issue is "availability of disposal" rather than "period that turf can handle not being watered"). To ensure a high level of service, separate duty and standby dosing systems are provided downstream of the chemical storage tank (i.e. two separate dosing panels). This allows maintenance to be safely done on one dosing system, while the other dosing system is in operation.

1.7 Standards

This design standard refers (directly or indirectly) to the following standards and regulations:

Australian & International Standards:

AS 1111.1	ISO metric hexagon bolts and screws – Product grade C – Bolts
AS 1112.3	ISO metric hexagon nuts – Product grade C
AS 1170	Structural design actions – General principles
AS 1214	Hot–dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
AS/NZS 1170.1	Structural design actions – Permanent, imposed and other actions
AS 1158.3.1	Lighting for roads and public spaces – Pedestrian area (Category P) lighting – Performance and design requirements

AS 1318	SAA Industrial safety colour code
AS 1319	Safety signs for the occupational environment
AS 1345	Identification of the contents of pipes, conduits and ducts
AS 1657	Fixed platforms, walkways, stairways and ladders – Design, construction and installation
AS 1680.2.4	Interior Lighting – Industrial tasks and processes
AS 1688.2	The use of ventilation and air-conditioning in buildings – Part 2: Ventilation design for indoor air contaminant control
AS 2032	Installation of PVC pipe systems
AS 2293.1	Emergency escape lighting and exit signs for buildings – System design, installation and operation
AS 2634	Chemical plant equipment made from glass fibre reinforced plastics (GRP) based on thermosetting resins
AS 3500	National plumbing and drainage code (provision of backflow prevention devices)
AS 3780	The storage & handling of corrosive substances
AS 3879	Solvent cements and priming fluids for PVC (PVC-U and PVC-M) and ABS pipes and fittings
AS 3953	Construction of buildings in bushfire-prone areas
AS 4041	Pressure piping
AS/NZS 4087	Metallic flanges for waterworks purposes
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS4766	Polyethylene storage tanks for water and chemicals
AS 4775	Emergency eyewash & shower equipment
ASME RTP-1	Reinforced Thermoset Plastic Corrosion-Resistant Equipment
BS EN 13121-3	GRP Tanks and Vessels for use above ground. Design and workmanship.
BS 4994	Design & Construction of Vessels & Tanks in Reinforced Plastics
DVS 2205	Design Calculations for Containers & Apparatus Made of Thermoplastics
DVS 2207	Welding of Thermoplastics

Water Corporation Standards:

DS 20	Electrical Design Process
DS 22	Ancillary Plant & Small Pump Stations – Electrical
DS 24	Electrical Drafting
DS 26	Type Specifications - Electrical
DS 27	Regulating Valve Control
DS 28	Water and Wastewater Treatment Plants - Electrical
DS 30	Mechanical General Design Criteria & Glossary
DS 31-01	Pipework
DS 31-02	Valves & Appurtenances

DS 32	Pump stations
DS 33	Water Treatment Mechanical Design Standards
DS 35	Ancillary Plant Mechanical Design Standards
DS 36	Strategic Product Specifications and Product Atlas
DS 40	SCADA Standards
DS 40-06	Software Change Control
DS 40-08	Standard for the Control of Chemical Dosing
DS 40-09	Field Instrumentation
DS 62-01	Site Security, Public Safety and Emergency Treatments
DS 78	Chemical Dosing
DS 79-01	Design of Chemical Systems - Legislative Requirements and General Principles
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 Storage & Dosing Systems – Basis of Design
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)
SPS 498	HDPE Chemical Storage Tanks
WS-2	Welding & Joining Specification – Thermoplastics

Acts and Regulations:

Dangerous Goods Safety Act 2004 (Western Australia)

Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007 (Western Australia).

1.8 References

Criteria for Drinking Water Supply, Release 3 – Asset Investment Planning Regional, Water Corporation, April 2019.

Australian Drinking Water Guidelines, National Water Quality Management Strategy, National Health & Medical Research Council, Rolling revision.

KWS Investigation Report – Hypo Dosing Faults, Service Reservoir Chlorination and Independent Artesian GWTP, July 2005 to January 2006, P. Hanley, 7 March 2006 (with installation standard drawing and notes Rev 8, 25 August 2008)

Sodium Hypochlorite – General Information for the Consumer, Odyssey Manufacturing Co., Revised 6 April 2012

White’s Handbook of Chlorination and Alternative Disinfectants, 5th Edition, Black &Veatch Corporation.

1.9 Terminology & Abbreviations

ADWG	Australian Drinking Water Guidelines
Corporation	Water Corporation
DG Regs	Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007 (Western Australia)
EPDM	Ethylene Propylene Diene Monomer (a synthetic elastomer)
Hypo	Sodium Hypochlorite
FRP	Fibreglass Reinforced Plastic
GRP	Glass-fibre Reinforced Plastic
HDPE	High Density Polyethylene
HMI	Human Machine Interface
OIP	Operator Interface Panel
PE	Polyethylene
UPVC	Unplasticised Polyvinyl Chloride

1.10 Units

Dose Rate	mg/L
Chemical Flow Rate	L/hr
Water Main Flow Rate	kL/hr
Chemical Strength	% w/v (equal to grams of available chlorine per 100mL)

2 CHEMICAL BUILDING

2.1 General

The storage and dosing system shall be constructed within a building such as a Prefabricated Treatment Module (see modular specification PTM - https://nexus.watercorporation.com.au/otcs/cs.exe/link/101394855 for requirements). The function of the building is:

a) To shield the stored sodium hypochlorite from heat and UV light, thus minimising its degradation rate;

b) To protect the equipment inside from UV degradation and excessive temperature;

c) To exclude rainfall from the bund, therefore eliminating the need to size the bund with additional capacity for rainwater;

d) To provide an additional level of separation of this hazardous chemical from staff and visitors to site; and

e) To safeguard the assets in line with the Corporation's security principles[2].

2.2 Layout and Design

The internal layout shall be as uncluttered as possible with all piping located around the periphery of the building to give a tidy arrangement with good access to all components for operation and maintenance. 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 wall mounted equipment, instruments, switchboards (where the Principal has approved switchboard installation in the chemical storage room), control panels and simplify pipe and cable routing . The piping shall also be appropriately located to allow easy access to equipment and valves, and facilitate unobstructed cleaning of the work areas. It is preferred to design layout to avoid ramps; however, where this is not practical then include ramps at changes in floor level for easy moving of equipment in and out of the building.

The design and layout of the facility shall include consideration of section 7.2.1 of AS 3780. This shall include sufficient space between bund walls, storage areas and other structures to allow access for maintenance and during emergencies. Specifically for maintenance access, an unobstructed clearance of not less than 1.0 m shall be provided in front of the dosing pump/panel and other equipment, with a minimum 2.1 m head clearance.

The building, inclusive of doors, windows and ventilation openings shall be designed to withstand bushfires in accordance with AS 3959.

The building shall also be designed to exclude wildlife, insects, and vermin. Measures shall include door seals, tropical midge mesh on ventilation openings, and brushware around the edges of roller shutters to impede the ingress of vermin.

The building shall be designed so that the storage tank(s) can be removed and replaced through a doorway (e.g. roller door for large tanks). For facilities with two or more storage tanks, the design shall allow for replacement of any tank while the others remain in operation.

[2] DS62 Site Security, Public Safety and Emergency Treatments.

2.3 Materials of Construction

Various materials of construction may be appropriate for the sodium hypochlorite room e.g. metal clad, concrete, or masonry walls. Choice of building materials will need to consider the corrosive properties of sodium hypochlorite (including fumes), as well as architectural and security requirements at the site. Consideration should be given to materials of wall panels, roof and doors including their insulation features and seals to minimise transfer of outdoor heat into the storage and dosing room.

2.4 Lighting

Internal lighting and external entry lighting 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 DS 28. The building shall be equipped with internal emergency lighting with battery backup.

2.5 Ventilation

Sodium hypochlorite degrades faster at higher temperatures. Studies have shown that for every 10°C increase in storage temperature, the decomposition rate increases by a factor of 3-4 in a solution of 5% to 16% (w/v) hypochlorite[3]. Sodium hypochlorite should be stored in rooms that are kept cool or at least well-ventilated.

Ventilation shall be accomplished in accordance with the Water Corporation's mechanical standards (refer DS30-02) which references AS 1668.2. Natural ventilation is preferred over mechanical ventilation as it does not require redundancy considerations nor does it incur running costs. Sodium hypochlorite fumes are considered Type A effluent as defined in AS 1668.2. If no leaks are present in the system and any spills are cleaned up thoroughly, then natural ventilation complying with AS 1668.2 will be sufficient to manage chemical fumes and corrosion within the chemical storage room. However, switchable mechanical exhaust systems[4] shall be provided and used whenever personnel are in attendance.

The ventilation system design shall comply with the requirements of AS 1668.2 and should incorporate the following key features:

a) The minimum total area of natural ventilation openings shall be 5% of the floor area.

b) Openings for natural ventilation should be positioned on opposite sides of the room to maximise cross-draught.

c) Openings for natural ventilation should be provided at high and low levels to maximise the benefits of thermal effects and to minimise heat accumulation.

d) The mechanical exhaust system shall be designed to achieve 20 L/sec per m^2 of floor area.

e) The exhaust fans shall be located near the floor and air shall be discharged vertically at a high level above the building with a discharge velocity not less than 5m/s to prevent further contamination of the storage areas.

[3] White's Handbook of Chlorination and Alternative Disinfectants, 5th Edition, Black & Veatch Corporation.

[4] AS 1668.2-2012 Cl 3.3.1 (a) defines a Type A effluent & Figure 3.1 provides general guide for the application of exhaust systems.

The mechanical exhaust system shall be activated by a switch located in the entry vestibule/electrical room. Consideration could be given for the exhaust fans to be controlled by a temperature switch located inside the building so that the fans would automatically operate to cool down the Hypo storage tank area when a temperature set-point is reached.

At sites where ambient temperature is normally high, the use of air-conditioning may be considered to significantly reduce the sodium hypochlorite degradation rate. However, this will have to be considered with cost analysis on a project-by-project basis. Ventilation requirements would then be determined (and may possibly deviate from above) based on the temperature management strategy and HVAC design.

2.6 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 in close proximity to the chemical store and/or dosing room. An exception to this requirement may be granted for systems located in operating regions where operators carry chemical PPE and first aid kits in their vehicles.

2.7 Personnel Doors

Personnel doors shall be designed to meet the required fire rating. Where air conditioning is installed then the doors shall be fitted with crash-bars for use as emergency exits. 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 and insulated to prevent heat transmission into the storage/dosing room. They shall have pull handles and retaining hooks for holding in the open position. A hydraulic-operated door anti-slam closer/dampener shall be provided for each door leaf. Appropriate signs shall be fitted on the doors.

When determining the location of personnel access doors to the storage/dosing room, the required separation and segregation distances outlined in AS 3780 must be maintained. If the floor area is greater than $25m^2$ then two means of access/egress are required[5].

2.8 Door to Storage/Dosing Room

Door access shall be provided to allow chemical deliveries to the storage/dosing room. The doorway width shall be sufficient to also allow movement of equipment (i.e. including tank replacement) into and out of the storage/dosing room.

Where used, roller shutters (rather than single curtain sheet roller doors) shall have thermal insulation in the interlocking slats. The operation of these doors shall be automated using heavy duty motors and they shall be equipped with manual override. These doors shall be industrial strength with galvanised fixtures and guides.

[5] Clause 4.4.b of AS 3780.

2.9 Platforms and Stairways

Platforms and stairways shall comply with DS30-02, DS100, AS 1170, and AS 1657 and be constructed from FRP when present in the storage/dosing room.

Any cut-outs provided to allow operation of valves below the platform shall not create a tripping hazard or obstruct access/egress ways. Where cut outs are required in the FRP grating, for access to equipment such as valve spindles or for intersection of pipework, proper strengthening and support of the modified grating shall be carried out by qualified designers and installers to ensure its integrity is not undermined. Any open holes in the grating as the result of 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 prevalent OSH requirements for safe access of Grid Mesh Landings.

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

2.10 Accessibility

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

All valves and instruments shall be accessible without having to enter the bund. Bund sump instruments and equipment may be permitted to have bund access if approved.

3 CHEMICAL STORAGE REQUIREMENTS

Irrespective of the exemptions for minor storage facilities stipulated in AS3780 (the storage and handling of corrosive substances) and the Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007, the Water Corporation requires small sodium hypochlorite storage and dosing systems to be designed and operated in accordance with the information provided within this standard. A “small storage and dosing system” within the context of this standard is defined as one with capacities between 20 – 1,000L that transfers sodium hypochlorite via dosing pumps for disinfection purposes.

3.1 Bund Capacity and Design

A bund of at least 110% of the volume of the storage tank shall be provided. The bund volume is the net available containment capacity and shall not include the volume occupied by foundations and other items within the bund. Bund drainage to site drainage and tan theta / crest locus limits apply to tank bunds. There shall be no penetrations through the bund wall, other than the drain pipework for the bund. Incompatible goods shall not be kept within the bund.

3.2 Bund Construction Materials

Bunds for small Sodium Hypochlorite tanks, and for standby packages and drums, shall be constructed from compatible plastic materials (e.g. polyethylene).

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.

3.3 Bund Valve

The bund outlet shall be designed to achieve complete drainage of the bund sump; hence, the preferred outlet location is through the base of the bund sump. A bund outlet pipe shall lead to site drainage outside the Sodium Hypochlorite building. The manually-operated lockable bund drain valve shall be left locked in the closed position until drainage is required.

3.4 Bund Leak Alarm

A bund leak alarm is not necessary for small sodium hypochlorite systems in circumstances where the consequences of a leak are minor (e.g. if no environmentally sensitive waterway is at risk), and where the tank low level alarm would alert an operator to the potential loss of chemical inventory / dosing.

Where a bund leak alarm is considered necessary, or where the possibility of a significant water leak exists, a conductivity sensor (toroidal-type) installed at the lowest practical level in the bund is appropriate. In such cases the alarms shall be linked to the plant control system and SCADA. A high conductivity alarm shall be configured to indicate water in the sump (since conductivity of water is high relative to air), and a high high conductivity alarm to indicate chemical is in the sump.

Suggested high conductivity alarm setting = 0.2 ms/cm (approx. 150 mg/L TDS water)

Suggested high-high conductivity alarm setting = 85 mS/cm (approx 0.5% NaOCl).

Note that bund leak alarms for any spare container bunds are not necessary.

3.5 Spare Container Bunding

Bunding for full spare containers such that 110% of the largest container or 25% of the total storage quantity (whichever is higher) shall be provided. Empty containers do not require bunding.

4 STORAGE SYSTEM

4.1 Tanks

4.1.1 Tank Sizing

A single storage tank shall be provided for small sodium hypochlorite storage and dosing facilities. The tank will generally be a prefabricated, off-the-shelf product with appropriate chemical certification; hence, a replacement tank would be readily available should any issue with the tank be detected. Consideration may be given to having a spare storage tank as a dry spare depending on the criticality, remoteness, and alternative means available for disinfection at the site. Factors to consider when sizing the storage tank include:

- the required storage inventory; and
- the delivery size.

Shelf-life is a major concern in the storage of sodium hypochlorite as its strength degrades over time. The frequency of deliveries impacts the reliability of disinfection and must be considered in determining the storage volume.

Unless using dilute sodium hypochlorite, minimum operational storage (i.e. for 12.5% w/v solution) should not exceed 14 days at peak flow to avoid excessive degradation, and the operational storage should be optimally designed to ensure the frequency and quantity of deliveries are manageable, particularly in remote areas. Design of the chemical storage should look into the delivery logistics at the particular location taking into consideration any nearby facilities on the same delivery route as sodium hypochlorite may be delivered in “milk runs” for small sites. Storage requirements should be reviewed for regional areas to align with the particular site conditions. Operators should not “top up” the hypo at each visit. The hypochlorite in the storage tank should be allowed to deplete to below the reserve volume at each cycle. Hypochlorite degrades over time and continual topping up will cause the hypochlorite to be compromised.

The tank shall have a "reserve volume" between the re-fill level (Low alarm level) and the Low Low alarm level. The "reserve volume" shall be sized to provide adequate time for delivery to be arranged.

4.1.2 Tank Materials

The storage tank shall be constructed of a material that is resistant to sodium hypochlorite with a concentration of 12.5% w/v (12.5 grams of available chlorine per 100mL of solution) which practically excludes most metals except titanium. The Corporation prefers glass-fibre reinforced plastic (GRP) tanks (designed to SPS 498) to store sodium hypochlorite, but the Corporation may consider (i.e. requires approval from Senior Principal Engineer – Water Treatment) sheet-fabricated HDPE tanks designed to SPS497 for tanks 1,000L or less if doorways and layout are designed to suit readily replacing tanks as frequently as every 5 years. Rotationally moulded polyethylene tanks shall only be considered for temporary installations with a life expectancy of no greater than 2 years (requires approval from Senior Principal Engineer – Water Treatment). PVC tanks are not considered suitable for various reasons including that they are brittle.

The tank shall be installed inside a building to avoid rapid deterioration of the sodium hypochlorite from heat and UV light. The specific design and construction requirements associated with each material are listed below.

Glass-Fibre Reinforced Polyester (GRP)

a) GRP tanks shall be designed and constructed to SPS 498.
b) GRP tanks shall have a design life of at least 20 years.
c) GRP tanks have been adopted for the following reasons:
    - GRP tanks are stiffer than HDPE tanks, so they have a decreased thickness for the same application which makes them lighter;
    - Their maximum life is not adversely affected by high temperature;
    - Their design life tends to be longer than HDPE tanks for chemical storage applications; and
    - They are not as prone to leaking at the nozzle welds as HDPE.

High Density Polyethylene (HDPE) where approved.

a) HDPE tanks shall be designed and constructed to DVS 2205, DVS 2207 and SPS 497.
b) HDPE tanks shall have a design service life of at least 15 years in sodium hypochlorite service and shall be inspected at year 5, 7, 9 & 10 and then annually until replaced or decommissioned.
c) Some of the benefits HDPE tanks are thought to offer are:
    - Better impact damage resistance than GRP;
    - Higher scratch resistance than GRP;
    - Homogeneous material so no chemical attack points when scratched; and
    - Easier to repair (though for small tanks they are more likely to be replaced).

4.1.3 Tank Design

Each tank shall include as a minimum the following nozzles and fittings:

a) One (1) flanged tank fill point inlet nozzle on the top of the tank.
b) One (1) flanged process outlet nozzle on the side of the tank located in a low position.

c) One (1) flanged tank overflow nozzle.

d) One (1) flanged tank vent nozzle at the highest point of the tank.

e) One (1) flanged scour outlet nozzle on the bottom of the tank; and

f) Sufficient lifting lugs as necessary.

Nozzles shall have a minimum diameter of DN50 (smaller sizes are impractical to weld). All connections shall be flanged (threaded connections are impractical because they are difficult to seal for complete prevention of sodium hypochlorite weeping, and if a thread gets stripped then it may be necessary to replace the tank).

Each tank shall be designed for the following criteria:

a) Contents: 12.5% to 13.5% (if delivered neat) or 4.5% (if delivered dilute) weight/volume sodium hypochlorite solution.

b) Operating & design temperature: range as appropriate to the site.

c) Operating & design pressure: atmospheric and hydrostatic.

Adequate fixings at the base of each tank shall be provided for stability.

The designer should provide drawings to the tank supplier which clearly shows the desired location and size of all connections and fittings on the tank.

Commissioning Plan Information
Prior to delivery to site, all tanks shall be hydrostatically tested using clean water filled to the overflow level. The full static head is to be held for a minimum of 12 hours. Once installed, the tanks shall be hydrostatically tested to the full static head again to check for any damage which may have occurred during transportation or installation[6]. All tanks shall be transported with capped/covered nozzles to prevent dust and vermin entering.

Testing, transportation, quality assurance, and other design and manufacturing requirements for GRP tanks are specified in SPS 498. For HDPE tanks this is covered in SPS 497.

4.2 Tank Plinth or Stand

A plinth or tank stand shall be provided for the storage tank so that its base is higher than the dosing pumps, placing the pumps as low as practical (relative to the tank outlet) reduces suction lift to the pumps which mitigates unwanted gassing and air-locking. Pumps shall be located either outside the bund, or in the bund above the 110% fill level.

4.3 Tank Instrumentation

4.3.1 Tank Level Transmitter

Level measurement using a pressure transmitter has the advantage of avoiding working at heights. This may not be a significant consideration for small volume tanks if they have low height where an ultrasonic level transmitter is preferred. Ultrasonic level transmitters have the advantages of direct measurement of fluid level (i.e. not reliant on calibration with the specific gravity of the solution) and not being in contact with the corrosive chemical but consideration needs to be given to the minimum range (deadband) that the ultrasonic sensor can detect and the beam angle versus the nozzle size.

An externally mounted level transmitter shall be provided to measure liquid level in the storage tank. The signal from the level transmitter shall be used to calculate the amount of sodium hypochlorite in

[6] Water used for testing tanks at site can then be discharged through the scour valve to test the bund as well.

the tank and to generate level alarms. This quantity shall be displayed on the OIP and HMI. The preferred display quantity unit is litres for sodium hypochlorite.

The level alarms and their set points are discussed further in section 9.3.

4.3.1.1 Pressure Transmitters for Level Measurement

For larger tanks, where access to a top mounted level instrument is difficult, a pressure transmitter with impulse line and diaphragm seal shall be used. The impulse line connecting the tank to the pressure transmitter shall be from the scour outlet and the diaphragm seal wetted material shall be titanium. Impulse lines shall be glycol filled. An isolation valve shall be provided at the connection point to the scour line. The pressure transmitter shall be mounted on a sturdy bracket at a convenient location.

When pressure transmitters are used to derive a level in the tank it is important that the specific gravity of the sodium hypochlorite is known when setting up and calibrating the pressure transmitters and level indicator. Note that the specific gravity of 4.5% w/v hypochlorite is 1.05, and the specific gravity of 12.5% w/v hypochlorite is 1.18.

4.4 Storage System Pipework

4.4.1 Fill Line

Fill lines shall be DN15 minimum and sized to suit the required load-in flow rate. The fill line into the tank should 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.

Apart from a small section of fill pipework drawing from the delivery container, the filling line shall be sloped 1 to 50 minimum to drain to the tank.

Although, generally not the preferred arrangement (refer sections 1.6.3.1 & 1.6.3.3), fill pipework from a portable pump (such as a drum pump) shall have a transfer (load-in) connection point:

a) Preferably located above the tank lid level to allow the entire fill line to slope towards the tank.
b) Have a polypropylene male NATO camlock coupling with matching dust cover. The camlock coupling must be pre-approved and of reputable make.
c) It should, if feasible, have a safety shower and eye wash located between 2 and 7m from the transfer point and on the same level (no stairs or other obstacles along route) to mitigate any safety risks associated with hose disconnection (these should be gravity discharges at worst).
d) The transfer connection point shall be located inside the building so it is over the bund. Location over the bund may not be required for dilute hypochlorite (refer section 1.6.3.2).

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 minutes. 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 static head up to the overflow level.

4.4.2 Vent Line

Each tank shall have a vent line (whose diameter shall be a minimum of 1.5 times the larger of the fill line and the scour line e.g. a DN25 scour would require a DN40 vent) 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.

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. The vent outlet shall be located such that it is possible to gain access to it for maintenance purposes.

The vent line shall be securely supported to prevent excessive stress on the tank roof. The vent pipework shall be configured so that condensation of vapours is directed back into the tank. It is important to ensure the vent line is not blocked at any time.

4.4.3 Scour Line

There shall be a DN25 minimum scour outlet line from the bottom of the tank to the bund. A DN25 minimum manual isolation valve shall be installed as close to the nozzle flange as possible.

4.4.4 Process Line

The tank outlet line shall be DN25 minimum commencing from the tank outlet isolation valve. After the tank outlet isolation valve the line size may be reduced.

To minimise retention time in the piping, the line to the dosing pump shall be kept as short as possible. The piping from the storage tank shall be 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.

4.4.5 Overflow Line

Each tank shall have a DN25 minimum overflow pipe which terminates in a water-filled seal pot. No valves or equipment which could potentially cause blockages shall be installed in the overflow lines. Care shall be taken on the overflow line design to ensure that no liquid can be drawn back into the tank under any conditions.

4.4.6 Return Line

Provide a return line from the dosing panels back to the tank (can be connected into the tank vent line at a location where that line drains back to the tank). This line acts as:

1) a gas escape route for the gas purge column (i.e. calibration tube)
2) the pressure relief valve vent / return line
3) the dosing pump priming vent / return line

5 CHEMICAL TRANSFER

5.1 Chemical Transfer

5.1.1 Transfer Pumping

The transfer pump shall be sized to unload the delivery container in less than 10 minutes (i.e. ~100 L/minute for an IBC). If the transfer is from a 20-litre package, then the target pumping time should be approximately 2 minutes (i.e. ~10 L/minute). These timeframes are based on the need for the Operator to remain in attendance during unloading. Any longer duration would be an unreasonable use of the Operator's time.

The preferred arrangement is to use a permanently installed peristaltic pump that is mounted lower than the IBC; locating the peristaltic pump lower than the IBC enables the entire IBC to be emptied. A hose with camlock fittings shall be used to connect the pump suction inlet to the low-level outlet of the IBC. Although it is hard to completely prevent minor leakage of hypochlorite such as drips from camlock fittings, this is considered acceptable for suction piping especially as it is only in place for a short period of time. The discharge pipework from a fixed unloading pump shall be hard-piped in order to minimise potential for leakage.

5.1.2 Delivery of Dilute (4.5%) Sodium Hypochlorite

Dilute hypochlorite is available in 200 Litre drums or 1000 L IBCs. This design standard has been based on transfer from 1000 L IBCs. Although 200 Litre drums may be convenient for very small sites, they have constraints such as safely unloading them from the delivery vehicle and chemical transfer only being through the top of the drum. Therefore, it is recommended that small sites instead receive deliveries from an IBC on a trailer that could serve multiple hypochlorite sites. Provided that the trailer is stored in a shed (to protect from UV light) then the dilute hypochlorite will not significantly degrade between deliveries.

Sites with storages greater than 1000 L would have one or more IBCs delivered. These would typically be unloaded by crane and the WTP operator would then transfer all the hypochlorite from each IBC into the storage tank using a fixed peristaltic pump housed within the dosing module. Designs shall not incorporate gravity decanting unless approved by the Senior Principal Engineer - Water Treatment. Note: The Wyndham WWTP gravity decanting system using mother & daughter tanks for Citric Acid and Sodium Hypochlorite is an example of a system that has been approved by the Principal in the past.
Sites with storages less than 1000L would have delivery from an IBC on a trailer, which could be used to deliver to multiple small sites. The operator would transfer the required volume of hypochlorite from the IBC into the storage tank using a fixed peristaltic pump housed within the dosing module.

The chemical transfer area and transfer pump for unloading and transfer of 4.5% sodium hypochlorite shall consider risk factors such as nearby equipment or sensitive environments which may require protection from potential spills during chemical transfer.

5.1.3 Delivery of Neat (12.5%) Sodium Hypochlorite

20L Packages

20L plastic packages may be used for deliveries to smaller systems where the storage tank is less than 200L. To avoid OSH issues associated with decanting, a peristaltic pump and suction lance, or handheld electric chemical drum pump is used for transfer from packages to the tank.

200L Drums

200L plastic drums may be used for deliveries to storage tanks between 200L and 1000L. The design shall consider the unloading, movement, and loading of 200L drums.

It is recommended that a peristaltic pump and suction lance be used for transfer from the drum to the storage tank. If it is acceptable to the Region, an alternative is to provide a handheld drum pump (chemical resistant/non-metallic; electric) for transfer from the drum to the storage tank.

If it is not possible to house the drum inside the dosing room it can be placed outside the dosing room for transfer operations. Chemical transfer may optionally be carried out from a drum while it is still on a trailer if acceptable to a Region. Transfer directly from a vehicle tray is prohibited due to Water Corporation working at height restrictions.

6 DOSING SYSTEM

6.1 General Considerations

Sodium hypochlorite is prone to gassing off (oxygen formation) and crystallisation if allowed to lie static even for short period of time. The rate of gassing off is exacerbated by temperature, light and most metals. The gassing-off bubbles in the suction piping tend to stay locked in suspension and over time, cause vapour-locking problems in the diaphragm dosing pump. Oxygen gas produced will also build up pressure in the pipework to the point of catastrophic failure if there is no outlet for the trapped gas to escape. Sodium hydroxide (caustic soda) in the sodium hypochlorite tends to precipitate and leave a crusty residue which can cause ball valves to stick making them inoperable.

The dosing system must therefore incorporate measures to mitigate the effects of gas build-up. The most effective method is to dilute sodium hypochlorite to below 5% m/v. Storing at the reduced concentration also has the benefit of reducing degradation during storage. Very few sites will have sufficiently soft (<5 mg/L total hardness) service water for on-site dilution, and therefore it will be more practical to have dilute[7] (i.e. 4.5% m/v) sodium hypochlorite delivered.

Contact the Senior Advisor Procurement (who manages the Corporation's chemical supply contracts) for details of the chemical supplier. Since this is custom-diluted, the supplier requires four working days' notice to prepare a batch. Delivery container sizes are 200 Litre drums or 1,000 Litre IBCs.

Other measures for limiting gas-locking include installing the dosing pipes with gradients that vent gases back to the storage tank and/or gas purge columns. Pipe lengths are to be kept short and over-sizing of the piping, valves and pumps is to be avoided to minimise detention time in the system. Dosing pipes transporting neat solution should ideally be sized to maintain a flow velocity of 0.5 m/s to 2 m/s to reduce gas accumulation

[8] but this is not always possible. The pipes are usually selected to keep the size as small as the flow rate will allow. To maintain flow velocity, the number of obstructive fittings such as bends, tees and reducers should be kept to a minimum.

Ball valves shall have pre-drilled balls to prevent trapping of sodium hypochlorite in the cavity between the valve body and the ball.

6.2 Materials of Construction

All materials of construction used in any part of the process system that comes in contact with sodium hypochlorite will have to be compatible with the chemical (refer section 1.3 for guidance on materials selection). Incompatible materials that come in contact with sodium hypochlorite will result in accelerated degradation of the chemical and formation of oxygen gas. Care must be taken to select equipment for use in the dosing system as incompatible metals such as stainless steel, aluminium, brass or copper which are often found in pumps, pump seals, check valve springs, electrodes in magnetic flow tubes, and diaphragm seals for gauges, switches and transmitters. Generally, all metals should be avoided except for titanium, tantalum, silver, gold and platinum.

6.3 Dosing Pumps and Dosing Panels

Separate duty and standby dosing pumps and dosing panels shall be provided. Each pump and dosing panel with its associated equipment shall be capable of operating independently and automatically[9].

The pumps and dosing panels shall be enclosed within a barrier protection cabinet in compliance with DS 79-03. Enclosure of the pumps and dosing panels with a transparent front cover (e.g. PVC cabinet) enables the panel to be viewed during operation, at the same time as protecting personnel from any chemical spray or leak.

[7] Note that suppliers may name this "4.5% bleach".

[8] Sodium Hypochlorite – General Information for the Consumer, Odyssey Manufacturing Co.

[9] One dosing panel with duty and standby dosing pumps may only be approved if the system is non-critical because it can be readily shut down for maintenance – e.g. it is an intermittent operation or maintenance downtime is acceptable because of sufficiently large drinking water storage or other similar reasons.

Minimising complexity in small dosing systems assists with achieving reliable dosing performance at very low flows. Consequently, for small systems it is preferred to use a digital dosing pump which has:

- Integrated Flow Measurement instead of a miniature magflow meter;
- an automatic deaeration feature instead of a de-gassing valve; and
- a controlled discharge stroke duration instead of a pulsation dampener.

6.3.1 Calibration Tubes and Pump Suction Piping

The calibration tube/gas purge column on the dosing panel serves two functions. As a calibration tube, it is used for fault finding and for calibrating the performance of new or refurbished dosing pumps during commissioning and after maintenance. The calibration tube shall have sufficient capacity to allow a single calibrating run of at least two minutes with the dosing pump at full design flow rate.

The tube also serves as a bubble-trap or gas purge column where gas from solution can be vented out just prior to entering the dosing pump head to prevent vapour lock. The suction piping before the pump should be configured in a specific manner to allow for this disengagement of the gas bubbles to occur. As it enters the dosing panel, the pipe conveying the sodium hypochlorite shall slope up towards the calibration tube to allow gases to rise and expel into the vertical column before continuing on to the pump. The short section of the pipe from the calibration tube leading to the pump suction connection should also slope back to the column for the same reason. It is important to keep this section of the pipe as short as possible[10]. Suitable flexible tubing may be used for this section of piping from the calibration tube to the pump. The vent line from the top of the column is directed back to the storage tank through the tank roof vent pipework.

The calibration tube/purge column should cover the full height of the storage tank to provide full usage reading. The calibration tube shall be constructed out of clear PVC or similar plastic. Glass tube is not suitable as the caustic in the sodium hypochlorite will react with it, eventually making the glass opaque.

The isolation valve below the calibration tube shall remain open at all times except during flushing to allow gas to escape even when the system is shut down. It will need to be closed during flushing to prevent water getting into the calibration tube and into the sodium hypochlorite storage tanks.

Camlock couplings shall not be used in dosing pump suction piping (between the chemical storage tank and dosing pumps).

6.3.2 Sodium Hypochlorite Dosing Pumps

There shall be a dosing pump for each dosing panel. Digital dosing pumps shall be used in the Corporation's small hypochlorite facilities. They can be configured to have a long duration discharge stroke (and quick suction stroke) with the result that pump output is sufficiently steady to avoid the requirement for pulsation dampeners. Each pump shall comply with the requirements of the Water Corporation's Mechanical standard DS32 (refer section on Chemical Dose Pumps). Pumps operating at less than 20 L/h flowrate shall have an integral de-gassing capability.

Materials of construction for wetted parts of the pump in direct contact with Hypo shall be compatible and resistant to the solution. Metals such as stainless steel, aluminium, Monel®, brass or copper must be avoided. Suitable diaphragm materials are Teflon® or Viton® stabilized with carbon black.

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

[10] It has been recommended to be no more than 300mm in length in the KWS Investigation Report by P. Hanley (with installation standard drawing and notes Rev 8)

Measures recommended to reduce vapour locking of the pumps include ensuring pumps are operated with flooded suction. Pumps should be installed below the storage tank lowest operational level for this reason, but at the same time, should not be installed below the top of the bund wall level to avoid submergence during a major spill. The suction pipeline should be made as short as possible.

Peristaltic pumps are not recommended for dosing, though may be used for delivery transfer of sodium hypochlorite into the storage tank.

Small dosing pumps may require short lengths of flexible hose or tubing at the pump suction and discharge ends. Hose material shall be approved black polyethylene (PE) or reinforced PVC with a minimum of PN10 and PN16 pressure rating respectively. PE hose shall be replaced every 12 months regardless of condition. Chemical barrier protection (refer DS79-03) shall be designed to accommodate this frequency of replacement by providing quick and easy access to the hoses. If pumps have to be installed outdoor (not preferred), a shed shall be provided to protect the pumps and hoses from direct sunlight.

Set up the dosing pumps to change over automatically on an adjustable set time period e.g. daily. This will help ensure the pumps have similar operating hours and are not offline for long periods.

6.3.3 Pressure Relief Valves

A pressure relief valve is required at the discharge of each dosing pump in all instances (to be tagged PSV – Pressure Safety Valve). A test point shall be provided in the piping for the use of a hand-held gauge to test its set pressure. The relief valve shall be installed to direct any excess solution to the top of the calibration tube so that any pressure relief can be easily detected from the tube.

When procuring a dosing pump it is necessary to check the manufacturer's internal pressure relief set point (as this is typically pre-set) and this will need to be considered when setting up the external pressure relief valve to ensure it will relieve ahead of the dosing pump internal relief system.

The pressure relief valve shall be set to open on failure (fail open).

Commissioning Plan Information
Safety relief valves shall be fitted with carseals to protect against unauthorised adjustment. The pressure setting of safety relief valves shall be recorded on a metal tag attached to either the valve body or the carseal.

6.3.4 Strainers

To prevent pipework shavings, silica scale, or other solid impurities from blocking or damaging the dosing pump internals, the magnetic flow meters or the pressure sustaining valves, each dosing system has a PVC in-line Y-body strainer installed upstream of the dosing pump before the calibration tube. As a minimum the strainer shall be fitted with a cylindrical mesh having 0.5mm perforations. As duty/standby panels are recommended there is no need to provide a bypass around the strainer. However, for single panel systems a bypass, complete with standby strainer, will be necessary to keep the panel running whilst the blocked strainer is taken out for service.

6.3.5 Pressure Gauges

A glycerine-filled stainless steel pressure gauge with a minimum display diameter of 63mm (2.5") shall be provided with sufficient range to allow setting of each pressure sustaining valve and to assist in continuous monitoring of correct pump performance. The pressure gauge shall incorporate a diaphragm barrier seal of suitable material as recommended by the instrument supplier to prevent sodium hypochlorite coming directly into contact with the gauge components. The gauge scale shall be sized so that the maximum operating pressure will not exceed 75% of full scale.

6.3.6 De-aeration

It is preferred to use the automatic de-gassing feature on the digital dosing pump rather than having a de-gassing valve on small dosing systems. In addition, start pump at full speed for a pre-set period of time (e.g. typically 10 – 20 seconds, adjustable) to assist clearing the line before the dose pump reverts to a speed suited to the required dosage.

6.3.7 Flow Measurement

It is preferred to select a digital dosing pump with Integrated Flow Measurement (rather than miniature magflow meters whose small bore is prone to blockage from scale build-up) for small dosing systems. Although occasional failure to detect loss of flow may occur, the chlorine analyser will trigger swap over to the standby system. Resumption of operation of the faulted system will involve a short period of operation at full pump speed which generally clears the problem. Consequently, this occasional minor problem self corrects.

Flow measurement is used to monitor and record the dosing pump discharge flow rate, and totalise the amount dosed. A low flow alarm (configurable) would indicate a dosing hydraulic fault such as blockage at the dosing spear, and would initiate shutdown of the duty dosing system and changeover to the standby system.

6.3.8 Pressure Sustaining Valves

A pressure sustaining valve (also called a Pressure Control Valve, PCV) automatically holds a steady pre-set upstream pressure, within close limits. The main pressure sustaining valve installed on the dosing line on each panel improves the accuracy of dosing by providing and maintaining the necessary discharge pressure[11] required by the dosing pump to work against. It shall be set at a pressure which optimises pump accuracy as per the pump manufacturer's recommendation. The pressure setting shall be recorded on the valve tag.

A normally-closed vent line upstream of the PCV allows the pump to be primed and allows the system to be de-pressurised prior to maintenance, should the PCV become blocked or fail.

For dosing lines longer than 10 metres, an additional pressure sustaining valve and pressure gauge shall be provided near the dosing point to provide stable dosing control and prevent diffusion of chemical from the chemical line into the water main during idling periods (refer to section 5.4.3). This second PCV is typically set at a low pressure (100 - 200 kPa). Setting this second PCV at too high a value can result in surging of the chemical dose rate due to the control valves hysteresis causing expansion and contraction of the chemical dose line piping.

Provision shall be made to allow a hand-held gauge to test the pressure on each PCV.

Commissioning Plan Information
The pressure setting of PCVs shall be recorded on their valve tags.

6.4 Dosing

The sodium hypochlorite which leaves the panel and exits the sodium hypochlorite building is then dosed into the recipient water main via a dosing spear/sparger arrangement. The design of the dosing system downstream of the dosing panel is described in more detail in the chemical dosing design standard DS78.

6.4.1 Dilution Carrier Water

Where 12.5% w/v sodium hypochlorite is used, dilution carrier water may be considered to avoid the requirement to use double contained dosing lines, or to assist rapid mixing of the sodium hypochlorite into the recipient water main. It is important that full mixing is achieved in the recipient water main

[11] The PCV is typically set at 100kPa above the maximum normal operating pressure at the chemical injection point but no lower than the minimum discharge pressure that is specified by the dosing pump manufacturer - KWS Investigation Report by P. Hanley (with installation standard drawing and notes Rev 8).

prior to the sample point because otherwise the feedback trim of the dose pumps will be based on erroneous feedback.

The main issue with using a carrier water stream is that the sodium hydroxide (caustic soda) in the sodium hypochlorite will react with the calcium and magnesium hardness in the carrier water to induce scale formation in the immediate area and downstream of the mixing point. Depending on hardness concentration in the carrier water stream, the carrier water must be softened or demineralized to reduce the formation of scale. Alternatively, a sequestering agent such as Calgon (sodium hexametaphosphate[12]) can be introduced into the carrier water before diluting the sodium hypochlorite. Calgon in some applications will reduce scale formation by inhibiting/slowing precipitation of hardness (keeping metals such as calcium and magnesium in solution for a period of time)

Dilution carrier water for chemical dosing is described in more detail in design standard DS78.

6.4.2 Dosing Diffusers & Valves

Duty and standby dosing diffusers shall be provided. For recipient water mains less than 750mm in diameter, a dosing spear (open ended pipe projecting at least one-third into the main) should be adequate to provide good mixing. The design details and marking requirements of the dosing sparger are described in DS78.

Blockage of pipework and sparger orifices caused by scaling is a major problem especially if the recipient water or Hypo carrier/dilution water (for small system with low dose flow) contains an elevated concentration of alkalinity and hardness. Scaling at some Water Corporation sites has been managed by dosing a sequestering agent such as Calgon into the dilution stream prior to the addition of the neat sodium hypochlorite.

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 that spear is not in place. A non-return valve shall be provided on each dosing line close to the dosing spear to ensure the recipient water does not back-feed up the dosing line when the spears are not in operation. Non-return valves are not required where a pressure sustaining valve is proposed to be installed near the injection point (ref. 5.3.8). Isolation ball valves shall also be provided to enable the individual spears to be isolated from the sodium hypochlorite and removed for maintenance whilst the other spear is in operation.

For long dosing lines (more than 10m in length), a suitable pressure sustaining / control valve (PCV) and pressure gauge (PI) shall be installed near to the dosing diffuser. Refer section 5.3.8 for more details).

6.4.3 Pressure Gauge

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

6.5 Flushing Water System

Flushing water valves and connections shall be provided to flush sodium hypochlorite from the storage and dosing system pipework prior to equipment removal or maintenance. The flushing connections shall be located strategically so that all of the sodium hypochlorite lines, right back to the tank, can be flushed. The valve below the calibration tube must be closed during flushing to prevent water entering the sodium hypochlorite storage tank. It is important that the calibration tube isolation valve shall be

[12] Sites with Calgon dosing include Carabooda Tank, North Mandurah Tank, Yanchep, Two Rocks and Albany.

re-opened prior to returning the system to service. A sign with instruction to close the calibration tube valve (during maintenance) shall be displayed next to all the flushing points[13].

Flushing should take place in preparation for maintenance or if sodium hypochlorite has been left in the system for a long period. It should not necessarily occur simply when changing from one operating mode on a system to another (e.g. Dosing Mode to Stopped Mode), or when changing over from one dosing system (duty) to another (standby). Routine or excessive flushing of the sodium hypochlorite system with un-softened water will result in scaling in the pipelines, so it should be avoided.

Drainage points should be provided at various locations on the dosing pipeline for draining of the flushing water when required. However, when flushing the sodium hypochlorite system, the flush water should preferably be directed to the dose point as this is the safest and easiest disposal route. During the initial flushing period the dosing operation of the standby system should be suspended to ensure over-dosing does not occur.

Site service water is generally used as the flushing water supply and it shall have sufficient head to flush water through both the sodium hypochlorite dosing pump and pressure sustaining valve of the dosing system. If the site service water supply has insufficient flow or pressure to carry out flushing, then a dedicated flush water booster pump will be required. Alternatively, if the site water supply has excessive flow and pressure, which could cause damage to valves and equipment then a flow or pressure control valve may be required to limit the flushing flow and pressure.

If the same site service water supply is used to supply the safety shower(s) then the flushing water off-take shall be located downstream of a reduced pressure zone device (RPZD) with the safety shower(s) being supplied from upstream of the RPZD.

[13] Other ways to ensure the calibration tube valve is closed during flushing have been considered including a keyed valve system but these have been assessed as too costly for the level of risk presented.

7 WATER SAMPLING AND ANALYSIS

7.1 Sampling Point

The chlorine sampling point is located downstream of the sodium hypochlorite dosing point after the sodium hypochlorite has had the opportunity to be mixed thoroughly in the recipient water (refer DS78 for design guidance to achieve thorough mixing). The sampling point should not be too far downstream from the dosing point as this can result in excessive lag time for the dosing control loop.

Care shall be taken in the design of the water sample system to ensure that all analysers receive consistent sample water flow and pressure that is within the analyser manufacturer's specified requirements. The sample water system design shall also aim to minimise the travel time from the sample point to the water quality analysers. The designer shall consider the following design features in order to optimise the sample water system and analyser performance:

- Need for a sample booster pump
- Sample booster pump type - centrifugal or positive displacement. The Corporation has had recent good experience with use of microgear pumps in sample water systems.
- Sample water bypass flow to reduce the sample water travel time to analysers
- Requirements for pressure control valve(s)
- Manual or automatic flow control valves
- Minimising ambient temperature and solar impacts on the sample line, especially for longer sample lines.

A rotameter fitted with a low flow switch monitors the feed to the chlorine analyser.

Supply of other services from the sample water line often results in flow and pressure fluctuations at the water quality analyser(s) that adversely impact their performance. It is therefore highly desirable to supply such services from another location that does not result in significant hydraulic impact to the sample water system.

Normally a sample spear with an open end that projects half-way into the main is used for sampling. The holes/orifices on the spear should face towards the direction of flow (i.e. orifices on the upstream side of the sparger).

Sample water should be returned to the recipient pipe where it is feasible to do so.

DS78 Chemical Dosing Standard provides further details and requirements on the sampling system.

7.2 Chlorine Analyser

A chlorine analyser is used to continuously monitor the chlorine concentration of the treated water and provide feedback residual trim control of the sodium hypochlorite dose rate. The analyser shall be connected to the plant control system to generate High High, High, Low and Low Low alarms when the concentration strays outside of acceptable limits. The High and Low alarms are also used to initiate changeover to the standby system. If the standby sodium hypochlorite dosing system is called and then the High High or the Low Low chlorine residual alarms are active for a given time a "Water Quality Poor" alarm is raised. The standby Hypochlorite system should continue to run – it should not shut down. A "Water Quality Poor" alarm should shut down the recipient water main source to prevent delivery of poor quality water to consumers. The loss of mains flow will shut down the sodium hypochlorite dosing system, thus maintaining the disinfection (although potentially compromised) into the main. The Water Safety Plan (WSP) of the particular site should provide all the alarm set-points and the required action to take.

The analyser should be installed on a sampling panel in a sampling room, laboratory or other covered area suitable for instrumentation. Sites that do not have a sampling room or laboratory will have the analyser sampling panel located in the dosing room. Analyser performance is notably improved when it is installed in a relatively stable temperature environment. This may be achieved by room insulation, shading and/or room HVAC. The analyser shall be selected from one of the suppliers on the Water Corporation's SCADA Approved Equipment List and it shall be approved by the client prior to purchase. This is to ensure the selection complements other analysers operated and maintained in the client's region to promote uniformity, familiarity, and to reduce spares holdings.

8 PIPEWORK AND VALVES

8.1 Pipework Requirements

The requirements of DS79-05 Sections 8.1 to 8.7 shall be adhered to for pipework.

8.2 Valves

All valve components including handles, actuators, balls, ball seals and O-rings shall be constructed of materials suitable for contact with sodium hypochlorite. Natural rubber, as well as other rubber-like elastomeric materials, including Nitrile and Buna N (NBR), shall not be used for seals, O-rings and gaskets. Plastic valves made of uPVC with Teflon ball seals and FPM (also known as FKM and Viton®) O-rings such as the Georg Fischer Type 546 uPVC ball valves have historically provided satisfactory performance.

Valves shall have tags for identification and to indicate whether they are "normally open" or "normally closed". For critical valves, a sign should also be displayed alongside.

Ball valves inherently have a cavity between the body and the ball inside the valve where sodium hypochlorite can be trapped when it is in the closed position. Gases released from the trapped hypochlorite can increase the pressure inside the valve potentially to the point of catastrophic failure. Crystallisation of the caustic as the hypochlorite decomposes may 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 hypochlorite applications (vented ball valves). This modified ball effectively vents the gases while keeping inner valve surfaces constantly wetted, eliminating the conditions required for gas accumulation and caustic 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.

Ball valves of sizes DN50 or smaller generally perform well in sodium hypochlorite application. Larger ball valves are more prone to freezing up due to the formation of crystallite salts on the sealing surfaces of the valves. At locations where larger valves are required, butterfly and diaphragm valves can be considered as alternatives.

8.3 Flanges and Gaskets

All flanges shall be drilled in accordance with AS/NZS 4087 for pressure class PN16, unless a different flange standard has been adopted for 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 FPM (also known as /FKM and Viton®) material stabilized with carbon black[14]. natural rubber, nitrile, EPDM and buna N (NBR) are not suitable to be used in sodium hypochlorite service.

8.4 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]

[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.

9 ANCILLARIES

The requirements of DS79-05 Section 9 shall be adhered to for Ancillaries.

10 PROCESS CONTROL

10.1 Control Philosophy

The required sodium hypochlorite dose rate (in mg/L) is determined by the output of a PID controller that receives the measured chlorine residual as its process variable and a target chlorine residual setpoint from an operator input. The output of the chlorine residual PID controller is scaled across an appropriate dose rate range in mg/L. This dose rate is then multiplied by the measured flow in the recipient water main (m3/hr) to arrive at the required equivalent chlorine mass flow rate in g/hr. The g/hr mass flow is then divided by the sodium hypochlorite solution strength (typically 125g/L) to give the required sodium hypochlorite flow rate in L/hr which is sent to the duty dosing pump.

If there are any problems with the above automatic control mode (e.g. suspected faulty analyser), then the control can be reverted to flow paced only by placing the residual feedback PID controller in manual and then manually setting that PID controller's output.

All the above is visible at both the local OIP and UWSS/SCADA. PID controller mode changes and setpoint adjustments can be made by operations personnel at the OIP (when in local control mode) or via UWSS/SCADA (when in remote control mode).

A schematic of the control loop for dosing system 1 is shown in Figure 10-1 below. The control loop for dosing system 2 is similar.

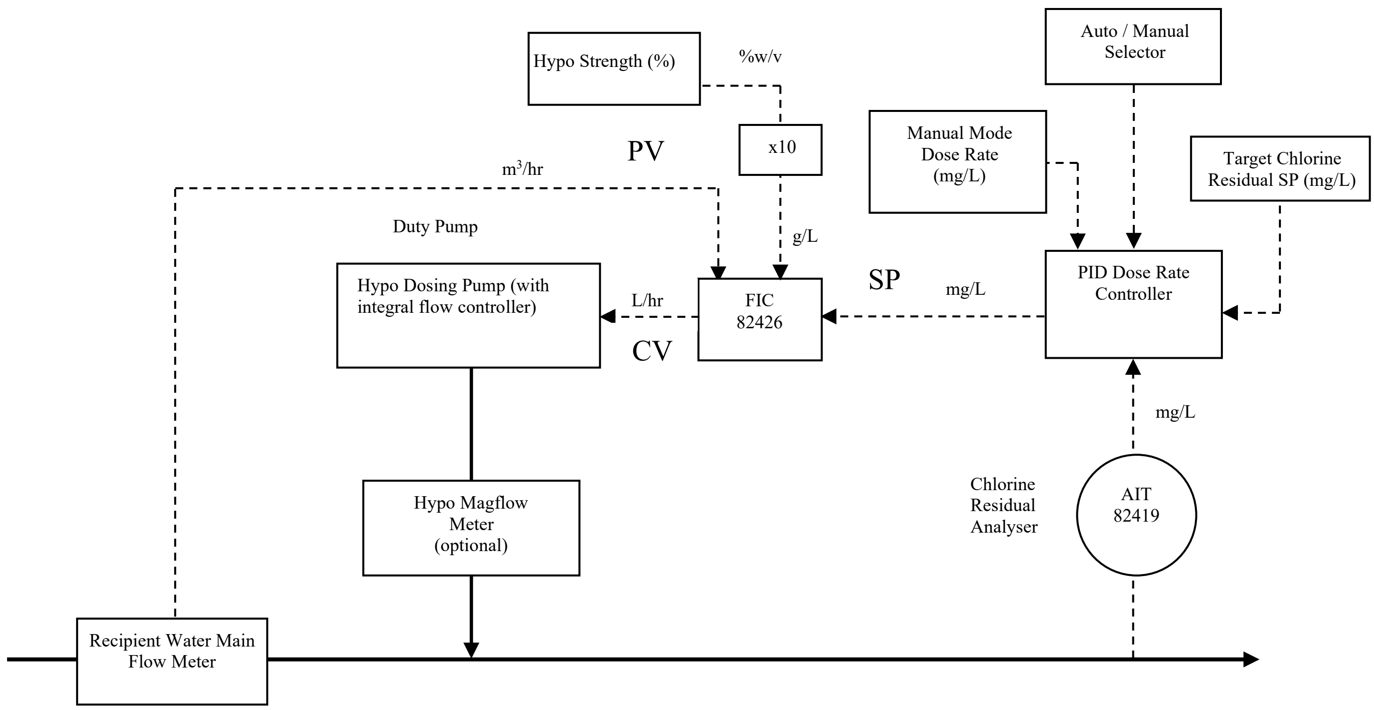

Figure 10-1: Dosing Control schematic for Dosing System 1

When the duty dosing system is in ‘Ready’ mode, the dosing pump will remain idle until a minimum set point flow rate is achieved in the recipient water main. Similarly, the dosing pump will stop running and the system will sit idle in the ‘Ready’ mode when the flow rate in the recipient water main drops below the minimum set point.

If the selected duty dosing system is ‘Not Available’ or failed then the standby system will automatically commence operation, providing it is in the ‘Ready’ mode operational state. The failed system will not be available for selection until the alarm condition is acknowledged and reset (i.e. the failed system will be latched out). The standby system will be allowed a period of time for operation before any faults shuts it down too. In this way, changing back and forth between the duty and standby system is prevented.

In the event of a plant power failure during sodium hypochlorite dosing, the system shall resume dosing automatically following restoration of power and return of the permissive conditions such as the minimum set point flow rate in the water main. The low chlorine level in the treated water or other fault/alarm directly due to the plant power failure should not trigger a shutdown or system changeover when the power is restored i.e. a time delay shall be allowed for the chlorine residual to return to normal. However, if the system is in ‘Fixed’ mode, it shall revert to the ‘Stopped’ (off) mode in the event of a power failure, and thus the equipment shall remain off when power is restored.

- Chlorination is initiated once the mains flow rate is above the ‘Initiate chlorination’ flow and the system has previously been off for two minutes or more.
- On ‘initiate chlorination’, the duty dose pump will start and run at maximum speed for a given time to purge the dose line of gas and to achieve the required pressure in the dose line for injection into the water main. The dose pump should return to the requested hypochlorite dose flow when the max speed timer has timed out. Operation on maximum speed at start-up should also occur for the standby dose pump when it is called.
- For critical or primary chlorination sites, a chlorination failure shall automatically stop the water flow in the recipient water main (either by interlocking relevant pumps or closing an automated valve in the line).
- There should be no confusion between the “dose rate” (concentration) measured as mg/L and hypo “flow rate” (volumetric rate) measured as L/h which is a flow measurement of the hypo that should be annotated as “Hypo Flow Rate”.
- For sites using dilute hypochlorite, the strength is 4.5% concentration; hence, hypochlorite flow rate required is calculated as:

Hypochlorite flow rate (L/h) = Mains flow rate (m^3/h) * dose rate (mg/L) / (4.5 * 10)

- For sites using neat hypochlorite, the strength is normally 12.5% concentration at time of delivery. However, it is normal to calculate the required flow rate based on a tank strength of 10% to allow for some degredation while stored on site, thus hypochlorite flow rate required is calculated as:

Hypochlorite flow rate (L/h) = Mains flow rate (m^3/h) * dose rate (mg/L) / (10 * 10)

- Dose pump flow rate monitoring shall preferably be a derived flow rate as determined by the dose pump (i.e. Integral Flow Measurement) rather than determined from a miniature magflow meter.
- The standby dose pump should start on one of the following conditions:
  - Duty dose pump failed to start,
  - Duty dose pump hypo flow rate is less than 50% of the hypo flow rate required,
  - The chlorine residual is high or low for a given time.

The control philosophy is provided in more detail in the Small Hypochlorite Storage and Dosing System standard Functional Control Specification DS73-11.

10.2 Control Location

The Sodium Hypochlorite storage and dosing system may be controlled from the following locations:

a) Operator Interface Panel (OIP) – Full automatic and manual control is possible from this panel located in the viewing room. Any operational mode can be selected from this panel. Operation from the OIP requires prior approval from the OC.

b) Human Machine Interface (HMI) –The full dosing system is monitored from the UWSS / Statewide SCADA Operations Centre at John Tonkin Water Centre.

c) Control functionality from the OIP and HMI shall be identical unless stated otherwise in the functional control specification.

10.3 Tank Level Low Alarm

The Sodium Hypochlorite Tank Low Level Alarm shall be set to initiate at a level which corresponds to the tank being sufficiently empty to receive a full delivery of sodium hypochlorite. This is also known as the re-order level. This alarm should generate a “Chemical Re-Order” message on the OIP & HMI.

10.4 Tank Level High Alarm

The Sodium Hypochlorite Tank High Level Alarm shall be set to initiate at a level which corresponds to 1 minute before a tank would commence overflowing during a filling operation. This alarm will initiate the High level alarm on the HMI.

10.5 Chlorine Residual Low Alarm

The setpoint for this alarm is operator adjustable. If this alarm remains continuously active for 6 minutes and a standby dosing pump is available, then automatic changeover to the standby dosing pump is initiated. If a standby dosing pump is not available, then no control action is taken.

10.6 Chlorine Residual High Alarm

The setpoint for this alarm is operator adjustable. If this alarm remains continuously active for 6 minutes and a standby dosing pump is available, then automatic changeover to the standby dosing pump is initiated. If a standby dosing pump is not available, then no control action is taken.

10.7 Required Dose Rate Low Alarm

This alarm is displayed on OIP and SCADA screens. “Required dose rate low” is initiated when the required chlorine dose rate is less than the lower dose rate limit continuously for 5 minutes. This alarm flags a possible problem with the dosing process. When this alarm is triggered, the dose rate becomes limited to the lower dose rate limit.

10.8 Required Dose Rate High Alarm

This alarm is displayed on OIP and SCADA screens. “Required dose rate high” is initiated when the required chlorine dose rate is greater than the upper dose rate limit continuously for 5 minutes. This alarm flags a possible problem with the dosing process. When this alarm is triggered, the dose rate becomes limited to the upper dose rate limit.

11 PROCESS SAFEGUARDING

This section details the process safeguarding controls that are implemented to protect personnel, equipment and the environment. PLC and/or RTU code associated with these process safeguarding controls shall be separated and clearly identified in the PLC/RTU and denoted within the code as subject to strict Management of Change (MoC) procedures.

Strict Management of Change requires both of the following procedures to be followed:

1) Safety & Wellbeing MoC procedure
https://nexus.watercorporation.com.au/otcs/cs.exe/app/nodes/58727880

2) DS40-06 – Software Change Control standard

11.1 Sodium Hypochlorite Tank Low-Low Level Alarm

The purpose of the Sodium Hypochlorite Tank Low-Low Level Alarm is to protect the sodium hypochlorite dosing pumps from running dry and to prevent air from being entrained in the suction pipework. Therefore, the set point for the Low Low level alarm should be just above (e.g. 25 mm above) the obvert level of the process outlet on the tank.

On initiation of the Sodium Hypochlorite Tank Low-Low Level Alarm, immediately initiate the Water Quality Poor Alarm and after 60 seconds, inhibit operation of all sodium hypochlorite dosing pumps.

The setpoint for this alarm shall be hard-coded into the PLC and not adjustable from the OIP or SCADA.

11.2 Sodium Hypochlorite Tank High-High Level Alarm

The High-High level alarm should indicate imminent overflow of the tank and should be set at a level which corresponds to 20 seconds before tank overflow.

On initiation of the Sodium Hypochlorite Tank High-High Level Alarm, trip the power supply to the Transfer Pump and raise an alarm on the OIP and SCADA.

The setpoint for this alarm shall be hard-coded into the PLC and not adjustable from the OIP or SCADA.

11.3 Sodium Hypochlorite Bund High Level Alarm

Section 3.4 discusses whether a Bund High Level Alarm is necessary to alert of a sodium hypochlorite or water spill.

On initiation of the Sodium Hypochlorite Bund High Level Alarm, trip the power supply to the Transfer Pump and raise an alarm on the OIP and SCADA. Note: A Bund High Level Alarm does not initiate automatic shutdown of the hypo dosing system.

11.4 Low Sample Water Flow Alarm

On low sample water flow an alarm is raised to the OIP and HMI and the residual feedback PID loop is automatically placed in manual with its output set at the last recorded healthy dose rate. This safeguard protects against potential over-dosing or under-dosing of sodium hypochlorite due to incorrect chlorine residual analyser reading (which would occur if the analyser is receiving inadequate sample flow). If the sample flow becomes healthy again then the interlock with the PID controller self-resets (the controller is returned to automatic mode) after a pre-set time (default = 300 seconds).

11.5 Chlorine Residual Low-Low Alarm

The Low-Low Chlorine Residual Alarm protects against the supply of inadequately disinfected water. The alarm is initiated if the measured chlorine residual is continuously less than the low-low limit for

60 seconds. If a standby dosing pump is available, then this alarm shall initiate an automatic changeover to the standby dosing pump.

Once triggered, if this alarm persists for 30 seconds, then the "Water Quality Poor" alarm is triggered. This will initiate shutdown of the recipient water main which will then stop the sodium hypochlorite dosing system.

The setpoint for this alarm shall be adjustable from SCADA only (not from the OIP) with supervisor or higher access required.

11.6 Chlorine Residual High-High Alarm

The High-High Chlorine Residual Alarm protects against the supply of over-chlorinated water. The alarm is initiated if the measured chlorine residual is continuously higher than the high-high limit for 60 seconds. If a standby dosing pump is available, then this alarm shall initiate an automatic changeover to the standby dosing pump.

Once triggered, if this alarm persists for 30 seconds, then the "Water Quality Poor" alarm is triggered. This will initiate shutdown of the recipient water main which will then stop the sodium hypochlorite dosing system.

The setpoint for this alarm shall be adjustable from SCADA only (not from the OIP) with supervisor or higher access required.

11.7 Water Quality Poor Alarm

A Water Quality Poor alarm is triggered on any of the following conditions:

- Sodium Hypochlorite Dosing System is initiated and:
    - Neither dosing pump is on; or
    - Both dosing pumps have faulted; or
    - Turbidity high alarm (where turbidity analyser is installed); or
    - Turbidity analyser failure (where turbidity analyser is installed); or
    - Inlet chlorine residual high-high alarm persists for 30 seconds; or
    - Inlet chlorine residual low-low alarm persists for 30 seconds; or
    - Chlorine residual analyser failure; or
    - Flowmeter fault (or fault in its analogue input); or
    - Mains Flow Discrepancy alarm persists for 120 seconds.

For critical or primary disinfection sites, the water quality poor alarm shall be interlocked to stop flow in the recipient water main.

The "water quality poor" alarm must be manually reset either locally or remotely (unless self-reset on power restore) before the system can be returned to operation.

11.8 Safety Shower High Flow Alarm

Operation of the safety shower or eyewash shall initiate an alarm on the OIP and SCADA to alert operations personnel of a possible personnel emergency requiring medical assistance.

12 DECONTAMINATION

The design of the sodium hypochlorite dosing facility shall accommodate the following decontamination methods.

12.1.1 Spills Within Bund

For small spills, neutralisation can be accomplished by dilution and hosing down with water within the bund. For larger spills, the bulk of the spill should first be pumped into a sealable container for correct disposal. The spill area should then be thoroughly flushed with water.

12.1.2 Dosing Pump and Piping Decontamination

A connection point shall be incorporated upstream of the dosing pump to provide service water for flushing and decontamination of the dosing pump, dosing pipe and pressure sustaining valve prior to disassembly. The flushing will reduce the possibility of occupational exposure to concentrated sodium hypochlorite.

Additionally, a wash down trough should be located close to the dosing pump(s). This facilitates further decontamination of the dosing pump within the bund once the pump has been removed from its mounting for maintenance.

13 PLACARDING, LABELLING AND SAFETY SIGNAGE

All the following safety signs and placards shall be provided for any sodium hypochlorite storage and/or dosing facility regardless of whether the stored concentration is neat (12.5% m/v) or dilute (4.5% m/v):

a) A Sodium Hypochlorite Storage Placard (DS WCSS003-2 or DS WCSS003-3 whichever applicable) shall be posted near each entry door to the sodium hypochlorite storage room. These signs shall be displayed to be clearly visible from the normal direction of approach.

b) Multi-Sodium Hypochlorite Signs (DS WCSS108) shall be posted on the outside wall of the Sodium Hypochlorite building near the unloading area and next to the personnel door to the viewing room. These signs shall be displayed to be clearly visible from the normal direction of approach.

c) Storage Tank Identification & Volume Labels (DS WCSS404) indicating the tank number and size shall be posted on each tank. These labels shall be displayed at a level so that they are visible from the normal direction of approach.

d) Emergency Shower & Eyewash Signs (DS WCSS306) shall be posted on the wall next to the safety shower unit or attached to the rear of the shower. These signs shall be displayed to be clearly visible from the normal direction of approach.

e) Maximum Fill Level Labels (DS WCSS402) shall be posted on the tank.

Pipe Identification Markers (DS WCSS452) shall be posted on all pipework to indicate pipe contents and flow direction. These markers should be prominently displayed on the pipework to ensure the observer can clearly read the information.

Commissioning Plan Information
All signs and placards shall comply with the requirements of DS 79 - 04 Safety Signage, Labels and Markers.

Where a sign is fitted onto or near a door, the sign shall be easily visible with the door either open or closed. This may require identical signs to be fitted to both sides of the door.

14 APPENDIX A: SODIUM HYPOCHLORITE PROPERTIES AND SAFE HANDLING REQUIREMENTS

Some of the properties and safe handling requirements of 12.5% sodium hypochlorite are included in the table below. Please refer to the Sodium Hypochlorite SDS for more information.

Name	Sodium Hypochlorite
Other Names	Bleach Solution, Hypo, Hypochlorite Solution.
Formula	NaOCl
UN No	1791
Hazchem Code	2X
Poison Schedule	6
DG Class	8
Packaging Group	III
NaOCl concentration	12.5% to 13.0% (w/v)
S.G.	1.18 (approx) at 20°C
pH	>12 (note 4.5% w/v solution has pH 11.3)
Colour	Clear green-yellow
Health Hazards	Highly corrosive – severe irritant. Avoid eye or skin contact, vapour inhalation and ingestion.
Eye	Contact with eyes may result in irritation, lacrimation, pain, redness, conjunctivitis and corneal burns with possible permanent damage.
Inhalation	Over exposure may result in mucous membrane irritation, coughing and burning sensation of upper respiratory tract. At high levels; ulceration, breathing difficulties, chemical pneumonitis and pulmonary oedema can occur.
Skin	Contact with skin may result in irritation, redness, itching, pain, rash, dermatitis and burns. Prolonged or repeated contact may result in ulceration.
Ingestion	Ingestion may result in burns to mouth and throat, nausea, vomiting, ulceration of the gastrointestinal tract, breathing difficulties, circulatory collapse and coma.
Personal Protective Equipment	Chemical Face Shield Full Length Butyl Gloves Impervious Coveralls (such as Tychem ® F Coverall) PVC Boots PVC Apron Full Face Type B (Inorganic and Acid Gas) Respirator Any or all of the above may be required depending on the task. Please refer to "S022 Personal Protective Clothing and Equipment and Work Wear" on the Safety and Wellbeing website for more guidance.

15 APPENDIX B: COMMISSIONING PLAN ISSUES LIST

This appendix collates issues (raised in the main body of this Standard) for consideration in the Commissioning Plan.

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

> A 24 hour hydrostatic leak test shall be conducted on a bund prior to the filling of its associated storage tank(s) with chemical.

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

> Prior to delivery to site, all tanks shall be hydrostatically tested using clean water filled to the overflow level. The full static head is to be held for a minimum of 12 hours. Once installed, the tanks shall be hydrostatically tested to the full static head again to check for any damage which may have occurred during transportation or installation[16].
> All tanks shall be transported to site with capped nozzles to prevent dust and vermin entering.

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

> 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: The tank shall not be subject to the test pressure as it is only rated for static head up to the overflow level.

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

> The pressure setting of PSVs shall be recorded on their valve tags.

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

> All above ground PVC 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 and labelled as described in section 11.
> Buried pipework or pipework installed in culverts (not exposed to UV) does not require painting, but shall be labelled for identification purposes.

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

> 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.

Hazard: Personnel not being able to identify or be alerted of a potential hazard.

> All signs and placards shall comply with the requirements of DS79.4 Safety Signage, Labels and Markers.

[16] Water used for testing tanks at site can then be discharged through the scour valve to test the bund as well.

END OF DOCUMENT