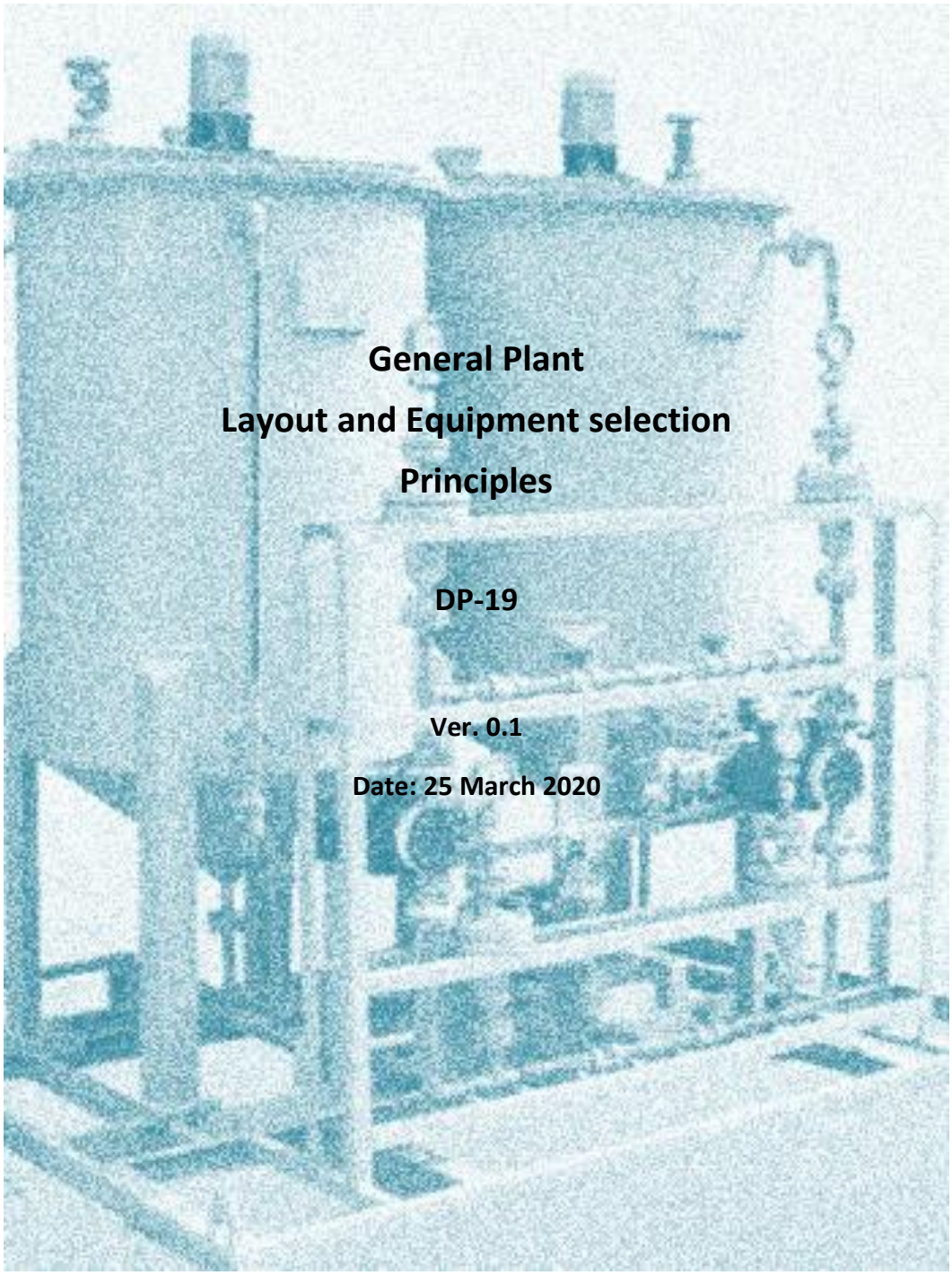
This document is a working draft, meaning that it may be used in practice whilst Watercare is seeking feedback on the contents. Works undertaken in accordance with this revision will be considered compliant. Once the working draft is updated following feedback, the previous version be superseded.



General Plant
Layout and Equipment selection
Principles

DP-19

Ver. 0.1

Date: 25 March 2020

Revision	Description	Released By	Date
0.1	Working draft	J de Villiers	25/03/2020

Table of contents

Definitions

Treatment (plant)	Water treatment plants for the treatment of raw water by mechanical or chemical processes to meet the Drinking water Standards for New Zealand, or Wastewater treatment that receives wastewater from Wastewater transmission (ref. "Transmission") to remove contaminants through mechanical, chemical and biological processes.

Acronyms

CAD	Computer aided design
kPa	Kilo Pascal
L	Litre
m	Metre
m^2	Metre square
m^3	Metre cubic
mm	Millimetre
NB	Nominal bore
O&M	Operations and Maintenance
PVC	Polyvinyl chloride pipe
sec	seconds

Part A –General requirements

1. Introduction

This document is to describe the general considerations for process plant layout and material selection in conjunction with the Health and Safety in Facility design guidelines and particular plant design requirements.

2. 'Must' versus 'Shall' versus 'Will'

Where the verbs must, shall and will (or its past tense forms) are used they describe a requirement for compliance with the statement in which it is used.

'Shall' and 'must' expresses a mandatory condition or action. 'Will' is used to prescribe a performance outcome or intent.

3. Referenced standards

3.1 Standards list

This standard must be read in conjunction with the Watercare, national and international standards listed below. Where conflict or ambiguity exists this standard shall take precedence. Where there is conflict between referenced standards, the higher level of standard shall take precedence.

3.1.1 Watercare standards

DP - 11 Health and Safety in Facility Design guidelines

DP – 09 Electrical design

DP – 12 Architectural design guidelines

ME - General mechanical construction standard

MS - Material supply standard

7363 - Watercare CAD manual

AI - Data and Asset Information standard[1]

3.1.2 National and international standards

Drinking Water Standards for New Zealand, 2005 (rev. 2018)

NZS 1170 Structural design actions
Part 5 Earthquake actions – New Zealand
Part 5 Supp 1 Earthquake actions – New Zealand – Commentary

NZS 3106 Code of Practice for concrete structures for the storage of liquids

NZS4219 Seismic performance of engineering systems in buildings

AS/NZS1657 Fixed platforms, walkways, stairways and ladders. Design, construction and installation

NZS 4541 Automatic fire sprinkler systems

AS/NZS4024.1601 Design of controls, interlocks and guarding - Guards - General requirements for the design and construction of fixed and movable guards

[1] At the time of publication, the referenced standard is still under review and will take affect once published.

NZS6801 Acoustics - Measurement of environmental sound

3.1.3 Regulations

Health and Safety at Work Act 2015

The Hazardous Substances and New Organisms Act 1996 (HSNO)

Health and Safety at Work (Hazardous substances) Regulation 2017

Resource Management Act 199

Building Act 2004

3.1.4 Other publications

Seismic Design of Storage Tanks 2009 (New Zealand Society for Earthquake Engineering).

API 650 Appendix E 12th Edition, American Petroleum Institute

Engineering NZ practice note 19 "Seismic resistance of pressure equipment and its supports" Jan 2013

4. Material schedules - material selection at design

Material selection shall be completed by the designer on the following principle:

Feasible materials shall be shortlisted based on their limitations of use to ensure reliability, future maintenance and the cost of repair is kept to a minimum. The consideration of technical advantages shall only be taken on the shortlisted materials. Function and maintainability shall take precedence.

The selected material shall be fit for purpose and submitted to Watercare for approval before commencing with detailed design.

As part of the design output, the designer shall complete the procurement schedules for the products and identify any design specific requirements over and above the minimum requirements stated by Watercare's Material Supply standard.

5. Design requirement exemptions

The following projects are typically excluded from design work:

a) Installation or replacements of like-for-like valves, fittings and meter assemblies with componentry that are fully compliant with the Watercare Material Supply standard.
b) Repair of a system component or replacing it with a similar Watercare approved component of the same operational capacity as described in the original design.
c) Maintaining corrosion protection on facilities, unless a new corrosion protection system is proposed.

To qualify for the design exemption the works must be reviewed by a Watercare engineer with suitable qualification and experience, completed to Watercare standard design and the asset data, including as-built drawings updated to the current standard.

Part B – Layout design

1. Premises access control

a) This section shall be read with consultation on the Watercare operational policy document: "Operational Facility/Asset Access and Key/Security Card Control Procedure". (This document is not publically available and must be requested from Watercare).

b) Reference shall be made to the Watercare architectural guidelines in relation to design considerations for sections on site layout with considerations in particular to crime prevention through environmental design (CPTED) principles.

c) Refer to the Health and Safety in Facility guidelines for arrangements between operational and break-out areas.

d) Wastewater (resource recovery) plants and water treatment plants for drinking water may require different consideration to access that could result in contamination or tampering or related public health incidents. Treatment facilities are often more remote and therefore may not have visibility where public alarm can be raised, or limited operator attendance due to comprehensive automation.

The following table describes access concerns control concerns and possible solutions:

Access concern	Potential Impact	Plant type impacted	Solutions
Vandalism and the wilful damage of property	Loss of operation Water quality Aesthetics	Water treatment Wastewater/Resource recovery	Security management, Monitoring
Terrorism	Water quality Loss of operation Loss of supply	Water treatment	Digital protection Minimise sensitive information within public realm
Theft	Lowered resilience Public health	Water treatment Wastewater/Resource recovery	Security management
Perimeter breach: • Gate access control • Number of access gates and fences • Fences	Public health Theft Vandalism	Water treatment Wastewater/Resource recovery	Inspection, digital monitoring Minimising access points Security control
Visitors for work	Public health	Water treatment Wastewater/Resource recovery	Induction and safety practices Works management
Public site visits	Public health	Water treatment Wastewater/Resource recovery	Manage information and limiting video and photo material
Audio-visual breach / Social media:	Public health Terrorism	Water treatment Wastewater/Resource recovery	Preventing unsolicited capture and sharing of video, photos, models and operational records
Contamination/pandemic	Water quality/Public health	Water treatment	Perimeter security Monitoring

Access concern	Potential Impact	Plant type impacted	Solutions
	Environmental health	Wastewater/Resource recovery	Staff isolation and flexibility in skills
IT/control/automation system security	Public health Loss of operation Loss of supply Terrorism	Water treatment Wastewater/Resource recovery	Digital protection

2. Chemical management and storage

2.1 General

The design must produce chemical storage and handling solutions that meets the current legislative requirements under the HSNO and Health and safety at work (Hazardous substances) regulations.

2.2 Treatment chemicals

2.2.1 Hazardous substance classes

Substance classification	Description
Class 1	Substance of explosive nature
Class 2	Flammable gas
Class 3	Flammable liquid
Class 4	Flammable solid
Class 5	Substance with ability to oxidise (to accelerate a fire)
Class 6	Acute or chronic toxicity – toxic to humans
Class 8	Corrosiveness
Class 9	Eco-toxicity with or without bioaccumulation (directly or indirectly toxic to the environment)

2.2.2 Storage

a) The design shall comply with the Health and Safety at Work (Hazardous substances) Regulations 2017.
b) Access to class 6 and 8 storage areas must be secured from access by unauthorised persons.
c) The storage area must have appropriate ventilation.
d) The storage area must be designed with appropriate spillage retention measures where tanks or pipe work may fail, or where chemicals are transferred or decanted.
e) Bund protection from rain whilst allowing air flow or retention as required for the substance (such as louvered walls to prevent rain but still facilitate air flow.
f) Incompatible substances or substances that may react dangerously must not be stored in the same area.
g) Onsite storage should be minimised to reduce hazards.
h) Larger volumes require chemicals to be stored in separate areas to public spaces as defined by the regulations.
i) The storage area must be prepared for any health related emergency or spillage that can occur from the stored substance.

j) Above ground tanks for must be earthed and bonded to AS/NZS1020:1995 and lightning protected in accordance with AS/NZS1768:2007 as appropriate for the related classification.
k) Class 2 tanks may not be stacked above one another.
l) Class 3 tanks may not be located end-to-end unless determined by risk assessment that failure of a tank end will not impact other tanks.

2.2.3 Labelling and signage

a) Containers and storage items must be appropriate for the substance and marked accordingly
b) Containers labels and signage should be such as not to be mistaken for food or beverage i.e. do not use containers that can be mistaken for such.
c) Tanks must be marked with the design approval number.

2.2.4 Waste management

The plant layout design should consider the practicalities of waste management for the particular site such as:

a) Emptying of bunds:
    - Discharge to waste of naturalised substances into the environment
    - Removing content off-site for disposal
    - Bund cleaning practice
b) Storage of out-of-date substances for collection, its labelling and segregation from other parts of the plant.

2.2.5 Record keeping

a) Inventory records shall be kept up to date.
b) Hazardous substances location plan must be developed and kept up to date.
c) Safety data sheets (SDS) availability and linked to inventory.
d) Compliance plans and training material must be prepared.
e) Emergency response plan (ERP) must cover:
    i. Reasonably foreseeable emergencies
    ii. Describe location of emergency equipment
    iii. Be tested within three months of a change made
    iv. Records for testing the ERP
f) Audit methods and frequency must be established.

3 Hazardous areas

a) Some areas of the plant may be classified as hazardous areas.
b) Any approved safety barriers must be designed for installation to the equipment supplier's instructions without modification.
c) All equipment installations within these areas shall employ protection techniques appropriate for the area of classification as defined by AS/NZS 60079.
d) All equipment including cable and glands, shall be certified by a suitably certified testing authority.
e) A verification dossier shall be established in accordance with AS/NZS60079.

4 Cross-connection control

Recommended cross-connection protection at equipment is listed below:

Description of equipment / installation	Recommended minimum protection
Liquid chemical tanks	i) Provide air gap on dilution water supply ii) Air gap to overflow and drain iii) Provide day-tanks
Dry chemical feeder tanks	i) Provide air gap on fill supply ii) Air gap to overflow and drain
Chemical feed pumps	i) Discharge at point of positive pressure ii) Provide vacuum relief or similar anti-siphon device iii) No pump priming or flushing line
Chemical carrier lines	Provide a reduced pressure zone (RPZ) backflow device at the supply
Chemical injection point to carrier line	Provide a reduced pressure zone (RPZ)
Chemical injection line in common with potable water / non-potable water	Provide a reduced pressure zone (RPZ), eliminate cross-connection (separate injectors for raw or filtered water)
Surface washers	i) Atmospheric vacuum break ii) Pressure vacuum breakers assembly iii) Double check valve assembly
Filter backwash	Provide air gap to overflow and drain
Filter-to-waste	Provide air gap to overflow and drain, or air gap to process stream ahead of filters
Membrane cleaning (in-place)	Physical disconnect
Sample lines to monitoring equipment	i) Air gap ii) Atmospheric vacuum breaker
Monitoring equipment for raw and potable water	i) Air gap ii) Physical disconnect

4 Process and potable water in plant piping

a) Potable water for consumption shall be completely separated from process water supplies. Due to the complexity of process water reticulation system layouts the probability of interconnection of process water piping is high.
b) Best practice is to take process water from discreet points for individual processes.
c) A reduced pressure zone (RPZ) backflow device shall be installed at these take-off points.
d) Potable water for process use in the facility shall be from no more than two discrete points with backflow prevention at the supply point.
e) Refer to Part C, section 4 for piping layout and section 10 for colour coding of pipework.

5 Common wall construction

The design shall consider cross contamination that may occur as a result of shared or common walls between water being treated and finished water. Double wall separation to allow inspection, or monitoring of either wall integrity of adjacent basins should be made, or be arranged to be completely separate.

6 Confined spaces

Confined space shall be minimised. There are dangers and difficulties associated with conducting maintenance work in confined spaces. The design shall seek to limit confined spaces and place infrastructure above ground, not restrict entry or exit, and not cause engulfment or poor air quality.

7 Equipment general positioning

This section must be read with Part C.

Equipment	Positioning
Valves	Size >50mm positioned 600mm to 1000mm from the operator platform to the top of the operating mechanism. This includes any valve of any size that is required to be disabled for r3gular maintenance such as check valves. Size <50mm positioned not higher than 1500mm from the operator platform (excludes regularly maintainable valves)
Pumps	Mounted on a pump skid with surface level minimum 200mm above the ground level. (excludes submersible pumps) Horizontal clearance of minimum 1000mm Vertical space above pumps over 25kg shall be clear and provided with access for lifting equipment.
Process (dosing) pumps	Mounted on a dosing skid positioned at a height of 600mm clear from pipework that could leak onto the pump and positioned to allow clearances for maintenance of pump components
Sensors	In reach of platforms and other access means and removable such that equipment or parts cannot be dropped into process containers
Meters	Clearances and pipe runs must be observed as described by the manufacturer's installation requirements
Monitoring stations	Suitable for human interaction not requiring leaning over other equipment and at a height from standing surface of 1.2m to 1.5m
Cable runs	Short as possible, either mounted above 2000mm overhead on cable trays or in cable ducts. Ducting should not be in areas that can flood or have poor ventilation and prone to high temperatures.

Part C – Mechanical design

1. Guards

a) All rotating, moving or oscillating items shall be fully guarded to comply with the relevant standards and WorkSafe requirements.
b) All drive mechanism, rotating and reciprocating parts and drive belts shall be securely shrouded to provide protection and safety for both maintenance and operating personnel.
c) All such guards shall be of adequate material and coverage, but shall also be readily removable for gaining access to the plant without the need for first removing or displacing any major item of plant.
d) Guard design shall allow inspection ports or with expanded metal sections to allow inspection without having to remove the guards in compliance with AS/NZS4024.1601.
e) All guards shall be designed and fitted with location pins or other suitable devices to ensure the correct positioning of the guard and provide positive fixing.
f) Guards shall require the use of engineering tools for removal, and shall not be able to be simply lifted on and off.
g) Grilles, bars or mesh shall be provided behind inspection ports where moving equipment may be reached. Interlocks shall be provided to stop equipment in the event that covers are opened.

2. Maximum equipment noise levels

a) The sound pressure level (L_{10}) for all equipment operating at full load shall not exceed 80 dB(A) at a distance not greater than three metres radius from the equipment or sound enclosure.
b) Noise levels shall be reduced by the enclosure, or lagging, or other special treatment of the noise source.
c) Further noise reduction measures shall be taken in order to comply with any condition set to maintain the wellbeing of neighbouring properties to the facility.

3. Piping layouts

a) Detailed design shall include:
   - Detailed layout and co-ordination, including all necessary bends and offsets.
   - Support and anchorage
   - Flexibility and dismantling
   - Expansion and contraction
   - Prevention of water hammer
b) All pipe supports shall be seismically rated to suit the site conditions. Pipes may not be supported:
   - From existing steel structures
   - From roofs girts, rafters of purlins
   - Any other structure not specifically designed for pipe static and dynamic loadings
c) Components within the pipe systems such as meters valves and strainers shall be independently supported to facilitate dismantling and not pass stress onto the connecting pipework.
d) Thrust support shall be designed for at equipment such as pumps and nozzles.
e) The drawings indicate the size of pipes, their material selection and the exact arrangement.
f) The pipe arrangement shall provide for ease of installation and future dismantling with consideration to suitable clearances around supports, saddles, slings, fixing bolts and foundation bolts.
g) Pipes laid horizontally shall have a gradual fall towards drain or scour points as appropriate.
h) High points shall be vented and low points shall have suitable drainage devices appropriate to the media.
i) Dismantling joints or dismantling options through flange and pipe arrangement (such as at bends) shall be made available:
   - Maximum 10m apart on all pipe carrying solids, sludge, sludge, etc.; and
   - At pipe material or diameter changes

- At key changes in height, structures (access areas) and change in direction
- To allow dismantling without interfering with adjacent pipe runs

j) Hangers and supports shall be designed with adequate spacing for the material type so as not to cause any spacing or stresses in the pipe and designed to NZS4219 for seismic resilience. In general the following considerations shall be followed for hangers or supports:
   - Installed at directional changes
   - Adjacent to connections for valves, pumps and large instrumentation
   - Manufactured from a material that is suitable to the installation environment
   - Provided with appropriate insulation to prevent galvanic reaction
   - Allow for adjustment, dismantling and replacement
   - For fire sprinklers refer to NZS 4541

k) Unless required for sealing against ventilation or liquid, all pipework passing through structures shall be run through a sleeve.

l) Pipework carrying thick media shall be provided with regular clean-out ports, typically at directional changes with suitable containment to catch run-off during the cleanout procedure.

m) Components within the pipe systems such as meters valves and strainers shall be independently supported to facilitate dismantling and not pass stress onto the connecting pipework.

n) Bends shall be long radius. Short radius elbows shall be avoided.

o) Pipe layouts shall have clean lines, neat and with true alignment and grade, without unsightly offsets, minimising cross-overs and be arranged to be accessible and readily replaceable.

p) Pipe layouts shall allow for expansion and contraction.

q) Offsets where required shall use 45° bends.

r) For process pipework up to 50mm diameter, a minimum 100mm clear space shall be provided between the pipe (or pipe flange), to adjacent structures, pipes and equipment. For larger pipe the clearance shall be x2 the external diameter.

s) Pipework shall be labelled in accordance with NZS 5807 and show the pipe content and flow direction. Labels shall be placed to ensure that the pipeline is identified as soon as possible after a person passes through a doorway, around a corner, or any other obstruction that breaks the continuous line of sight.

t) Coating colours shall be as per section 10.

4. Frames and mountings

a) All supports, holding down details and fixings for plant and equipment shall be detailed by the design, ensuring that all plant and equipment can withstand seismic loading (refer Part F) with the necessary support fixings and anchors.

b) Baseplates for motor driven plant shall hold both the driver and driven units. Sub-baseplates shall be welded to the main baseplate.

c) Fixing systems provided with base plates shall be designed for taking up adjustment for necessary alignment and to compensate for wear during normal service.

d) Baseplates shall be designed to be without distortion or deflection that could permanently damage the equipment or baseplate.

e) Eye bolts or holes shall be provided for lifting the complete assembly on the base plate in addition to lifting facilities on the individual components.

f) The underside faces of baseplates that contact foundations shall be rough machined to ASME B46.1 machinery surface.

g) Provision shall be made for all baseplates to be completely filled with grout during installation.

h) All baseplates, pipe supports and other items fixed to the concrete foundation shall have straight smooth sides.

i) All holes as necessary shall be machined and not flame cut.

j) All bolt holes in steelwork shall be a distance of minimum1.5 x hole-diameter from the nearest metal edge.
k) Flexibly mounted equipment shall be provided with suitable dampeners with resilient surfaces to limit seismic movement.
l) Frame members, if constructed from hollow sections, shall have the ends closed off and be fully sealed against ingress of moisture. Galvanised hollow frame members shall have vent holes fully sealed with lead plugs after being galvanised.
m) Separation/galvanic isolation of the two dissimilar metals shall is required to prevent possible galvanic action.

5. Acoustic louvers

a) The louver shall be of weatherproof design suitable for and proven for use in the specific application.
b) For air intake louvers where the velocity through the effective pressure area exceeds 4m/s, or the pressure drop exceeds 30 Pa, provide side draining louvers.
c) Where clear wall height above louver ≥ 2m, provide gutter across top of louver to divert rain water to sides of louver face.

6. Material and equipment handling

a) Equipment shall be designed and installed so as to provide sufficient access and clearance to allow for the safe and efficient carrying out of routine inspections and maintenance activities.
b) All equipment shall be readily accessible for removal, and be fitted with appropriate and readily identified lifting points.
c) Equipment shall be installed to the requirements of the manufacturer.

7. Platforms and access structures

a) The design of platforms and access structures shall take into consideration the structural steelwork requirements and Access structures and platforms of the mechanical construction standard.
b) Walkways and platforms shall be provided for maintenance access and inspections. Platforms should be extended such as to prevent reaching over handrails and at a suitable height for equipment handling.
c) Allow for site specific spill conditions and corrosion protection.
d) Stairways are preferred over ladders. Where ladders are provided it shall be extendable to a minimum of 1000mm through the chamber lid above ground level.
e) Platform system shall be complete with grating, kick-plates, stairs, handrails, ladders and all associated accessories.
f) Platform system material selection must be appropriate for the environment to prevent or reduce corrosion.
g) The design shall in general comply with AS/NZS 1657 with the following considerations:
    i. Walkways shall be provided for maintenance access and operational inspection.
    ii. Access platforms shall be provided at all equipment drives at a suitable height for maintenance.
    iii. Extend walkways to prevent the need to reach over railings for equipment access.
    iv. Apply additional specific or calculated loads for equipment or pipework. This could include loads related to lifting equipment mounted to platforms/walkways and loads for equipment laydown and removal via trolley. Additional loading capacity shall be allowed as required for lifting equipment into mounting areas or where platforms may be used to transport equipment, or for laydown areas.
h) The walkway systems shall be suitable for installation outdoors, for exposure to continuous 90% relative humidity conditions, for ambient air temperature from 5 C to 35 C and for exposure to intermittent water or sludge splash, spill conditions and a marine coastal environment.

8. Gantries and cranes

a) Consideration should be given to use of temporary gantries and cranes to be retained as part of the permanent installation thereby reducing the need for mobile plant and ensuring the installation is adequate for equipment handling of the site.
b) Where gantries and cranes become permanent installations they must be services after completion of the works before being handed over into Watercare's service.
c) Fixed cranes can be considered where frequent equipment movement in a localised area is necessary or where the equipment is of a particular type that requires a specific handling method.
d) Gantry rails provide flexibility in the movement of equipment across distance, reducing downtime and increasing productivity, but is more expensive in initial design and setup.
e) Total cost option analysis that includes operational value must be completed for selecting the most appropriate crane system.

9. Loading materials, hoppers and conveyors for handling

Docking and loading, and materials handling plans must be prepared.

9.1 Loading access

a) Truck and vehicle movement should consider a one-direction access road for vehicle movement to reduce the necessity for manoeuvring areas to offloading areas and site road width.
b) The road surface around the site shall be level and rate HN-HO-72.
c) Suitable drainage for surface water must be provided.
d) Loading docks and road approach surface must not exceed 10% angle difference to prevent truck to platform misalignment, cargo topple and traction problems. Build-out blocks must be designed to make up the hypotenuse angle to prevent impact of the top of trucks with the facilities or structures.
e) Depressed docking or elevated platforms are recommended over downloading to road surface. Where forklifts or scissor platforms are used suitable clearances and bump protection must be provided for manoeuvring of this equipment.
f) Bumpers must be positioned to prevent vehicles damaging loading structures in line with the expected manoeuvrings for delivery and docking.
g) Some deliveries and material handling may require to be kept dry. The docking or offloading areas must then be suitably covered and protected from the elements.

9.2 Hoppers and conveyers

a) Hoppers and conveyors for loading product into processes must be positioned such as to limit the distance from the material offload area.
b) Lifting of product to hoppers by gantry is preferred over the use of a forklift. Gantries must be suitably rated, refer to section 8.
c) Hoppers should be positioned at low or recessed levels and product transferred to elevation by a conveyor or alternatively a vacuum system for fine powdered product.

10. Coating colours

The appropriate coating system shall be determined with input from a coatings engineer and identify the site specific macro and micro environments. Also see Part D for specific corrosion protection considerations. The designer must complete the project schedule in the Material Supply standard and provide it to the coating supplier to support the coating selection.

10.1Water treatment plant colour scheme

Service	Definition	Colour No. BS 5252	Colour (Resene)
Raw water (incl. coagulant dosed water)	Untreated water arriving from catchments, underground, or river Raw water dosed with coagulant/polyelectrolyte and pH adjusted prior to clarification in a clarifier or settling tank	12 C 39	Turtle green
Clarified/settled water	Water decanted from clarifiers or settling tanks prior to filtration	18 D 41	Glacier
Filtered water (ex-sand filter, GAC or membrane) and chlorinated water	Water discharging from a sand filter, GAC tank or membrane filter and including chlorinated water	18 D 41	Glacier
Treated water and plant potable water supply	Fully treated water in the treated water tank or conduit ready for transmission to consumers and to plant use	18 E 53	Bahama blue
Backwash water/ backpulse water	Clean water for backwashing sand filters & GAC tanks or backpulsing membrane filters	14 C 33	Gum leaf
Wash water	Dirty water from backwashing sand filters & GAC filters	06 D 45	Peru tan
Wash water	Dirty water from backwashing sand filters & GAC filters	06 D 45	Peru tan
Wastewater	Dirty water from membrane filters	06 D 45	Peru tan
Wash water sludge	Settled sludge from wash water recovery tanks	06 D 45 & 08 C 39 in bands	Peru tan & Saddle brown in bands
Clarifier sludge	Sludge from clarifiers or settling tanks	06 D 45	Peru tan
Thickened sludge	Thickened sludge drawn from the base of sludge thickeners	08 C 39	Saddle brown
Wash Water supernatant	Water decanted from washwater recovery tanks	10 D 45	Yukon gold
Thickener supernatant	Water decanted from the top of sludge thickeners	10 D 45	Yukon gold
Centrate	Water separated from thickened sludge by centrifuge	10 D 45	Yukon gold
Filtrate	Water separated from thickened sludge by filter press	10 D 45	Yukon gold
Alum	Aluminium sulphate coagulant	8 B 17	Soft amber
Polyelectrolyte	Coagulant aid, powder, liquid in dilute or concentrated form	12 B 21	Flax
Lime	Hydrated lime	12 E 51	Lime
Caustic soda	Caustic soda	24 C 37	Trendy pink
Carbon slurry	Powdered activated carbon slurry		Black
CO_2	Carbon dioxide gas	08 C 35	Twine
CO_2 solution	Carbon dioxide solution	08 C 35	Twine

Service	Definition	Colour No. BS 5252	Colour (Resene)
Chlorine	Chlorine gas	08 E 51	Buttercup
Chlorine solution	Chlorine solution	08 E 51	Buttercup
Fluoride	Hydrofluosilicic acid	04 E 56	Flame red
Hypochlorite	Sodium hypochlorite solution	08 E 51	Buttercup
Brine	Sodium chloride (salt) solution	20 C 33	Spindle
Citric acid	Citric acid (CIP)	10 D 41	Golden sand
Sodium bisulphite	Sodium bisulphite (CIP)	10 B 15	Pearl lusta
Stormwater	Manhole covers and pipes	10 A 03	Grey nickel

10.2Resource recovery (wastewater) treatment plant colour scheme

Equipment	Colour No. BS 5252	RAL	Colour (Resene)
Centrifuges	White		
Blowers		RAL 5015	Sky blue
Blowers panels	00 A 03 (grey)	RAL 7035 (Light grey)	
Blowers		RAL 5002	Ultramarine blue
Inter-stage pumps		RAL 5010 or NCS 1950: 5040-R 90 B (Mid-blue)	Gentian blue
Other major pumps		RAL 8022 or NCS 1950: S 9000 N	
Sludge tanks	06 A 03	RAL 080 80 05	
Clarifier mechanism	00 A 09		Haze grey
DAF Mechanism	00 A 09		Haze grey

Equipment	Colour No. BS 5252	RAL	Colour (Resene)
Gantry cranes/monorails	08 E 53		Yellow
Transformers	08 C 33 (Beige)		
11kV Switchgear	08 C 33 (Beige)		
415V MCCs	04 B 15	RAL 070 90 05 (Off-white)	
Variable speed drives	08 C 33 (Beige)		
Distribution boards	04 B 15	RAL 070 90 05 (Off-white)	
Battery chargers	04 B 15	RAL 070 90 05 (Off-white)	
DCS Panels	04 B 15	RAL 070 90 05 (Off-white)	
Electric motors	Same colour as connected rotating equipment		
Conveyors	TBC, site specific		
Polymer tanks	10 B 15		Ivory
Sludge feed tanks	10 B 15		Ivory
Sludge/Polymer Pumps	TBC, site specific		
Gravity belt thickeners	Stainless Steel Epoxy		
Blended sludge tanks			Sky white
Digester feed tanks			Sky white
Progressive cavity pumps		RAL 5015	Sky blue
Recirculation pumps	14 D 56	RAL 6032	Fun green
Plug valves		RAL 260 30 35 (royal blue)	
Blended sludge polymer tanks	10 A 01 (white)	RAL 9003	
Odour fans	White to match ducting		

Part D – Seismic design of equipment, equipment supports and tanks

1. General

a) This part covers the requirements for seismic resistance of tanks, equipment and equipment supports and provide additional relevant information to assist designers. It does not override any statutory requirements.

b) All structural aspects of design shall be verified by a New Zealand Chartered Professional engineer experienced in the seismic design of industrial structures and tanks.

c) All equipment and equipment supports shall comply with the applicable requirements of the NZ Building Act (2004) and the New Zealand Building Code and the applicable approved documents including the New Zealand Loadings code AS/NZS 1170 (Structural design actions) and the appropriate materials codes. Equipment inside buildings shall be designed to the appropriate risk level and as prescribed by NZS4219 (see section 5 below).

d) Pressure vessels shall, in addition, comply with the specific seismic requirements of the New Zealand Ministry of Transport, Marine Division.

e) Alternative design methods must be approved by the relevant Territorial Authority (to be sought by the designer) and accepted by Watercare.

f) The seismic design should consider the structural system as a whole comprising both the equipment and its supporting system.

g) The Supplier/Contractor shall submit with his design the following information:

i. Weight and geometry of the equipment including positions of the centre of gravity and support points for maximum weight and normal operating weight.
ii. Ductility capability.
iii. Structural type and methods of achieving ductility (if applicable)
iv. The equipment horizontal design action co-efficient.
v. Displacements of equipment for the serviceability and ultimate limit states.
vi. Foundation loadings (dead, basic live, earthquake and wind load, where applicable)

2. Tanks outside buildings

a) Refer to section 6 below for pressure vessels.

b) Seismic design of tanks should comply with either:

- Seismic Design of Storage Tanks (New Zealand Society for Earthquake Engineering), or
- API 650 - Appendix E; except that:

The earthquake loading coefficients should be derived from the seismic loading spectra specified in NZS 1170.5 with corrections for damping levels appropriate to storage tanks as follows:

$$C_d(T_i) = C_h(T_i,\mu).Z.R.N(T_i,D).S_p..DF/k_\mu$$

Where:

$C_d(T_i)$ = horizontal design action co-efficient for response mode i

$C_h(T_i,\mu)$.. = spectral shape factor for structural period T_i

Z = hazard factor

R = return period factor (either R_s of R_u for the appropriate limit state under consideration. See below)

$N(T_i,D)$ = Near fault factor (assume = 1)

T_i, = period of vibration for response mode i

S_p = structural performance factor (assume = 1)

k_μ = inelastic spectrum scaling factor

μ = displacement ductility factor (assume = 2)

DF = Damping Correction Factor (see below)

c) **Risk factor R**. When selecting which state applies to individual parts, consider equipment/tanks designated as post disaster or essential for operational continuity:
Serviceability Limit State SLS1: $R_s = 0.25$
Serviceability Limit State SLS2:

i. Equipment/tanks essential to operational continuity after SLS2 earthquake: $R_s = 0.75$
ii. Other equipment: SLS2 not required to be considered

Ultimate Limit State:

i. Equipment/tanks designated as post disaster: $R_u = 1.8$
ii. Equipment/tanks containing hazardous materials capable of hazardous conditions beyond the boundary: $R_u = 1.8$
iii. Equipment/tanks part of the treatment process : $R_u = 1.3$
iv. Other equipment/tanks: $R_u = 1.0$

d) **Damping Correction Factor DF.** The NZS 1170.5:2004 spectra are based on 5% viscous damping. For other damping values, the following correction factors shall be used:

% Critical Viscous Damping	Correction Factor DF
0.5%	1.75
2%	1.33
5%	1.00
10%	0.80
15%	0.71
20%	0.67

For the convective mode, the appropriate value of damping is 0.5%. For the impulsive mode, refer to Seismic Design of Storage Tanks (New Zealand Society for Earthquake Engineering), or API 650 - Appendix E.

e) Tank materials shall satisfy to provisions of the appropriate material supply standard, except where these conflict with the requirements above.

3. Specific earthquake analysis

a) For all structures exceeding 10m in height, or, T1 > 0.4sec or, T1 > 2sec and regular in accordance with NZS 1170.5, a dynamic analysis shall be carried out to determine the following:
   - The degree of ductility demand on the yielding elements.
   - The acceleration of equipment attached to the vessel.
   - The structural separations required for connection bridges and appurtenances.

4. Seismic loading coefficient

Seismic loading shall be determined using NZS 1170.5. The relevant loading spectrum for the site subsoil shall be confirmed.

5. Equipment supported by building structures

a) In general, equipment seismic loadings will be larger the higher in the building the equipment is located, because earthquake induced accelerations in a structure increase with height.
b) Equipment fixed to the building structures with connections generally have little or no ductility capability and shall be designed to NZS 4219 “Seismic Performance of Engineering Systems in Buildings”. The design shall be dependent on:
   - Basic seismic coefficient for the structure.
   - Height of the centre of mass of the structure relative to the equipment.
   - Whether the structure has been designed to be ductile.
c) When the equipment mounting is ductile, the seismic coefficient shall be modified in accordance with NSZ 1170.5and NZS 4219.

6. Free standing equipment

a) The majority of items will have no provision for ductility. These shall be designed to remain elastic under the earthquake loading and will have seismic coefficients depending on the natural period of vibration.
b) Items with ductility capability may be designed with the lower seismic forces with consequent saving in structure and foundations.

7. Pressure vessels

The design seismic coefficient for pressure vessels shall be determined in accordance with Engineering NZ practice note 19 “Seismic resistance of pressure equipment and its supports” Jan 2013.

Part E – Specific materials considerations for processes

1. Introduction

a) This part shall be read with the Watercare material supply standard (MS) and shall take precedence where in conflict with MS as to relate to the specific requirements for process plants.
b) Materials and equipment must be specified to meet performance, construction, quality, space and structural loading requirements.
c) Materials must be compatible with other materials and equipment and must be corrosion resistant.
d) All material components must be specified with the exception of incidentals that may be reasonably expected to be supplied as part of the installation. However these must be verified to be of industrial standard and fit for purpose in the installation environment.

2. Materials that may not be used

The following materials may not be used in any part of equipment or design:

- Cadmium or cadmium plating
- Chromium plating
- Untreated exposed copper or copper based alloys (the exception of copper busbars and cabling exposed ends which shall be tin plated)
- Electroplated zinc coated carbon steel
- Asbestos
- Cupronickel
- PCBs or other similar hazardous materials

3. Piping systems

Pipe materials for process works shall in general comply with ASME B31.3

3.1 Mild Steel (MS)

a) Mild steel pipe shall comply with NZS 4442.
b) Steel tube or tubulars shall comply with BS EN 10255:2004 Non-alloy steel tubes suitable for welding and threading, in medium weight, or heavier if service conditions require.
c) Galvanised pipework shall be steel tube or tubulars and shall comply with BS EN 10255:2004 in medium weight, or heavier if service conditions require.
d) Galvanised pipes shall not be used for pipework with a diameter greater than 100 mm.

3.2 Stainless Steel

a) Grade 316L or Grade 316 stainless steel pipe and fittings.
b) Stainless steel pipe shall comply with ASTM A312M-13b.
c) Spiral wound tubing shall not be used.
d) Line pipe shall be minimum schedule 10.

3.3 Ductile Iron

a) Ductile iron pipework shall comply with AS/NZS 2280:2012 (Pressure pipe), BS EN 598:2007 +AS1:2009, BS EN 545:2010 and BS EN 969:2009.
b) Pipework shall be light cement mortar lined, unless specified otherwise.
c) All pipework shall be Class K9 except for flanged pipework which shall be Class K12, unless otherwise specified.

3.4 Polyvinyl Chloride (PVC)

a) Pipe shall be manufactured to AS/NZS 1477 (Pressure pipe), AS/NZS 1260 or AS/NZS 1254 (Drain pipe) as appropriate for the service and duty.
b) PVC must not be used on pressure systems (only gravity lines) except for chemical dosing systems or as otherwise approved.
c) Thermal expansion by the use of expansion loops or other proprietary device as required must be considered.

Note: PVC pipe must be either covered or protected with a coating system from direct sunlight.

3.5 Acrylonitrile Butadiene Styrene

a) ABS: Acrylonitrile Butadiene Styrene pipework shall comply with AS/NZS 3518.
b) ABS pipework shall be suitably rated for the design service, but as a minimum Class 9 shall be used.
c) The pipework shall be installed in accordance with AS IEC 60300.2.
d) Thermal expansion by the use of expansion loops or other proprietary device as required must be considered.

Note: ABS pipework must not be used for pressure systems or sludge applications.

3.6 Polyethylene

Note: PE pipe must be either covered or protected with a coating system from direct sunlight. UV protection is limited to short term resistance only.

As per the material supply standard

a) Thermal expansion by the use of expansion loops or other proprietary device as required must be considered.

3.7 Fibre Reinforced Plastic

a) Fibre reinforced plastic pipes shall comply with AWWA C950, AWWA M45 and PD ISO/TR10465-2 as appropriate.

Note: Fibre reinforced plastic pipes must not to be used for pressure applications.

3.8 Hose

a) Hose for process pipework shall be textile reinforced rubber, Dunlop D214 or equal.
b) Hose for wash down purposes shall be GEM type or equal.
c) Reels for hose storage shall be fabricated from stainless steel and be supplied with 10 metres of 32 mm diameter hose (PVC).
d) Flow shall be controlled at the downstream end by use of a proprietary nozzle allowing adjustment from jet through spray to stop.

3.9 Subsoil Drainage

Subsoil drainage pipes shall be class D PVC-U to Transit New Zealand F2 (PN12) or heavy wall (SDR 17) polyethylene.

4. Pipe fittings

4.1 General

Unless otherwise specified, the fitting materials shall be the same as the adjacent pipe material and the related standard.

4.2 Stainless steel and Mild Steel

a) Fittings may be fabricated from the same grade of steel as the adjacent pipe with the same coating and lining material. Refer to the mechanical construction standard for the appropriate welding practices.
b) Mild steel wrought pipe fittings for steel tube (including galvanised) shall comply with BS EN 1024:2012 heavy weight.
c) Stainless steel wrought pipe fittings for tube shall comply with ASTM A403M – 19a.

4.3 Polyvinyl Chloride (PVC) and Acrylonitrile butadiene styrene (ABS)

a) PVC fittings should be injection moulded.
b) Fittings must have the same pressure rating than the adjacent pipe.
c) Special manufactured pieces should be avoided and must be approved on a case-by-case basis.
d) Fittings shall be double socket.
e) All isolating valves 50 mm and smaller shall be double union ball valves with PVC body and ball and with PTFE ball seats and seals, or as appropriate for the fluid and duty. Check valves shall be of a similar specification. Valves greater than 50 mm shall be flanged unless noted otherwise.
f) Sufficient additional union couplings shall be provided in the pipeline to facilitate removal for maintenance or replacement.

4.4 Concrete

a) Prefabricated RC pipe fittings shall be factory fabricated by the pipe manufacturer.

4.5 Vitrified Clay

a) Moulded VC fittings shall comply with BS EN 295-1 and shall be as manufactured by the manufacturer of the adjacent pipe.

5. Jointing selection

5.1 General

a) The method of jointing of pipes, valves and fittings shall be specified by the designer.
b) All connections over 50mm shall be flanged or welded.
c) The number of joints must be minimised but keeping in mind to facilitate the removal for maintenance or replacement of sections and key fittings.

5.2 Steel Welding

Steel welding must follow the mechanical construction standard and may include:

- Arc welding
- Oxy acetylene welding

5.3 HDPE

a) Refer to the material supply and general civil construction standards for typical jointing methods.

b) Butt-weld shall take precedence over electrofusion welding or other mechanical means of jointing.

5.4 PVC

a) Below ground installations should be ring jointed and mechanically coupled. For below ground installations refer to the general civil construction standard.
b) Above ground installations may be solvent welded and union coupled.
c) Solvent welds joints shall:
    - Be made with pressure grade solvent cement (and associated primer and cleaners) to the manufacturer's method.
    - Have the socket pushed over the spigot and rotated a quarter to a half turn to ensure the full depth is reached. Witness marks should be made.
    - Excess cement must be removed from both internal and external surfaces.
    - Not be disturbed for a minimum of 5 minutes after being made.

5.5 Flanges

Note: On existing sites the flanges should be selected to the same standard of the majority of existing flanges, e.g. if the site has mostly ASME flanges, then the appropriate rated ASME flanges should be selected for the new installation.

a) Flanges shall be selected as per the material supply standard and assembled in accordance with the general mechanical construction standard.
b) All galvanised surfaces in contact with stainless steel shall be coated or painted to provide protection against galvanic corrosion.
c) Machined flange faces shall be coated with a suitable soluble lacquer for corrosion protection during storage only and must be cleaned on assembly.
d) Flange jointing sets shall include all bolts, nuts, washers and flange gaskets or insertions necessary for jointing together the flanges of the specific diameter and pressure rating.
e) Flanged joints shall be made with bolt sets, bolt studs with nuts on each end, or studs with nuts where the flange is tapped.
f) The gasket material must be selected suitable to contact with the conveyed media and operational duty.

5.6 Flexible couplings

a) Flexible coupling shall be selected to as per the materials supply standard.
b) Rubber ring joints shall be of suitable material for the contact with the media being conveyed and the operational duty. Rubber rings may not be reused.
c) Victaulic fittings may not be buried and must be of suitable material selection to not cause galvanic action and be suitable for the conveyed media.

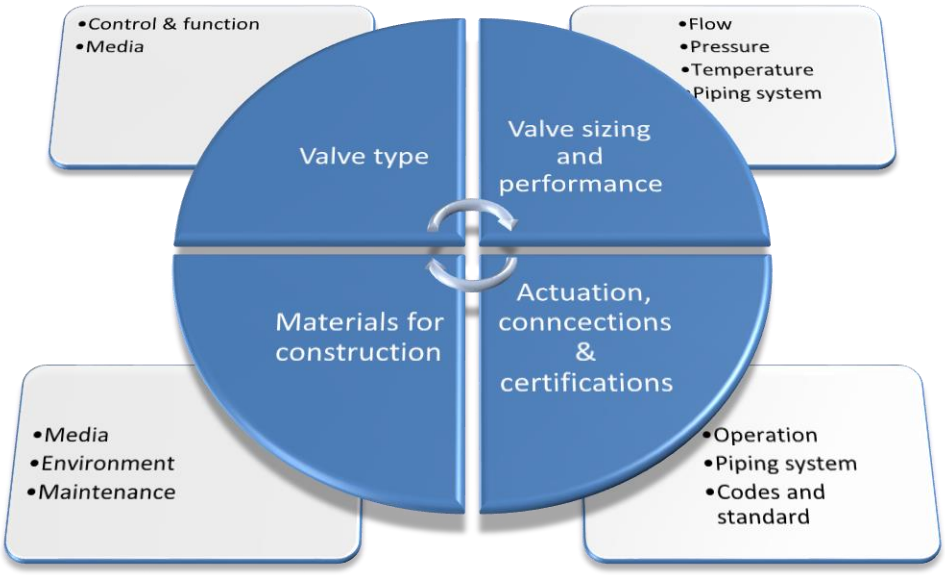
5.7 Pressed couplings

a) Pressed couplings must be installed to the supplier's methodology using brand specific proprietary pressing tools.

b) The rubber seal ring must be selected suitable for contact with the conveyed media and operational duty.

6. Valve selection

a) Valve type selection – application (grey) and attributes(blue):



b) Waterworks valves with ductile iron body material as described in the materials supply standard are suitable for mainstream water application throughout the processes, but may not be suitable for process systems.

c) For mainstream valves carrying slurries the abrasiveness of the media must be evaluated to ensure correct sealing mechanisms and any additional lining methods are specified.

d) When selecting waterworks valves for mainstream purposes consideration must be given to the micro location of the valve to ensure suitable external coating selection above what is standard provision from the manufacturer. Considerations may include solvents, volatile organic compounds, or inert gasses. The additional coating specification must be specified following the direction provided in the material supply standard for corrosion protection.

e) Industrial valve standards applies as follows as may be appropriate for the particular media:

Standard	Standard description
ASTM B61	Standard specification for steam or valve bronze castings
ASME B16.33	Manually operated metallic gas valves for use in gas piping systems up to 125 psi
ASTM F1794	Standard specification for hand-operated, globe-style valves for gas (except oxygen gas) and Hydraulic systems
ISO 9393-2	Thermoplastics valves for industrial applications
ISO 7508	Un-plasticized Polyvinyl Chloride (PVC-U) valves for pipes under pressure
ISO 19240	Industrial valves – Lines metal quarter turn and check valves for chemical process and related industries
BS EN 1984	Industrial valves Steel gate valves
EN 593	Industrial valves Metallic butterfly valves for general purposes

Standard	Standard description
BS EN 12288	Industrial valves. Copper alloy gate valves
BS EN 1983	Industrial valves. Steel ball valves

f) Depending on the media transported through the valve, the valve lining must be specified appropriate to the application and may include but is not limited to:

Material	Property considerations
Soft natural rubber	Good in either wet or dry abrasive services, water, and some acids and alkalis. Soft natural rubber has one of the best abrasion resistances when strong chemicals are not present. Temperature -30 to 80°C
Hard rubber	Hard rubber is a good general chemical resistant lining that can be used in slightly higher temperatures than its soft counterpart. Temperature -30 to 90°C
GRAPHITE BASED HARD RUBBER	Graphite hard rubber has a good chemical resistance and at higher temperatures than the normal hard and soft natural rubbers. Maximum temperature 120°C
EPDM: (Ethylene Propylene Diene Monomer)	General purpose material. Excellent chemical resistance to a wide variety of corrosive elements including acids, caustics and hot water. It is abrasion resistant and good for high temperature services. EPDM has poor oil resistance. It is also satisfactory for intermittent steam sterilization. Temperature range -30 to 150°C
Neoprene	Widely used in wastewater applications. A good choice for general purpose chemical resistance where the media contains entrained oils. It also resists aldehydes, certain alcohols, fertilizers, explosives, petroleum, air, acids alkalis, and is abrasive resistant. In most cases it is interchangeable with Buna-N (Nitrile) Rubber. Temperature range -30 to 90°C
BUNA--N: (Nitrile Butadiene Rubber)	A general-purpose oil resistant polymer known as nitrile rubber. It is a copolymer of butadiene and acrylonitrile. Buna-N has a good solvent, oil, water, and hydraulic fluid resistance. It displays good compression set, abrasion resistance, and tensile strength. Nitrile should not be used in highly polar solvents such as acetone and methyl ethyl ketone, nor should it be used in chlorinated hydrocarbons, ozone, or nitro hydrocarbons. In most cases it is interchangeable with Neoprene. Maximum temperature 135°C
Butyl	A good choice for gases because it has a very low vapor and gas permeability. Also good for many acids and alkalis. Good for applications involving steam sterilization. Temperature -28 to 120°C
Chlorobutyl	Chlorobutyl has excellent abrasion and corrosion resistant properties. The maximum recommended temperature for Chlorobutyl is 80°C
Polypropylene	A general purpose lining with good chemical and temperature resistance. Utilized for water treatment, chemical processing, most plating fluids, and steel mill pickling lines, foodstuff, and drinking water. Temp: -20 to 90°C
ECTFE (HALAR): (Ethylene Chlorotrifluoroethylene)	Excellent wear and abrasion qualities, excellent corrosion resistance, low coefficient of friction, and excellent electrical properties. Maximum use temperature 175°C

Material	Property considerations
ETFE (TEFZEL): (Ethylene Tetrafluoroethylene)	Outstanding resistance to chemicals and strong acids. Also has high abrasion resistance for tough services. Below 175°C has no known solvent.
PTFE (XYLAN): (Polytetrafluoroethylene)	Good wear resistance, low coefficient of friction, and fair corrosion resistance. Use Temperature 230 - 260°C
PFA: (Perfluoroalkoxy)	Good wear and abrasion qualities, excellent corrosion resistance, low coefficient of friction, and excellent release capabilities. Max use temperature 270°C
PVDF (KYNAR): (Polyvinylidene Fluoride)	Offers very low permeability. A strong, tough abrasion resistant fluorocarbon material resistant to most acids, bases, and organic solvents. It is ideally suited to handling wet or dry chlorine, bromine, and other halogens. Temperature -20 to 135°C.
FEP: (Fluorinated Ethylene Propylene)	Good wear and abrasion qualities, excellent corrosion resistance, low coefficient of friction, and excellent release characteristics. Max use temperature 200°C
Viton	Offers exceptional resistance to oils, most chemicals and many solvents at elevated temperatures. It can be used in most applications involving mineral acids, salt solutions and chlorinated hydrocarbons. Viton is not recommended for ammonia, its derivatives or polar solvents, e.g. Acetone. -28 to 150°C
Blue glass (CHEM)	Intended for viscous chemical applications such as wastewaters where a smooth lining is necessary to prevent process media from sticking to the walls of the valve.
Green glass (NON-CHEM)	Intended for non-chemical applications such as wastewaters where a smooth lining is necessary to prevent viscous fluids from sticking to the walls.
Polyurethane	Polyurethane has excellent abrasion resistance. Temperature -30 to 65°C
FDA epoxy	Good wear and abrasion qualities, good corrosion resistance. Max use temperature 100°C.
PVC	PVC has resistance to a variety of chemicals including oxidizing acids and provides excellent abrasion resistance. Max use temperature 70°C.

7. Fixings and brackets

- Fixings and restraints shall ensure that the equipment withstands seismic loading without excessive stress or displacement, in accordance with the NZ Building Code and NZS 4219.
- Electrical equipment and instrumentation must not be fixed to handrail systems or pipework.
- Sensor lines should allow for vibration such as with coiled pipe or additional slack to allow for movement.
- Also see section 7 on corrosion control. Care must be taken when selecting dissimilar materials to prevent galvanic action.

8. Dose pumps

a) Chemical dosing pumps shall be a positive displacement type.
b) Minimum turndown of 100:1.
c) Power supply shall be single phase.
d) The pumps shall be capable of providing a flow rates defined in data sheets that must be provided during design.
e) Dosing pumps shall have an analogue input for pump speed control, a stop/start input and a fault signal.
f) Dosing pumps shall be standardised throughout the site where practicable.
g) The pumps shall provide accurate and controllable dosing of each chemical.
h) All wetted materials shall be appropriate for contact with the chemical being pumped.
i) Dosing pumps shall be able to pump degassing liquids such as sodium hypochlorite.
j) Appropriate connection joints from the dosing pump to the suction and discharge pipework shall be included.

9. Corrosion control

a) When selecting corrosion control measures consideration must be given to the micro location of the assets to ensure suitable external coating selection above what is standard provision from the manufacturer.
b) Considerations may include solvents, volatile organic compounds, or inert gasses from adjacent processes that may impact on the corrosion of the assets in another area.
c) Internal corrosion protection for specific media must be considered.
d) The coating specification of any additional corrosion protection measures must be specified following the direction provided in the material supply standard for corrosion protection.