



# Pr9693 - Specification for Mechanical Installations



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## Document details

|                          |   |
|--------------------------|---|
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## 1. Purpose

The purpose of this Specification is to specify the minimum requirements for Unitywater's mechanical equipment to ensure safety, quality of materials, equipment reliability and workmanship.

This Specification defines Unitywater requirements for manufactured mechanical equipment and mechanical installation works at all Unitywater sites.

## 2. Scope

The scope of this Specification applies to complete and partial mechanical design, supply, factory testing and installation works:

- at Unitywater sites
- on behalf of Unitywater
- which will be handed over to Unitywater to own, or
- which will be owned by a third party but will require Unitywater to operate or monitor the asset.

### 2.1 Technical departures

Departures from any requirement of this Technical Standard shall be identified and submitted for review via [F10996](#) - Deviation to Unitywater Technical Specification.

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

The Designer shall not proceed to document/incorporate the non-conforming work before Unitywater has assessed and accepted the proposed action in writing via [F10996](#).

## 3. Planning

### 3.1 Language and Units of Measurement

All drawings and documentation shall be written in English.

The units used throughout the documentation shall be the SI metric system of measurement, in accordance with ISO 80000-1. Where units of another convention are nominated, conversion to SI units shall be made in accordance with the relevant ISO 80000 series.

### 3.2 Documentation

All drawings and documents must comply with [Pr8843](#) - Specification for Drawing, Document and Equipment Tag Numbering; and [Pr9080](#) - Specification for CAD/BIM drafting and modelling standards.

## 3.3 SEQCode compliance and WSAAs specifications

For some assets, there is a requirement to comply with the SEQCode. This specification is in addition to the requirement of SEQ Code. In the event of ambiguity, discrepancy, divergence or inconsistency of technical requirements in or between documents, this document takes precedence over SEQCode standard documents.

## 3.4 Condition Assessments of existing asset(s)

If equipment or materials are to be incorporated into existing assets, upgrade an asset, or replace existing assets, a condition assessment report may be required to ascertain the baseline technical requirements. Refer to [Pr10879](#) - Asset Condition Assessment Framework. The Condition Assessment should be undertaken on representative (exposure) areas or items of equipment as necessary to determine the condition and remaining life (if relevant) of the asset. The outcomes noted in the report may assist in the design of the new asset.

## 3.5 Deliverables from the planning stage

Unless otherwise agreed, Unitywater shall supply to the Designer the essential inputs to be used in design.

The planning phase prepares the design inputs for the subsequent design phase including, but not limited to, the following details:

- Pump or equipment sizing
- Hydraulic profiles
- Material selection
- Equipment selection
- Operational modes
- Operational constraints
- Site constraints
- Staging details
- System characteristics
- Redundancy requirements.

Where these details are provided during planning they should form the basis of design for the mechanical plant and equipment for the works.

The planning phase must consider the operational requirements and provide relevant details of subsequent design and construction phases.

The following should be considered during this phase for further development during design phase:

- lowest lifecycle costing considered
- fit for purpose
- maximise efficiency and capability of the existing assets
- integrate with asset renewals/augmentation/rehabilitation programs
- minimise impact on environment
- sustainability aspirations
- assess maintenance regimes
- review alternate options and assess each option on service requirements and select preferred options
- involve operations and maintenance team members in the decision making process as required.

## 4. Design

### 4.1 General design aspects

#### 4.1.1 Scope of design

The design shall be carried out in conjunction with the Scope of Works or the Principals Project Requirements or any other overarching document that details the specific requirements for the work.

All equipment shall be of a sound and robust design, suitable for the specified capacity or the capacity necessary to achieve the performance requirements and provided with all minor and incidental items for proper functioning of the whole system.

Equipment and components shall be to the manufacturer's normal design for the service specified with readily available replacement parts. Standard replacement parts shall be readily available in Australia.

The designer shall be responsible for assessing the specific operating and maintenance requirements and loadings for each individual piece of equipment or facility.

All rotating machines shall provide a minimum of N+1 redundancy (i.e. minimum 1 standby unit), unless otherwise specified.

The scope of design shall include, but is not limited to, preparation of the following:

- Engineering Report(s)
- Engineering Drawings (General Arrangement, sections and details) – including sufficient detail to:
  - show interface with existing assets and equipment
  - enable coordination with other disciplines
- Vendor drawings, including assembly drawings and other details necessary for successful installation, operation and maintenance
- Technical Specifications and datasheets
- Design Calculations, as required
- Engineering Lists and Registers (i.e. equipment list, valve list, etc.), as required
- Lift analysis and plans (including lifting drawings and studies), as required.

At least the following shall be considered, and associated risks mitigated, in the design of all mechanical systems and equipment:

- Operational site topographical, environmental and seismic characteristics and conditions.
- Operability and maintainability, including safe and efficient means to undertake maintenance while minimising disruption to operations.
- Design capacity and redundancy for continuous operation with minimum downtime to meet prescribed service levels and availability.
- Surge conditions and extreme excursions from the design operating point.
- Robustness, and necessary de-rating, of equipment to meet off design conditions for extended periods.
- Energy efficiency not only at the design point but across the anticipated operational range.
- Starting of equipment under fully loaded conditions.
- Failsafe modes of operation during power outages and safe re-starting modes.
- Standardisation of assemblies and components selected to reduce spare parts inventory.
- Economy in capital and maintenance cost consistent with reliability and reasonable operating cost (minimising life cycle costs).
- Maximising shop fabrication of systems and components.

## 4.1.2 Design review and verification of design

The Designer is responsible for providing a design that is fit for purpose and meets or exceeds the requirements of project specifications, this Specification and other relevant Standards.

Unitywater may carry out a design review for general compliance with this Specification and relevant Australian Standards. A Unitywater review does not imply the design meets all of the requirements of this Specification or relevant Standards.

Full details of design criteria, references, assumptions and details of software used for the design shall be submitted to Unitywater for review during the design process.

All designs shall be design checked or verified. The design verification shall be undertaken by a professional engineer who has RPEQ Registration from the Board of Professional Engineers Queensland, in the category appropriate to the item being design checked or verified.

## 4.2 Site and service conditions

Design and/or selection of equipment and materials shall be governed by the need for long periods of service without frequent maintenance and attention being necessary. All equipment shall be capable of operating over the full operating range, for the given service characteristics, and environmental conditions, for the duration of the design life.

Plant shall consist of standard commercial equipment proven in actual service conditions on similar duties, suitable for the selected service and environments, drinking water, non-drinking water, recycled water, sewage and sludge environments, as applicable.

Particular attention shall be taken in the design to ensure ease of operation, inspection and maintenance, minimisation of corrosion and wear, safety of operation, and cleanliness of the surrounding areas.

At a minimum, mechanical equipment shall be designed to operate in following environmental conditions and appropriate de-rating factors shall be applied:

- Coastal environment, if less than 5km from the ocean
- Wet conditions
- Relative humidity up to 95 %
- Ambient temperature up to 45°C
- Cyclone Region as per AS/NZS 1170.2
- Temperature rises due to solar radiation and heat generated by the equipment itself.

Where equipment is to be subjected to more aggressive conditions, design for those conditions shall be adopted in preference to the above. Where the equipment is to be installed in a wastewater treatment plant or sewage pump station, air can be expected to contain sulphur bearing compounds.

Particular attention shall be paid to high corrosion resistance for all externally mounted equipment. Corrosion resistance and protection shall ensure the life expectancies listed in Table 1 are achieved or exceeded.

## 4.3 Design life

Unless specified otherwise in project-specific documentation, the minimum design life of various mechanical plant and equipment shall be as per Table 1.

Within the design life of equipment, only routine maintenance shall be required, without the need for a major refit or replacement. Where the equipment is in highly abrasive fluid or highly abrasive solids service, replacement of wearing parts within the design life is considered acceptable.

Table 1: Minimum Design Life

| Item                           | Minimum Design Life (Years) |
|--------------------------------|-----------------------------|
| General Mechanical Equipment   | 25                          |
| Penstocks and Stopboards       | 50                          |
| Pipework and General Piping    | 100                         |
| Process Tank – Polymer         | 15                          |
| Process Tank – Stainless Steel | 30                          |
| Process Tank – Steel           | 30                          |
| Process Tanks - GRP            | 15                          |
| Process Tubing – Metallic      | 25                          |

| Item                                     | Minimum Design Life (Years) |
|--|-----------------------------|
| Pumps                                    | 25                          |
| Sewer Pumping Station Discharge Pipework | 50                          |
| Solids Handling and Slurry Pumps         | 15                          |
| Valves                                   | 30                          |

## 4.4 Design loads

Mechanical equipment shall be designed to accommodate the most adverse combination of loading(s) to which it may be reasonably subjected during its design life, without the risk of equipment damage or risk of injury to team members.

Design loads shall include, but may not necessarily be limited to the following:

- Dead loads
- Live loads
- Thermal loads
- Wind loads – including cyclone strength winds on equipment while full or empty
- Earthquake loads
- Pressure-induced loads
- Transient / surge pressures
- Loads applied by machine action (e.g. torque)
- Acceleration or deceleration (inertia) loading (e.g. braking forces)
- Impact loads
- Loading produced by expansion or contraction of materials of construction
- Loading produced by material spillage or abnormal operation (e.g. conveyor spillage onto included walkways, blocked chutes)
- Loading induced by inadvertent closure of upstream or downstream isolation devices (i.e. deadhead of pump)
- Loading produced during the course of plant maintenance (e.g. resting equipment on included platforms)
- Loading occurring during transport and construction.

Mechanical systems and equipment shall be designed in accordance with:

- AS/NZS 1170.0 – Structural design actions – General principles
- AS/NZS 1170.1 – Structural design actions – Permanent, imposed and other actions
- AS/NZS 1170.2 – Structural design actions – Wind actions
- AS 1170.4 – Structural design actions – Earthquake actions in Australia.

Where equipment is driven by a prime mover(s), e.g. an electric motor or other prime driver, it shall be designed to accommodate the maximum torque that the prime mover(s) can produce.

## 4.5 Fatigue

Equipment shall be designed for a fatigue life at least equal to the plant design life when applying maximum operating loads unless otherwise specified or approved by Unitywater.

Design loads for fatigue analysis shall be determined using the minimum and maximum expected loads during typical operation. The loads shall include consideration of any transient conditions such as surge, vacuum, and shock scenarios.

## 4.6 General vibration requirements

Mechanical systems, equipment, pipework and valves shall be designed in a manner as to minimise the transmission of vibration and noise from rotating or reciprocating equipment to other building elements, structures or equipment.

The design and selection of any absorbing or vibration compensating devices / isolators shall suit the equipment and its installation in all operating conditions.

The designer must ensure that the natural frequencies of the complete installed arrangement of any mechanical equipment do not coincide with the rotational frequencies of the machine or with any of its significant harmonics.

The vibration level of any item of equipment or attached pipework shall not exceed Severity Classification 2.8 in accordance with ISO 20816-1 when operating over its full range. Suppliers shall nominate maximum allowable vibration in the equipment data sheets, e.g. drive end and non-drive end, x and y directions.

All rotating equipment, including fans and motors, shall be both statically and dynamically balanced, and installed on foundations or bases specifically designed to accommodate vibration isolators.

## 4.7 General noise requirements

### 4.7.1 General

All mechanical equipment must comply with the objectives, recommendations and requirements of Safe Work Australia, Environmental Protection Act 1994 (EP Act) and subordinate Environmental Protection (Noise) Policy 2019, AS 1055, and AS/NZS 1269.

Where there is a discrepancy between the recommendations or requirements contained in the aforementioned documents, the more stringent recommendation or requirement shall apply.

### 4.7.2 Occupational noise

Noise exposure assessment shall follow the guidelines outlined in the WorkSafe Managing Noise and Preventing Hearing Loss at Work Code of Practice.

All noise generated by equipment, machinery, and systems provided or installed for Unitywater must be controlled to prevent exposing workers or others on-site to harmful noise levels. The maximum exposure limits are:

- LAeq,8h – 85 dB(A)
- LAeq,12h – 82 dB(A)
- Peak sound pressure level must not exceed 140 dB(C)

Furthermore, during regular operation, the sound pressure level produced by any newly installed or altered equipment in the workplace must remain at or below 85 dB(A) LAeq, measured at a distance of one metre from the source.

### 4.7.3 Environmental noise - EPA Compliance

All mechanical equipment must comply with the *Environmental Protection Act 1994* (EP Act) and subordinate legislation including the *Environmental Protection Regulation 2019* (EP Regulation), and the Environmental Protection (Noise) Policy 2019 (EPP). This includes noise limits specified under Unitywater's Environment Authority. The EP Act and associated legislative compliance limits shall take precedence over occupational noise level limits if the regulatory requirements are lower for the proposed installation location.

The noise criteria, noise limits and noise assessments must be determined and carried out in accordance with the EPP.

Both the health and wellbeing, and the amenity noise criteria as per the EPP must be considered. The noise criteria must be met at all site boundaries.

Refer to [Pr10753](#) - Environmental Noise Management Procedure for additional requirements. Noise Control

Controls shall be implemented for noise emission of completed works to achieve the maximum noise level permitted by conditions of any statutory approvals that apply to the operation of plant and equipment and are in accordance with Unitywater's [Pr8184](#) - Noise Management Procedure (WHS noise levels).

Equipment and systems which do not meet these requirements on site testing may be rejected.

## 4.8 Design for safety

Systems shall be designed and constructed as far as reasonably practicable, to protect against foreseeable misuse and damage to the facilities and equipment, and injury to personnel. The design shall consider the safe operation and maintenance of the installations over the duration of the nominated asset life without need of rehabilitation.

During design of the system, a Safety in Design process in compliance with [Pr8187](#) - Safety in Design Procedure and [Pr10883](#) - Safety in Design Guidelines shall be incorporated to ensure safe design with full facility life cycle and function. The design process shall follow a structured approach to identify and document all potential safety risks associated with the proposed system in accordance with relevant acts, regulations, Australian standards and industry codes of practice.

Due consideration shall be made in the design of the equipment to simplify installation and future maintenance operations. Particular attention shall be paid to large items that may require manual handling to remove or replace in the future.

## 4.9 Lifting facilities

### 4.9.1 Provision for handling equipment

All heavy equipment items supplied to Unitywater shall have provision for lifting, slinging and handling during installation and overhaul or maintenance.

All tare mass of equipment exceeding 50 kg and normally lifted during periods of maintenance shall be marked in accordance with AS 4991.

Certified eyebolts and lifting points shall be provided where necessary to facilitate handling and overhaul of the various parts of the equipment.

### 4.9.2 Lifting equipment

All equipment shall be readily accessible for removal. Lifting gear, either fixed or portable, shall be provided as appropriate. All lifting points and appliances shall comply with the relevant Australian regulations and standards.

All supplied lifting equipment shall be clearly marked with the Safe Working Load in accordance with AS 2549 and AS 4991, with lettering that can be read easily from the nearest normal working platform or floor.

An original Certificate of Test and Examination signed by the person doing the test and examination in accordance with AS 2549 and AS 4991 shall be provided for all lifting equipment.

All temporary lifting devices such as davits shall be load tested in their location of use and certified accordingly. Supports for such devices shall be designed such that overall deflection (including that of the support) remains within prescribed limits.

All permanent lifting equipment must be registered with Unitywater. When advised of new plant installation, Unitywater will advise a suitable plant identification number for stamping, printing, or otherwise fixing to the equipment after the completion of site testing.

### 4.9.3 Eyebolts and lifting lugs

All equipment shall be fitted with such permanent eyebolts, lifting lugs or jacking points as are required to install, remove, and maintain the equipment or components. These attachments shall be located such that equipment is balanced and stable during lifting and placement. The lifting points shall be clearly marked.

Where equipment is fixed to a baseplate and both the equipment and baseplate are fitted with lifting lugs, only the lifting lugs fitted to the baseplate shall be used for lifting the baseplate and fixed equipment. The lifting lugs provided on the equipment shall not be used to lift the fixed equipment and baseplate together.

## 4.10 Access to equipment

### 4.10.1 General

All equipment shall be located and installed so that it is readily accessible for operation and maintenance. All indicators and gauges shall be in easy-to-read locations.

All platforms, walkways, stairways, ladders, and handrails shall be designed and supplied in accordance with AS1657, [Pr9903](#) - Specification for Building and Structural Works, and [Pr9821](#) - Specification for Reservoir Design and Construction, as applicable.

Valves, actuators, pumps, drives, instrumentation, manual controls and other equipment requiring access shall be accessible from ground level or from permanently installed access platforms or pits where operation and maintenance can be readily carried out without the use of any ladders, scaffolding etc.

Equipment mounted in or above vessels shall be easily and safely accessible without the need for use of an elevated working platform or similar temporary platform access.

Access to equipment shall be designed to reduce risks as far as is reasonably practicable. In recognition of spatial constraints, the preferred means of access is listed in Table 2 unless otherwise specified.

Table 2: Access preferences

| Location                         | Preferred Access                        | Material [Note 1]                      |
|----------------------------------|---|--|
| <b>General workspaces</b>        | Stairs                                  | Aluminium                              |
| <b>Reservoirs – Refer Pr9821</b> | External – Stairs<br>Internal – Ladders | External – Aluminium<br>Internal – FRP |
| <b>Treatment Plants</b>          | Stairs                                  | Aluminium or FRP                       |
| <b>Sewage Pump Stations</b>      | As per SEQ Code                         | As per SEQ Code                        |
| <b>Pits</b>                      | Ladders                                 | Aluminium or FRP                       |
| <b>Surge Vessels</b>             | Stairs                                  | Aluminium                              |
| <b>Odour Control Systems</b>     | Stairs                                  | Aluminium                              |

**Note 1:** Where access structures may be exposed to corrosive atmospheres, materials or chemicals (including those located in chemical bunds), the material and/or corrosion protection shall be suitably selected in consideration of material/chemical compatibility and durability, to ensure the design life is achieved.



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### 4.10.2 Void protection and fall arrest systems for pit openings

All openings on pits such as pump station wet-wells, dry-wells, valve chambers, etc. with access covers shall be fitted with void protection systems.

The void protection system shall include the items outlined in Table 3.

Table 3: Void protection requirements

| Void Protection Equipment                       | Requirements  | Design Reference  |
|---|---|---|
| <b>Hinged aluminium safety grille</b>           | A safety grille is required on openings used for routine inspection or cleaning of the pit area, where personnel entry into the pit is not required, e.g. pump station wet-wells, dry-wells, reservoir access covers, as a minimum. | Refer SEQ-SPS-1304 series drawings for grille details                       |
|   | A safety grille is not required on openings used only for infrequent maintenance activities, such as valve pits or maintenance holes, etc.  |   |
| <b>Railsafe post inserts</b>                    | Post inserts required for a temporary barricade around square or rectangular pit openings with a depth greater 1500 mm. Posts and handrails to be supplied by others.   | Refer SEQ-SPS-1300 series drawings for positioning of Railsafe post inserts |
| <b>Recessed davit base for a portable davit</b> | Flush floor-mounted davit base required to service the opening. A cap is required on certain models to plug the davit base. Davit to be supplied by others.   | Refer SEQ-SPS-1300 series drawings for positioning of davit bases           |
| <b>Fall arrest anchor point</b>                 | Platforms, walkways, open flooring, stairways and handrails Anchor point required for attaching safety lanyard when personnel are working around the pit opening.   | Refer SEQ-SPS-1300 series drawings for positioning of anchor points         |

### 4.10.3 Spacing between equipment

Plant and equipment (including any plinths or other supporting structures) shall be positioned with consideration to operating and maintenance access. In the selection and placement of equipment, access and egress requirements shall be maintained in accordance with WHS Regulation section 40. WorkSafe QLD provides additional guidance on minimum regulatory requirements under section 274 of the *Work Health and Safety Act 2011*, refer Managing the work environment and facilities Code of Practice 2021.

Clearance requirements for access and maintenance shall be as required by relevant codes and standards, including minimum platform and walkway widths described in [Pr9903](#) - Specification for Building and Structural Works and AS 1657. Clearance requirements shall not, in any case, be less than the clearances nominated in Table 4.

Table 4: Minimum Clearance Requirements for Equipment Spacing

| Access   | Minimum Clearance |
|--|-------------------|
| Main access – building or enclosure entry including fenced compounds | 1.8 m             |
| Operating aisle  | 1.2 m             |
| Maintenance  | 0.6 m             |
| Overhead clearance from ground level                                 | 2.1 m             |

Manufacturer recommendations for equipment access and clearance, including space to facilitate dismantling, removal of components, and maintenance activities, shall take precedence if the recommendation exceeds the requirements of this Specification. No supports, pipework, cables, ducting or any other plant and equipment shall be installed which will obstruct the minimum required clearances.

## 4.11 Preferred equipment and standardisation

Designers should, wherever practical, standardise equipment with similar functions and capacity across the facility. All items of equipment having equal or similar functions shall be of the one manufacturer and of similar appearance, finish, mounting arrangement and other features as relevant to the application.

This approach minimizes the need for spare parts and promotes interchangeability of machinery components.

For guidance, refer to the SEQ Code Accepted Infrastructure Products and Materials (IPAM) lists, which detail the preferred civil and mechanical products and materials by Unitywater. Preference shall be given to Unitywater's [F10975](#) - Preferred WWTP Equipment List for Wastewater Treatment Plant equipment.

Where particular items of equipment to be supplied are not listed on the IPAM lists or other Unitywater preferred equipment lists, they shall meet the requirements of this Specification and shall require the acceptance of Unitywater prior to installation of such equipment. Where this is required refer to Section 2.1. Existing equipment on facilities/sites/plant shall be considered when new equipment is installed to ensure standardisation, however new designs should generally follow the latest Unitywater requirements where practicable.

Where alternatives of equipment are permitted under this Specification and more than one item is to be supplied, all equipment shall be of the same manufacturer and type.

Designs must be carried out as far as practicable using Unitywater's typical drawings where available.

## 4.12 Environmental design aspects

All designs, plant and equipment shall be arranged and implemented as far as practicable to achieve the following:

- Ensuring that regulatory requirements to which Unitywater is obligated to comply with are complied with sustainably.
- Ensuring that life cycle management aspects and related environmental consequences can be sustainably addressed.
- Contributing to carbon footprint and energy cost minimisation.

Considerations for regulatory requirements include design mitigations to prevent any reportable loss of primary containment and ensure environmental discharges are within approved limits.

Chemical systems, including, but not limited to storage units, delivery systems, transfer piping, dosing equipment, and dosing lines up to the point of application, must be designed with a comprehensive containment strategy. This strategy should ensure that any leaks or failures within the system are effectively captured and managed for safe disposal.

All designs must channel any spills or leaks to a designated safe area where they can be properly handled. Additionally, the approach must incorporate suitable locations for both visual leak detection and monitoring at low points within the system. This containment approach must be reviewed and approved by Unitywater prior to being implemented.

Refer to [Pr11053](#) - Specification for Chlorine Dosing Systems Design and Construction and [Pr10852](#) - Specification for Design and Construction of MHL Dosing Systems, as applicable, for further information.

## 5. General installation

### 5.1 Statutory and Regulatory requirements

All works and installation activities shall comply with relevant Commonwealth and Queensland legislation, including but not limited to the *Work Health & Safety Act 2011* and *Electrical Safety Act 2002*, as well as the latest applicable Australian Standards.

Refer to Appendix A - References for requirements relating to legislation, Standards and specifications, and the associated order of precedence that should be applied in the event of a contradiction of technical requirements.

### 5.2 Equipment installation

#### 5.2.1 General

Mechanical equipment supplied shall be new, fit for purpose, and suitable for the application and environment.

Mechanical equipment shall be installed in accordance with this Specification and the manufacturer instructions, and must achieve any performance requirements nominated in project documentation.

At a minimum, the installation works shall:

- Ensure the reliable and efficient operation of the mechanical system over the design life of the equipment.
- Ensuring functional performance and long-term operability of equipment.
- Facilitating safe and unobstructed maintenance access.
- Minimize the need for future realignment.
- Ensuring full compatibility between mechanical, electrical, and civil interfaces.
- Operate within acceptable vibration and alignment limits.
- Remain structurally and dynamically stable under full load.
- Be accessible for inspection, maintenance, and future replacement.
- Be installed with appropriate tolerances, anchors, and corrosion-resistant materials suitable for the process and environment.
- Be compatible with fluids, and other materials and equipment to be used in the works, including material and chemical compatibility.
- Be securely fixed, correctly aligned, and spaced to prevent sagging or overstress.

All installed equipment shall be aligned, levelled, balanced, anchored, and commissioned in a manner that guarantees mechanical integrity under operational loads and conditions specific to the application. This includes proper alignment with process piping and drives, and secure mounting to ensure stability under operating and fault loads.

Equipment shall be installed with due allowance for:

- Thermal expansion and mechanical movement (operational load).
- Dynamic forces (e.g. torque, thrust, hydraulic surge).
- Geotechnical conditions, including settling allowances, where applicable.
- Chemical and environmental exposure.
- Mechanical and electrical separation of services.
- Clearances for maintenance and removal (including future installation).

All installation, including welding, rigging, electrical, and confined space activities shall be performed by competent and suitably certified personnel with demonstrable experience. No on-site hotworks fabrication or solvent welding shall be undertaken unless prior exemption is provided by Unitywater.

All work must be conducted under appropriate supervision and supported by a documented quality assurance process in accordance with [Pr11211](#) - Specification for Commissioning and Handover of Active and Passive Assets. This includes, but is not limited to:

- Inspection Test Plan (ITP)
- Inspection Test Checklists (ITC)
- Non-Destructive Testing (NDT) results and reports.

All the relevant certification, inspection reports and compliance documentation must be provided as part of the equipment supply package.

Valves and manual controls shall be located so that no part of a valve or control in any way constitutes a hazard to team members. There shall be no encroachment on recognised walkways or areas set aside for maintenance. Refer to Section 4.10 for access requirements.

All equipment shall be readily accessible for removal and be fitted with appropriate and readily identified lifting points. Refer to Section 4.9 for lifting requirements.

All equipment shall be capable of being isolated for maintenance or removal with minimal interruption to process flows.

Where equipment or machinery is required to be assembled outdoors, it shall not be carried out in wet or dusty conditions unless the work area is suitably protected. Where equipment is buried and flanges, fittings, and/or threaded fixings are exposed to the surrounding media, they shall be wrapped with polyethylene sleeving (200µm) colour aligned to the carrier service or a suitable petrolatum tape system e.g. 'Denso' or approved equivalent. Where the fixture is a Gibault or dismantling joint, the entire assembly shall be wrapped. Petrolatum wrapping of plastic fittings (including polyethylene and PVC) is not permitted in drinking water applications.

Where necessary equipment which has been installed and run for commissioning, torque of hold-down bolts shall be checked and bolts re-tightened where necessary. The torque required and, where necessary, order of bolt tightening and interval for periodic checking of bolt tightness during normal service shall be documented on flange management sheets with torque intervals specified by manufacturer, with details provided in handover documentation. The torquing equipment shall be calibrated within the last 12 months, and have a validation certificate.

Equipment installation shall be in accordance with the manufacturer's certified drawings, tolerances for both alignment and level, and all general and specific installation instructions necessary to ensure the correct and successful installation of all materials and equipment.

All applicable equipment (e.g. reduction gearboxes) shall be flush thoroughly with approved flushing oil, in accordance with the manufacturer's recommendations. The flushing procedure shall include, where possible, the manual rotation of equipment to ensure complete penetration. On completion of flushing, the flushing oil shall be completely removed prior to first fill with the manufacturer recommended operating oil. Flushing oil, once used, shall not be re-used.

Some mechanical equipment may need to be bonded to the electrical earth grid as per the requirement of [Pr9380](#) - Specification for Electrical Installations at Network Sites or [Pr9835](#) - Specification for Electrical Installation at Treatment Plants. Where bonding to earth is required, suitable holes or fixed bolts are to be provided on frames and/or the body of the equipment.

All materials in contact with drinking water shall comply with the requirements of AS/NZS 4020.

## 5.2.2 Keys and key-ways

All keyed connections for rotating equipment shall be installed in accordance with the manufacturer's drawings and shall comply with applicable Standards (e.g. BS 4235-1 or BS 4235-2). Keys shall be properly fitted to ensure secure torque transmission, with no excessive play. Taper or gib-head keys shall be seated correctly and oriented for safe removal where required.

## 5.2.3 Baseplates and mountings

All plant items shall be delivered to site with the necessary support fixings and anchors.

Equipment foundations shall be constructed and finished in accordance with AS 3600 (Concrete Structures) and/or AS 4100 (Steel Structures) and include provision for non-shrink grouting using materials in accordance with [Pr9903](#) - Specification for Building and Structural Works. Anchors shall comply with AS 5216.

All supports, holding down details and fixings for plant and equipment shall be provided to ensure that all plant, equipment, mountings, supports and concrete plinths (where suitably designed and constructed) can withstand the specific design loads.

Where separate components/items of interconnected plant depend on correct alignment for satisfactory operation each item shall be positively located by machined spigots or by dowels or pins after alignment.

Inertia blocks shall be provided and fitted where required and shall be mounted on appropriately supported spring mountings. Inertia blocks shall be designed and mounted to suit the static and dynamic loadings transferred from the equipment to its mountings and its operational characteristics in the most extreme operating condition.

Plinths for the mounting of equipment, formed of concrete, shall extend no less than 75 mm beyond the edge of the extremity of the equipment. Surfaces shall be shaped and shall be graded to drain, where appropriate.

All baseplates, pipe supports, and other items fixed to the concrete foundation shall have straight smooth sides. Bases shall have bevelled or rounded edges and corners.

Where baseplates, supports and other items are installed with channel mounting systems e.g. 'UNISTRUT' the base channel material shall be Stainless Steel (316) or Marine Grade Aluminium. Galvanised mild steel shall not be used.

Baseplates shall have sufficient rigidity to support the equipment mounted on it during handling (where applicable) or use, without distortion or deflection that could permanently damage the equipment or baseplate. Eye bolts or holes shall be provided for lifting the complete assembly on the baseplate in addition to lifting facilities on the individual components. The entire assembly shall not be lifted on component lugs other than those on the baseplate itself.

Baseplates for motor driven plant shall rigidly hold both the driver and driven units. Sub-baseplates shall be welded to the main baseplate. Fixing systems provided with baseplates shall be designed for taking up adjustment necessary to compensate for coupling alignment and wear during normal service.

Baseplates shall be hot dip galvanized per the requirements of System 24 (Section 10.4.1), as a minimum, with additional protective coating systems required on a case-by-case basis, including cases where elevated corrosion conditions exist (i.e. hydrogen sulphide atmospheres). Alternative baseplate material may be accepted on a case by case basis if required based on exposure to environmental conditions.

Provision shall be made on all baseplates to enable them to be completely filled with grout after installation. Equipment mounted direct to concrete slabs or plinths shall have not less than 20 mm nor more than 35 mm of non-shrink flowable grout.

Where the baseplate design may result in trapped air pocket during grouting, air vent holes shall be provided to allow air to escape. Baseplates shall be shimmed or held firmly in position by double nuts before grouting.

Installed equipment which has been grouted shall not be run or operated within the recommended curing period for the grout.

Flexibly mounted equipment shall be provided with suitable snubbers with resilient surfaces to limit seismic movement.

## 5.2.4 Frames

All bolt holes in steelwork shall be a distance of not less than 1.5 times the hole diameter from the nearest metal edge, unless otherwise specified.

These shall be used in conjunction with levelling nuts or packers during equipment installation. Separation of dissimilar metals shall be completed to prevent possible galvanic action.

Holes in fabricated frames shall be formed by drilling or punching only. Thermal cutting methods, including flame cutting or plasma cutting, shall not be used for hole formation to ensure material integrity, dimensional accuracy, and fatigue resistance are maintained.

Any holes drilled after fabrication shall be repaired in accordance with a manufacturer-accepted process, with minimum requirements as per clause 8.2 of AS4680.

Hollow-section frame members shall be fully sealed to prevent moisture ingress. Weep holes, and holes for draining and venting during the hot dip galvanising process are acceptable. Hollow-section frame member used in submerged equipment shall be provided with access for periodic inspection of welded joints.

## 5.2.5 Packers and shims

Shims used for levelling of mechanical equipment shall be made from stainless steel (Grade 304 or 316), unless otherwise specified. Shims shall be flat, uniform in thickness to suit application, and free from rust, burrs, or deformation. Each shim shall support at least 75% of the full contact area of the equipment foot to ensure uniform load distribution and to prevent point loading.

Plastic or composite shims (e.g. PTFE or HDPE) may be used only for non-load-bearing applications and where galvanic isolation is required.

All exposed machined surfaces (e.g. flange faces, shaft ends, and mounting pads) shall be coated with a suitable corrosion-inhibiting compound to prevent oxidation prior to final assembly or startup. The corrosion-inhibiting compound shall be compatible with materials and easily removable prior to mating or operation.

## 5.2.6 Tolerances and alignment

Installation tolerances for rotating and coupled mechanical equipment shall meet or exceed the equipment manufacturer's tolerances.

All identical parts of plant shall be manufactured to such tolerances as to ensure that they are fully interchangeable.

All tolerances must be verified by calibrated tools, i.e. dial indicator, laser alignment tools, or equivalent certified methods during commissioning and recorded in commissioning documentation. Installed equipment shall not exhibit unacceptable movement, excessive noise, or undue vibration under any operating condition.

## 5.3 Workmanship and welding

### 5.3.1 General

Workmanship shall be of the highest standard consistent with recognised industry best practices. The following shall apply:

- All work shall be performed by competent personnel under appropriate and suitably qualified supervision.
- Appropriate tools, torque settings, and lifting methods shall be used at all times.
- Fabrication, assembly, and installation shall be carried out in a manner that prevents damage, misalignment, or contamination of components, including damage to corrosion protection coatings, sealing surfaces, or mating components.
- Threaded and flanged connections shall be installed with appropriate sealing compounds or gaskets per manufacturer recommendations.
- All surfaces shall be clean and free of burrs, sharp edges, or foreign materials at handover.
- Welds shall be executed in accordance with AS 1554 (Structural Steel Welding) and where applicable, visually or non-destructively tested to ensure compliance with [Pr9903](#) - Specification for Building and Structural Works.
- Welded components shall be stress relieved prior to machining.
- Defective work shall not be repaired by welding, filling, plugging or any other process unless written permission is granted by Unitywater.

### 5.3.2 Approved applicators

Surface preparation and coating application shall be undertaken by an appropriately skilled Applicator. The Applicator shall demonstrate that its personnel have the required industry certification, training, track records and equipment in applying the nominated product. Unless otherwise accepted by Unitywater, the Applicator shall be accredited to a recognised protective coating application scheme to the class relevant to the work to be undertaken. In addition, where the work involves the maintenance or removal of coatings containing lead compounds or other toxic substances, it shall be undertaken to the requirements of AS/NZS 4361.1. All coating applications must be completed in accordance with Section 10 of this document.

### 5.3.3 Qualifications of welders

The Constructor shall ensure only qualified and competent personnel carry out welding work and, where necessary to meet Australian Standards, carry out non-destructive testing. Any periodic non-destructive testing and its interval, deemed necessary during normal operation of the equipment shall be advised by the Constructor.

Qualification requirements for welders are described in [Pr9903](#) - Specification for Building and Structural Works.

### 5.3.4 Independent Quality Control Inspector/Technical Support

Subject to the project size and complexity and at Unitywater's discretion, an approved Independent Quality Control Inspector shall be appointed by the Constructor for the works.

The Independent Quality Control Inspector shall witness and monitor operations to ensure that they meet the specified requirements and standards, inspect, test, or measure materials to the prescribed criteria or standard, and audit the Constructor's quality documentation. The Constructor is not relieved of its own Quality Assurance/Quality Control and remediation / coating system performance responsibilities.

The Independent Quality Control Inspector shall be a professionally qualified person with no less than 5 years experience and hold the following appropriate current certifications for the relevant scope of services or Unitywater's agreed alternative, for the works they are responsible for inspecting. If the Independent Quality Control Inspector is an Engineer, they must be a certified RPEQ.

### 5.3.5 Pipe welding

See Section 11.8.8 for requirements.

## 5.4 Installation in hazardous areas

Where equipment is located in a Hazardous Areas as classified by the AS/NZS 60079 series, equipment shall be installed to comply with AS/NZS 60079.14, with verification by EEHA-certified inspectors per AS/NZS 60079.17. This includes the appropriate selection, installation, and maintenance of all equipment and components to suit the hazardous area classification.

All mechanical and electrical equipment intended for use in hazardous areas shall be certified for the Zone classification (e.g. Zone 1 or Zone 2) as defined in AS/NZS 60079.10.1.

Equipment enclosures, seals, and materials shall be selected to ensure no ingress of flammable substances or vapours and rated for corrosion resistance as per AS/NZS 60079.31.

All equipment within hazardous zones must:

- prevent ignition sources during normal and fault conditions
- be rated to comply with the relevant protection class according to the application environment
- be installed and maintained to preserve the integrity of Ex protection methods
- hazardous area installations shall be inspected and verified by a qualified hazardous area assessor before commissioning, in accordance with AS/NZS 60079.17.

Hazardous area documentation shall be in accordance with AS/NZS 60079 and [Pr11211](#) - Specification for Commissioning and Handover of Active and Passive Assets and include the following at a minimum:

- hazardous area verification dossier
- equipment certification and conformity documents
- hazardous area drawings showing zone extents and classification
- hazardous area classification report.

Where a site already has Hazardous Area equipment, the new equipment shall be incorporated into the existing site documentation and the impact of the Hazardous Area equipment shall be considered for the entire site and not just the area it is installed in. New equipment shall use Unitywater's standard Hazard Area Dossier templates where available.

If a site does not have any existing Hazardous Areas, Unitywater's standard Hazard Area Dossier templates shall be used.

The installation and maintenance of equipment located in hazardous areas shall only be carried out by personnel who fulfil the hazardous area competencies as outlined in AS/NZS 4761.1.

## 5.5 Shipping and handling protection for equipment

All equipment shall be suitably protected in accordance with the manufacturer's recommendations to prevent foreign substances from entering the working parts and to prevent damage during transport, loading and unloading, and off-site or on-site storage.

Materials and equipment shall be secured rigidly in water-proof crates suitable for open air storage. Crates shall be constructed so as to be easily handled by forklift and by slings. Lifting points and orientation shall be clearly marked.

Suitable blocking straps and skids shall be provided to protect the equipment from damage in transit.

All crates or packages shall have the gross weight painted thereon in a conspicuous location (as an aid to the receiver in providing proper handling facilities).

Prior to dispatch from the manufacturer's premises, rotating equipment shall be fitted with individual anti-brinelling clamps to prevent both axial and radial movement of shafts during transport. The manufacturer shall advise when, before or after installation, such clamps can be removed.

Nozzles on all equipment items such as tank connections, suction and discharge nozzles and pipe ends shall be protected using timber or plastic covers and securing bolts or tape to prevent entry of foreign bodies into the relevant equipment. Where equipment is packed in robust closed shipping crates, nozzle covers are not required.

All gasket surfaces, flange faces, tube holes and tube ends shall be thoroughly cleaned and greased and protected with suitable wood, metal or other substantial covering to ensure their full protection.

All exposed threaded parts shall be greased and protected with durable caps or covers appropriate to the environment, such as metallic or heavy-duty non-metallic types.

All female threaded openings shall be closed with tight fitting plastic closures unless otherwise specified. Where equipment is packed in robust closed shipping crates, closure plugs are not required.

Should special lifting frames or beams be required for installation purposes, these, and their instructions for correct use, shall be supplied.

Pipes, fittings, pipeline materials and equipment shall be stored, transported and handled with care. Adequate precautions shall be taken to maintain the circularity of the ends of all pipes to ensure watertight joints when assembled. Slings, hooks and lifting appliances shall be of the correct type as recommended by the manufacturer. Items shall be stacked safely, off the ground on timber or polystyrene blocks.

All gaskets shall be stored in a cool, dry place away from direct sunlight.

At the works and on site, all mechanical components and structural steelwork shall be stacked clear of the ground so that the collection of water in troughs, pockets and the like is reduced to a minimum. Parts which can be damaged by rain shall be stored under cover.

Any item of equipment that has been exposed to weather, flooding, excessive heat, physical impact, or other forms of misuse or neglect may be rejected by Unitywater.

## 6. Nuts, screws, washers, bolts, fixings and fasteners

All bolts, screws, studs, nuts and ISO metric hexagon lifting clamps shall be manufactured from grade 316 stainless steel, unless noted otherwise.

All bolts, screws, studs and nuts shall comply with AS 1111.1, AS 111.2, AS 1112.1, AS 1112.2, AS 1112.3 and AS 1112.4, including thin nuts, slotted nuts and castle nuts. Self-tapping screws shall comply with AS 3566.1 and AS3566.2.

All plain washers shall comply with AS 1237.1 and AS 1237.2.

All dowels shall be manufactured from a suitable grade of steel or stainless steel. The material selection shall be suitable for the environmental exposure it is subjected to, inclusive of any potential interaction with process medium.

Nickel-based galling prevention compounds shall be applied to all metallic threads prior to assembly. Where in contact with drinking water, food grade anti-galling compound is to be used in line with AS/NZS 4020.

Flange bolting shall be in accordance with AS 2528. Stud bolts shall not be used unless required for tapped holes.

Blind rivets shall only be used where nuts, bolts and screws are not practicable, and shall comply with IFI-505:1999 "Metric Break Mandrel Blind Rivets".

The hold-down requirements and fixing points must be confirmed with the supplier. The supplier shall also provide specifications for all anchor bolts, nuts and washers for the equipment supplied.

The minimum size of fixings and fasteners shall be M12 on all items other than proprietary items such as gearboxes and motors.

Each bolt and nut shall be assembled with one washer which shall be placed on the surface against which the stationary component is to be tightened. Tapered washers shall also be fitted, where necessary, to ensure full-face contact.

Where short and long slots are used in equipment, a hardened steel plate and washer shall be used to minimise deformation when tightened. For oversized and short slotted holes a plate washer is required to fully cover the hole such that the minimum distance from the edge of the slot to the edge of the plate is 0.5 times the bolt diameter. For all structural steel work any oversized or slotted holes shall comply with AS 4100.

On fixings and fasteners that may be subject to vibration, an approved method of locking shall be incorporated. Anchor bolts for vibrating equipment installation shall follow manufacturer's specifications and instructions. In the absence of an appropriate manufacturer's specification and instructions, the bolts should have a minimum length of 300 mm and shall be designed to be epoxy fixed into a hole drilled into the concrete. Epoxies exposed to potable water shall comply with AS/NZS 4020. Plant hold-down bolts shall have double nuts; machinery shall have nylon lock nuts, locking tab or spring washer.

Care shall be exercised when installing fixings and fasteners so as not to damage any thread or protective coating. Should any such damage occur, the fastener or fixing shall be replaced or the protective coating repaired as required.

All bolts shall be of a length such that when assembled and fully tightened, the nut shall be totally engaged, but with no less than three threads and no more than five threads protruding.

Stainless steel fixings and fasteners shall be used for the fixing of demountable galvanized or aluminium parts.

Where dissimilar metals may come into contact, the surfaces shall be kept from direct metal to metal contact. Isolation on such demountable items can be made by use of PTFE gaskets, high strength phenol washers, fibre or nylon insulating washers, or other Unitywater approved method of isolation. Where it is not practicable to fit an insulating washer under the fastener head (e.g. countersunk screws securing an aluminium plate) the thread and head of the fastener shall be coated with an approved suitable anti-corrosive jointing compound upon assembly.

Equipment bolted to frames and structures shall have the bolt heads on top of the connecting components, so that the bolts will not drop out of the holes whenever a nut works loose.

Drilling of bolt holes shall be accurate and any slight misalignment in the matching of holes may be corrected by reaming. Drifting to enlarge or draw unfair holes will not be permitted.

Where anchor bolts are required for fixtures to previously completed concrete work, details of the proposed chemical or mechanical masonry anchors or block-outs shall be submitted to Unitywater for approval.

## 7. Plant and equipment identification and labelling

### 7.1 General

All plant and equipment shall be provided with a manufacturer nameplate and site-specific identification tag.

Labelling and identification tagging of equipment, services (pipework, ductwork, etc.) and other associated plant items shall be in accordance with AS 1319, AS 1345 and [Pr8843](#) - Specification for Drawing, Document and Equipment Tag Numbering.

All labels and identification shall be in English.

### 7.2 Manufacturer nameplates

All equipment shall be provided with permanently fixed nameplates and tag plates of engraved stainless-steel Grade 316. Fixings shall be durable, and of a similar material as the label or nameplate to prevent galvanic corrosion. Adhesive nameplates or labels shall not be used unless otherwise approved. All labelling shall be plainly visible at the angle from which the equipment is likely to be viewed.

Nameplates on mechanical equipment shall show all information necessary for the proper identification, servicing, maintenance and operation of equipment and shall include the following information where applicable:

- Manufacturer's name, model number, size and serial number
- date and country of manufacture
- impeller or rotor type, size and reference number
- rotating equipment speed (rpm), rated and maximum
- direction of rotation and/or flow
- warning notices
- temperature limits
- weight (dry or wet but this must be specified)
- machine bearing identity drive end and non-drive end.

#### 7.2.1 Pipes

Identification lettering and banding for pipes and services shall be applied in accordance with AS 1345:

- For buried and concealed runs (including in floors and walls) – at the points where the service disappears/reappears.
- For concealed runs in ceiling spaces – at least once.
- For exposed runs – at least once.

The identification on the band shall consist of indelible stencilled lettering 25 mm high.

The direction of flow in pipes and ducts shall be appropriately indicated by an arrow of length 3 x diameters of pipe and its insulation. Adhesive labels are acceptable.

Where these services are required to be painted, the identification band colour shall extend throughout the length of the service.

Colours, letters, arrows and labels shall be plainly visible at the angle from which the works are most likely to be viewed.

## 7.2.2 Motors

All motors shall also be fitted with engraved stainless-steel nameplates fastened to the motor body.

Machines shall have a direction of rotation arrow cast into casing or indicated on a stainless-steel plate mounted on the bearing housing or machine pedestal close to the drive end.

## 7.2.3 Valves

The following lettering shall be cast on the body of the valve, where practical:

- Manufacturer's brand
- valve size and type
- pressure rating.

The cast lettering shall be in legible block type letters and shall be as per AS/NZS 2638.

For buried valves  $\geq 300\text{mm}$ , a metal plate detailing the following information shall be fixed at the surface location:

- valve type
- size DN
- PN rating
- closing direction
- gearbox type
- for primary and secondary input shafts:
  - ratio
  - No of turns
  - Cracking Torque Nm
  - Seating Torque Nm
  - Running Torque Nm
- model and serial number
- Manufacturer
- weight
- date.

## 7.2.4 Pumps

For submersible pumps, a second identical nameplate shall be supplied loose for installation by Unitywater at a suitable location for equipment identification purposes.

## 7.3 Site-specific equipment ID tag

A separate stainless steel equipment tag shall be affixed to the equipment including the following information:

- Tag number in accordance with Pr8843 - Specification for Drawing, Document and Equipment Tag Numbering, in letters not less than 15mm high
- Name of equipment.

Tag format shall be as provided in the equipment schedules and drawings. Sample labels may be requested by Unitywater prior to mass production.

Tags to be deburred, corners radiused and where applicable edges chamfered.

Every instrument shall have a tag stating the Site-Specific Equipment ID tag number securely attached to the body. Tags shall be engraved stainless steel plate.

Note that adhesive style tags are not acceptable.

## 8. Safeguarding of machinery

### 8.1 General

All exposed moving machinery shall be provided with a safeguarding system that shall be designed, manufactured, installed and validated in accordance with the requirements of the AS/NZS 4024. The design of the guarding shall be appropriate for the category of machine being guarded and conform with WorkSafe QLD requirements.

### 8.2 Hazard analysis and risk assessment

During the detailed design, a hazard analysis and risk assessment must be undertaken in consultation with the relevant Unitywater stakeholders. This hazard analysis and risk identification shall determine the approach to the safeguarding system and the category for the safety-related parts of the machinery control system. The safeguarding system shall be designed to satisfy the requirements of the hazard analysis and risk assessment.

The category attributed to the safety-related parts of the machinery control system shall be approved by Unitywater prior to the commencement of the guard design.

## 8.3 Guidelines for safeguarding

Where applicable, fixed (non-interlocking) guards shall be provided:

- to prevent personnel from contact with the hazardous parts of the machine
- where the parts of the machine, to be guarded, do not require access by the machinery operators in order to operate the machine or attend to frequent lubrication, adjustment or other regular duties required to maintain the machine in operation.

Where applicable, interlocking guards shall be provided:

- where operators need to access hazardous parts of the machine frequently in order to operate the machine or perform regular tasks required to maintain the machine in operation
- if operators cannot be protected from risk by fixed guards, keeping hazardous parts out of reach etc.

Indications shall be provided of the status of all interlocking guards and alarms when interlocking guards are open. Where interlocking guards are provided, the machine control system shall include control mode selections for auto, manual and maintenance mode operation as required.

Manual suspension of the stop-function of the movable guards may be necessary where an “inching” mode operation of the machine is required for maintenance while personnel are working with the guards removed. Such suspension of the stop function shall be fully workshopped and accepted by Unitywater prior to construction.

Emergency stop devices shall be provided on all machines in accordance with WorkSafe QLD and the relevant Unitywater electrical Specification ([Pr9835](#) - Electrical Installations at Treatment Plans and [Pr9380](#) - Electrical Installations at Network Sites).

The machinery must be designed to leave the plant in a safe condition in the event of any failure in part of the machinery or its associated safeguards, control circuits or its power supply. The safeguarding system shall include provisions for the isolation and dissipation of all energy sources: electrical energy, fluid pressure, gravity, etc. associated with the machine. For components that may move under gravity, the machine safeguarding system shall include provision to fix the moving parts in a safe position.

Where the machine is part of a process and connected to upstream and downstream equipment and/or materials supplies, the safeguarding system shall include:

- interlocking of upstream processes and equipment to prevent the supply to the machine of materials or energy when the safety related parts of its control system have been activated
- stop function when the safety related parts of downstream processes and/or equipment are activated.

## 8.4 Guards

Guards shall be designed and installed to ensure effective protection from hazardous machine parts. They must be large enough to fully cover the required protection area, allowing operators to view the guarded zone without being able to contact or reach the hazardous parts of the machine, nor reach or climb around the guard to do so. Guard design shall be based on anthropometric data in accordance with AS/NZS 4024.1704.

Guards shall be constructed of rigid, impact resistant, corrosion resistant material and securely fixed either to the machine frame, surrounding fixed surface or floor by fixings of adequate strength, spacing and number to ensure that guards remain secure under any foreseeable loading. Fixing shall be by means of mechanical fasteners or clamps, welded or bonded joints or other means suited to the application. Self-tapping screws shall not be used to secure guards.

Guard assemblies shall be designed in accordance with AS/NZS 4024.1601 and prevent the accumulation of process materials within the guard and allow for easy cleaning. The guard shall be designed and positioned to avoid interference with any moving components of the equipment. Plugged tachometer access holes shall be provisioned for in guards at pulley shaft centres to facilitate maintenance and performance monitoring.

Guards shall be suitable to facilitate manual installation and removal, and shall be hinged where practical. Guides must be easily removable by standard tools for maintenance access. Any single guard panel (dimension or mass) shall not be more than 2.0 metres in length or 16 kilograms in weight. Movable hinged guards or removable sections of fixed guards shall be designed to be of a suitable size and weight to permit ease of handling/operation. If possible, operating forces shall be reduced by the use of springs, counterbalances or gas struts. Movable guards shall be interlocked. All drive guards must be fabricated such that the guards can be removed without disturbing the sensing devices, chain or belt tensioners, field instruments and lubricators.

Guards shall be painted as per the requirements of Section 10.1.2 and 10.4, and a sign shall be affixed to the outside reading "HAZARD – MOVING MACHINERY. Lock guard in place for normal production operation."

Guards attached to equipment handling hazardous substances (e.g. chemical dosing systems) shall be transparent to allow personnel to detect leaks before they are removed/opened.

## 8.5 Fixed guards

Where fixed guards are required the design criteria for these guards shall be as follows:

- Fixed guards shall be provided in accordance with the requirements of AS/NZS 4024.1601 for a Fixed Guard (Non-Interlocking).
- Fixed guards shall be bolted and require the use of standard tools for removal.

## 8.6 Interlocking guards

Where interlocking guards are required the design criteria for these guards shall be as follows:

- Designed in accordance with the requirements of AS/NZS 4024.1601 for an interlocked fixed or movable guard as required.
- Minimum one (1) lockable fastener device on each guard.
- The locking device shall be an electrically interlocked safety latch, arranged with the bolt on the guard and the interlocking keeper fixed to the machine frame and interlocked to the machine control system using a dual output safety relay selected from the [F10678](#) - Accepted Electrical Equipment List.
- An interlocking guard, when unlocked, shall allow as free and unobstructed access as is technically possible to the machine assembly for cleaning and maintenance or other task required.
- The guard assembly when fixed in place shall allow safe and ergonomic access for operating the machine.
- Lubrication points covered by closed guards shall be brought outside the guard by tubing and presented in a logical and labelled arrangement on a lubrication manifold.

## 8.7 Documentation

In alignment with the requirements of AS/NZS 4024.1501, Unitywater requires the submission of documentation detailing the process which was undertaken to determine the selection, design and validation of the safeguarding system. This documentation is to be provided for Unitywater review and acceptance, and shall include, but is not limited to, the following:

- hazard analysis and risk assessment
- determination of the risk reduction provisions
- specification for any safety related parts of the machine control system
- safeguarding design drawings, specifications, descriptions that fully detail the safeguarding system provided
- the safeguard validation process undertaken.

For Unitywater's Safety in Design Procedures and Guidelines, refer to [Pr8187](#) - Safety in Design Procedure and [Pr10883](#) - Safety in Design Guidelines respectively. For further information and details around documentation handover requirements refer to [Pr11211](#) - Specification for Commissioning and Handover of Active and Passive Assets.

## 9. Plant building ventilation

### 9.1 General

Plant building ventilation ductwork, fittings and appurtenances shall be designed, supplied and installed in accordance with AS 4254.1 and AS 4254.2 or SMACNA "HVAC Duct Construction Standards - Metal and Flexible". Where conflicting requirements arise from the use of the above standards, the Australian Standard shall take precedence.

Air intake points are to be positioned strategically along all ventilation ductwork, enclosures and covered areas to effectively collect foul and/or hot air from each location or equipment. Manual dampers shall be provided on the intake points to allow for full control and proper balancing of the ventilation system.

All ductwork must be fabricated from corrosion resistant materials, such as PVC, FRP or grade 316 stainless steel. Fans, dampers and other ventilation equipment shall similarly be constructed from corrosion resistant materials such as plastics or 316 Stainless Steel. Where stainless steel is nominated, spiral welded pipe shall not be used for ductwork containing hydrogen sulphide.

For ventilation specific to Odour Control Units within sewer reticulation network and pumping stations, refer to [Pr10999](#) - Specification for Odour Control Unit Design and Construction (Network).

For all electrical components such as access panels, refer to [Pr9380](#) - Specification for Electrical Installations at Network Sites and [Pr9835](#) - Specification for Electrical Installation at Treatment Plants.

## 9.2 Ventilation fans

For mechanically ventilated systems, a single fan with upstream isolation valve shall be provided. Electrical supply to fans are to be directly from the site switchboard; where this is not possible, Unitywater direction is required and a control panel design may be accepted.

Fixed fans are to be industrial quality and direct driven. Where fan flowrates require limiting or throttling, a VSD shall be installed to control the fan speed.

Fans are to be fitted with a weatherproof shroud, constructed from 3mm marine grade aluminium, powder coated as per the painting system detailed in Section 10.

Fans are to operate within the noise limits stipulated in Section 4.7. Where the noise limit is exceeded, fans shall be fitted with inlet/discharge silencers and/or acoustic enclosures to achieve the noise requirements.

Fans and motors shall be selected such that they are capable of increasing the “as built” system flow rate by 10%. The selected fan shall offer the highest power efficiency at the nominated operating conditions. Fan motors must have non-overloading power characteristics. Performance test curves with the design operating point clearly indicated, shall be provided for each fan and must be incorporated in the Operation and Maintenance Manual. The performance curves must be based on tests carried out in accordance with AS ISO 5801.

Fan bearings shall be sufficiently lubricated. All fan motors shall be provided with grease packed ball or ball-and-roller bearings. All bearings shall be supplied with dust seals.

Fans and associated accessories must be positioned to allow clear access for maintenance, servicing, and removal or replacement of components and assemblies, without interfering with other plant equipment.

Flexible connections shall be provided to prevent vibration transmission to the ductwork. Expansion pieces are required between fans and flexible connections where thermal effects are significant.

## 9.3 Dampers

Dampers shall be provided as necessary to ensure effective balancing of airflow throughout all parts of the system and to enable automatic isolation of non-operational sections.

Dampers must be of rugged, heavy-duty construction, capable of withstanding 2 to 3 times the design airflow and static pressure. They shall operate free of rattles, fluttering, or slack movement and must allow precise adjustment over the required range without generating excessive self-noise or requiring special tools.

All dampers must be installed with suitable access to facilitate inspection, adjustment, and maintenance.

## 9.4 Vibration

All plant building ventilation shall comply with the vibration requirements in Section 4.6.

# 10. Painting and corrosion protection

## 10.1 General requirements

### 10.1.1 Approvals

All coating materials used shall be of the type and quality described herein and shall have Australian Paint Approval Scheme (APAS) approval for the relevant application.

Where this specification is unsuitable for the application, then an equivalent system from WSA 201 Manual for selection and application of protective coatings may be submitted for the approval of Unitywater.

If equivalent products from alternative manufacturers are proposed to be used, then Schedules and data sheets for those products shall be submitted for the approval of Unitywater. If requested by Unitywater, sample panels of any proposed coating system shall also be supplied.

Coating inspection and certification of fabricated equipment and pipework shall be completed by a qualified, experienced and registered third party CIP II (formally NACE II) inspector with a minimum of three (3) years relevant experience.

### 10.1.2 Colour code

Colours for top coats shall be as specified in the table below, or if not specified, as agreed by Unitywater.



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Table 5: Colour code for top coat on corrosion protected equipment

| Item   | Colour   | No. to AS2700 |
|--|--|---------------|
| Tanks  | Sand   | Y44           |
| Valves   | Sapphire   | B14           |
| Pumps  | Sapphire   | B14           |
|  | Ultramarine Blue (RAL 5002) and Gentian Blue (RAL 5010) are accepted as equivalents to AS2700 Sapphire B14 |               |
| Designated spare pumps and ancillary equipment for spare pumps   | Orange   | X15           |
| Blowers, Compressors, including ancillary equipment  | Dark Grey  | N64           |
| Machine Bases  | Mid Grey   | N52           |
| Structural steelwork   | Lightbox Grey  | N33           |
| Bulk mechanical equipment, bridges for settling tanks, gearboxes, general fabrications, etc.                     | Lightbox Grey  | N33           |
| Equipment located in within sight of the general public such as vent poles, OCUs, switchboards and surge vessels | Mist Green   | G54           |
| Cranes and Crawl Beams   | Golden Yellow  | Y14           |
| Protrusions, low beams, trip hazards, etc.   | Black / Golden Yellow stripes  | N61 / Y14     |
| Guards   | Golden Yellow  | Y14           |
| Turning shafts, Couplings, Pulleys, etc.   | Orange   | X15           |
| Electric Motors  | Orange   | X15           |
| Terminal Boxes for Motors  | Orange   | X15           |
| Emergency Stop   | Signal Red   | R13           |
| Firefighting equipment and pipework  | Signal Red   | R13           |
| Handrails, knee rails, stanchions and kickplates   | Golden Yellow  | Y14           |
| Coating required only for steel. Aluminium, galvanized steel and stainless steel to remain uncoated.             |  |               |
| Bollards   | Golden Yellow  | Y14           |

### 10.1.3 Operating conditions

The selection of corrosion protection systems shall be governed by the need for long periods of service without frequent maintenance and attention being necessary. All systems shall be capable of providing protection over the full operating range and plant design life across the range of climatic conditions.

Corrosion protection systems shall comprise standard commercially available materials proven in actual service conditions on similar duties, suitable for service in sewage and sludge treatment processes and environments. Particular attention shall be taken in the design to ensure minimum corrosion and wear of all protected surfaces.

### 10.1.4 Material painting requirements

The following materials shall not be painted (unless noted otherwise). This does not negate the need to have adequate corrosion protection as outlined in Section 10.4.

- stainless steel
- insulated carbon steel piping (prime coated only prior to installation of insulation)
- GRP
- ABS
- PE.

## 10.2 Surface preparation

### 10.2.1 General

All surface defects, including cracks, laminations, deep pitting, weld splatter, slag, burrs, fins and sharp edges shall be removed. Surface defects revealed by the blast cleaning process shall be ground, filled or treated in the appropriate manner.

All edges and corners shall be de-burred to provide smooth, radiused surfaces or similar.

Surface contaminants, such as oil, grease, dirt and loose particles, must be removed in accordance with AS 1627.1 or SSPC-SP1 using a suitable solvent or oil emulsifier/alkaline degreaser as recommended by the coating manufacturer.

Care shall be exercised to protect and prevent damage or contamination of partially or entirely completed portions of the work, machinery, equipment and adjacent areas from overspray, abrasive and other possible damage likely to occur as a result of the work, by the erection of screens barriers, boardings, dropsheets, etc.

### 10.2.2 Abrasive blast cleaning

Surfaces shall be dry abrasive blast cleaned in accordance with AS 1627.4. Surfaces shall be cleaned to Class Sa 2½ (AS 1627.9) or SSPC-SP10, unless noted otherwise in the particular painting system.

The minimum surface profile height shall be 40-75 µm peak-to-valley, or as required by coating manufacturer, but not more than the specified minimum dry film thickness of the primer. The surface profile shall be determined by a Keane-Taylor Surface Profile Comparator for grit blasted surfaces.

Acceptable materials for the abrasive blast are:

- **Metallic:** chilled iron grit. The abrasive shall be angular, free from dust and foreign matter. The maximum particle size shall not be larger than that passing through a 1.18 mm test sieve.
- **Non-metallic (silica free):** aluminium oxide, zircon, rutile, garnet, or crushed hard non-silica containing rocks (e.g. diorite). Abrasives shall be hard and free from clay. Salt contamination shall not exceed 50 parts per million (100 µs/cm). The particle size shall be such that not more than 10% passes a 1.3 mm Australian Standard sieve and not more than 10% is retained on a 1.18 mm Australian Standard sieve. Suppliers shall note the limits placed on any radioactive substances in blast cleaning materials. Where copper slag is used, the surface shall be finished by a final clean-up blast using ilmenite or other approved material to remove traces of copper slag left on the surface.

Immediately after blasting operations and before coating, all surfaces shall be air blown with clean dry air (adequate driers and oil mist filters shall be used in air lines) and vacuum cleaned to remove all blast products and abrasives from the entire surface, giving particular attention to corners, intersections and horizontal areas where settlement of dust is most likely to occur.

All free oil and moisture shall be effectively removed from the air supply lines of all blasting equipment, using adequate approved filters and driers. Free oil and moisture content in the air shall each not exceed 0.5 mg/cubic metre of free air, verification testing to align to ASTM D 4285 "blotter test".

### 10.2.3 Hand and power tool cleaning

The cleaning of metal surfaces with hand and power tools shall comply with the requirements of AS 1627.2.

### 10.2.4 Post cleaning inspection

Cleaned surfaces shall be kept free of all contamination before coating or galvanizing and shall not be touched by bare hands or other bare parts of the body. Any area inadvertently touched by bare parts of the body shall be immediately cleaned again.

All items of metal work to be painted or galvanised shall be so treated not more than four hours after surface preparation of each item has been completed.

Any uncoated surfaces that have been subjected to conditions that might induce condensation of water thereon or that have been left longer than the above specified two hours after blast cleaning shall be again blast cleaned before being coated.

## 10.3 Painting

### 10.3.1 Handling and storage

All coating materials shall be delivered to the site of application in the original unopened containers bearing the manufacturer's labels and instructions and thereafter stored in cool shaded places.

## 10.3.2 Application

All paint and coating materials shall be in a thoroughly mixed condition at the time of application and may only be thinned in accordance with the manufacturer's instructions.

Effective controls shall be established to preclude operations in unsuitable weather conditions. Work shall not be performed:

- on surfaces wetted or likely to become wetted after blasting and before coating
- on surfaces where the surface temperature is less than 3°C above the dew point of the surrounding air
- when the wet bulb temperature in the immediate vicinity shows a difference of <7% from the dry bulb temperature (standard wet and dry bulb thermometer)
- when the extremes of surface metal temperature exceed 40°C or are lower than 10°C.

## 10.3.3 Prime coating

The first coat shall be applied as soon as possible after cleaning the surface, but in any case, not longer than four hours after cleaning.

The coating shall be applied to produce a smooth, even coating free of lumps, ripples, sags, runs, air holes and other defects and imperfections and shall be allowed to dry or harden to the paint manufacturer's requirements before the succeeding coat is applied. All deficiencies and defects shall be corrected.

## 10.3.4 Reinstatement of damaged coatings

Coatings shall be fully inspected and marked-up to clearly identify damaged areas.

Reinstatement of the coating shall be in accordance with the manufacturer's recommendations and shall provide an equal level of protection to the structure as the original coating system.

The reinstatement systems and procedures shall be accepted by Unitywater before being applied.

The repaired areas shall be retested and allowed to cure as specified before placing the finished coating into service.

## 10.3.5 Quality control

The following quality control procedures detailed in Sections 10.3.6 to 10.3.13 shall be performed daily, or at greater frequency as required during and after periods of surface preparation and coating application. The results of the tests shall be permanently recorded.

## 10.3.6 Surface cleanliness

Australian Standard AS 1627.6 shall be used as a guide for assessing the respective degree of surface cleanliness. All surfaces shall be tested.

### 10.3.7 Profile

The profile or Anchor Pattern shall be measured using a Clemtex Anchor Pattern Standard or approved equivalent standard. All surfaces shall be tested with reference to AS 3894.5 Method A or C.

### 10.3.8 Wet film thickness

A comb type Wet Film Gauge shall be used continuously during application to minimise the possibility of low dry film thicknesses.

All surfaces shall be tested with reference to AS 3894.3.

### 10.3.9 Dry film thickness

All surfaces shall be tested to determine the dry film thickness with reference to AS 3894.3.

The thickness of each individual coating and the thickness of the coating system shall be recorded using a suitable non-destructive magnetic gauge producing a permanent (hard copy) printout for each item or structural member.

Instruments shall be calibrated in accordance with AS/NZS 1580.108.1 using non-magnetic shims on polished steel.

Defects are to be marked with school grade chalk, spirit pen, adhesive inspection labels or masking tape; crayon and paint are not acceptable.

### 10.3.10 Identification

The following shall be recorded:

- batch numbers of all coatings
- item numbers coated with each batch
- time and date each item was coated.

### 10.3.11 Pinholes

The dry, fully cured coating shall be checked for pinholes and holidays in accordance with AS 3894.1.

All testing carried out shall be documented and shall be available upon request.

### 10.3.12 Handling and packaging

Suitable precautions shall be taken in bundling, packing, crating and lifting to ensure that the protective treatment is not damaged during handling, transporting and installation. Soft slings shall be used unless adequate lifting lugs/eye bolts have been provided.

## 10.3.13 Reporting

A report of the painting quality control documentation shall also be completed to include, but not be limited to:

- General:
  - names of the company and the responsible personnel
  - dates when work was carried out.
- Materials preparation:
  - equipment and techniques used
  - materials receipt condition.
  - type and calibration of instrument used.
- Environmental conditions:
  - weather and ambient conditions.
- Painting periods.
- Surface preparation:
  - condition of surface before preparation
  - tools and methods used to prepare surface.
- Condition after preparation.
- Paints and painting:
  - information on systems being applied
  - mixing and testing prior to application
  - paint application techniques
  - application rates (actual)
  - atmospheric and environmental conditions during coating applications.
- Testing:
  - type of quality control checks carried out, and results
  - compliance or otherwise with specification.

Reporting shall be in accordance with AS 3894.10 to AS 3894.14.



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## 10.4 Corrosion protection systems

### 10.4.1 Summary table

The corrosion protection systems are summarised in Table 6. Further details are provided in the subsequent sections.

Table 6: Corrosion protection systems

| System | Application   | Coat  | Paint*  | DFT    |
|--------|---|-------|---|--------|
| 1      | Structural Steel – Mildly corrosive environment, not H <sub>2</sub> S, decorative top coat          | 1st   | Intergard 251 Polyamide Cured Epoxy           | 75 µm  |
|        |   | 2nd   | Interfine 629 Anhydride Cured Acrylic         | 75 µm  |
|        |   | Total |   | 150 µm |
| 2      | Structural Steel – Exposed or damp corrosive environment, not H <sub>2</sub> S                      | 1st   | Interzinc 52 Polyamide Cured Epoxy            | 75 µm  |
|        |   | 2nd   | Intergard 475HS Polyamide Cured Epoxy         | 200 µm |
|        |   | Total |   | 275 µm |
| 3      | Structural Steel – Highly corrosive environment, coastal, not H <sub>2</sub> S, decorative top coat | 1st   | Interzinc 52 Polyamide Cured Epoxy            | 75 µm  |
|        |   | 2nd   | Intergard 475HS Polyamide Cured Epoxy         | 250 µm |
|        |   | 3rd   | Interthane 990 Aliphatic Acrylic Polyurethane | 75 µm  |
|        |   | Total |   | 400 µm |
| 4      | Structural Steel – Immersed in sewage, open to atmosphere   | 1st   | Interzone 954 Polyamine Cured Epoxy           | 250 µm |
|        |   | 2nd   | Interzone 954 Polyamine Cured Epoxy           | 250 µm |
|        |   | Total |   | 500 µm |



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| System | Application   | Coat  | Paint*  | DFT    |
|--------|---|-------|---|--------|
| 5      | Steel or Cast Iron – External, not H <sub>2</sub> S, light grey epoxy top coat  | 1st   | Interzinc 52 Polyamide Cured Epoxy            | 75 µm  |
|        |   | 2nd   | Interplus 1180 Epoxy                          | 125 µm |
|        |   | 3rd   | Interplus 1180 MIO N33 Epoxy                  | 125 µm |
|        |   | Total |   | 325 µm |
| 6      | Steel or Cast Iron – External, not H <sub>2</sub> S, decorative top coat  | 1st   | Interzinc 52 Polyamide Cured Epoxy            | 75 µm  |
|        |   | 2nd   | Interplus 1180 Epoxy                          | 125 µm |
|        |   | 3rd   | Interthane 990 Aliphatic Acrylic Polyurethane | 75 µm  |
|        |   | Total |   | 275 µm |
| 7      | Steel or Cast Iron - Highly corrosive H <sub>2</sub> S environment open to atmosphere, pipes internally coated, not potable water | 1st   | Interzone 954GF or Amerlock 400 GF            | 200 µm |
|        |   | 2nd   | Interzone 954GF or Amerlock 400 GF            | 200 µm |
|        |   | Total |   | 400 µm |
| 8      | Steel or Cast Iron – Immersed, internally coated, potable water   | 1st   | Interline 975P Solvent Free Epoxy             | 400 µm |
|        |   | Total |   | 400 µm |
| 9      | Steel or Cast Iron - Highly corrosive environment, damp H <sub>2</sub> S  | 1st   | Interline 984 Epoxy Phenolic                  | 200 µm |
|        |   | 2nd   | Interline 984 Epoxy Phenolic                  | 200 µm |
|        |   | Total |   | 400 µm |
| 10     | Steel or Cast Iron - Highly corrosive environment, damp H <sub>2</sub> S - Rapid application                                      | 1st   | Rust Bullet Industrial urethane coating       | 150 µm |
|        |   | 2nd   | Rust Bullet Industrial urethane coating       | 150 µm |
|        |   | Total |   | 300 µm |



## Pr9693 - Specification for Mechanical Installations

| System | Application   | Coat  | Paint*   | DFT     |
|--------|---|-------|--|---------|
| 11     | Cast Iron Ceramic Coating, for abrasion resistance  | 1st   | Ceramic based two-component epoxy of one colour          | 200 µm  |
|        |   | 2nd   | Ceramic based two-component epoxy of contrasting colour  | 200 µm  |
|        |   | Total |  | 400 µm  |
| 12     | Cast Iron Coating, for erosion-corrosion resistance | 1st   | Hydrophobic two-component epoxy of one colour            | 200 µm  |
|        |   | 2nd   | Hydrophobic two-component epoxy of contrasting colour    | 200 µm  |
|        |   | Total |  | 400 µm  |
| 13     | Steel or Cast Iron - Thermal Bonded Polymer         |       | Thermal-bonded polymeric coating                         | 350 µm  |
| 14     | Steel or Cast Iron - Fusion Bonded Epoxy            |       | Fusion Bonded Epoxy                                      | 350 µm  |
| 15     | Steel Pipes – External Surfaces (Buried)            |       | Sintakote  | 1600 µm |
| 16     | Steel or Cast Iron Pipes – Cement Mortar Lining     |       | Steel or Cast Iron Pipes – Cement Mortar Lining          |         |
| 17     | Electrical Machines                                 | 1st   | Interprime 198 Alkyd                                     | 75 µm   |
|        |   | 2nd   | Interfine 629 Anhydride Cured Acrylic                    | 75 µm   |
|        |   | Total |  | 150 µm  |
| 18     | Electrical Switchgear Cubicles                      | 1st   | Acid wash and Chromate pe-treatment                      | N/A     |
|        |   | 2nd   | Dulux Duralloy powder coating or Taubmans powder coating | 80 µm   |
|        |   | Total |  | 80 µm   |
| 19     | PVC Pipes   | 1st   | Low Sheen Acrylic  | 25 µm   |
|        |   | 2nd   | Low Sheen Acrylic  | 25 µm   |
|        |   | 3rd   | High Gloss Alkyd Enamel                                  | 25 µm   |
|        |   | Total |  | 75 µm   |



## Pr9693 - Specification for Mechanical Installations

| System | Application                                       | Coat  | Paint*   | DFT         |
|--------|---|-------|--|-------------|
| 20     | Minor Metallic Piping Systems – External Surfaces | 1st   | Epoxy Primer   | 30 µm       |
|        |   | 2nd   | High Gloss Alkyd Enamel  | 25 µm       |
|        |   | 3rd   | High Gloss Alkyd Enamel  | 25 µm       |
|        |   | Total |  | 80 µm       |
| 21     | Stainless Steel Surfaces                          |       | Stainless steel components pickled and passivated to ASTM A 380/A380M                    | N/A         |
| 22     | Stainless Steel Surfaces, electropolished         |       | Stainless steel components with electropolished finish                                   | N/A         |
| 23     | Stainless Steel – External, decorative top coat   | 1st   | Interbond 2340 UPC alkylated amine epoxy   | 150 µm      |
|        |   | 2nd   | Interthane 990 Aliphatic Acrylic Polyurethane  | 75 µm       |
|        |   | Total |  | 225 µm      |
| 24     | Hot-dip Galvanising                               |       | Hot-dip Galvanising  | To standard |
| 25     | Electroplated Metal Coatings                      |       | Electroplated coatings, Nickel, Chromium or Zinc   | To standard |
| 26     | Wax-based anti corrosion coating                  |       | Wax-based, general purpose, corrosion preventive compound, Tectyl 506 or equal approved. | 300 µm      |

\*Where brand names are used in this Specification, equivalent paints may be used subject to approval by Unitywater.

### 10.4.2 System 1: Structural steel – Mildly corrosive environment, not H2S, decorative top coat

**Applicability:** This system is for the painting of structural steelwork in mildly corrosive conditions without H2S (AS/NZS 2312 atmospheric corrosivity category A) and where non-chalking or specific colour top coat is required.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification.

- **1st Coat:** Two component epoxy primer containing zinc phosphate pigment (Intergard 251 or approved equivalent) to a minimum dry film thickness of 75 µm.
- **2nd Coat:** Two pack high gloss acrylic (Interfine 629 or approved equivalent) finish to a minimum dry film thickness of 75 µm.

### 10.4.3 System 2: Structural Steel – Exposed or damp corrosive environment, not H2S

**Applicability:** This system is for the painting of structural steelwork in exposed or damp conditions without H2S which can be abrasive blast cleaned (AS/NZS 2312 atmospheric corrosivity category C).

**Surface Preparation:** Oil or grease shall be removed in accordance with AS 1627.1 or SSPC-SP1 and abrasive blast cleaned to Sa 2½ (AS 1627.9) or SSPC-SP10. If oxidation has occurred between blasting and application, the surface shall be reblasted to the specified visual standard. Surface defects revealed by the blast cleaning process shall be ground, filled or treated in the appropriate manner.

- **1st Coat:** Two component metallic zinc rich epoxy primer (Interzinc 52 or approved equivalent) to a minimum dry film thickness of 75 µm.
- **2nd Coat:** Two component, high build, high solids epoxy (Intergard 475HS or approved equivalent) to a minimum dry film thickness of 200 µm.

### 10.4.4 System 3: Structural steel – Highly corrosive environment, coastal, not H2S, decorative top coat

**Applicability:** This system is for the painting of structural steelwork in high corrosivity conditions without H2S which can be abrasive blast cleaned (AS/NZS 2312 atmospheric corrosivity category D) and where non-chalking or specific colour top coat is required.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification.

- **1st Coat:** Two component metallic zinc rich epoxy primer (Interzinc 52 or approved equivalent) to a minimum dry film thickness of 75 µm.
- **2nd Coat:** Two component, high build, high solids epoxy (Intergard 475HS or approved equivalent) to a minimum dry film thickness of 250 µm.
- **3rd Coat:** Recoatable aliphatic acrylic polyurethane (Interthane 990 or approved equivalent) finish, to a minimum dry film thickness of 75 µm.

### 10.4.5 System 4: Structural Steel – Immersed in Sewage, open to atmosphere

**Applicability:** This system is for the painting of structural steelwork immersed in sewage or subject to splashing by sewage without enclosed H2S and that can be abrasive blast cleaned. Typical application: Clarifier bridges, sludge hoppers, etc.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification.

- **1st Coat:** Two component epoxy polyamine cured coating (Interzone 954 or approved equivalent) to a minimum dry film thickness of 250 µm.
- **2nd Coat:** Two component epoxy polyamine cured coating (Interzone 954 or approved equivalent) to a minimum dry film thickness of 250 µm.

## 10.4.6 System 5: Steel or Cast Iron – External, not H2S, light grey epoxy top coat

**Applicability:** This system is for the painting of structural steelwork in exposed or damp conditions without H2S which can be abrasive blast cleaned (AS/NZS 2312 atmospheric corrosivity category C) and where light grey top coat is required, some chalking is acceptable.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification.

- **1st Coat:** Two component metallic zinc rich epoxy primer (Interzinc 52 or approved equivalent) to a minimum dry film thickness of 75 µm.
- **2nd Coat:** Two component, high build, high solids epoxy (Interplus 1180 or approved equivalent) to a minimum dry film thickness of 125 µm.
- **3rd Coat:** Two component, high build, high solids epoxy (Interplus 1180 MIO N33 or approved equivalent) to a minimum dry film thickness of 125 µm.

## 10.4.7 System 6: Steel or Cast Iron – External, not H2S, decorative top coat

**Applicability:** This system is for the painting of structural steelwork in exposed or damp conditions without H2S which can be abrasive blast cleaned (AS/NZS 2312 atmospheric corrosivity category C) and where non-chalking or specific colour top coat is required.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification.

- **1st Coat:** Two component metallic zinc rich epoxy primer (Interzinc 52 or approved equivalent) to a minimum dry film thickness of 75 µm.
- **2nd Coat:** Two component, high build, high solids epoxy (Interplus 1180 or approved equivalent) to a minimum dry film thickness of 125 µm.
- **3rd Coat:** Recoatable aliphatic acrylic polyurethane (Interthane 990 or approved equivalent) finish, to a minimum dry film thickness of 75 µm

## 10.4.8 System 7: Steel or Cast Iron - Highly corrosive H2S environment open to atmosphere, pipes internally coated, not potable water

**Applicability:** This system is for painting of steel or cast iron in highly corrosive environments open to atmosphere with H2S present and for internal coating of pipes used for water or sewage but not potable water.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification.

- **1st Coat:** High solids epoxy mastic (Interzone 954GF, Dulux Amerlock 400 GF or approved equivalent) to a minimum dry film thickness of 200 µm.
- **2nd Coat:** High solids epoxy mastic (Interzone 954GF, Dulux Amerlock 400 GF or approved equivalent) to a minimum dry film thickness of 200 µm.

## 10.4.9 System 8: Steel or Cast Iron – Immersed, internally coated, potable water

**Applicability:** This system is for painting of steel or cast iron, including internal coating of pipes used for water or effluent with potable water certification.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification. The surface profile shall be a sharp, angular surface profile of 75-100 µm.

- **1st Coat:** Two component solvent free epoxy (Interline 975P or approved equivalent) to a minimum dry film thickness of 400 µm.

## 10.4.10 System 9: Steel or Cast Iron - Highly corrosive environment, damp H2S

**Applicability:** Steel or cast iron in highly corrosive environments, un-vented sewage applications in the presence of H<sub>2</sub>S, such as sewage pump station wet-wells.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification. The surface profile shall be a sharp, angular surface profile of 75-100 µm.

- **1st Coat:** Heavy duty epoxy phenolic (Interline 984 or approved equivalent) to a minimum dry film thickness of 200 µm.
- **2nd Coat:** Heavy duty epoxy phenolic (Interline 984 or approved equivalent) to a minimum dry film thickness of 200 µm.

Where the abrasive blast profile of 75-100 µm is not practicable, the following alternative system may be used:

- **1st Coat:** Complete surface preparation as above, with a sharp, angular surface profile of minimum 50 µm. Apply epoxy holding primer (Interline 982 or approved equivalent) to a minimum dry film thickness of 40 µm.
- **2nd Coat:** Heavy duty epoxy phenolic (Interline 984 or approved equivalent) to a minimum dry film thickness of 400 µm. Total coating: 440 µm.

## 10.4.11 System 10: Steel or Cast Iron, highly corrosive environment, damp H2S - Rapid application

**Applicability:** Steel or cast iron in highly corrosive environments, un-vented sewage applications in the presence of H<sub>2</sub>S, such as sewage pump station wet-wells where rapid application of the coating is required. Use is subject to approval by Unitywater.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification.

For applications where the curing time is critical, an accelerator additive may be added to the coating to reduce curing time down to 1 to 2 hours:

- **Accelerator additive:** Rust Bullet Rapid Fire may be added to Rust Bullet Industrial urethane coating to reduce curing time by approximately 80%. Refer Rust Bullet Rapid Fire data and application guidelines.
- **1st Coat:** Rust Bullet Industrial urethane coating to a minimum dry film thickness of 150 µm.
- **2nd Coat:** Rust Bullet Industrial urethane coating to a minimum dry film thickness of 150 µm.

## 10.4.12 System 11: Cast Iron Ceramic Coating, for abrasion resistance

**Applicability:** This system is for coating surfaces of cast iron, steel, bronze or brass components subject to extreme abrasion, such as sewage pump impellers, wear plates, back plates and the inside surface of volutes.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification.

- **1st Coat:** Ceramic based two-component epoxy of one colour to a minimum dry film thickness of 200 µm.
- **2nd Coat:** Ceramic based two-component epoxy of contrasting colour to a minimum dry film thickness of 200 µm.

Approved ceramic based two-component epoxy vendors for general applications:

- AES FG Ceramic Repair Fluid
- Belzona 1321
- Devcon Brushable Ceramic
- METALCLAD CeramAlloy CL+AC
- Peerless Industrial Systems Pty Ltd. Item Code: 95010K
- 3M Scotchkote Epoxy Ceramic Surfacer FG 512.

Approved ceramic based two-component epoxy vendors for un-vented sewage applications in the presence of hydrogen sulphide such as sewage pump station wet wells:

- Devcon Brushable Ceramic
- METALCLAD CeramAlloy CL+AC.

## 10.4.13 System 12: Cast Iron Coating, for erosion-corrosion resistance

**Applicability:** This system is for coating surfaces of cast iron, steel, bronze or brass components subject to erosion-corrosion, such as water pump impellers, wear plates, back plates and the inside surface of volutes.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification.

- **1st Coat:** Hydrophobic two-component epoxy of one colour to a minimum dry film thickness of 200 µm.
- **2nd Coat:** Hydrophobic two-component epoxy of contrasting colour to a minimum dry film thickness of 200 µm.
- Approved Hydrophobic two-component epoxy vendors:
  - Belzona 1341 Supermetalgilde

## 10.4.14 System 13: Steel or Cast Iron Equipment – Thermal Bonded Polymeric Coating

**Applicability:** This system is for the protection of the external surfaces of steel or cast iron equipment installed either indoors or outdoors in the presence of H<sub>2</sub>S with a thermal-bonded polymeric coating.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification.

- **1st Coat:** Thermal-bonded polymeric coating (Rilsan PA11, Plascoat PPA 571 AQUA or approved equivalent) to a minimum dry film thickness of 350 µm applied in accordance with AS 4158.

## 10.4.15 System 14: Steel or Cast Iron Equipment – Fusion-bonded Epoxy

**Applicability:** This system is for the protection of the external surfaces of steel or cast iron equipment installed either indoors or outdoors in the presence of H<sub>2</sub>S with fusion bonded epoxy.

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification.

- **1st Coat:** Thermosetting Epoxy Powder (Axalta NAP-GARD 7-2501 or approved equivalent) to a minimum dry film thickness of 350 µm applied in accordance with the manufacturer's recommendations.

## 10.4.16 System 15: Steel Pipe – External Surfaces (buried)

**Applicability:** This system is for the protection of the external surfaces of buried steel pipes in the presence of aggressive soils.

**Proprietary Product:** Sintakote 1.6 mm thick.

## 10.4.17 System 16: Steel or Cast Iron Pipes – Cement Mortar Lining

**Applicability:** This system is for the cement mortar lining of the internal surface of steel or cast iron pipes and specials.

**Method:** All pipes and specials shall be lined with cement mortar to a finished thickness as specified. Cement shall comply with AS 3972 Type SR. Materials for lining, methods of application and curing of the lining shall be in accordance with AS 1281. In the lining of pipes and specials, the Supplier may use a mixture of Portland cement and fly ash blended in proportions not exceeding 10% by weight of fly ash and approved by the Superintendent. The Supplier shall not incorporate any admixture into the cement mortar without the approval of the Superintendent.

## 10.4.18 System 17: Electrical Machines

**Applicability:** This system is for the painting of motors and mechanical equipment (AS/NZS 2312 atmospheric corrosivity category A).

**Surface Preparation:** Oil or grease shall be removed in accordance with AS 1627.1 or SSPC-SP1. Surfaces shall be lightly sanded and free of dust and dirt prior to application of coatings.

- **1st Coat:** Fast dry universal alkyd primer (Interprime 198 or approved equivalent) to a minimum dry film thickness of 75 µm.
- **2nd Coat:** Two pack high gloss acrylic (Interfine 629 or approved equivalent) finish to a minimum dry film thickness of 75 µm.

## 10.4.19 System 18: Electrical Switchgear Cubicles

**Applicability:** This system is to provide a high gloss, high quality system for electrical switchboards and cubicles, free from defects and able to withstand transport, handling and installation. The system is designed to be applied over sheet aluminium and shall provide at least a 25 year life without recoating.

**Surface Preparation:** After bending, welding, drilling and punching, the surface shall be lightly abraded with fine wet and dry paper where required. Oil or grease shall be removed in accordance with AS 1627.1 or SSPC-SP1.

- **1st Coat:** Acid wash and Chromate pe-treatment.
- **2nd Coat:** Thermosetting powder coating (Dulux Duralloy powder coating, Taubmans powder coating or approved equivalent) to a minimum dry film thickness of 80 µm.

## 10.4.20 System 19: PVC Pipes

**Applicability:** This system is for the painting of PVC pipes and fittings.

**Surface Preparation:** Surfaces shall be cleaned with methylated spirits, isopropanol or warm water and detergent and abraded with nylon pad, steel wool or P800 wet and dry paper.

- **1st Coat:** Low sheen acrylic (Dulux Weathershield Low Sheen Acrylic for exterior plastics or approved equivalent) to a minimum dry film thickness of 25 µm.
- **2nd Coat:** As per 1st coat.
- **3rd Coat:** (If required for colour coding) High gloss alkyd enamel (Dulux High Gloss Enamel or approved equivalent) to a minimum dry film thickness of 25 µm.

## 10.4.21 System 20: Minor Metallic Piping Systems – External Surfaces

**Applicability:** This system is for the painting of the external surfaces of minor pipe work manufactured from aluminium, copper, brass or galvanized steel.

**Surface Preparation:** Oil or grease shall be removed in accordance with AS 1627.1 or SSPC-SP1 and abraded with nylon pad, steel wool or P800 wet and dry paper to remove the oxide layer.

- **1st Coat:** Epoxy primer (Dulux Luxepoxy 4 White Primer or approved equivalent) to a minimum dry film thickness of 30 µm applied immediately after degreasing. For galvanized surfaces, Dulux Galiron is an approved alternative.
- **2nd Coat:** High gloss alkyd enamel (Dulux High Gloss Enamel or approved equivalent) to a minimum dry film thickness of 25 µm.
- **3rd Coat:** As per 2nd coat.

## 10.4.22 System 21: Stainless Steel Surfaces

Stainless steel fabrications shall be passivated in accordance with ASTM A 380/A380M, including the following procedure:

- The surface of the stainless steel shall be thoroughly degreased by solvents and, if necessary, rubbed down with a fine grade abrasive cloth or pumice stone.
- The item to be passivated shall be treated using an electrochemical weld cleaning unit in conjunction with an electrolyte solution made of non-harsh acid such as citric acid.
- After passivation, the items shall be thoroughly hosed with clean water. Care must be taken in choosing the wash down area and undertaking hosing to avoid uncontrolled discharge of citric acid.

## 10.4.23 System 22: Stainless Steel Surfaces – Electropolished

Stainless steel fabrications in highly corrosive environments, un-vented sewage applications in the presence of hydrogen sulphide such as sewage pump station wet-wells shall also be firstly passivated in accordance with System 21.

## 10.4.24 System 23: Stainless Steel – External, decorative top coat

**Applicability:** This system is for the protection of the external surfaces of stainless steel with decorative top coat (i.e. Corrosive environments or applications where glare reduction is required).

**Surface Preparation:** Surface preparation shall be in accordance with Section 10.2 of this Specification. Minimum surface blast profile of 35 µm shall be used.

- **1st Coat:** Two component alkylated amine epoxy of one colour to a minimum dry film thickness of 150 µm.
- **2nd Coat:** Recoatable aliphatic acrylic polyurethane (Interthane 990 or approved equivalent) finish, to a minimum dry film thickness of 75 µm.

## 10.4.25 System 24: Hot-dip Galvanising

Following completion of all welding, cutting, drilling and grinding operations, steel and iron work to be galvanised shall be degreased, pickled, washed, fluxed and dried before being hot-dip galvanised in accordance with AS/NZS 4680 to achieve a minimum zinc thickness according to Table 7.

Table 7: Minimum Zinc Thickness for Hot Dip Galvanizing (extract from AS 4680)

| Steel Thickness (mm) | Local coating thickness ( $\mu\text{m}$ ) min | Average coating thickness ( $\mu\text{m}$ ) min | Average coating mass ( $\text{g}/\text{m}^2$ ) min |
|----------------------|---|---|--|
| $\leq 1.5$           | 35  | 45  | 320  |
| $1.5 \leq 3$         | 45  | 55  | 390  |
| $>3 \leq 6$          | 55  | 70  | 500  |
| $>6$                 | 70  | 85  | 600  |

Care shall be taken to prevent hydrogen damage (embrittlement) to high tensile and high carbon steels during the pickling process.

Where structural steel fasteners are specified, bolts, nuts and washers shall be hot dip spun galvanized and the threads of nuts re-run after galvanising.

Damaged areas on small fabricated components including brackets which have been welded or cut following galvanizing shall be regalvanised.

Damaged areas on large fabricated components which cannot be readily removed for regalvanising shall be repaired by either applying a minimum dry film thickness of  $75 \mu\text{m}$  of a Eutectic-Castolin zinc alloy by means of Tero Dyn system 2000 or equivalent in order to produce a metallurgically bonded deposit or CIG Comweld Galvanizing Bar applied in accordance with the manufacturer's instructions.

Damaged areas on thin sheet metal products including cable trays shall be degreased, wire brushed and coated with two coats of single pack Zinc Rich Primer (Dulux Zinc Rich 1P or approved equivalent).

## 10.4.26 System 25: Electroplated Metal Coatings

Electroplating shall be either:

- nickel plus chromium plating
- cadmium plating, or
- zinc plating,

as stated in the nominating specification.

Each plating type shall comply with the following relevant Standard:

- AS 1192 Electroplated coatings, Nickel and chromium
- AS 1789 Electroplated coatings, Zinc on iron or steel
- AS 1897 Electroplated coatings on threaded components (metric coarse series).

## 10.4.27 System 26: Wax-based Anticorrosion Coating

**Applicability:** This system is for any uncoated carbon steel drive shaft or a bearing race which is exposed to atmospheres where a painted coating is not practical.

**Surface Preparation:** Oil or grease shall be removed in accordance with AS 1627.1 or SSPC-SP1 and abraded with nylon pad, steel wool or P800 wet and dry paper to remove the oxide layer.

**Coating:** Exposed surfaces shall be coated with a wax-based, general purpose, corrosion preventive compound such as Tectyl 506 aerosol spray, or approved equivalent. Coating shall be applied immediately after degreasing to achieve a uniform minimum dry film thickness coating of 300 µm.

## 11. Pipework

### 11.1 Design life

All pipework supplied shall be suitable for the specified operating conditions and shall be designed and constructed for a minimum design life as defined in Section 4.3.

### 11.2 Pipework design

The piping system design outlined in this specification is based on the Australian Standard AS 4041 – Pressure Piping, as well as the relevant WSA Product Specifications.

The pipework installation shall be designed and arranged to provide for ease of erection and future dismantling. All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipework and its associated equipment in an approved manner.

Sufficient dismantling joints, flange adaptors or flexible couplings shall be provided to enable removal for replacement, cleaning and maintenance. Acceptable dismantling jointing systems include proprietary straight spool-type dismantling joints, couplings such as Gibault, Staub, and Victaulic, as well as 45° and 90° flanged bends.

Pipes crossing roads shall be designed and constructed for this purpose and to withstand the traffic loading applicable to the road.

Pipes laid horizontally shall have a gradual fall towards drain or scour points as appropriate.

Overhead piping shall be run clear of all walkways with a minimum clearance of 2.1 m.

Pipework which has potential to suffer from blockages (raw sewage, grit, screenings and sludge etc.) shall be fitted with adequate facilities for cleaning or purging. These may include blank flanges, flanged bends, tee pieces, pigging stations and connections for high pressure flushing.

Pipelines conveying sludge shall not be smaller than DN150. Clean-out points shall be provided on sludge lines to facilitate cleaning and maintenance.

For pipes run at ground level, the minimum clearance between piping and ground level is to be 300 mm measured to the underside of the pipe or flange whichever is lower, unless specified otherwise, providing the following dimensions (measured between extremities) are also observed:

- Pipe - Pipe : 100 mm
- Flange - Pipe : 50 mm
- Flange - Flange : 50 mm.

A minimum clearance of 300 mm shall be maintained between crossing pipes and their relative positions.

For pipes with unions, sufficient clearance shall be provided to allow tools to be used to undo the union.

Where valves, flow meters, strainers and other devices mounted in the pipework are large enough to put undue strain on the pipework, these shall be supported independently of the pipes to which they connect. Particular care shall be taken to ensure that pipework thrusts are not transmitted to pumps, tank nozzles, machinery or associated apparatus.

The high points of all pipe routes shall have provision for venting air. The low points shall have provision for drainage if appropriate.

Design details shall be such as to reasonably minimise head loss in the pipework. To this end, long radius bends shall be used wherever possible, particularly on sludge lines.

Pipe runs shall be laid out to minimise crossovers and shall be coordinated with other services. All pipes, valves and fittings shall be so arranged that they are conveniently accessible and readily replaceable.

Bellmouths shall be of a shape that will promote low head loss flow entry into a pipeline. Tapers are not acceptable. The diameter of the bellmouth lip shall be not less than 1.5 times the pipe diameter. The length of the bellmouth shall be not less than the pipe diameter.

High standards of cleanliness must be maintained during the erection of piping systems to ensure that no foreign matter is introduced in the pipe system. In particular, for potable water pipes ensure the requirement of [F9785](#) - Water Hygiene Field Guide and [Pr9032](#) - Procedure for Managing Water Quality During Mains Commissioning are met. Newly installed pipes should be flushed prior to commissioning as per the requirements of [Pr11211](#) - Specification for Commissioning and Handover of Active and Passive Assets.

## 11.3 Pipe loads

The maximum design pressure for each line is the maximum non-shock internal pressure. In lieu of modelled or calculated minimum pressures, the minimum pressure for loading calculations shall be full vacuum pressure. The design temperature for each line is the maximum internal service temperature.

Pipeline stress calculations due to thermal loadings shall be based on an ambient temperature range of 0 to 50 degrees C, or as agreed with Unitywater in the project specifications.

Flexibility analysis shall conform to AS 4041 Section 3.27. If the flexibility assessment according to AS 4041 determines a rigorous analysis is required, an approved computer program (e.g. Caesar II, AutoPipe) shall be used.

## 11.4 Pipe supports

The design and installation of structural pipe supports shall comply with the requirements of AS 3990 and AS 4041.

Supports and supporting structures shall be designed to meet all expected loading conditions, including earthquake and wind loads to AS 1170.

The pipework shall be rigidly and safely supported at intervals not exceeding the manufacturer's recommendation or as defined by the pipe material specification. Supports shall be designed and arranged so that no restrictions in access are created.

Pipework shall be adequately supported to prevent undue sagging, vibration, and strain on connected equipment.

Pipe supports shall be designed to allow for pipe movement due to thermal expansion and contraction and vibration from mechanical equipment.

Pipework shall be suitably anchored to minimise pipe stresses caused by pipe pressure, thrust and weight of valves, instruments and equipment.

Pipework shall be designed with independent supports and restraints to accommodate loads and thrust so as not to transfer stresses onto machinery or plant items. Pumps, valves, meters, strainers and other such in-line equipment shall be supported independently of the pipework.

Pipe supports shall be designed such that no static or dynamic load is transferred to equipment.

Pipe spools and pipe supports shall be designed with respect to the maintenance of mechanical equipment, instrumentation and valves. Where pipework is required to be removed for maintenance it shall be suitably flanged and include lifting lugs at appropriate locations to assist in removal.

Where not specifically designed, hangers, saddles, racks and clamps shall be standard purpose manufactured 'Unistrut' components or equal.

Where pipework is supported from a concrete structure 'Unistrut' or equal channel sections adequately anchored into the concrete shall be provided and particular attention shall be given to the safe load capacity of such inserts.

Where pipe hangers are used, hangers located in areas subject to pipe vibration shall be adequately braced to dampen the vibration.

All springs shall be preloaded and provided with travel stops for hydrostatic line testing. Stops shall be removed after testing, and springs adjusted to the correct load.

Additional supports shall be provided adjacent to connections to pumps, tanks, etc. and on either side of valves, measuring instruments and the like. Expansion joints and/or bends thrust blocks and anchors shall be provided where appropriate.

In assessing the design loads of pipe supports, all pipelines shall be assumed to be full of water, or associated process medium (whichever induces higher loadings). Further, pipe supports shall be sufficiently designed to provide allowance for redundancy and prevention of progressive failure. The location and type of support to be installed shall make the appropriate allowance for thermal expansion of pipework including plastic pipelines.

Some cases of thin wall pipe or high specific gravity fluid may require individual calculations to determine pipe support requirements.

Supports may be fabricated from 316 stainless steel, aluminium or structural grade steel. The material selection shall be structurally sufficient and be suitable for the environmental exposure it is subjected to, inclusive of any potential interaction with process medium.

All carbon steel pipe supports shall be hot dip galvanised and coated to suit the environmental conditions in accordance with section 10.4.

## 11.5 Pipework penetrating structures

Metallic pipes cast into reinforced structures must include puddle flanges and ensure no leakage through the penetration. The puddle flange should be centrally located in the wall with continuous reinforcing on either side of the flange.

Cast-in pipes shall include allowance for differential movement by means of approved pipe joints. Similarly, pipework penetrating structures from soil shall include allowance for flexible pipe joints.

Pipework flanges for cast-in pipes shall be a minimum of 150mm off the wall face for pipes DN400 and smaller. Flanges on pipes larger than DN400 shall be a minimum of 250mm off the wall face.

Plastic pipe penetrations through concrete structures must be sealed with hydrophilic rubber seal (Hydrotite® or similar). The pipe surfaces must be roughened to form a suitable bond to the concrete.

Refer to [Pr9903](#) - Specification for Building and Structural Works for further requirements.

## 11.6 Flushing connections – sludge pipework

Flushing connections shall be used on all sludge lines. Connections shall be a minimum of DN50.

Flushing connections shall be located either side of valves, at the bottom of vertical risers and at suitable intervals on long horizontal runs for pipes prone to blockages.

Flushing connections shall include a manual isolation valve and “camlock” fitting to suit the existing services at the plant.

## 11.7 Drains and vents

Drains shall be provided to facilitate shutdown and general maintenance.

Adequate high point vents and low point drains shall be included to suit the spooling arrangement.

Valved drains shall be provided at the bottom of riser piping and other pipework low points (where shown in the drawings) to drain liquids completely from the piping.

Other drain points shall be provided for equipment including drains for drip trays, automatic air vents and equipment with drain points.

Pipework which is double contained shall be provided with catch pots at the end of the double containment where appropriate.

Drain point connections shall be installed on the suction piping of all pumps in between the first suction isolation valve and the pump. Pumps shall have a method of draining the pipework located between the nearest suction and discharge valve.

Drain size shall generally be a minimum DN25. For pipework smaller than DN25, the drain size shall be the same as the main pipe size.

Where reasonably practicable, piping running at low level within buildings shall be installed in concrete trenches. The trenches shall be provided with suitable grating and drainage to the satisfaction of Unitywater.

## 11.8 Mechanical jointing

### 11.8.1 Grooved pipe couplings

Grooved mechanical pipe couplings, fittings, valves and other grooved components may be used as an option to welding, threading or flanged methods on carbon or stainless steel pipework. The grooved components, including gaskets shall be supplied from an ISO 9001 certified manufacturer and shall be fully compatible with AS 4041.

Pipe end-grooves may be rolled or cut as appropriate to the pipe material, wall thickness, pressure rating, size and method of jointing. Grooves shall be in accordance with the manufacturer's guidelines. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.

Couplings shall generally be of ductile iron construction. Where design conditions require the use of an alternative to ductile iron piping materials for both interior and exterior piping surfaces, stainless steel Grade 316 couplings shall be used as determined by the Superintendent.

Fittings shall be selected and assembled fully in accordance with the manufacturer's recommendations.

### 11.8.2 Pressfit pipe couplings

Victaulic Pressfit (or approved equivalent) pipe couplings, fittings, valves and other components may be used as an option to welding, threading or flanged methods of jointing on stainless steel pipework up to DN50 diameter.

Pipework shall be certified for use with Pressfit products. Pipes shall be finished annealed with polished OD. Pipes shall be square cut to  $\pm 0.75$  mm, properly de-burred and cleaned to ensure a leak tight O-ring seal.

Coupling and fitting housings shall be Pressfit products formed of approved 316L stainless steel.

Pipework shall be assembled fully in accordance with Victaulic recommendations.

### 11.8.3 Flanges

Flanges shall comply with AS/NZS 4087 as specified in the pipe class specifications. All flanges shall be assembled square and true prior to bolting to a matching flange.

Flanges shall have a pressure rating higher than the maximum operating pressure, including allowance for surge pressures.

Flange bolt holes shall be spaced equally on the pitch circle circumference and, for integral flanges, the bolt holes shall be spaced equally off the centreline of the component of which it forms part and shall be parallel to the axis of the flange, in accordance with AS/NZS 4087. Flange bolt holes shall be located to straddle centrelines to allow correct and neat orientation of valves, instruments and equipment.

Flanged connections shall be tightened as follows:

- Tighten nuts to finger tight and verify that flange faces are parallel, aligned, and that the gasket is centred. Correct any misalignment before proceeding.
- Determine the required torque using approved torque tables or vendor data for the specific flange class, bolt diameter, bolt material, gasket type, and lubrication condition.
- Using the star (criss-cross) tightening pattern, tighten the bolts in three gradual, even passes to reach full final torque.
- After the third pass, perform one final around-the-clock (circumferential) pass to ensure uniform bolt load.

The surface of the flange gasket face shall be free from rust, weld spatter, scars, paint, dents, arc strikes, corrosion pitting and other imperfections.

Bolting torque for valves and lined piping shall be in accordance with the manufacturer's recommendations.

Nickel based anti-seize compounds shall be used for stainless steel bolts, stud bolts and nuts to prevent binding.

Flanges shall be installed square with the run of pipe and aligned parallel to each other.

Misalignment shall not be corrected by bolting.

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.

Flanged joints shall be made with bolts or studs with nuts where the flange is tapped.

For equipment and valves fitted with flanges other than the above, the mating piping flanges shall be compatible and match that of the equipment and valve flanges.

## 11.8.4 Fixed couplings and dismantling joints

Flexible pipe couplings, flange adaptors, proprietary dismantling joints or flanged fittings shall be incorporated into the pipework as appropriate to:

- facilitate removal of plant items for maintenance without the need to dismantle or disturb adjacent pipework/manifolds, and
- allow for final closure of pipework joints without superimposing stresses onto plant items, and
- provide flexibility on pipelines which may be influenced by ground movement. Couplings shall be suitable for buried installation as appropriate.

Rubber jointing rings for use in spigot and socket pipes shall be as supplied by the pipe supplier for the particular pipe. Rubber jointing rings shall be stored in a cool shaded environment and shall not be hung over pegs or similar supports. Previously used rings shall not be reused.

Unrestrained mechanical couplings shall comply with AS/NZS 4998.

Band type couplings shall be of stainless steel Grade 316 construction, with stainless steel Grade 316 fasteners and EPDM sealing sleeves complying with AS 1646.

Gibault, Victaulic, similar slip over couplings and non-tension resisting type pipe couplings shall be cast iron or fabricated steel with stainless steel bolt sets as supplied or recommended by the pipe manufacturer for use with the particular pipe.

## 11.8.5 Flexible connections and expansion joints

Flexible connections shall be bolted directly to the flanged outlets of mechanical equipment as shown on the drawings.

Bolts and retainer plates or flanges shall be provided at each end of flexible connections. All flexible connections shall be rated for operating pressures including the pipeline design rating.

Flexible connections shall be provided at all equipment where vibration, thermal expansion or loading may occur.

Where necessary, flexible connectors shall incorporate tension-resisting tie bolts. Expansion joints shall generally be of the single sphere elastomer type (e.g. Radcoflex FSF), unless otherwise specified.

Flexible rubber joints shall incorporate nylon reinforced synthetic rubber suitable for use with materials of selection compatible with the relevant pipework and equipment, material to be conveyed and the environmental conditions. Metal bellows shall be supplied with flanges suited to the body of the joint and tied or hinged where required.

Any internal lining/sleeving shall be suitably designed to prevent vibration. Internal lining/sleeving shall not be used in a coupling where a liquid is being conveyed and the design allows the conveyed material to contact the compensating element.

Expansion joints shall not be used to correct pipe misalignment.

Pipework adjacent to the coupling shall be adequately supported and restrained for the intended service and shall not rely on the coupling to provide such support/restraint other than that required to compensate for intended axial movement.

Extreme care shall be taken during handling and erection of expansion joints. Shipping rods shall remain in place until erection is complete but must be removed immediately after the expansion joint is installed.

### **11.8.6 Tapping bands**

Tapping bands shall consist of two semi-circular rings manufactured from gunmetal. The two rings shall be bolted at the horizontal diameter using gunmetal studs and nuts.

The upper ring shall incorporate an elastomeric seal designed to prevent leakage between the pipe and band at the system design pressure.

The two rings shall be designed so as to provide full circle pipe support and to prevent over-tightening.

### **11.8.7 Screwed joints**

Screwed pipe connections shall be in accordance with AS ISO 7.1 and AS ISO7.2. Screwed connection threads shall be sealed with degreased PTFE tape or a thread sealing compound.

### **11.8.8 Pipe welding**

The following requirements are provided for minimum guidance. Pipe welding shall also be governed by the specific material requirements of the pipe being welded. All carbon and stainless steel welding and associated procedures shall be in accordance with AS 4041.

Stainless steel pipe welds shall be passivated as soon as practicable after welding. Welds shall be contiguous and fully penetrating so that crevices do not occur.

Cutting of pipe may be done either by mechanical means or by flame cutting, depending on the type of material to be cut. For carbon steel, flame (or arc) cutting and bevelling is acceptable only if the cut is reasonably smooth and true, and all oxides are removed from the flame cut surfaces by grinding back to bright and sound metal. For stainless steel, flame cutting is not permitted.

For stainless steel plasma cutting, if the pipe ends cannot be machined, the pipe must be ground back to bright sound metal prior to welding.

All welding areas shall be adequately protected against inclement weather conditions such as rain, wind, dust and the like.

All weld end preparations and adjacent areas 50 mm either side of the weld shall be thoroughly cleaned and degreased prior to welding. This includes any supplier-applied coating system.

Repairs to welded joints, defective or damaged pipe fittings or any other pressure part shall be subject to approval by Unitywater.

Prepared weld ends (bevels) shall be examined for defectiveness or damages and repaired. Use of hot or cold hammering as a means of repair is prohibited.

If repairs or modifications are carried out after heat treatment has been completed, the areas affected by the repair or modification shall be heat treated again.

Joints shall be tested using non-destructive testing (NDT) techniques, unless it is necessary to use destructive testing to achieve adequate interpretation. When interpreting NDT findings of welds made in castings and ductile iron, consideration shall be given to allowable defects in the parent material. All NDT results shall be provided to Unitywater.

All uncoated surfaces of the spool shall be surface prepared and painted immediately after all non-destructive testing of the welds has been completed.

Use of permanent internal backing rings is prohibited. Consumable inserts placed inside the pipe joint shall not be used.

### **11.8.9 Pipe brazing / soldering (copper)**

The following requirements are provided for minimum guidance. Pipe brazing / soldering shall also be governed by the specific material requirements of the pipe being brazed / soldered. All brazing filler materials must comply to the specific material and application in accordance with AS/NZS ISO 17672. All copper brazing / soldering works must be in accordance with AS4809. All fittings for brazing / soldering shall be socket and spigot type.

Cutting of pipe must be done by mechanical means.

All brazing / soldering work areas shall be adequately protected against inclement weather conditions such as rain, wind, dust and the like.

All pipe and tube ends must be cut square, free from distortion with internal and external burrs removed. All fittings, pipe and tube are to be thoroughly cleaned and degreased.

For spigots and pipe / tube ends the oxide layers are to be lightly mechanically abraded with abrasive pads to a bright surface and cleaned to remove debris. The clean area must be slightly more than the depth of the fitting socket / cup.

For socketed fittings the oxide layers are to be lightly mechanically abraded with abrasive pads or properly sized fitting brush to a bright surface and cleaned to remove debris.

Chemical removal of oxide layers is subject to approval by Unitywater.

All fittings, pipe and tube must be adequately supported when assembled to ensure no movement during the brazing process.

During the brazing process, surrounding structures must be protected from heat by using a heat shield.

Brazing / soldering is to be completed with using an oxyacetylene flame with "Silbeloy 15" (containing 15% silver) and shall be neatly made to avoid dead legs or other features which may lead to corrosion or build-up of debris. All works on potable water infrastructure must be in accordance with AS/NZS 4020.

Soft solder joints are prohibited from use.

Upon completion of all brazing works all residues must be removed immediately once joint has cooled.

Repairs to brazed / soldered joints, defective or damaged pipe fittings or any other pressure part shall be subject to approval by Unitywater.

## 11.8.10 Uni flanges

Uni-flanges shall only be installed in above ground locations or within accessible pits. In locations where significant surge or pressure fluctuations are expected, Uni-flanges should be avoided, or should be installed with tie rods to permit transmission of thrust without relying on the set screws for restraint.

## 11.8.11 Fasteners

Flange bolts shall be fitted with nuts and two flat washers.

Where bolts are used in a location not in the horizontal plane, the bolt should be at the top of the joint and nut below.

Fasteners shall also comply with the requirements of Section 6.

## 11.8.12 Gaskets

Unless specified or required otherwise because of pressure or other criteria, flange gaskets shall be full-face thickness to suit the test pressure and flange dimension but not be less than 3 mm thick for EPDM gaskets and 1.5 mm for compressed fibre gaskets.

The gasket material shall be suitable for contact with the fluid being conveyed, the operating conditions and the environment. Unless otherwise specified, gasket materials for all flanged pipework shall be EPDM or compressed fibre, with the exception of gaskets on sodium hypochlorite pipework which shall be PTFE.

All gaskets shall be supplied and installed in accordance with AS 1646.

Insertion rubber gaskets are not acceptable.

## 11.8.13 Instrument fittings

Unless otherwise specified, G $\frac{1}{2}$  (BSPT compatible) branch connections shall be used. The connectors shall be selected and fitted in accordance with the manufacturer's recommendations.

Each connection shall be fitted with a G $\frac{1}{2}$  (BSPT compatible) plug, installed with PTFE tape and tensioned to provide a seal at the pipe hydrostatic test pressure.

All instrumentation piping shall be manufactured from Grade 316L stainless steel seamless tube and fittings of a thickness suitable for threading.

## 11.9 Ductile Iron Cement Lined (DACL) pipes

### 11.9.1 General

All ductile iron piping and fittings shall be manufactured in accordance with the requirements set out in AS/NZS 2280.

Bolt-on type puddle flanges shall be designed to resist the thrust from a dead-end pipe with the full test pressure applied. As a minimum, the pipe shall be grooved to receive the flange and an epoxy applied between the flange and the pipe.



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## 11.9.2 Pipe class specifications

The following descriptors apply to the DICL pipe class:

- Pipe Sizes: DN 100 to 750
- Design Pressure: 1600 kPa
- Design Temperature: 50°C (limited by EPDM gaskets)

The following specification and standards apply to the DICL pipe class:

Table 8: Specifications for DICL Pipes

| Item                                      | Size<br>DN (mm) | Material/ Standard                       | Description   |
|---|-----------------|--|---|
| <b>Pipe</b>                               | 100 to 750      | AS/NZS 2280<br>WSA PS-200<br>WSA PS-202S | Ductile iron pipe, PN 35 spigot and socket ends for rubber ring joints and flange class for flanged joints. Unless specified otherwise, external coating shall be bituminous paint 50 µm thick or approved equivalent for underground pipes and in accordance with Section 10 Painting and corrosion protection of this Specification for above ground pipes. Pipes shall be of 5.5 m effective lengths unless otherwise specified. |
| <b>Fittings</b>                           | 100 to 750      | AS/NZS 2280<br>WSA PS-201                | Ductile cast iron with thermal bonded polymeric coating.  |
| <b>Joints:<br/>Rubber Ring<br/>Joints</b> | 100 to 750      | AS 1646                                  | EPDM<br>Rubber ring to be located in a specially designed groove within the socket.   |
| <b>Joints A:<br/>Flanges</b>              | 100 to 750      | AS/NZS 2280                              | To conform to AS 4087 PN16, Ductile Cast Iron, raised face flange.<br>Preferred option: Integrally cast with pipe or fittings.<br>Non-preferred alternative: Screw-on flange only to be used with Flange Class pipe; thread sealed with epoxy.  |
| <b>Joints B:<br/>Gibault joints</b>       | 100 to 750      | AS/NZS 2280                              | Long barrel type or short barrel to suit pipe joint geometry. Bolts shall be metric, 316 stainless steel.   |
| <b>Dismantling<br/>joints</b>             | 100 to 750      | Ductile iron                             | Thrust or non-thrust type to be nominated by the Engineer. Coating shall be thermal bonded polymeric. Bolts shall be metric, 316 stainless steel.   |
| <b>Gaskets</b>                            | 100 to 500      | Solid EPDM<br>WSA-109                    | Full face gasket - 3.0 mm thick<br>Type WA, WC or WG to suit fluid<br>Hardness - 70 IRHD.   |
| <b>Gaskets</b>                            | 600 to 750      | Compressed fibre<br>WSA-109              | Full face gasket - 1.5 mm thick   |
| <b>Flange Bolts</b>                       | 100 to 500      | ISO 4014<br>AS 1111                      | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |



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| Item   | Size<br>DN (mm) | Material/ Standard   | Description   |
|--|-----------------|----------------------|---|
| <b>Nuts</b>                                  | 100 to 500      | ISO 4032<br>AS 1112  | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Studs</b>                                 | 100 to 500      | DIN 976-1<br>AS 2528 | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Flange Bolts</b>                          | 600 to 750      | ISO 4014<br>AS 1111  | Metric, 316 stainless steel, DIN A4 Class 70  |
| <b>Nuts</b>                                  | 600 to 750      | ISO 4032<br>AS 1112  | Metric, 316 stainless steel, DIN A4 Class 70  |
| <b>Studs</b>                                 | 600 to 750      | DIN 976-1<br>AS 2528 | Metric, 316 stainless steel, DIN A4 Class 70  |
| <b>External protection for buried piping</b> | 100 to 750      | Polyethylene sleeve  | Loose polyethylene sleeve shall be fitted and strapped over the piping in accordance with AS 3680 and the installation instructions from the sleeving and pipe supplier. Sleeving colour shall be blue for potable and raw water supply, cream for sewerage and lilac for reclaimed effluent. |
| <b>Lining</b>                                | 100 to 600      | AS 3972              | Cement Mortar Lining:<br>i. Thickness = 5 mm<br>ii. Tolerance $\pm$ 1.5 mm  |
|  | 750             | AS 3972              | Cement Mortar Lining:<br>iii. Thickness = 6 mm<br>iv. Tolerance $\pm$ 1.5 mm  |

Bolt-on type puddle flanges shall be designed to resist the thrust from a dead-end pipe with the full test pressure applied. As a minimum, the pipe shall be grooved to receive the flange and an epoxy applied between the flange and the pipe.

## 11.10 Carbon steel pipes

### 11.10.1 General

All carbon steel piping shall be manufactured in the accordance with the requirements of ASTM A53 or ASTM A106. Dimensions for carbon steel piping shall comply with ASME B36.10.

### 11.10.2 Pipe class specifications

The following descriptors apply to the Carbon Steel pipe class:

- Pipe Sizes: DN 20 to 250
- Design Pressure: 1600 kPa
- Design Temperature: 50°C (limited by EPDM gaskets)



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The following specifications and standards apply to the Carbon Steel pipe class:

Table 9: Specifications for Carbon Steel Pipes

| Item     | Size DN (mm) | Material/Standard                 | Description  |
|----------|--------------|-----------------------------------|--|
| Pipe     | 20 to 40     | API 5L Gr B or ASTM A53/A53M Gr B | ERW pipe, schedule 80, plain ends  |
|          | 50 to 250    | API 5L Gr B or ASTM A53/A53M Gr B | ERW pipe, schedule 40, plain ends  |
| Fittings | 20 to 250    | ASME B 16.9                       | Wrought fittings, butt welding   |
| Flanges  | 20 to 250    | AS/NZS 3678-250                   | AS/NZS 4087 PN 16, steel, plate flange, raised face, slip-on                             |
| Gaskets  | 20 to 250    | Solid EPDM WSA-109                | Full face gasket - 3.0 mm thick<br>Type WA, WC or WG to suit fluid<br>Hardness - 70 IRHD |
| Bolts    |              | ISO 4014<br>AS 1111               | Metric, 316 stainless steel, DIN A4 Class 50 (min)                                       |
| Nuts     |              | ISO 4032<br>AS 1112               | Metric, 316 stainless steel, DIN A4 Class 50 (min)                                       |
| Studs    |              | DIN 976-1<br>AS 2528              | Metric, 316 stainless steel, DIN A4 Class 50 (min)                                       |
| Joints   | 20 to 250    | AS 4041                           | Butt welds or flanges  |

The following preferred diameters and branch types apply to the Carbon Steel pipe class:

Table 10: Preferred Diameter and Branch Types for Carbon Steel Pipes

| Line Size (mm) | Branch Size (mm) |    |    |    |    |    |    |     |     |     |     |
|----------------|------------------|----|----|----|----|----|----|-----|-----|-----|-----|
|                | 15               | 20 | 25 | 40 | 50 | 65 | 80 | 100 | 150 | 200 | 250 |
| 15             | ET               |    |    |    |    |    |    |     |     |     |     |
| 20             | RT               | ET |    |    |    |    |    |     |     |     |     |
| 25             | RT               | RT | ET |    |    |    |    |     |     |     |     |
| 40             | SO               | SO | SO | ET |    |    |    |     |     |     |     |
| 50             | SO               | SO | SO | RT | ET |    |    |     |     |     |     |
| 65             | SO               | SO | SO | SO | RT | ET |    |     |     |     |     |
| 80             | SO               | SO | SO | SO | RT | RT | ET |     |     |     |     |



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| Line Size (mm) | Branch Size (mm) |    |    |    |    |    |    |    |    |    |    |    |
|----------------|------------------|----|----|----|----|----|----|----|----|----|----|----|
| 100            | SO               | SO | SO | SO | SO | SO | SO | RT | ET |    |    |    |
| 150            | SO               | SO | SO | SO | SO | SO | SO | W  | RT | ET |    |    |
| 200            | SO               | SO | SO | SO | SO | SO | SO | W  | W  | RT | ET |    |
| 250            | SO               | SO | SO | SO | SO | SO | SO | W  | W  | W  | RT | ET |

## Legend

- ET Equal tee
- RT Reducing tee
- W Weldolet (integrally reinforced branch outlet fitting)
- SO Sockolet or Half Coupling (integrally reinforced branch outlet fitting)

## 11.11 Stainless steel (GR 316L) seamless and ERW pipes

### 11.11.1 General

All seamless and ERW stainless steel pipe shall be manufactured in accordance with the requirements of ASTM A312/A312M, with a grade of 316/316L. Dimensions of ERW stainless steel pipe shall be in accordance with ASME B36.19.

### 11.11.2 Pipe class specifications

The following descriptors apply to the Stainless Steel and butt welded ERW pipe class:

- Pipe Sizes: DN 15 to 500
- Design Pressure: 1400 kPa
- Design Temperature: 50°C (limited by EPDM gaskets)

The following specifications and standards apply to the stainless steel seamless and ERW pipe class:

Table 11: Specifications for Stainless Steel Seamless and ERW Pipes

| Item | Size DN (mm) | Material/ Standard                     | Description                                 |
|------|--------------|--|---|
| Pipe | 15 to 50     | ASTM A 312/A312M-TP316L<br>ASME B36.19 | Stainless steel seamless pipe Sch 40S       |
|      | 80 to 500    | ASTM A 312/A312M-TP316L<br>ASME B36.19 | Stainless steel ERW pipe Sch 10S plain ends |



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| Item                                  | Size DN (mm) | Material/ Standard          | Description   |
|---------------------------------------|--------------|-----------------------------|---|
| <b>Screwed fittings</b>               | 15 to 50     | ASTM A 182/A182M-F316L      | Forged austenitic stainless steel Grade 316L fittings, screwed to AS 1722.1 (BSPT compatible)                             |
| <b>Butt-welding fittings</b>          | 15 to 500    | ASTM A 403/A403M-WP316L     | Wrought austenitic stainless steel butt weld fittings   |
| <b>Flanges</b>                        | 15 to 500    | ASTM A 240/A240M-316L       | AS 4087 PN 16, stainless steel Grade 316L, plate flange, raised face, slip-on   |
| <b>Gaskets</b>                        | 15 to 500    | Solid EPDM WSA-109          | Full face gasket - 3.0 mm thick<br>Type WA, WC or WG to suit fluid<br>Hardness - 70 IRHD                                  |
| <b>Nuts</b>                           |              | ISO 4032<br>AS 1112         | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Studs</b>                          |              | DIN 976-1<br>AS 2528        | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Welded joints</b>                  | 15 to 500    | AS 4041                     | Butt welds  |
| <b>Screwed joints</b>                 | 15 to 50     | AS ISO 7.1 and AS ISO 7.2   | BSPT: RT series   |
| <b>Welding, pickling, passivation</b> | 15 to 500    | AS 4041<br>ASTM A 380/A380M | Welding in accordance with Section 11.8.8.<br>Pickling, passivation and electropolishing in accordance with Section 10.4. |

As an alternative to threaded pipe, DN 15 to DN 50 pipe may be plain ended to suit butt-weld fittings where specified.

## 11.12 Spiral welded stainless steel (GR 316L) pipes

### 11.12.1 General

All spiral wound stainless steel tube used shall be manufactured in accordance with the requirements set out in AS 4041 for class 3 piping with Straub, Vanstone or equal couplings. The pipe shall comply with the requirements of ASTM A554, with a material grade of 316L.

### 11.12.2 Pipe class specifications

The following descriptors apply to the spiral welded Stainless Steel pipe class:

- Pipe Sizes: DN 150 to 1200
- Design Pressure: 700 kPa
- Design Temperature: 50°C (limited by EPDM gaskets)



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The following specifications and standards apply to the spiral welded stainless steel pipe class:

Table 12: Specification for Stainless Steel Pipes (spiral welded)

| Item                                  | Size<br>DN (mm) | Material/ Standard                   | Description   |
|---------------------------------------|-----------------|--------------------------------------|---|
| <b>Pipe</b>                           | 150 to 1200     | ASTM A554 TP316L                     | Stainless steel spiral welded pipe (inert gas shielded spiral TIG butt weld), fully pickled and passivated, plain ends.<br><br>Minimum wall thickness per Table 13.                       |
| <b>Fittings</b>                       | 150 to 1200     | ASTM A 403/A403M-WP316L              | Wrought austenitic stainless steel butt weld fittings   |
|                                       | 400 to 1200     | ASTM A554 TP316L<br>AWWA Manual M11  | Fabricated from pipe of same or larger wall thickness as line pipe  |
| <b>Flanges</b>                        | 150 to 1200     | ASTM A 240/A240M 316L neck ring      | Neck ring with stainless steel back-up flange to AS 4087 PN16   |
|                                       |                 | ASTM A 240/A240M 316L back-up flange | Neck ring wall thickness not less than pipe wall thickness  |
| <b>Gaskets</b>                        | 150 to 1200     | Solid EPDM<br>WSA-109                | Full face gasket - 3.0 mm thick<br>Type WA, WC or WG to suit fluid<br>Hardness - 70 IRHD  |
| <b>Bolts</b>                          |                 | ISO 4014<br>AS 1111                  | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Nuts</b>                           |                 | ISO 4032<br>AS 1112                  | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Studs</b>                          |                 | DIN 976-1<br>AS 2528                 | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Joints</b>                         | 150 to 1200     | AS/NZS 1554.6                        | Butt welds or flanges as specified  |
| <b>Welding, pickling, passivation</b> | 150 to 1200     | AS/NZS 1554.6                        | Unless specified otherwise, all weld filler material shall be 316L. All welds shall be TIG or MIG. Passivation and pickling shall be carried out on all welded areas as per Section 10.4. |



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Table 13: Spiral Welded Stainless Steel – Minimum Wall Thicknesses

| DN (mm) | OD (mm) | Min. Wall Thickness (mm) |
|---------|---------|--------------------------|
| 150     | 168     | 2.5                      |
| 200     | 219     | 2.5                      |
| 250     | 273     | 2.5                      |
| 300     | 324     | 3                        |
| 400     | 406     | 3                        |
| 450     | 457     | 3                        |
| 500     | 508     | 3                        |
| 600     | 610     | 4                        |
| 700     | 711     | 4                        |
| 750     | 762     | 4                        |
| 800     | 813     | 4                        |
| 900     | 914     | 5                        |
| 1000    | 1016    | 5                        |
| 1200    | 1219    | 5                        |

## 11.13 Polyethylene (PE) pipes and fittings

### 11.13.1 General

Polyethylene pipe shall be designed, fabricated and installed in accordance with [Pr11034](#) - Specification for Trunk Water Mains Design and Construction, [Pr9875](#) - Specification for Non-Pressure Pipeline Construction, [Pr9904](#) - Specification for Pressure Pipe Construction, WSA 01 "Polyethylene Pipeline Code", and AS/NZS 4130 / AS/NZS 4131.

Polyethylene pipe shall not be bent to a radius less than 25 times its outside diameter, except where alternative limits are specified in PIPA POP202. Hot bending shall not be permitted.

All fusion bonding processes shall be strictly in accordance with the pipe manufacturer's recommendations and procedures.

All pipe laying shall be in accordance with both the manufacturer's recommendations and installation procedures and AS/NZS 2566.

Polyethylene has a coefficient of linear expansion of about 0.18 mm/m/°C. Installation shall incorporate sufficient allowance for expansion and contraction.



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The Constructor shall take special care with all polyethylene pipes and fittings which are prone to surface damage if incorrectly handled or stored as well as being subject to degradation when exposed to sunlight. All handling and storage shall be strictly in accordance with the manufacturer's recommendations and procedures. No metal chains or slings shall be used.

Compression fittings shall not be used without prior written approval from Unitywater.

## 11.13.2 Pipe class specifications

The following descriptors apply to the Polyethylene pipe class:

- Pipe Sizes: DN 20 to 1200
  - Design Pressures, PN16: 1600 kPa @ <20°C  
1400 kPa @ <30°C  
1200 kPa @ <40°C  
1000 kPa @ <50°C
  - Design Temperature: 50°C (limited by EPDM gaskets).

The following specifications and standards apply to the Polyethylene pipe class:

Table 14: Specifications for PE Pipes

| Item         | Size DN (mm) | Material/ Standard                                 | Description  |
|--------------|--------------|--|--|
| Pipe         | 20 to 1000   | AS/NZS 4130AS/NZS 4131<br>WSA PS-207<br>WSA PS-242 | Series 1 PE 100 SDR per IPAM list requirements, or by design.  |
| Fittings     | 20 to 1000   | AS/NZS 4129,<br>AS/NZS 4131                        | PE 100, SDR per IPAM list requirements, or by design. SDR of fittings to match the SDR of the line size. Electrofusion or butt welding type  |
| Flanges      | 20 to 1000   | AS/NZS 4131,<br>AS/NZS 3678                        | PE 100 SDR per IPAM list requirements, or by design. Electrofusion or butt welding type stub flange with stainless steel backing flange to AS 4087 PN 16. SDR of stub to match the line size SDR. Full face flanges are required up to OD355. AS 2129 Table D (or E for ≤ DN 100) flanges may be accepted if AS 4087 PN 16 type are not available. |
| Gaskets      | 20 to 1000   | Solid EPDM<br>WSA-109                              | Full face gasket - 3.0 mm thick<br>Type WA, WC or WG to suit fluid<br>Hardness - 70 IRHD   |
| Flange Bolts |              | ISO 4014<br>AS 1111                                | Metric, 316 stainless steel, DIN A4 Class 50 (min)   |
| Nuts         |              | ISO 4032<br>AS 1112                                | Metric, 316 stainless steel, DIN A4 Class 50 (min)   |
| Studs        |              | DIN 976-1<br>AS 2528                               | Metric, 316 stainless steel, DIN A4 Class 50 (min)   |



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## 11.14 Acrylonitrile Butadiene Styrene (ABS) pipes

### 11.14.1 General

All ABS pipework shall be manufactured in accordance with the requirements of AS/NZS 3518. All ABS pipework systems shall be installed in accordance with AS/NZS 3690.

All flanged ABS piping shall be fitted with Grade 316 stainless steel backing rings. If exposed to direct heat from sun, use pressure rating stated below for 40°C.

### 11.14.2 Pipe class specifications

The following descriptors apply to the ABS pipe class:

- Pipe Sizes: DN 15 to 750
  - Design Pressures, PN15: 1500 kPa @ -20 to ≤ 20°C  
850kPa @ >20 to ≤ 40°C  
630 kPa @ >40 to ≤ 50°C
- Design Temperature 50°C (limited by EPDM gaskets)
- Design Pressures, PN12: 1200 kPa @ -20 to ≤ 20°C  
680 kPa @ >20 to ≤ 40°C  
500 kPa @ >40 to ≤ 50°C
- Design Temperature 50°C (limited by EPDM gaskets)

The following specification and standards apply to the ABS pipe class:

Table 15: Specifications for ABS Pipes

| Item         | Size<br>DN (mm) | Material/ Standard         | Description  |
|--------------|-----------------|----------------------------|--|
| Pipe         | 15 to 750       | AS/NZS 3518                | PN 12 and PN 15 pipe, plain ends   |
| Fittings     | 15 to 750       | AS/NZS 3518                | Moulded with female socket ends for ABS solvent cement joints. PN not less than pipe pressure class  |
| Flanges      | 15 to 50        | AS/NZS 3678<br>AS/NZS 4087 | Full face flange with socket solvent cement joint to pipe and with stainless steel backing ring to AS/NZS 4087 PN 16                       |
|              | 80 to 750       | AS/NZS 3678<br>AS/NZS 4087 | Stub flange with socket solvent cement joint to pipe and with carbon steel hot dip galvanized backing ring conforming to AS/NZS 4087 PN 16 |
| Gaskets      | 15 to 750       | Solid EPDM<br>WSA-109      | Full face gasket - 3.0 mm thick<br>Type WA, WC or WG to suit fluid<br>Hardness - 70 IRHD   |
| Flange Bolts |                 | ISO 4014<br>AS 1111        | Metric, 316 stainless steel, DIN A4 Class 50 (min)   |

| Item   | Size<br>DN (mm) | Material/ Standard   | Description   |
|--------|-----------------|----------------------|---|
| Nuts   |                 | ISO 4032<br>AS 1112  | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| Studs  |                 | DIN 976-1<br>AS 2528 | Metric, 316 stainless steel, DIN A4 Class 50 (min). |
| Joints | 15 to 750       | AS/NZS 3879          | Solvent cement joints                               |

## 11.15 Unplasticised Polyvinyl Chloride (PVC-U)

### 11.15.1 General

All PVC-U pressure pipe systems shall be manufactured in accordance with AS/NZS 1477. Non pressure (DWV) PVC-U systems shall be manufactured in accordance with AS/NZS 1260. All PVC-U systems shall be installed strictly in accordance with the requirements of AS/NZS 2032 and AS/NZS 2566.

The requirements below are generally made for pressure piping systems, and may be used as guiding principles for non pressure. Solvent welded jointing systems are to be used for pressure piping only, and are not acceptable for non pressure.

Where pipe will be exposed to direct sunlight, pipe shall be painted in accordance with System 19, Section 10.4.1.

Cleaning fluids or solvents that might damage PVC-U must not be used.

Pipe and/or fittings containing lead-based stabilisers and/or plasticisers are not allowable and shall not be used.

Pipes shall be cut square and flat using a fine-toothed PVC saw. Burrs shall be removed from both inside and outside edges of the pipe and a 15° chamfer cut on the external surface with PVC bevelling tool.

Joints shall be made in accordance with the pipe manufacturer's recommended method using pressure grade solvent cement and the associated cleaner/primer as supplied by the pipe manufacturer.

Immediately after application of the cement the socket shall be pushed over the spigot, rotating one quarter to one half turn at the same time until the spigot "bottoms" in the socket.

Joints shall not be disturbed for a minimum period of five minutes after making the joint.

Excess cement shall be removed from both internal and external surfaces.



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### 11.15.2 Pipe class specifications

The following descriptors apply to the PVC-U pipe class:

- Pipe Sizes: DN 15 to DN 300
- Design Pressures, PN 18: 1800 kPa @ <20°C  
1620 kPa @ <30°C  
1260 kPa @ <40°C  
900 kPa @ <50°C
- Design Pressures, PN 12: 1200 kPa @ <20°C  
1080 kPa @ <30°C  
840 kPa @ <40°C  
600 kPa @ <50°C

The following specifications and standards apply to the PVC-U pipe class:

Table 16: Specifications for PVC-U (Pressure Pipe)

| Item                | Size<br>DN (mm) | Material/ Standard    | Description  |
|---------------------|-----------------|-----------------------|--|
| <b>Pipe</b>         | 15              | PVC-U AS/NZS 1477     | PN15 or PN18 pressure pipe plain ends, not less than PN of piping system. Dimensions to AS/NZS 1477 Series 1 for solvent cement joints   |
|                     | 20 to 300       | PVC-U AS/NZS 1477     | PN12 or PN18 pressure pipe plain ends, not less than PN of piping system<br>Dimensions to AS/NZS 1477 Series 1 for solvent cement joints or Series 2 for rubber ring joints, compatible with ductile iron pipes ≥ DN 100 |
| <b>Fittings</b>     | 15 to 300       | PVC-U AS/NZS 1477     | PN12, PN15 or PN18 PVC-U socket type fittings, not less than PN of piping system. Dimensions to AS/NZS 1477 Series 1 for solvent cement joints   |
| <b>Flanges</b>      | 15 to 40        | PVC-U AS/NZS 1477     | PN18 full face PVC-U flange to AS/NZS 4087 PN 16. AS 2129 Table D (or E for ≤ DN 100) flanges may be accepted if AS/NZS 4087 PN 16 type are not available.   |
| <b>Gaskets</b>      | 15 to 300       | Solid EPDM<br>WSA-109 | Full face gasket - 3.0 mm thick<br>Type WA, WC or WG to suit fluid<br>Hardness - 70 IRHD   |
| <b>Flange bolts</b> |                 | ISO 4014<br>AS 1111   | Metric, 316 stainless steel, DIN A4 Class 50 (min)   |
| <b>Nuts</b>         |                 | ISO 4032<br>AS 1112   | Metric, 316 stainless steel, DIN A4 Class 50 (min)   |
| <b>Studs</b>        |                 | DIN 976-1<br>AS 2528  | Metric, 316 stainless steel, DIN A4 Class 50 (min)   |
| <b>Joints</b>       | 15 to 300       | AS 3879               | Solvent cemented joints  |



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## 11.16 Oriented Polyvinyl Chloride (PVC-O)

### 11.16.1 General

All oriented PVC (PVC-O) pipes shall be manufactured in accordance with AS/NZS 4441. All PVC-O systems shall be installed strictly in accordance with the requirements of AS/NZS 2032 and AS/NZS 2566.

Where pipe will be exposed to direct sunlight, the pipe shall be painted in accordance with System 19, Section 10.4.1.

Cleaning fluids or solvents that might damage the PVC-O must not be used.

Pipe and/or fittings containing lead-based stabilisers and/or plasticisers are not allowable and shall not be used.

Pipes shall be cut square and flat using a fine toothed PVC saw. Burrs shall be removed from both inside and outside edges of the pipe and a 15 degree chamfer cut on the external surface with PVC bevelling tool.

### 11.16.2 Pipe class specifications

The following descriptors apply to the PVC-O pipe class:

- Pipe Sizes: DN 100 to DN 375
  - Design Pressures, PN 16: 1600 kPa @ <20°C  
1390 kPa @ <30°C  
1120 kPa @ <40°C  
1020 kPa @ <45°C

The following specifications and standards apply to the PVC-O pipe class:

Table 17: Specifications for PVC-O Pipes

| Item   | Size DN (mm) | Material/Standard                              | Description   |
|--------|--------------|--|---|
| Pipe   | 100 to 375   | PVC-O, PN16<br>AS/NZS 4441<br>ISO 16422 series | Dimensions to AS/NZS 4441 Series 2 for rubber ring joints, compatible with ductile iron pipes |
| Joints | 100 to 375   |  | Rubber ring joints only, seals to AS 1646   |



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## 11.17 Modified Polyvinyl Chloride (PVC-M)

### 11.17.1 General

All modified PVC (PVC-M) pipes shall be manufactured in accordance with AS/NZS 4765. All PVC-M systems shall be installed strictly in accordance with the requirements of AS/NZS 2032 and AS/NZS 2566.

Where pipe will be exposed to direct sunlight, the pipe shall be painted in accordance with System 19, Section 10.4.1.

Cleaning fluids or solvents that might damage the PVC-M must not be used.

Pipe and/or fittings containing lead-based stabilisers and/or plasticisers are not allowable and shall not be used.

Pipes shall be cut square and flat using a fine-toothed PVC saw. Burrs shall be removed from both inside and outside edges of the pipe and a 15 degree chamfer cut on the external surface with PVC bevelling tools.

### 11.17.2 Pipe class specifications

The following descriptors apply to the PVC-M pipe class:

- Pipe Sizes: DN 100 to DN 375
  - Design Pressures, PN 16: 1600 kPa @ <20°C  
1390 kPa @ <30°C  
1120 kPa @ <40°C  
925 kPa @ <50°C

The following specifications and standards apply to the PVC-M pipe class:

Table 18: Specifications for PVC-M Pipes

| Item   | Size<br>DN (mm) | Material/<br>Standard      | Description   |
|--------|-----------------|----------------------------|---|
| Pipe   | 100 to 375      | PVC-M, PN16<br>AS/NZS 4765 | Dimensions to AS/NZS 4765 Series 2 for rubber ring joints, compatible with ductile iron pipes |
| Joints | 100 to 375      |                            | Rubber ring joints only, seals to AS 1646   |



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## 11.18 Copper tube

### 11.18.1 General

Copper tubing shall be manufactured in accordance with AS 1432.

Compression fittings shall be “Alltite”, “Starkie” or equivalent. “Crox” unions shall not be acceptable.

The preparation of copper tube for jointing (brazed / soldered / compression) shall follow the principles as per the requirement of Section 11.8.9.

### 11.18.2 Pipe class specifications

The following descriptors apply to the Copper Tube pipe class:

- Pipe Sizes: DN 15 to 50
  - Design Pressure: 1400 kPa
  - Design Temperature: 50°C (limited by EPDM gaskets)

The following specifications and standards apply to the Copper Tube pipe class:

Table 19: Specifications for Copper Tube

| Item                | Size<br>DN (mm) | Material/<br>Standard | Description   |
|---------------------|-----------------|-----------------------|---|
| <b>Pipe</b>         | 15 to 20        | AS 1432 Type A        | Bendable grade copper tube, plain ends, straight lengths  |
|                     | 25 to 50        | AS 1432               | Hard drawn copper tube, plain ends, straight lengths  |
| <b>Fittings</b>     | 15 to 50        | AS 1572               | Copper alloy dezincification resistant (DR) fittings for soldered, threaded and compression type joints |
| <b>Flanges</b>      | 15 to 50        | AS 1572               | Copper plate flange brazed inside and outside or integral flange, flat face, AS 4087 PN16               |
| <b>Gaskets</b>      | 15 to 50        | Solid EPDM<br>WSA-109 | Full face gasket - 3.0 mm thick<br>Type WA, WC or WG to suit fluid<br>Hardness - 70 IRHD                |
| <b>Flange bolts</b> |                 | ISO 4014<br>AS 1111   | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Nuts</b>         |                 | ISO 4032<br>AS 1112   | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Studs</b>        |                 | DIN 976-1<br>AS 2528  | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Joints</b>       | 15 to 50        | AS4809                | Soldered, capillary, brazed, compression or threaded fittings to approved standards.                    |

## 11.19 Glass Reinforced Plastic (GRP) pipes and fittings

### 11.19.1 General

GRP piping shall be designed, constructed and installed in accordance with AS/NZS 2885.1 and ISO 14692 Parts 1 to 4. It is recognised that AS/NZS 2885.1 primarily relates to steel pipelines but provides guidelines for the use of pipe manufactured from GRP. Consequently, certain provisions of AS/NZS 2885.1 are not applicable to GRP piping (specifically those relating to materials, fracture control, stress, strain and corrosion) and the relevant provisions of ISO 14692 shall be used in their place.

All fittings shall be manufactured, and suitability prepared for butt and over wrap jointing to pipe.

Standard bends shall be manufactured having radii of 1.5 x the pipe diameter as standard.

Tapers shall be manufactured with standard reductions.

### 11.19.2 Raw materials

Thermoset resins shall be as specified below:

- Inner Surface and Corrosion Barrier:
  - Vinyl ester (VE) Derakane 411-350 or equivalent with minimum elongation of 4.5% and a heat distortion temperature (HDT) not less than 20°C higher than the pipe design temperature.
- Structural Resin:
  - Isophthalic Polyester (IP) resin, high grade resin with a minimum elongation of 2% and a HDT not less than 20°C higher than the pipe design temperature.
- Outer Surface and External Corrosion Layer Resin:
  - IP resin containing an ultraviolet ray absorber /inhibitor.
  - No colour code pigment shall be used for pipework installed indoors unless specified.
- Post Curing Resins:
  - The Designer/Constructor, in conjunction with the resin supplier/manufacturer, shall determine whether post-curing is necessary and ensure that the resin cure is adequate for service duties and life expectancy requirements.
  - Post-curing shall be performed in accordance with the resin manufacturer's requirements and published data.
- Glass fibre reinforcements shall be as specified below:
- Surfacing Veil 'Tissue':
  - Glass veil shall be a minimum 25 g/m<sup>2</sup> non-woven commercial grade type C glass with binder compatible to lay up resins.
- Chopped Strand Mat (CSM):
  - CSM shall be 450 g/m<sup>2</sup> and 600 g/m<sup>2</sup> commercial grade type E (electrical borosilicate) glass in non-continuous strands with coupling agent to provide compatible bond to resins.

- Woven Rovings (WR):
  - WR shall be 600 g/m<sup>2</sup> and 800 g/m<sup>2</sup> commercial grade type E (electrical borosilicate) glass with coupling agent to provide compatible bond to resins and warp and weft to be equal.
- Continuous Rovings (CR):
  - CR shall be commercial grade type E (electrical borosilicate) glass with coupling agent to provide compatible bond to resins.
- Glass to Tape:
  - Glass tape shall be plain weave glass fibre fabric with selvage edge 195-325 g/m<sup>2</sup> in 50, 75 and 100 mm wide.
- Glass Cloth:
  - Cloth shall be plain woven glass fibre cloth 195-325 g/m<sup>2</sup> in 1520 mm width roll.
- E-Glass Corrosion Resistant reinforcement:
  - When required, corrosion resistant CSM and WR shall be specified by type and mass according to the application.

Reference shall be made to the raw material supplier's Safety Data Sheets and guides for safe handling of unsaturated polyester resin and curing systems.

### 11.19.3 Pressure design basis

Piping shall be designed and manufactured in accordance with the service conditions as provided in the pipe schedule.

In any case, the GRP piping shall not have a pressure rating less than PN6.

The Designer/Constructor shall provide design calculations for all sizes and classes of pipe, fittings, flanges and joints together with unit masses.

### 11.19.4 Pipe stiffness

The minimum allowable pipe stiffness shall be 10,000 N/m<sup>2</sup> for all underground pipes except where otherwise stated by the Superintendent.

The stiffness class shall be verified by the Constructor in accordance with the design to ensure suitability with burial conditions, axial loads, traffic loads and negative pressures.

### 11.19.5 Pipe construction

The pipe shall be manufactured by machine-made filament winding process using thermosetting resin to impregnate strands of continuous glass filament rovings which are wound onto a straight mandrel at a prescribed helix angle and under controlled tension over a thermosetting chemical barrier.

## 11.19.6 Flanges

Flanges shall be of the full-face type with tapered necks in preparation for butt/over wrap joints. Flanges shall be drilled in accordance with AS/NZS 4087.

Flanges shall be flat faced GRP contact moulded from CSM and WR impregnated with thermosetting resin with a design strain of 0.0020.

Minimum glass content of flanges shall be 30%.

In the event that flanges with O-ring seals are called for, the seal groove shall be machined and suitably resin sealed, ensuring that the O-ring contact surfaces are smooth, uniform and free from resin runs.

The outer surface shall comprise a clear waxed reinforced resin rich finishing coat of thermosetting resin containing an ultraviolet ray absorber/inhibitor.

All bolt holes shall be drilled after full cure of the laminate has been achieved. The backs of flanges are to be smooth, flat and suitable for backing ring acceptance and/or correct washer seating. Special attention shall be paid to the hub area in order to facilitate torque wrench and socket access when tightening up the bolts.

Flat split stainless steel backing flanges shall be fitted behind flange faces on flange sizes above DN500 when used for pressure duties above 600 kPa. It is the Contractor's responsibility to determine the optimum internal diameter of the backing ring so that it does not make contact with the hub neck/flange transition radius.

Fittings shall be one-piece contact moulded reinforced with CSM and RW, impregnated with thermosetting resin.

## 11.19.7 Jointing system and procedures

Butt and over wrap joints are the preferred method of jointing, however, the Constructor shall prove competence through quality systems and qualification testing of these joints. Design calculations shall also be provided for the overlay widths and thickness requirements of these joints.

## 11.19.8 Corrosion barriers

Unless specified, all pipe and fittings shall be constructed with a 2 mm internal and 0.2 mm external corrosion barrier.

## 11.19.9 Tolerances

Tolerances shall be in accordance with ISO 14692-2 and ISO 14692-4.



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## 11.19.10 Pipe class specifications

The following descriptors apply to the GRP pipe class:

- Pipe Sizes: DN 300 to 1200
    - Design Pressure: To suit service conditions. Not less than PN6
    - Design Temperature: 35°C
- Apply de-rating factors:
- 0.9 for 45°C design temperature
  - 0.8 for 55°C design temperature

The following specifications and standards apply to the GRP pipe class:

Table 20: Specification for GRP Pipes

| Item                | Size DN (mm) | Material/Standard             | Item  |
|---------------------|--------------|-------------------------------|---|
| <b>Pipe</b>         | 300 to 1200  | AS/NZS 2885.1,<br>ISO 14692-2 | GRP piping, pressure rating to suit service conditions as defined in Pipe Schedule (minimum PN6)<br>Stiffness 10 000N/m <sup>2</sup> for buried pipes |
| <b>Flanges</b>      | 300 to 1200  | ISO 14692-2,<br>AS/NZS 3678   | Full face GRP flanges with AS 4087 PN16 drillings   |
| <b>Gaskets</b>      | 300 to 1200  | Solid EPDM<br>WSA-109         | Full face gasket - 3.0 mm thick<br>Type WA, WC or WG to suit fluid<br>Hardness - 70 IRHD  |
| <b>Flange bolts</b> | 300 to 1200  | ISO 4014<br>AS 1111           | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Nuts</b>         |              | ISO 4032<br>AS 1112           | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Studs</b>        |              | DIN 976-1<br>AS 2528          | Metric, 316 stainless steel, DIN A4 Class 50 (min)  |
| <b>Fittings</b>     |              | ISO 14692-2                   | GRP fittings, pressure rating to suit service conditions (minimum PN6)  |
| <b>Joints</b>       | 300 to 1200  | ISO 14692-2                   | Butt joints and over wrap joints preferred  |

## 11.20 Flexible piping

Hose for process pipework shall be of a suitable material for chemical resistance to the conveyed fluid, and shall be suitably pressure rated.

Hose for wash down purposes shall be GEM type or equal. Reels for hose storage shall be fabricated from stainless steel and be supplied with 20 metres of 25 mm diameter hose (PVC), except where shown otherwise. Flow shall be controlled at the downstream end by use of a proprietary nozzle allowing adjustment from jet through spray to stop.

## 11.21 Potable water fittings

Potable water systems shall be designed, installed and commissioned in accordance with AS/NZS 3500.1. All fittings and other components in potable water systems shall be guaranteed to be manufactured from material approved for use with potable water as per AS/NZS 4020.

The surface of pipes, valves and fittings which come into contact with potable water shall be protected by materials that:

- shall not constitute a toxic hazard
- shall not support microbial growth
- shall not give rise to unpleasant taste or odour, cloudiness or discolouration of the water.

Where bituminous paints and coatings are accepted by Unitywater, they shall be made from petroleum or asphaltic bitumen and not coal tar bitumen. Surfaces to be protected shall be correctly prepared and given two coats of protective finish. The Constructor shall specify the finish to be applied for future repairs.

## 11.22 Fabrication and installation of carbon and stainless steel

### 11.22.1 Workshop requirements

Site fabrication of pipe spools will not be permitted.

The surface preparation and painting of pipe spools shall be conducted in a separate area from the pipe fabrication.

A separate area shall be provided for non-destructive testing. This area shall be located at a safe distance from the piping spool fabrication. The area shall comply with all statutory and safety requirements.

### 11.22.2 Stainless steel

Stainless steel fabrication shall be carried out in an area where contamination from carbon steel grindings and other carbon steel items is completely prevented.

Direct contact between carbon steel and stainless steel is not permitted. The Designer/Constructor shall confirm that the supplier uses procedures which prevent such contact and the resultant contamination of the stainless steel.

Tools and grinding discs containing carbon steel shall not be used on stainless steel. Tools used for fabrication of stainless steel shall be clearly identified and labelled, used only for fabrication of stainless steel piping and piping components. They shall be stored separately to avoid accidental switching with tools previously used on carbon steel fabrication work.

### 11.22.3 Misalignment tolerance

All piping fit-ups shall be subject to the bore misalignment tolerances indicated in the table below:

Table 21: Pipe Misalignment Tolerance

| Nominal Pipe Size (DN) | Misalignment Tolerance (mm) |
|------------------------|-----------------------------|
| ≤150                   | 1.0                         |
| 200 – 300              | 2.0                         |
| ≥350                   | 2.5                         |

Misalignments shall be minimised wherever possible, at least by rotating the pipe/fitting for best fit and/or by grinding the bore as required.

### 11.22.4 Slip-on flanges

Slip-on flanges shall be positioned so that the end of the pipe is recessed from the face of the flange a distance equal to the lesser of the pipe wall thickness or 9 mm.

Seal welding for slip-on flanges shall be carefully applied in order to avoid refacing the flange. Internal and external welds shall be as identified in AS 4041.

Pipes for insertion in slip-on flanges shall be cut square within 0.5 mm.

### 11.22.5 Socket welding

Pipe insertion in a socket weld joint shall be cut square within 0.5 mm. A minimum gap of 1.6 mm shall be maintained between the end of the pipe and the bottom of the socket.

### 11.22.6 Threaded connections

Unless otherwise specified, all threads shall be in accordance with AS ISO 7.1 and AS ISO 7.2 (taper threads) (BSPT compatible).

Reaming shall deburr inside ends of threaded pipes.

All threaded connections shall be gauged checked or chased after galvanizing.

Threaded connections shall not be seal welded except where specified.

Threaded joints in a piping system shall be made up using PTFE pipe tape or thread seal compound installed on the male except for stainless steel piping where nickel-based thread tape shall be used.

## 11.22.7 Branch connections

Fabricated branch connections shall be in accordance with AS 4041.

All cuts shall be carefully bevelled and accurately matched to form a suitable preparation for welding and to permit full penetration of welds between the branch and the run pipe at all points.

All reinforcement pads for pressure openings or each segment of build-up type reinforcement pads for pressure openings shall be provided with G $\frac{1}{4}$  (BSPT compatible) threaded hole for testing and venting. The vent hole shall be sealed after completion of the pressure test with grease or silicon sealant to prevent ingress of moisture.

Branch connections, vent nozzles, trunnions and other attachments including reinforcing pads shall not be welded over or near longitudinal or circumferential welds. The minimum distance between the weld in the pipe and the weld at the fitting shall be 50 mm measured between the heat affected zones. For reinforcing pads, the minimum distance measured between the heat-affected zones of the weld in the pipe and fillet weld of the pad shall be 25 mm.

## 11.22.8 Cold bending

Pipes of DN40 and smaller shall be bent only where cold bending is indicated on the project drawings. In all other cases, butt weld, socket weld or screwed elbows shall be used depending on piping class.

Cold bending shall be carried out using pipe bending machines; otherwise presses and dies shall be employed to prevent flattening.

Unless noted otherwise, the centreline radius of bends shall be five nominal pipe diameters. Butt welds in the arcs of bends or for the addition of pulling legs shall not be permitted.

All bends shall be smooth, free from cracks and surface defects, without buckles and they shall be within tolerance limits identified in AS 4041.

Cold or hot bending of stainless steel pipe is prohibited.

## 11.22.9 Mitre bends

Segmented bends shall be manufactured by butt welding together segments of pipe, shaped to produce the required bend. Wherever possible, the segments shall be taken from the same length of pipe. However, the segments shall be limited to applications detailed on piping drawings.

The change of centreline at butt welds in segmented bends shall not exceed 30 degrees.

## 11.22.10 Factory inspection and testing

All fabrication shall be inspected in accordance with AS 4041.

Inspection shall include 100% visual examination and any other additional examination necessary to ensure compliance with this Specification.

Inspection and testing shall be carried out before any painting or coating is applied.

Non-destructive testing of welds shall be carried out after final heat treatment is completed.

The extent of non-destructive inspection of fabricated piping shall be in accordance with AS 4041 unless stated otherwise.

## 11.23 Pipeline identification

Where specified, piping shall be identified with colour coding, flow direction and fluid ID markers in accordance with AS 1345 and AS 2700.

Colour coding shall either be by bands or by full colour code according to the Australian Standards.

Identification markings shall be placed in accordance with AS 1345.

### 11.23.1 Material and pipe spool identification

All pipes and fabricated fittings shall be tagged or marked using an approved system and procedure.

Piping spools shall be marked/stamped after fabrication and prior to corrosion protection.

Material identification shall be maintained throughout the fabrication, installation, up to and including final inspection. In particular, an approved system shall be used to clearly identify the material of all pipes and fittings of ABS and PVC-U construction due to their visual similarity.

Where plastic pipe has been selected for use and is to remain uncoated out of direct UV exposure; manufacturer markings (inc. material, class rating, size and date) shall be clearly visible and marked on the section of pipe.

## 11.24 Storage and handling

### 11.24.1 General

All piping components shall be stored in a clean area away from the fabrication and construction activities and handled such that no damage or mixing of materials occurs.

Materials shall be stored on pallets and not on the ground. End caps shall be kept on all components during storage. Threaded ends shall be protected by end caps.

Hooks shall not be used for lifting. Pipes shall not be rolled off or dropped onto the ground or dragged over the ground.

Flange facings shall be protected from damage. Covers shall be securely fastened to flange facings during handling, transportation and storage at site.

### 11.24.2 Stainless steel materials

Stainless steel materials must be stored on non-metallic pallets.

End caps shall be kept on piping components until immediately prior to installation.

All flanges and flanged connections shall be sealed with blinds to prevent ingress of water, moisture and foreign matter. Threaded ends shall be capped with a plastic cap and sealed.

Stainless steel piping and components shall be stored in separate areas away from storage areas for carbon steel and other materials to avoid direct contact causing galvanic corrosion.

Steel wire slings shall not be used for handling and transporting stainless steel materials. Canvas or nylon slings shall be used.

The surfaces of components shall be cleaned with acetone and then rinsed with demineralised water to remove deposits of foreign materials.

### **11.24.3 Lined steel pipes**

Pipes and piping components shall be handled in such a way that the lining and other materials are not damaged.

For cement lined pipe, airtight end covers shall be fitted at all times to ensure a moist atmosphere inside the pipe and for retaining any broken pieces of the lining.

Lined pipe shall not come into contact with sharp edges and shall always be supported uniformly along its length.

The lined pipe shall be stored under cover to protect it from exposure to high temperatures.

### **11.24.4 Repair of coatings and linings**

The Constructor shall ensure that damage caused to the coatings or linings of pipework before acceptance of delivery at site shall be repaired by the supplier using the appropriate repair procedures in accordance with manufacturer guidelines.

## **12. Rotating machines**

### **12.1 Lubrication**

All components shall be lubricated as required prior to testing and delivery.

Prior to placing machinery into service, all reservoirs, sumps and tanks shall be filled to their correct levels and all lubrication pipework shall be fully primed in accordance with the manufacturer's recommendations.

The lubricant shall be suitable for the particular duty and ambient temperature conditions. Brands, grades and types of lubricants shall not be mixed for the same machine application.

All items above coping level requiring lubrication shall be capable of lubrication from one location, if at all practical.

Unless specified otherwise, grease lines, brackets, and fittings shall be stainless steel. High pressure flexible lines shall be used in moving or vibrating applications. All grease lines shall be of adequate size and strength and permanently marked for identification.

A list of recommended lubricants and their equivalents shall be provided as part of handover to Unitywater. Lubrication points shall be labelled with "initial fill" lubricants.

All lubrication and oil fill points shall be labelled to specify the type of lubricant used and the quantity required. A nameplate shall be provided at each remote lubrication point to indicate the item it serves.

Plates shall be engraved stainless steel Grade 316, fastened with stainless steel screws. Lubrication nameplates are not required on submersible pumps.

Where lubrication is required at a frequency higher than one application per month an automatic lubrication system shall be provided. The automatic system, whether centralised or decentralised, shall be easily viewed for fill status and functionality by the operator.

All items of mechanical equipment shall be provided with a lubrication schedule showing recommended lubricants, acceptable alternative lubricants, lubrication points, lubrication volumes and lubrication frequency. The lubrication schedule for each item of equipment must be provided to Unitywater separately and prior to the delivery of the equipment.

Recirculating oil systems shall be provided with an easily and safely accessible reservoir. The reservoir shall be provided with a contents level indicator and a filler point complete with filter. Lubrication systems reliant upon pumped circulation of the lubricant and where failure of the system would result in catastrophic failure of the process plant or equipment shall incorporate instrumentation to provide an alarm signal in the event of a blockage, loss of lubricant or another malfunction.

Lubrication systems for plant used on potable water treatment installations shall be designed to ensure that failure will not affect the potable water supply.

## 12.2 Couplings

Couplings shall be selected to enable separation of the driver and driven components without the need to disturb the “other” component. Split-type couplings shall be supplied as a matched pair and shall be marked accordingly. Spacer-type couplings shall be used where this would facilitate maintenance of either the driver or driven machine in-situ.

Couplings shall be designed to take up axial shaft movement from either driver or the machine, or both, without either the driver or the machine being affected.

Flexible shaft couplings shall be provided, where necessary, between motor shafts and the driven shafts. Flexible couplings shall be of cone ring type or flexible element type rated to suit the torque output of the motor or gearbox under all conditions of loading.

## 12.3 Alignments

The installed alignments, fits, pre-tensions, float, and settings on all items of equipment shall be in accordance with the item manufacturer’s written instructions which may include precision tools (for example, steel straight edge, dial indicator and graduated machinist levels).

Specifically, all direct driven equipment shall be aligned by the use of a dial test indicator or laser alignment. Both the driver and the driven shafts shall be rotated simultaneously to each of the four positions at 0°, 90°, 180° and 270° at which readings shall be taken.

The maximum allowable out-of-alignment tolerance shall be 50 µm (0.05 mm) unless specified otherwise in individual equipment installation instructions. An alignment record sheet shall be supplied with the installation instructions showing the factory set alignment and shall be completed for each coupling aligned. This alignment procedure shall also conform to the equipment manufacturer’s instructions. All alignments are to be documented by the installer.

Where separate items of interconnected plant, such as motors, couplings, gearboxes and similar items depend upon correct alignment for satisfactory operation, then each and every item shall be positively located in its correct operational position by means of dowels, locating pins, fitted bolts or other approved means to ensure that correct re-alignment can be easily achieved when re-assembling the items after removal for overhauls.

## 12.4 Belt drives

Belt drives shall be designed such that not more than 20% of the speed reduction is achieved by pulley ratios. All belt drives shall include a means of adjusting the tension of the belt(s) so that belts maintain motion in a single plane and are not subject to lateral movement.

## 12.5 Gearboxes and casings

Gearboxes shall be designed to operate continuously at maximum duty with a minimum service factor in accordance with AGMA standards based on maximum operating torque and the specified ambient operating condition. In addition, each gearbox shall be designed to withstand starting torques of up to 250% of the full load running torque of the driving motor.

The recommended grade of gear box oil shall be supplied by the installer at handover.

Gearboxes and casings shall be designed to suit the machine seating arrangement and the service specified.

Gear housings shall be in two-piece constructions with a top cover for ease of inspection and maintenance where practicable.

The direction of rotation of input and output shaft shall be permanently marked on the housing.

Removable inspection covers, complete with gaskets, shall be provided to permit inspection of the gears without disassembly of the gear reducer/increaser where practicable. Lifting lugs shall be provided for all gearboxes heavier than 20 kg.

Unless otherwise specified gears shall be splash lubricated from a sump and the bearings shall be either splash lubricated or grease lubricated. Where grease lubricated bearings are fitted, seals shall be installed to retain the grease in the housing. Grease nipples and grease relief devices shall be fitted to housings containing grease-lubricated bearings. Greasing tubes and nipples shall be connected to the bearing housing and terminated in a location accessible for application of a grease gun if the bearing housing is otherwise inaccessible.

The gearbox itself shall be provided with sight glasses or indicators to observe lubrication oil levels.

All oil fill points and drain lines shall be of sufficient size to permit efficient functioning without spillage and shall be located on the gear unit in a position which is easily accessible from the floor. A drain tray/lubricant container shall be supplied to fit beneath the drain valve. The drain tray/container shall have sufficient capacity to receive the total volume of waste gearbox oil and be designed to be easily and safely transported without spillage.

## 12.6 Balancing and critical speed

Rotating elements shall be statically and dynamically balanced in two planes to prevent excessive vibration. Balancing shall be by machining.

Vibration levels shall not exceed values stated in Section 4.6 and shall be evaluated in accordance with ISO 20816. Lateral critical speeds shall not occur within the range between  $\pm 20\%$  of the rotational speed. Fixed speed machinery which needs to pass through its first critical speed to reach its normal running speed shall do so without damage to the machine and other rotating elements. The speeds of machines which are designed to be driven at variable or partial speed shall be comfortably in range of "normal running speed" so as not to cause damage or adversely affect machine design life. Torsional critical speeds shall not occur within the range between  $\pm 10\%$  of the rotational speed.

## 12.7 Bearings

All bearings shall be heavy duty, grease lubricated unless otherwise noted and selected to accommodate all mechanical loads imposed by the operation of the equipment including starting and motor stall, up to its maximum operating conditions.

All bearings shall be to ISO standard SI unit dimensions where practicable.

Bearings on rotating machinery shall be supported during transportation to ensure work hardening does not take place. Signage to this effect must be prominently displayed.

All bearings shall be sealed to prevent contamination and fitted in machined housings and located by dowels to assist maintenance.

Ball and roller bearings shall be steel caged. All ball or roller bearings shall be rated in accordance with ISO 281 with factors  $a_1$ ,  $a_2$  and  $a_3$  equal to one (1) to give a L10 life of 100,000 hours unless otherwise specified.

Pump shaft rolling-element bearings shall be designed to achieve a calculated L10 life in accordance with ISO 281 at the pump's maximum continuous operating speed and loading.

Plain bearings shall have steel shafts running in bronze bushes and shall have a loading, based on projected area, of no more than 300 kPa. Materials other than steel and bronze may be accepted where full details are submitted to and accepted by Unitywater.

Hydrodynamic radial bearings shall be either of split or axially removable design for easy replacement. These bearings shall be equipped with anti-rotation pins and be secured in the axial direction.

Hydrodynamic thrust bearings shall be steel backed, babbitted and arranged for continuous pressurised lubrication. Integral thrust collars are preferred.

Air and oil shaft seals must achieve the following:

- contain compressed air inside the compressor casing
- prevent oil from entering the compressor casing and contaminating the compressed air
- prevent oil from leaking out of the gear box
- prevent atmospheric air from entering any gear or compressor casing that could allow contamination of the oil system or compressed air by dirt or moisture.

Drive shafts shall be mounted in heavy duty bearing assemblies. The bearings may be oil or grease lubricated. Oil-bath lubricated bearings shall be fitted with a pressure venting device, oil fill and drain tapping's and an oil-level sight glass. Where grease lubrication is provided, grease relief provisions shall be supplied to prevent over greasing. Routine greasing points shall be located at an accessible location, without the need for removal of guards or covers.

If grease lubricated bearing are provided they shall be fitted with automatic grease dispensers. Automatic grease dispensers shall provide a clear indication of grease contents.

If oil-lubricated bearings are used, the bearing housing shall include easily accessible fill and drain plugs for in-situ oil changes without spillage or disturbing the blower mounting. An oil level sight glass shall also be provided.

## 13. Valves

### 13.1 General requirements

All valves shall comply with WSAA and Australian Standards. Where valves of international standards are required, they shall meet the performance requirements, including material, components and testing of equivalent AS/NZ standards. Valves offered to international standards in lieu of AS/NZS standards require Unitywater approval prior to purchase.

Valves shall be selected to suit the fluid properties, temperature, maximum differential pressure, maximum flow, and access requirements for operation and maintenance. Valving shall have a minimum pressure rating of PN16 unless otherwise accepted by Unitywater.

Unless otherwise stated, flanges on valves shall be to AS/NZS 4087.

Valves with threaded connections shall use British Standard Pipe Taper (BSPT) threads conforming to AS ISO 7.1 for pressure-tight joints. Threaded ends shall be: Male: R (taper), and/or Female: Rc (taper), as required for the valve type and installation.

All fasteners shall comply with the requirements of Section 6 and shall be manufactured from Grade 316 stainless steel.

All valves installed below ground shall be located within an appropriate pit structure.

Valves shall not be installed as direct-buried installations, except for gate valves where specified.

Direct-buried gate valve installations shall comply with SEQ-WAT-1308-2. Valves and components in contact with drinking water shall comply with AS/NZS 4020.

Valves exceeding 25 kg shall be provided with a means for lifting the total mass of the valve.

Dual flanged and restrained socketed valves are preferred due to their ability to remain restrained while nearby pipework is disassembled. As such, wafer and lugged valves shall only be used with approval of Unitywater, in cases where adjacent mechanical and electricals assets that need to be maintained (such as pumps, flowmeters, etc.) can be removed without loss of restraint of the wafer or lugged valve.



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All valves shall be capable of opening against full unbalanced head and closing against full flow. They shall open and close smoothly without vibration or cavitation and without damage. Isolating valves shall permit disassembly of downstream piping with the valve closed against the rated pressure.

Valves shall be closed by an anti-clockwise rotation of the closing mechanism. The face of each mechanism shall show clearly the labels OPEN and CLOSE to indicate the direction of turn to open and close the valve. Exceptions to the valve closing directions are outlined in Table 22.

Table 22: Valve Closing Direction Exceptions

| Valve Type  | Closing Direction |
|---|-------------------|
| All valves smaller than DN80  | clockwise closing |
| Knife gate valves   | clockwise closing |
| Ball valves with lever operator   | clockwise closing |
| Butterfly valves with lever operator  | clockwise closing |
| Valves in wastewater treatment plants, mounted above ground or in open pits accessible via standard walkways.<br>Definition of below ground is: Buried valves, valves mounted in enclosed pits where confined space entry is required or operation via a valve extension spindle is required. | clockwise closing |

Unless specified otherwise, the maximum allowable manual torque applied to the spindle shall be 125 Nm under the expected maximum operating differential pressure. If greater than the maximum allowable manual torque is expected, a gearbox shall be provided to reduce torque to no greater than 125 Nm. For resilient seated gate valves, to determine the required torque to operate at a pressure other than the rated pressure, the following assumptions can be made:

- The operating torque at zero differential pressure is roughly equivalent to the running torque.
- The operating torque at the valve rated pressure is equal to the rated pressure open / close torque.
- The operating torque is linear between zero and the maximum differential pressure.

Above ground valves shall be located, where practicable, to allow operation and maintenance from grade or an access platform.

Where specified, isolation valves shall be provided with a lockable mechanism in the open or closed position to prevent unauthorized or inadvertent operation.

Air valves shall be mounted above a manual isolation valve of the same diameter as the air valve. Control valves shall be suitable for cavitation free operation over the complete range of valve operating conditions. When possible, control valves shall be installed with the stem in the vertical position.

Resilient-seated valves shall be drip tight in the closed position when hydro tested at the specified design pressure.

Valve internal surfaces shall be free of sharp protrusions.

All parts requiring grease lubrication shall be fitted with grease nipples.



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Valves of the same type, size and intended for the same operating conditions located at the same site shall preferably be supplied by the same manufacturer.

## 13.2 Material requirements

Castings shall be as per requirements of Section 20.1. Valve materials shall be in line with requirements of the individual subsections, or as specified within the SEQ Accepted Civil IPAM list and/or SEQ Accepted Mechanical IPAM List. Where otherwise unspecified, shafts, spindles, external components and appropriate supports shall be constructed from 316 stainless steel or other approved corrosion resistant material”.

All shafts, spindles and appropriate supports shall be as per the below sections.

## 13.3 Valve identification

See Section 7.2.3 for valve identification requirements.

## 13.4 Water Services Australia Specifications

Valves shall comply with this Specification, Unitywater’s preferred equipment lists, SEQCode Infrastructure Products and Materials (IPAM) Lists and WSAA Product Specifications (in that order of precedence) where such specifications exist. Reference is made to the following WSAA Product Specifications:

Table 23: WSAA Valve Coating Specifications

| WSAA Valve Product Specification | Title                                    | Coating Standard           | DFT [µm] Polymeric coating - External surfaces | DFT [µm] Polymeric coating – Internal surfaces | DFT [µm] High-build two-pack epoxy coating (no primer) | DFT [µm] High-build two-pack epoxy coating (with primer) |
|----------------------------------|--|----------------------------|--|--|--|--|
| <b>WSA PS – 260</b>              | Gate Valves, Resilient Seated            | AS/NZS 4158                | 300  | 350  | Not accepted   | Not accepted   |
| <b>WSA PS – 261</b>              | Gate Valves, Metal Seated                | AS/NZS 4158                | 300  | 350  | Not accepted   | Not accepted   |
| <b>WSA PS – 266</b>              | Knife Gate Valves for Water and Sewerage | N/A                        | Uncoated                                       | Uncoated                                       | Uncoated   | Uncoated   |
| <b>WSA PS – 263</b>              | Butterfly Valves                         | AS/NZS 4158<br>AS/NZS 3750 | 300  | 350  | 500  | 550  |
| <b>WSA PS – 268</b>              | Automatic Control Valves for Water       | AS/NZS 4158<br>AS/NZS 3750 | 300  | 350  | 500  | 550  |



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| WSAA Valve Product Specification | Title                            | Coating Standard           | DFT [ $\mu$ m] Polymeric coating - External surfaces | DFT [ $\mu$ m] Polymeric coating – Internal surfaces | DFT [ $\mu$ m] High-build two-pack epoxy coating (no primer) | DFT [ $\mu$ m] High-build two-pack epoxy coating (with primer) |
|----------------------------------|----------------------------------|----------------------------|--|--|--|--|
| <b>WSA PS – 274</b>              | Ball Valves for Water & Sewerage | N/A                        | Uncoated   | Uncoated   | Uncoated   | Uncoated   |
| <b>WSA PS – 264</b>              | Non-Return (Reflux) Valves       | AS/NZS 4158                | 300  | 350  | Not accepted   | Not accepted   |
| <b>WSA PS – 265</b>              | Air Valves for Water Supply      | AS/NZS 4158<br>AS/NSZ 3750 | 300  | 350  | 500  | 550  |
| <b>WSA PS – 275</b>              | Air Valves for Sewerage          | AS/NZS 4158<br>AS/NZS 3750 | 300  | 350  | 500  | 550  |

The WSAA Product Specifications refer to various options for each valve. These options will be specified in the individual project valve schedule.

### 13.4.1 Isolation requirements

All items of plant shall be capable of being adequately isolated so that work on the plant may be undertaken in a safe manner. Isolation methods shall address liquids and gasses. Block valves or isolation valves shall be capable of being padlocked in the open or closed position appropriate to the safety being provided.

For gas handling systems, facilities shall be provided to purge isolated sections.

## 13.5 Types of valves, applicability and functionality

The valves used in UW facilities fall into one of the categories listed in Table 24 and must be the most appropriate for the intended service, operating conditions and type of fluid to be handled. The use of valve types not listed in Table 24 shall be conditional to the provision of adequate technical justification and subject to UW acceptance. Refer Section 2.1 Technical departures.



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Table 24: Summary of Valve Types

| Valve Type   | Valve Function   |                |            |                 | Notes  |
|--|------------------|----------------|------------|-----------------|--|
|  | Isolation On/Off | Control On/Off | Regulating | Solids Handling |  |
| <b>Gate valves – Resilient Seated</b>                    | Yes              | Limited        | No         | Yes             | Water, sewage and general duties where some solids may be present. Not preferred for high solids such as grit and sludge.  |
| <b>Gate valves – Metal Seated</b>                        | Yes              | Limited        | No         | Yes             | Water and general duties for high pressure applications. Not preferred where some solids may be present.   |
| <b>Knife-gate valves</b>                                 | Yes              | Yes            | No         | Yes             | Water, sewage and general duties where solids may be present. Preferred for high solids such as grit and sludge. May be used instead of gate valve where short axial length is required. |
| <b>Butterfly valves</b>                                  | Yes              | Yes            | Yes        | No              | Water and general duties. Not suitable for sewage. Not suitable where solids and stringy material may be present.  |
| <b>Automatic control valves - Hydraulically-operated</b> | Yes              | Yes            | Yes        | No              | Pressure reducing / pressure sustaining globe-type valves for water and recycled water duties, fitted with an integral hydraulic diaphragm actuator                                      |
| <b>Diaphragm Valve</b>                                   | Yes              | Yes            | Yes        | Yes             | Chemical and slurry duties where some solids may be present. Not suitable where high solids and stringy material may be present.   |
| <b>Pinch Valve</b>                                       | Yes              | Yes            | Yes        | Yes             | Sewage and sludge duties where solids and stringy material may be present.   |
| <b>Plug valves</b>                                       | Yes              | Yes            | Yes        | Yes             | Sewage and general duties where solids may be present  |
| <b>Ball valves</b>                                       | Yes              | Yes            | No         | No              | Water and general duties. Preferred for small-bore instrument isolation, vents and drains. Not suitable for large-bore applications due to cost.   |
| <b>Non-return valves – Swing flex type</b>               | N/A              | N/A            | N/A        | Yes             | Water, sewage and general duties where solids and stringy material may be present.   |
| <b>Non-return valves – Other</b>                         | N/A              | N/A            | N/A        | Limited         | Water, sewage and general duties. Dependent on layout valve.   |
| <b>Gas Release valves for water</b>                      | N/A              | N/A            | N/A        | No              | May be single acting or combination air valves. Sizing dependant on application.   |
| <b>Gas Release valves for sewage</b>                     | N/A              | N/A            | N/A        | Limited         | May be single acting or combination air valves. Sizing dependant on application. Must be suitable for sewage and sludge duties where solids and stringy material may be present.         |
| <b>Pressure Relief Valves</b>                            | N/A              | N/A            | N/A        | No              | Materials to be suitable for the application. Sizing dependant on application.   |

## 13.6 Valve testing

### 13.6.1 General

All valves shall be tested by the manufacturer in accordance with the relevant Australian Standard applicable to the specific valve type. Certified copies of the manufacturer's test reports shall be included in the project documentation.

The manufacturer testing shall simulate the valve in a terminal position, rigidly supported at one end, with the valve blanked off so that axial hydraulic force is not externally restrained. The manufacturer's test report shall confirm compliance with the fully differential-pressure test condition.

### 13.6.2 Valve testing – body tests

The valve shall be blanked off at both ends and a body test pressure of 1.5 times the valve rated pressure shall be applied for 15 minutes with the disc in the partially open position.

No leakage shall be visible through the valve body, end joints or shaft seals. Nor shall any part of the valve be permanently/plastically deformed.

### 13.6.3 Valve testing – gates tests

The valve shall be flanged off at the upstream flange only and a test pressure of 1.5 times the valve rated pressure shall be applied for five (5) minutes with the valve in the closed position.

There shall be no visual evidence of structural damage to or leakage through the disc or valve seat.

### 13.6.4 Valve testing – operational test

The operational test shall prove that the rim force required on the valve operating mechanism does not exceed the operating force requirements outlined in Section 13.1.

The valve shall be operated from fully closed to fully open positions and reverse under no-flow conditions in order to demonstrate the valve assembly operates normally.

### 13.6.5 Valve testing – seat testing

The valve shall be flanged off at the downstream flange only and a test pressure of 1.5 times the valve rated pressure shall be applied for five (5) minutes with the valve in the closed position.

No leakage of the valve seat shall be observed.

## 13.7 Gate valves – resilient and metal seated

### 13.7.1 Minimum requirements

The valves shall comply with the following minimum requirements:

- WSAA Product Specification and coating requirements as per Table 23.
- Flanges as per Section 13.1 General Requirements.
- Closing direction as per Section 13.1 General Requirements.

## 13.7.2 Function

Full-bore isolation valve, not for throttling.

Resilient seated gate valves are used for isolation in water, sewage and general applications, both above ground and buried. These valves are suitable for where some solids may be present. They are not preferred for high solids such as grit and sludge.

Metal seated gate valves are used for isolation in water and general duties for high pressure applications, both above ground and buried. They are not preferred where some solids may be present.

Metal seated gate valves are suitable for applications where the nominal size is  $\geq$ DN800, or where the nominal pressure is PN35, as this exceeds the scope of resilient seated gate valves specified in AS/NZS 2638.2.

## 13.7.3 Operation

Non-rising stem type.

## 13.7.4 Actuator

Spindle cap (with or without extension spindle), handwheel, gearbox, or powered actuator, as specified.

Gearboxes shall be provided where the maximum rim pull force exceeds the limits specified in Section 13.1.

Where an integral bypass valve is specified, it shall comply with the requirements of AS/NZS 2638.2.

Valves shall be installed in the upright position with the spindle oriented vertically. Horizontal spindle orientation is not accepted. Alternative spindle orientations require Unitywater approval.

Gate valves DN600 and larger shall be fitted with dual-input gearboxes incorporating two gear ratios. The primary (low-ratio) input shall be sized for running torque and used for normal operation. The secondary (high-ratio) input shall be sized for the greater of the cracking or closing torque and used for off-seating and seating. The specified maximum rim pull force and closing direction shall apply to both inputs.

## 13.7.5 Testing and certification requirements

All gate valves shall be subjected to production tests, and type tests where specified, in accordance with AS 2638.1 or AS 2638.2, as applicable. For metal seated gate valves, permissible seat leakage is listed in Table 5.2 of AS 2638.1.

If valves are intended to be installed in a horizontal position (following approval by Unitywater), valves shall be production-tested in that position.

For bypass valves, the small valve shall be tested prior to the fitment of the bypass arrangement. The in-line valve shall be tested after the fitment of the bypass arrangement, with the bypass valve in the closed position.

Valves must be supplied with test certificates.

## 13.8 Knife gate valves

### 13.8.1 Minimum requirements

The valves shall comply with the following minimum requirements:

- WSAA Product Specification and coating requirements as per Table 23.
- Lugged pattern with drilling to match flange specifications as per Section 13.1 General requirements.
- Closing direction as per Section 13.1 General requirements.
- Pressure Rating: Valves shall have a minimum pressure rating of PN10.

### 13.8.2 Function

Full-bore isolation valve with a sharp-edged gate capable of cutting through solids, not for throttling.

Knife-gate valves are used for isolation in water, sewage and general applications for above ground installations. These valves are preferred for high solids such as grit and sludge. May be used instead of gate valve where short axial length is required.

Bonneted Knife Gate Valves shall be used for a highly corrosive environments, un-vented sewage applications in the presence of H<sub>2</sub>S, such as sewage pump station wetwells.

### 13.8.3 Operation

Rising stem type.

### 13.8.4 Actuator

Spindle cap on a torque tube (with or without extension spindle), handwheel, gearbox, or powered actuator, as specified.

Gearboxes shall be provided where the maximum rim pull force exceeds the limits specified in Section 14.4 Manual Gearboxes.

Valves shall be installed in the upright position with the spindle oriented vertically. Horizontal spindle orientation is not accepted. Alternative spindle orientations require Unitywater approval.

## 13.9 Butterfly valves

### 13.9.1 Minimum requirements

The valves shall comply with the following minimum requirements:

- WSAA Product Specification and coating requirements as per Table 23.
- Flanges as per Section 13.1 General requirements.
- Closing direction as per Section 13.1 General requirements.
- For lever actuated valves, lever mechanism, position notch plate, pins and spring shall be:
  - stainless steel (minimum AISI 316), **OR**
  - cast iron with polymeric coating to AS/NZS 4158, **OR**
  - fusion-bonded epoxy, minimum DFT 300 µm.
- Butterfly valves shall be resilient-seated with a seal-on-body configuration. The seal shall encapsulate the wetted portion of the valve body and form an integral part of the flange face.

### 13.9.2 Function

Isolation and flow regulation valve for water and general clean fluid duties. Butterfly valves are used for isolation and throttling in water and general duties. Not suitable for sewage. Not suitable where solids and stringy material may be present.

### 13.9.3 Operation

Not used.

### 13.9.4 Actuator

Lever, gearbox, or powered actuator, as specified.

Gearboxes shall be provided on valves DN300 and larger, or where the maximum rim pull force exceeds the limits specified in Section 14.4 Manual Gearboxes.

Butterfly valves shall be installed with the shaft in the horizontal plane and have the lower part of the disc move in the same direction as the flow when the valve is opened.

Valve disc shall be fully operable without obstruction from upstream or downstream pipe fittings.

### 13.9.5 Resilient Seated

Sealing types of resilient-seated butterfly valves include seal-on-body, where the seal encapsulates the wetted part of the body and forms an integral part of the flange face, and seal-on-disc, where the seal is attached to the perimeter of the disc. Seal-on-body valves may be used for in common applications up to PN16, with emergency flow velocities up to 7.5 m/s. Seal-on-disc valves may generally be used for critical assets (e.g. large trunk mains), high emergency velocities (above 7.5 m/s), pressures above PN16 or high-frequency of operation (i.e. modulating service).

## 13.9.6 Metal seated

While most butterfly valve applications will be resilient-seated, metal seated butterfly valves may be required where the temperature exceeds 40 degrees C. In such cases the butterfly valve shall be double offset and bi-directional. Metal seated butterfly valves shall comply with the applicable provisions of API 609, as the Australian Standards do not cover metal-seated butterfly valves.

## 13.9.7 Installation

Butterfly valve connection types include flanged, lugged, and wafer.

Butterfly valves shall be installed with the shaft in the horizontal plane and have the lower part of the disc move in the same direction as the flow when the valve is opened. It is preferred that the spindle to a handwheel be orientated horizontally for above-ground applications. Each handwheel and spindle cap shall be marked 'CLOSE' with an arrow to indicate the direction of closure.

Butterfly valves DN300 and above shall have gearboxes sized in accordance with, and compliant to, Section 3.5 of AS4795.2. Butterfly valves with gear boxes shall have position indicators which show open, closed and intermediate valve disc positions and be manufactured with an enclosure rating of IP68 as per AS 60529. Butterfly valves with extension spindles shall have remote position indicators at the surface operating location, immediately below the spindle cap or handwheel.

Butterfly valves fitted with gearboxes shall have input stops and torque limiting devices in line with the requirements of AS4795.2 Section 3.3.10 to protect against over-torque damage to the gearbox and valve, particularly given the increased risk associated with the use of portable actuators. The torque limit shall be set and calibrated by the manufacturer.

Buried double-flanged butterfly valves shall be installed with an extension spindle and rigid spindle tube connecting to the gearbox. Butterfly valves shall be located in a pit or above ground. If accepted by Unitywater, buried valves shall be installed with a suitable corrosion protection system for flanges.

## 13.9.8 Testing and certification requirements

All butterfly valves shall be subjected to production tests, and type tests where specified, in accordance with AS 4795.1 or AS 4795.2, as applicable.

Valves must be supplied with test certificates.

## 13.10 Automatic control valves – hydraulically operated

### 13.10.1 Minimum requirements

The valves shall comply with the following minimum requirements:

- WSAA Product Specification and coating requirements as per Table 23.
- Flanges as per Section 13.1 General requirements.

Hydraulically operated automatic control valves are used for the regulation of flow, pressure, and level within the water network. Examples include Pressure Reducing Valves (PRVs), Flow Control Valves (FCVs), Altitude Valves, and Pressure Sustaining Valves (PSVs).

Hydraulically operated automatic control valves shall be located in pits or above ground to facilitate maintenance access and control system tuning.

Where a hydraulically operated automatic control valve has been deemed at risk of cavitation over its operating range, a noise assessment shall be completed to determine any extra requirement for an acoustic enclosure.

### **13.10.2 Function**

Flow regulation valve for water and general clean fluid duties.

Automatic control valves are used for pressure reducing, pressure sustaining, flow control in water and general duties. Not suitable for sewage. Not suitable where solids and stringy material may be present.

Automatic control valves shall be globe-type with metal seats.

Automatic control valves with diaphragm-type seats shall not be accepted.

Where pressure-reducing or pressure-sustaining valves are installed in pit structures, the associated control piping shall be routed to an accessible above-ground cubicle. Control tubing and fittings shall be stainless steel in accordance with Unitywater standard drawings.

### **13.10.3 Actuator**

Hydraulically operated diaphragm type, powered directly by the process fluid, with the actuator integrated into the valve body.

For pressure reducing applications where the upstream-to-downstream pressure differential may be 50 kPa or less, then double-chambered actuators with 3-way pilot controls are required.

### **13.10.4 Valve Control System**

Contact Unitywater's Infrastructure Standards and Assurance Team for further information

## 13.11 Diaphragm valves

### 13.11.1 Minimum requirements

The valves shall comply with the following minimum requirements:

- BS EN 13397– Specification for diaphragm valves (metal-bodied).
- Body and bonnet materials: Cast Iron to BS EN 1561 or ASTM A 126 Class B or Ductile Iron to BS EN 1563 or ASTM A 536.
- Flanges as per Section 13.1 General requirements.
- Closing direction as per Section 13.1 General requirements.

Diaphragm valves shall have straight pattern bodies with no lining. The diaphragm assembly shall be replaceable inline. Valves shall have non-rising hand-wheel spindle operation and a position indicator protruding from the bonnet assembly.

Valves shall be easily automated by the replacement of the manual bonnet assembly with a pneumatic actuator bonnet assembly.

### 13.11.2 Diaphragm material

EPDM or Butyl, rated for compatibility with the process fluid in the application service.

### 13.11.3 Body coating

Internal and external: Polymeric coating to AS/NZS 4158 or fusion-bonded epoxy, minimum DFT 300 µm.

### 13.11.4 Function

Isolation and flow regulation valve for chemical and slurry duties where some fine solids may be present. Not suitable where large solids, fibrous, or stringy materials may be present.

### 13.11.5 Operation

Non-rising stem type.

Valve stem shall include integral open-close position indication.

### 13.11.6 Actuator

Handwheel, or powered actuator, as specified.

### 13.11.7 Valve body

Valves of size DN50 and larger shall be fully flanged to AS/NZS 4087.

### 13.11.8 Valve diaphragm

The diaphragm shall provide a uniform seal around the throat of the valve.



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## 13.11.9 Valve operating assembly

Valve bearings shall be self-lubricated.

The design of the spindle and bearings shall be such that they will safely sustain maximum differential pressure rating across the closed valve. The spindle and any keys or dowels etc. for transmitting the torque between the shaft and hand wheel shall be capable of withstanding the maximum torque required to operate the valve.

The operating assembly shall be provided with adequate drainage of any diaphragm leakage of water to indicate a diaphragm failure.

The following material requirements apply to valve operating assemblies:

Table 25: Diaphragm Valve Operating Assembly Material Requirements

| Valve Operating Assembly Component     | Material  |
|--|---|
| Body and bonnet materials              | Cast Iron ASTM A 126 Class B or Ductile Iron ASTM A 536   |
| Diaphragm material                     | Butyl or EPDM Rubber (alternative materials to meet conveyed substance requirements by exception, to be approved by Unitywater) |
| Compressor material                    | Cast Iron ASTM A 126 Class B  |
| Spindle material                       | Carbon Steel  |
| Spindle nut material                   | Brass   |
| Coatings                               | System 6, Section 10.4.1 of this Specification or approved equivalent   |
| Flange gaskets, O-rings and lubricants | EPDM, Nitrile and Dow Corning O-ring Lubricant #55 or approved equivalent   |

## 13.12 Pinch valves

### 13.12.1 Minimum requirements

The valves shall comply with the following minimum requirements:

- MSS SP-134 Pressure Seal Pinch Valves.
- Body and bonnet materials: Cast Iron to BS EN 1561 or ASTM A126 Class B or Ductile Iron to BS EN 1563 or ASTM A 536.
- Elastomer sleeve material: EPDM.
- Flanges as per 13.1 General Requirements.
- Closing direction as per 13.1 General Requirements.
- Body coating: Internal and external: Polymeric coating to AS/NZS 4158 or fusion-bonded epoxy, minimum DFT 300 µm.

## 13.12.2 Function

Isolation and flow regulation valve for sewage and sludge duties where solids and stringy material may be present.

## 13.12.3 Operation

Enclosed-body pinch valve with a pinch mechanism compressing the elastomer sleeve via opposing pinch bars. Clockwise or anticlockwise to close as specified.

## 13.12.4 Actuator

Handwheel, or powered actuator, as specified.

## 13.13 Plug valves

### 13.13.1 Minimum requirements

The valves shall comply with the following minimum requirements:

- AWWA C517 Resilient-Seated Cast-Iron Eccentric Plug Valves.
- Seats on shall be welded overlay of not less than 95% pure nickel, with a raised profile. The raised surface shall be profiled to ensure that the resilient plug face contacts only the nickel seat.
- Plug facing / encapsulation material: EPDM.
- Flanges as per Section 13.1 General requirements.
- Closing direction as per Section 13.1 General requirements.

Body and bonnet materials: Cast Iron to BS EN 1561 or ASTM A 126 Class B or Ductile Iron to BS EN 1563 or ASTM A 536.

Body coating: Internal and external: Polymeric coating to AS/NZS 4158 or fusion-bonded epoxy, minimum DFT 300 µm.

### 13.13.2 Function

Isolation and flow regulation valve for sewage and sludge duties where solids and stringy material may be present.

### 13.13.3 Operation

Clockwise or anticlockwise to close as specified.

## 13.13.4 Actuator

Lever, gearbox, or powered actuator, as specified.

Gearboxes shall be provided on valves DN80 and larger, or where the maximum rim pull force exceeds the limits specified in Section 14.4 Manual Gearboxes. Gearboxes to be worm-gear type with external open and closed stops.

The plug shall be fully rubber-encapsulated, with eccentric offset action and resilient seating.

Shaft bearings shall be permanently lubricated and designed for wastewater duty.

## 13.14 Ball valves

### 13.14.1 Minimum requirements

Ball valves are small isolation valves used in drinking water and non-drinking water applications, including other services such as air, oil and chemicals. Ball valves may also be utilised in isolation for wastewater applications  $\leq$ DN50 where there are no suitable resilient seated gate valves available.

The valves shall comply with the following minimum requirements:

- WSAA Product Specification and coating requirements as per Table 23.

#### 13.14.1.1 REQUIREMENTS FOR METAL-BODIED BALL VALVES FOR GENERAL APPLICATIONS:

- Body and handle materials: Stainless Steel to A351 CF8M/AISI 316.
- Configuration: Two-piece or three-piece ball valve with position locking facility.
- Ball valves DN50 and smaller shall be supplied with threaded end connections in accordance with Section 13.1 General requirements.
- Ball valves DN65 and larger shall be supplied with flanged end connections in accordance with Section 13.1 General requirements.
- Closing direction as per Section 13.1 General requirements.

#### 13.14.1.2 REQUIREMENTS FOR BALL VALVES FOR WATER SERVICE CONNECTIONS:

- Body and handle materials: Copper alloy, dezincification resistant material and comply with AS 3688. Alternative: Stainless Steel to A351 CF8M/AISI 316.
- Ball valves shall have lockable handles for use with customer padlocks and shall be fitted with handles at least 50 mm long.

### 13.14.2 Function

Isolation valve for water and general clean fluid duties. Not suitable for sewage reticulation. Not suitable where solids and stringy material may be present. Preferred for small-bore instrument isolation, vents and drains.

### 13.14.3 Actuator

Lever, or powered actuator, as specified.

## 13.15 Non-return valves – swing flex type

### 13.15.1 Minimum requirements

The valves shall comply with the following minimum requirements:

- WSA Product Specification and coating requirements as per Table 23.
- Flanges as per Section 13.1 General requirements.

### 13.15.2 Function

Non-return valve for water, sewage and general duties where solids and stringy material may be present. Valve face-to-face (lay length) may exceed dimensions for the equivalent size and rating to API D6.

### 13.15.3 Operation

Flap-type swing-check disc, with no external disc lever or counterweight.

### 13.15.4 Actuator

Optional disc-lifting backflow actuator may be provided as specified, normally not required.

### 13.15.5 Top access port

Valve shall be fitted with top access port to enable disc removal without removing valve from the line.

### 13.15.6 Installation

Valves shall be installed horizontally, with the hinge in the horizontal plane and bonnet cover facing upwards. Vertical flow orientation is not permitted. Any alternative orientation requires prior approval from Unitywater.

Non-return valves shall comply with WSA PS-264 and any standards referenced within, including AS 1628, and AS 4794.

Swing check valves shall not be fitted with a counterweight unless otherwise specified and approved by Unitywater.

All non-return valves shall be located in a pit or an above ground structure to facilitate maintenance access.

### 13.15.7 Swing check valve

See WSA – PS-264.

Swing check valves shall be located in the horizontal position unless otherwise approved by Unitywater.

## 13.16 Non-return valves – other

### 13.16.1 Minimum requirements

The valves shall comply with the following minimum requirements:

- WSAA Product Specification and coating requirements as per Table 23.
- Flanges or wafer-pattern compatibility as per Section 13.1 General requirements.

### 13.16.2 Function

Non-return valve for water, sewage, air and general duties.

### 13.16.3 Operation

Swing-disc type, with or without external disc lever or counterweight. Wafer type and double-door type may be used for clean fluid applications.

### 13.16.4 Installation

Valves for clean fluids may be installed horizontally (hinge in horizontal plane) or vertically. Valves for sewage or solids-laden fluids shall be installed horizontally only. Any alternative orientation requires prior approval from Unitywater.

## 13.17 Gas release valves for water

### 13.17.1 Minimum requirements

The valves shall comply with the following minimum requirements:

- WSAA Product Specification and coating requirements as per Table 23.
- Gas Release valves DN50 and smaller shall be supplied with threaded end connections in accordance with Section 13.1 General requirements.
- Gas Release valves DN65 and larger shall be supplied with flanged end connections in accordance with Section 13.1 General requirements.

### 13.17.2 Function

Gas release and air admittance valves for water and general clean fluid duties. Valves may be single-acting (air release only) or combination (air release and air admission).

### 13.17.3 Operation

Automatic buoyancy-activated gas release mechanism.

### 13.17.4 Actuator

Automatic without manual actuator.

### 13.17.5 Top access port

Valve shall be fitted with top access port to enable float/seat removal without removing valve from the line.

### 13.17.6 Installation

Valves shall be installed vertically, at high points of the reticulation pipeline, in accordance with manufacturer's recommendations.

## 13.18 Gas release valves for sewage

### 13.18.1 Minimum requirements

The valves shall comply with the following minimum requirements:

- WSAA Product Specification and coating requirements as per Table 23.
- Gas Release valves DN50 and smaller shall be supplied with threaded end connections in accordance with Section 13.1 General requirements.
- Gas Release valves DN65 and larger shall be supplied with flanged end connections in accordance with Section 13.1 General requirements.

### 13.18.2 Function

Gas release and air admittance valves for sewage, where solids and stringy material may be present. Valves may be single-acting (air release only) or combination (air release and air admission).

### 13.18.3 Operation

Automatic buoyancy-activated gas release mechanism. Self-cleaning debris chambers mounted separately from the float/seat chamber are acceptable.

### 13.18.4 Actuator

Automatic without manual actuator.

### 13.18.5 Top access port

Valve shall be fitted with top access port to enable float/seat removal without removing valve from the line. Valves larger than DN100 with separate self-cleaning debris chamber are preferred for sewage rising main pipelines.

### 13.18.6 Installation

Valves shall be installed vertically, at high points of the reticulation pipeline, in accordance with manufacturer's recommendations.

## 13.19 Pressure relief valves

### 13.19.1 Minimum requirements

The valves shall comply with the following minimum requirements:

- SEQ–WSA-02 and WSA PS-129 (Pressure Relief Valves – Water).
- Pressure Relief valves DN50 and smaller shall be supplied with threaded end connections in accordance with Section 13.1 General requirements.
- Pressure Relief valves DN65 and larger shall be supplied with flanged end connections in accordance with Section 13.1 General requirements.

Body and bonnet materials: Copper alloy, dezincification resistant material, or Stainless Steel to A351 CF8M/AISI 316, or Ductile Iron to BS EN 1563 or ASTM A 536.

Disc: Stainless steel (minimum AISI 316) for wetted parts, rated for compatibility with the process fluid in the application service.

Body coating: For ductile iron valves, internal and external: Polymeric coating to AS/NZS 4158 or fusion-bonded epoxy, minimum DFT 300 µm.

### 13.19.2 Function

Pressure Relief valves for water and general duties.

### 13.19.3 Operation

Automatic operation only. No manual actuator required.

### 13.19.4 Installation

Valves shall be installed vertically, in accordance with manufacturer's recommendations.

## 13.20 Valves - miscellaneous

Reduced pressure zone (RPZ) valves shall be straight through, double check valve style units in accordance with SEQ Accepted Civil IPAM List.

Solenoid valves shall be direct-acting, media-separated valves in accordance with SEQ Accepted IPAM List and [F10678](#) - Accepted Electrical Equipment List.

Plastic-bodied butterfly valves shall be of wafer-pattern or lug-style design with integral elastomer seal, suitable for installation between flanges without separate gaskets.

Plastic-bodied ball valves shall be of three-piece configuration.

Plastic-bodied non-return valves shall be of union-type construction, allowing dismantling into three main parts for maintenance.

## 13.21 Eccentric plug valves

Eccentric plug valves are used to isolate or throttle flows particularly in wastewater applications or where a more linear characteristic of valve closure to flow is required (compared to butterfly valves).

Eccentric plug valves should generally comply with the requirements of AWWA C517-09.

### 13.21.1 General requirements

Plug valves shall be non-lubricated eccentric type.

Plug valves shall have a nickel seat welded to the valve body and an elastomeric plug which shall provide tight shut off against maximum working pressure from either direction.

Valve designs shall be such as not to allow grit build up within the valve or alternatively be provided with a collection point which is cleared when the valve is actuated. Grit protectors shall be used around bearings to prevent bearing damage.

### 13.21.2 Valve body

Valves of size DN50 and larger shall be fully flanged to AS/NZS 4087.

The valve body shall be constructed of ductile iron with a fusion bonded epoxy or thermal polymeric coating to AS/NZS 4158.

### 13.21.3 Valve plug and seat

The axis of rotation of the plug shall be offset from the plane of the sealing surfaces.

The valve seat shall be fully welded to the body and shall provide a uniform seal around the perimeter of the valve.

### 13.21.4 Valve operating assembly

The design of the trunnion shaft and bearings shall be such that they will safely sustain maximum differential pressure rating across the closed valve.

The shaft and any keys or dowels etc. for transmitting the torque between the shaft and disc shall be capable of withstanding the maximum torque required to operate the valve.

Manually operated valves up to and including size DN150 shall incorporate a positive latching operation lever with ten (10) positions. Manually operated plug valves over size DN150 shall incorporate gear boxes.



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### 13.21.5 Materials

The following material requirements apply to eccentric plug valves:

Table 26: Eccentric Plug Valve Material Requirements

| Valve Component                                    | Material  |
|--|---|
| <b>Body materials</b>                              | Ductile Iron, TBP or FBE coated   |
| <b>Plug material</b>                               | Ductile iron or cast iron   |
| <b>Plug facing material</b>                        | NBR or EPDM   |
| <b>Seat material</b>                               | Nickel  |
| <b>Flanged joint bolting selection (fasteners)</b> | Metric, 316 stainless steel, AS4085 B5                                    |
| <b>Flange gaskets, O-rings and lubricants</b>      | EPDM, Nitrile and Dow Corning O-ring Lubricant #55 or approved equivalent |

### 13.22 Solenoid valves

Solenoid valves shall be of a modular style, comprising a valve assembly and a push-over coil. The valve diaphragm shall be attached to the armature as a single assembly.

The diaphragm/armature assembly and the armature guide tube shall be mounted on the valve body. The coil shall push over and attach to the armature guide tube and therefore be isolated from the process fluid.

The valves shall be capable of operating from zero pressure.

Pilot operated solenoid valves will not be acceptable.

Solenoid valves shall be suitable for a 24 V DC power supply. 230V AC solenoid valves may be accepted by Unitywater in cases where it can be proven a 24V DC solenoid is not suitable for the application. In this case refer to Section 2.1 and provide detail why 24V DC is not acceptable. Unitywater may or may not accept the request based on safety and project requirements.

Solenoid valves shall be soft opening and closing type to mitigate against the effects of water hammer.

Solenoid valves shall be provided with manual over-ride facility (lock in position type).

Solenoid valves shall have an IP56 protection rating as a minimum. Higher degrees of protection shall be provided where appropriate.

Unless noted otherwise, solenoids shall be configured to fail in the closed position.



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The following material requirements apply to solenoid valves:

Table 27: Solenoid Valve Material Requirements

| Solenoid Valve Component      | Material   |
|-------------------------------|--|
| <b>Body materials</b>         | General applications: Brass<br>Corrosive environments: 316 Stainless Steel |
| <b>Diaphragm material</b>     | EPDM   |
| <b>Coatings</b>               | N/A  |
| <b>Additional testing</b>     | N/A  |
| <b>O-rings and lubricants</b> | Nitrile and Dow Corning O-ring Lubricant #55 or approved equivalent        |

### 13.23 Pressure Safety Valves

Pressure Safety Valves (PSVs) shall be installed in an upright position and in a position accessible from a platform or grade. Pressure safety valves discharging hazardous liquids or gases shall be piped to a point of safety to personnel.

PSVs shall be angle pattern relief valves with the spring assemblies physically separated from the process medium.

PSVs shall include a lever actuator for manual opening of the valves. The valves shall be capable of passing the maximum required flow at 10% over the valve set pressure.

PSVs on chemical feed systems shall be of diaphragm type.

The setting of pressure relief shall be field adjustable.

The following material requirements apply to pressure safety valves:

Table 28: Pressure Safety Valve Material Requirements

| Pressure Valve Component               | Material  |
|--|---|
| <b>Body materials</b>                  | Cast Bronze AS 1565-C83600  |
| <b>Cover material</b>                  | Cast Bronze AS 1565-C83600  |
| <b>Spindle material</b>                | DR Brass AS/NZS 1567-486  |
| <b>Disc material</b>                   | Cast Bronze AS 1565-C83600  |
| <b>Seat material</b>                   | Cast Bronze AS 1565-C83600  |
| <b>Diaphragm</b>                       | PTFE or EPDM (alternate materials considered for compatibility with conveyed fluid/gas) |
| <b>Spindle gland packing or O-ring</b> | PTFE or Nitrile   |

| Pressure Valve Component                           | Material  |
|--|---|
| <b>Spring material</b>                             | Spring steel  |
| <b>Flanged joint bolting selection (fasteners)</b> | Metric, 316 stainless steel, DIN A4                                       |
| <b>Flange gaskets, O-rings and lubricants</b>      | EPDM, Nitrile and Dow Corning O-ring Lubricant #55 or approved equivalent |
| <b>Bactericidal lubricant</b>                      | BK Standard Pipe Jointing Lubricant or approved equivalent                |

## 13.24 Reduced Pressure Zone Devices (RPZD)

Reduced Pressure Zone (RPZ) valves shall be straight through, double check valve style units suitable for high hazard rating areas.

RPZ valves shall be supplied with a strainer and an upstream and downstream lockable isolation valve.

RPZ valves shall be suitable for horizontal installation.

RPZ valves shall conform to AS/NZS 2845.1 and AS/NZS 2845.3.

The following material requirements apply to reduced pressure zone valves:

Table 29: RPZ Valve Material Requirements

| RPZ Valve Component                           | Material   |
|---|--|
| <b>Body materials</b>                         | DN 20 to DN 50: Bronze or 316 stainless steel<br>DN 65 to DN 150: Ductile Iron, TBP coated |
| <b>Disc/Piston material</b>                   | 316 stainless steel  |
| <b>Spring material</b>                        | 316 stainless steel  |
| <b>Seat material</b>                          | EPDM   |
| <b>Flange gaskets, O-rings and lubricants</b> | EPDM, Nitrile and Dow Corning O-ring Lubricant #55 or approved equivalent                  |

## 14. Actuators

### 14.1 General requirements

Actuators may be used on valves and penstocks.

The Designer/Constructor shall be responsible for ensuring that the actuators will provide the operating torques required to meet the operating conditions specified.

The Designer/Constructor shall ensure that the actuators are compatible with the valves and penstocks in every aspect.

The rating of each actuator shall be adequate to produce torque/thrust required to actuate under all conditions and shall be able to produce and withstand 1.5 times the maximum torque/thrust required under normal operating conditions.

Valves and penstocks shall only be accepted as satisfactory after hydrostatic testing of complete valve /penstock and actuator assemblies are complete, approved and appropriate certification issued.

All actuators shall be electric unless noted otherwise.

All components of the actuators shall have lifetime lubrication.

All actuators and accessories shall have an IP56 protection rating as a minimum. Higher degrees of protection shall be provided where appropriate.

## 14.2 Electric actuators

Electrical installation requirements are detailed in [Pr9835](#) - Specification for Electrical Installation at Treatment Plants and [Pr9380](#) - Specification for Electrical Installations at Network Sites.

Electric actuators for isolating applications shall be as per [F10678](#) - Accepted Electrical Equipment List and the IPAM list or approved equivalent.

Modulating applications shall be as per [F10678](#) - Accepted Electrical Equipment List and the IPAM list range of actuators, or approved equivalent.

Electric actuators shall have the functionality of both local (manual) and remote-control capability with local control being integral to the actuator where applicable. Actuator control boards shall have the functionality to be supplied by an external 24 V supply.

Actuators with electric motors may be fed from a single phase or three-phase supply depending on the valve and/or actuator requirements.

Unless noted otherwise, in the event of a power failure the actuator shall be able to retain the last operating state or set point.

As a minimum, the following control and monitoring signals shall be available from the actuator control board:

- Valve/penstock available
- Valve/penstock in remote/local control
- Valve/penstock fault
- Valve/penstock fully opened
- Valve/penstock fully closed
- Valve/penstock % open (for modulating valve actuators)
- Remote open
- Remote close.

The operating speed of the actuator/gearbox assembly shall be such as to give a gate opening and closing speed of 200-300 mm per minute.

The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure normal operation with the supply voltage 10% below nominal.

Each actuator supplied shall be provided with its own programming tool. The vendor must be engaged to set up the actuator on initial configuration.

The actuators shall be constructed from materials suitable for the intended application and provided with corrosion protection coatings appropriate for corrosive environments.

## 14.3 Pneumatic actuators

### 14.3.1 General requirements

Actuators shall be designed for full stroke and reliable operation under all specified operating conditions.

### 14.3.2 Material and construction

Actuators shall be constructed from materials suitable for the intended application and provided with corrosion protection coatings appropriate for corrosive environments. All trim, fasteners, and exposed hardware shall be manufactured from grade 316 stainless steel.

The actuator mechanism coupled to the cylinder shall be totally enclosed.

The cylinder shall be rigidly secured to the mechanism housing and shall not pivot, rotate, or swing during operation.

The piston rod shall be enclosed within the housing and shall not be exposed to view.

The actuator shall be designed to eliminate any risk, including in the event of damage, of actuator lubricant coming into contact with the fluid conveyed.

### 14.3.3 Air supply

The actuator shall be connected to either:

- a dedicated air receiver, or
- a compressed air system.

Both systems shall be designed to deliver sufficient air volume and pressure for a full and reliable operation for the actuator.

Actuators shall be capable of operating using dry, oil-free air at the specific pressure and flow rate specified in the specifications

Actuators shall be factory tested, and certified test reports shall be submitted for approval.

### 14.3.4 Control, instrumentation and condition monitoring

Each pneumatic actuator shall be equipped with the following as minimum:

- local valve position indicator
- handwheel-operated manual override
- pilot solenoid valves
- open and closed limit switches
- air filter and pressure regulator
- air flow control valves.

Air flow control valve shall permit control of the exhaust air flow rate and allow independent adjustment of valve opening and closing speeds.

A manual timer for piston stroke cycle adjustment shall be provided.

An electronic or digital positioner shall be provided, capable of accepting a 4–20 mA input signal and modulating the valve accordingly.

Intelligent positioners and a compatible electronic position transmitter shall be included to provide 4–20 mA feedback of valve position.

Actuators used for modulating control shall be fitted with integral feedback devices.

### 14.3.5 Fail-safe operation

Where pneumatic actuators are installed on fail-close valves, provisions shall be made for automatic valve closing in the event of supply air failure.

## 14.4 Manual gearboxes

Manual gearboxes shall be of the totally enclosed, weatherproof, grease lubricated type. The gearbox shall be operated by means of a hand wheel or taper square valve key. The direction shall be permanently indicated on the hand wheels. The gearbox shall meet the input torque requirements described in Section 13.1.

Manual gearboxes mounted on resilient seated gate valves shall be spur-gear type with dual input spindles and comply with AS/NZS 2638.2 Section 6. One spindle shall engage directly on the valve spindle, while the second spindle shall engage on the reduction drive input. Input shaft and output sleeve shall operate in the same direction. Directional arrows for open/close operation to be stamped on drive spindles. Gearboxes shall comply with ingress protection rating IP68.

Refer SEQ-WAT-1308-2 drawing for typical valve and gearbox layout which may be used for alternative applications to water.

Manual gearboxes shall be coated with a polymeric coating to System 13, Section 10.4 of this Specification or high build two-pack epoxy with 350 µm DFT (minimum).



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The following material requirements apply to manual gearboxes:

Table 30: Gearbox Material Requirements

| Gearbox Component             | Material  |
|-------------------------------|---|
| <b>Gearcase</b>               | Cast Iron to ASTM A48/A48M, Grade 35B/40B or SG Iron to ASTM A 536 Grade 85-45-12 |
| <b>Gears</b>                  | Steel to Grade 1010 or 4340 to the relevant ASTM                                  |
| <b>Input Shaft</b>            | Steel to Grade 1010 or 4340 to the relevant ASTM                                  |
| <b>Input Shaft bearings</b>   | Ball bearings   |
| <b>Output thrust bearings</b> | Needle Roller Bearings or Roller Thrust Bearings                                  |
| <b>Fasteners</b>              | Metric, 316 stainless steel, DIN A4   |
| <b>Seal and O-rings</b>       | EPDM or Nitrile Rubber  |

## 15. Penstocks and stopboards

### 15.1 Performance requirements

Penstocks and stopboards shall be designed for continuous operation against the on-seating and off-seating heads indicated in the penstock/stopboard schedule. Acceptable leakage rates shall be per BS 7775. Leakage rates shall be tested on site after installation.

### 15.2 Technical requirements - Penstocks

#### 15.2.1 General requirements

Penstocks shall be designed for the conditions shown in the project specification or on the drawings, with on- or off-seating capability as specified in the penstock and stopboard schedule. Off-seating wedges shall be provided where required.

Penstocks shall be wall mounted, flange mounted penstock or embedded within a concrete structure. Wall mounted installations shall have non-shrink grout between the and the wall. Embedded installations shall have non-shrink grout around the frame flush with the concrete face. Grouting and sealant selection shall be suitable for the environmental exposure it is subjected to, inclusive of any potential interaction with process medium. All designs shall account for the specific location of installation, including consideration of facilities for safe maintenance access.

The penstock design and materials shall be selected so that lubrication and maintenance works need to be performed no more frequently than once per year. All lubricants used for penstocks shall be suitable for the service application (food grade for water treatment, biodegradable for wastewater).

The penstock shall be designed and constructed to ensure that:

- Debris cannot readily collect on it.
- Where the process fluid contains fibrous or other solids, there are no inherent design features that are capable of obstructing the free movement of these solids.

Weir penstocks shall be selected from the same basic types available for downward closing penstocks. The design and construction of the penstock shall ensure effective side and invert sealing for all positions of the door.

## 15.2.2 Frames

The frames shall be designed to withstand all loads resulting from the nominated maximum head acting on the gate as well as forces exerted operation.

Frames fabricated from 'unistrut' channel section are not acceptable.

Side guides shall be provided over at least 1.7 times gate height. All components shall be designed for maximum deflection of  $L/720$  for worst case loads.

The frame design shall avoid the creation of crevices which may be susceptible to crevice corrosion.

Embedded frames shall have a flush finish within the recess.

Wall mounted frames must be sealed against the wall using compressed elastomeric seals appropriate to the application environment.

Frames for side wall and floor mounting shall be of a minimum cross section to reduce disruption of flow.

The mounting bolt size and pattern shall be designed to withstand any thrust forces that may be exerted on the frame during operation.

Grout must only be used against unlined concrete wall surfaces.

The gates shall be suitably stiffened. The stem connection shall be of clevis type coupling for rising stem applications, or a lift nut supported in a welded nut pocket for non-rising stem applications.

The coupling or nut pocket shall be capable of withstanding operation without permanent deformation.

## 15.2.3 Seals and guides

Side and top seals and guides shall be low friction, low wear, resilient backed material. They shall be under compression and shall be readily replaceable. The bottom seal shall be flush with the floor of the channel and shall be of resilient material such as neoprene, not less than 20 mm thick or 20 mm wide. All seals shall be fastened, not glued, in place.

Off-seating penstocks may have music note type neoprene seals where leakage prevention is critical, and a flush bottom invert is not required. In this case the seal shall be continuous around the opening and the gate shall be forced against the seal by a wedging action on closure. Sealing arrangements which do not require wedges are also acceptable.

Seals shall be bi-directional unless noted otherwise.

One full set of replacement seals and fasteners shall be provided.

Seals shall have a design life of ten years under normal operating conditions.

#### **15.2.4 Spindles/stems**

The stem shall be not less than 28 mm diameter but, in any case, shall not have a slenderness ratio (L/r) greater than 200. A limit nut shall be supplied on rising stems and set such that excessive force applied at closure cannot buckle the stem.

Where penstock valves are used for  $\geq$ DN450mm the spindle extension and torque tubes shall be designed for the proposed purpose with consideration given to debris interference with the free rotation of the stem. Design of the spindle extensions must account for a torque rating of 1.5 times the operating torque as per requirements in Section 14.1.

The rising stem shall be protected, above headstick level, by fixed, impact resistant, High-Grade UV resistant, weather resistant, clear acrylic tube fitted with an end cap and securely connected to the penstock door by a stem block. Other tube materials such as SS316 shall be subject to approval by Unitywater on a case-by-case basis.

The stem shall be rising where possible. The stem thread shall be ACME or stub ACME as per ASME B1.5. The stem shall be capable of withstanding manual operation without permanent deformation.

Nuts and screws for modulating service penstocks shall have high tolerance ACME threads. The stress on the threads shall be less than 6 MPa. The drive nut shall be sized to prevent exceedance of the thread stress limit.

#### **15.2.5 Handwheels and operating mechanisms**

Manual actuators shall comply with the requirements of Section 14. Handwheels or crank handles shall be between 1000 mm and 1200 mm above the operating floor level. Handwheels shall be mounted horizontally where practicable.

The penstock shall be closed by a clockwise rotation of the closing mechanism.

The minimum bolt size including seal pressure adjustment shall be M12 except for any seal fasteners. Anchor bolts shall be included complete with 2 No. nuts and 1 No. washer per anchor.

Calculations of deflections, operating torques and stem capacity shall be provided to Unitywater prior to purchase.

Handwheel finish shall be in accordance with Section 10.4 specified to suit the environmental conditions it is installed in.

Fixed and portable actuators shall conform to the requirements of Section 14 of this Specification.

#### **15.2.6 Portable actuators**

Portable actuators shall be used for penstocks actuation in open channel or slide gates. They shall consist of a lightweight marine grade aluminium chassis with UHMWPE handle. The gear motor shall have a lightweight aluminium single phase motor coupled with an aluminium gearbox with a stainless-steel Grade 316 torque plate and locating pins.



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Portable actuators shall have adjustable torque limiter, mounted forward and reverse switch and power lead for connection to a single phase 15A general purpose outlet (i.e. 3 pin plug).

The operating speed of the actuator shall give a gate opening and closing speed of 200 – 300 mm per minute.

The available torque operating margin shall be at least 25% greater than the required seating or unseating torque (whichever is the greater) of the gate. The safety margin of motor power available for seating and unseating the gate shall be sufficient to ensure normal operation with the supply voltage 10% below nominal without nuisance tripping of the actuator.

### 15.2.7 Other accessories

Extension stems or spindles (if required) shall be provided with guides, couplings and thrust tubes. Guides shall be suitably spaced for stability. Where stems or spindles are required in more than one piece, couplings to join stems shall be threaded and pin/screw lockable.

Gearboxes where fitted shall comply with requirements of Section 7.5.

### 15.2.8 Materials

Materials of construction shall be as indicated in the table below.

Table 31: Penstock Construction Materials – Minimum Requirements

| Penstock Component         | Material   |
|----------------------------|--|
| <b>Frame</b>               | Stainless steel Grade 316  |
| <b>Gate</b>                | Stainless steel Grade 316  |
| <b>Bolts and fasteners</b> | Metric, 316 stainless steel, DIN A4-70                             |
| <b>Seals</b>               | UHMW polyethylene with neoprene backing                            |
| <b>Guides</b>              | Low friction plastic, e.g. UHMW polyethylene                       |
| <b>Lift nut</b>            | Bronze to BS EN 1982 Gr. LG2 or AS 1565 Gr. C83600 or non-metallic |
| <b>Limit nut</b>           | Bronze to BS EN 1982 LG2 or AS 1565 C83600                         |
| <b>Stem</b>                | Stainless steel Grade 316  |
| <b>Stem cover</b>          | Stainless steel Grade 316 or clear polycarbonate                   |
| <b>Handwheel</b>           | Cast iron or Stainless steel Grade 316                             |
| <b>Guide</b>               | Stainless steel Grade 316 and UHMW polyethylene                    |
| <b>Coupling</b>            | Stainless steel Grade 316  |
| <b>Thrust tube</b>         | Stainless steel Grade 316  |

All welding shall be pickled, passivated in accordance with System 21, Section 10.4.1 of this Specification to remove all weld scorching.



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### 15.2.9 Penstocks for Sewage Pump Station inlet isolation

Penstocks in un-vented sewage applications in the presence of hydrogen sulphide such as sewage pump station inlet isolation service shall comply with the special requirements and materials of construction listed in Table 31 and Table 32.

Table 32: Penstocks for Sewage Pump Station Inlet Isolation Service

| Penstock Component                      | Requirements  |
|---|---|
| <b>Frame</b>                            | Flange mounted frame to suit AS/NZS 4087 PN16 flange drilling pattern, or: Wall mounted   |
| <b>Opening direction</b>                | Upward  |
| <b>Action</b>                           | Off-seating   |
| <b>Stem</b>                             | Rising stem mounted within non-rising torque tube   |
| <b>Method of operation</b>              | 316 Stainless steel Taper square valve key  |
| <b>Torque tube</b>                      | 316 Stainless steel torque tube enclosing stem  |
| <b>Stem nut mounting</b>                | Stem nut mounted on thrust tube above top water level (Overflow level for sewage pump stations). Stem nut to be enclosed in a 316 Stainless steel housing with O-ring sealing for the rotating parts.   |
| <b>Stem guides</b>                      | UHMWPE stem guide bushes mounted in thrust tube at spacing to manufacturers recommendations to prevent buckling   |
| <b>Thrust tube</b>                      | 316 Stainless steel thrust tube supported on brackets at spacing to manufacturers recommendations to prevent buckling.  |
| <b>Top seal, side seal, invert seal</b> | UHMWPE. Elastomeric seals are not acceptable.   |
| <b>Lift nut material</b>                | Aluminium Bronze to AS 1565 Gr. C95810  |
| <b>Surface treatment</b>                | Stainless steel components shall be electropolished to System 22, Section 8.4 of this Specification   |
| <b>Lubrication and special coating</b>  | Torque tube shall be packed with grease on assembly to ensure lubrication of stem.<br>Exposed surfaces of bronze stem nut shall be coated on assembly with wax-based, general purpose, corrosion preventive compound, Tectyl 506 or equal approved. |
| <b>Pressure head at invert</b>          | Difference between SPS Overflow Level and SPS Inlet Pipe Invert Level   |

## 15.3 Technical requirements - Stopboards

Stopboards shall be manufactured from marine grade aluminium of grade 6005A, 6061 T6, grade 6351 T5 or T6 or grade 5083 H321, H116 or H112 in accordance with AS/NZS 1734, AS/NZS 1866. ASTM B209M or ASTM B 928/B928M, EN 485-2.

Guide frames shall be fabricated from stainless steel Grade 316L to ASTM A 240/A240M.

The stopboards shall be required to seal against the guide frames with full hydraulic head on either side of the stopboard as defined in the penstock and stopboard schedule.

The stopboards shall be suitably designed to withstand all loads resulting from the nominated maximum head acting on it. Deflections shall not exceed 1/500 for the frame and 1/360 for the board of any span nor shall maximum stresses exceed half the yield stress of the material whichever is the worst case.

Frames for wall and floor mounting shall be of a minimum cross section to reduce disruption to the flow.

Frames for embedment mounting shall be of a cross section so as the block outs required in the structure are kept to a minimum to reduce interference with the concrete reinforcement steel.

The guide frames shall be fixed by means of stainless-steel Grade 316 threaded bar, set into the walls by stainless steel Grade 316 chemical anchors.

All contact surfaces between aluminium stopboards and stainless steel guide frames shall be isolated to prevent galvanic corrosion. Aluminium components shall be anodized or coated as appropriate. Suitable corrosion protection measures shall be clearly documented in the installation instructions.

The equipment shall be designed to avoid galvanic corrosion. Where necessary, insulating washer and sleeves shall be used to prevent direct contact between dissimilar metals.

On completion of fabrication, all stainless steel shall be pickled and passivated in accordance with System 21 (Section 10.4.22) and cleaned to remove weld scorching.

The stopboards shall be suitably braced to prevent distortion when fitting and/or removing.

The frame shall be designed not to catch rags and debris. Where the channel walls are lined with a corrosion protection liner, the frames shall form a seal with the liner.

Frames shall be fitted with sealing faces around the aperture. The side sealing faces shall provide minimal friction with the surface of the gate.

The Stopboard system shall incorporate the following seals:

- resilient, elastomeric or rigid, thermoplastic seals between the sides of each stopboard and the frame
- resilient, elastometric interlog seals.

The invert sealing shall be of resilient flush bottom seal arrangement and shall be securely attached to the frame along the invert. Side and invert seals shall be easily replaceable. One full set of replacement seals shall be provided.

Stopboards shall be manually removable and shall be provided with a lifting device for gate removal and deployment if the resultant lift force exceeds 16 kg.

## 15.4 Supervision of installation

An experienced and qualified supervisor shall be provided to oversee the installation and testing of the penstocks and stopboards to ensure that the specified or claimed leakage rates are obtained and not compromised as a result of sub-standard installation.

## 15.5 Painting

Given that the equipment will be located in an outdoor corrosive environment, and will be subject to warm damp conditions, painting of components shall be in accordance with System 3, Section 10.4 of this Specification. Manufacturer's standard painting systems shall be considered suitable where they are equal to or better than the provisions of this Specification.

Penstocks and stopboards shall be protected from corrosion based on the material and exposure type determined in the Corrosion Protection Systems (Section 10.4).

## 16. Pumps

### 16.1 General

The following general requirements are applicable to all the types of pumps included in Table 33. Specific requirements for the various types of rotodynamic and positive displacement pumps listed in Table 33 are detailed individually in the subsequent sections. For detailed requirements of electric motors associated with pumps, refer to [Pr9835](#) - Specification for Electrical Installation at Treatment Plants or [Pr9380](#) - Electrical Installations at Network Sites as applicable.

- The designer shall develop a pump data sheet structured as a returnable schedule. Pump vendors must return the completed data sheet, including detailed explanation/technical justification where any part of the requested information is not provided, or an alternative is proposed.
- Pumps selection must aim to minimise life cycle cost under the specified operating conditions.
- Pumps shall meet the full range of duty conditions stated in the pump data sheet and shall be capable of delivering the specified performance across the full range of site climatic conditions.
- The pumps must perform efficiently under the required modes of operation within the preferred operating range (POR) for continuous duty, and the allowable operating range (AOR) for short intervals, specified in Section 16.4.2 or as specified the datasheets in accordance with project-specific requirements, whilst maintaining reliability and continuity of operation.
- All pump components shall be adequate for the corrosive and/or abrasive characteristics of the fluids to be handled and the intended operating conditions.
- The pumps installation layout must consider space requirements for easy and safe operation and maintenance and for future upgrade/augmentation, where applicable.
- Both pumps and corresponding driving units must be supplied by the pumps manufacturer, to optimise mechanical/electrical compatibility.
- The equipment shall be the manufacturer's standard design with the additional requirements called for by this Specification, with due consideration to commonality with equipment in use at Unitywater facilities.



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- Where dry-mount pump sets, pumps and the associated equipment are specified for installation in an open, unprotected outdoor environment, they shall be suitable for unattended operation and be manufactured with materials and components adequate for such service and requiring a level of maintenance consistent with that of an equivalent equipment installed in an enclosed environment.
- Flanges for dry-mounted pumps must be compliant with the classification and allowable pressures, dimensional characteristics and tolerances, material grades and manufacturing requirements specified in AS/NZS 4087. Submersible pump suction and discharge flanges shall comply with EN 1092 PN10.

## 16.2 Types of pumps and typical usage

The pumps to be used shall be the most appropriate for the intended service, pumping conditions and type of fluid to be handled. Table 33 provides general guidance on the typical pumps used for certain applications.

Table 33: Types of Pumps and Service Applications

| Pump Class                   | Pump Type   | Typical Applications   |
|------------------------------|---|--|
| <b>Centrifugal</b>           | Horizontal Centrifugal – End suction                  | Potable and recycled water, effluent – moderately high flow and head applications.   |
|                              | Horizontal Centrifugal – Double suction axially split | Potable and recycled water, effluent – high flow and head combinations   |
|                              | Horizontal Centrifugal – Multistage axially split     | Potable and recycled water, effluent – high flows and high heads proportional to number of stages  |
|                              | Vertical multistage                                   | Potable and recycled water – moderately high flows/high heads – ideal for pressure boosting/constant pressure systems.   |
|                              | Sewage submersible                                    | Raw sewage or solids-laden raw water   |
|                              | Grit pumps - recessed impeller                        | Raw sewage/grit slurries/raw or digested sludge with 1 – 3% solids content/RAS – capable of passing 80mm solids - wet or dry installation  |
|                              | Sewage self-priming                                   | Raw sewage with up to 80mm solids – negative suction head installations – Moderately high flows and heads.   |
| <b>Axial Flow</b>            | Vertical axial flow                                   | Raw sewage, sediment laden storm water. – Very high flow capacity at very low heads – Typically used to transfer sewage between different treatment stages in large Wastewater Treatment Plants (WWTPs) through short distances. |
| <b>Positive Displacement</b> | Rotary lobe   | Pumping/transferring primary and secondary sludge, WAS, TWAS, RAS, septage, FOG and scum. Chemical dosing/metering in water and wastewater treatment plants.   |



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| Pump Class | Pump Type          | Typical Applications   |
|------------|--------------------|--|
|            | Progressive cavity | Pumping/transferring primary and secondary sludge, WAS, TWAS, RAS and thickened sludge with up to 7% solids content. Pumping raw sewage (recommended upstream macerator). Chemical dosing/metering in water and wastewater treatment plants, including polymer dosing. |
|            | Peristaltic        | Pumping/transferring grit, primary and thickened sludge and high solid content slurries. Chemical dosing/metering in water and wastewater treatment plants, including polymer dosing (low shear action and isolation of pumping fluid from other parts of the pump)    |
|            | Diaphragm          | Chemical dosing-metering in water and wastewater treatment plants  |

## 16.3 Electrical and protection requirements

Electric motors shall be provided in accordance with the [Pr9835](#) - Specification for Electrical Installation at Treatment Plants and [Pr9380](#) - Electrical Installations at Network Sites, as applicable.

All electric motors shall be provided with a built-in means of thermal monitoring and protection for motor windings and bearings. Protective devices shall be in accordance with AS/NZS IEC 60947.8. Motors shall be selected and rated to cover the maximum power absorbed by the pump over its entire operating range.

Motor starter details and requirements are shown in [Pr9835](#) - Specification for Electrical Installation at Treatment Plants and [Pr9380](#) - Electrical Installations at Network Sites, including motor ranges for use of DOL and VSD starters.

Motors shall be suitably de-rated for operation with, and matched to, a VSD.

## 16.4 Centrifugal pumps

### 16.4.1 General

Centrifugal pumps must be selected in accordance with Table 33 and must be the most appropriate for the intended service either potable water, recycled water, effluent or raw sewage in the case of submersible sewage pumps. All pump components shall be free from defects and all materials used in the construction of the pumps shall be suitable for the intended service,

All surfaces of pump components to be in contact with drinking, including materials used for coating, lining, sealing and lubrication shall be compliant with AS/NZS 4020.

The suction and discharge flanges and the pump casing shall have the capacity to withstand, without any deleterious effects or damage, the static and dynamic forces transferred by the suction and discharge pipework, as identified in the pump datasheet.

## 16.4.2 Performance requirements

Data sheets and project-specific requirements for the supply of pumps shall contain all the necessary information for proper selection of the pumps, showing the full set of conditions the pumps are expected to operate over their design life, including system curves, for the Vendor to superimpose over their proposed pump curves.

Vendors must be provided with clear information about the expected operational configuration of the pumps, including operation in parallel or in series, and whether the pumps will be driven via Variable Speed Drives (VSDs). Refer to [Pr9835](#) - Specification for Electrical Installation at Treatment Plants and [Pr9380](#) - Electrical Installations at Network Sites for motor size limits for DOL and VSD starters.

The following pump curves shall be provided by the Vendor:

- Flow vs Head
- Pump efficiency curves
- NPSH required
- Flow vs Absorbed Power.

The Vendor shall select a pump to meet the full range of duty conditions stated in the pump data sheet. Where pumps are intended to operate in parallel or in series, the Vendor shall provide flow vs head curves for all the combinations of pumps in parallel or in series specified in the pump data sheet.

The pump shall have a stable head-quantity characteristic curve (i.e. negative gradient from zero flow to end of curve) and the motor shall be non-overloading for all system conditions.

Consistent with WSA 130 - ISO End Suction Centrifugal Pumps Section 3.3.1, the pump shall be selected such that:

- continuous operation of the pump shall not occur outside the Preferred Operating Range (POR), which is between 70% and 115% of the best efficiency point for the operating speed, and
- short, intermittent intervals of pump operation shall not occur outside the Allowable Operating Range (AOR) which is between 50% and 120% of the best efficiency point for the operating speed.

If more stringent POR and AOR limits are nominated in project-specific documentation or the datasheet, or recommended by the pump manufacturer for a given application, those limits shall apply to the selection of the pump.

The pump shall be selected to maximise operating efficiencies without modification, polishing or coating of the impeller and without cavitation or damaging vibration over the entire range of flow conditions. Power consumption of the pump shall not exceed the motor rated power output at any point on its curve.

The same series of curves provided for pumps driven by fixed speed motors shall be provided for pumps driven by motors fitted with VSDs, extending from shut-off head condition to the maximum flow recommended by the manufacturer. Curves shall be provided for a series of speed ratios, down to the minimum recommended by the manufacturer. The maximum and minimum recommended flows shall be indicated on the pump curves for all operating speeds.

For variable speed driven pumps, the specified duty point shall be met with the pump running at no more than 95% of their nominal speed at 50 Hz frequency supply, and the motor shall not be overloaded if required to operate at 100% nominal speed. Over speeding motors beyond 50Hz is not allowed for normal operations. The Net Positive Suction Head Required (NPSHr) of the pump shall be based on actual 3% head drop method test results in accordance with AS ISO 9906, Section 5.8.2.1 – Type 1 Test. The pump shall have a NPSHr at least 1.5 m less than Net Positive Suction Head available (NPSHa) or, the NPSHa shall be at least 135% greater than the NPSHr, whichever is the greater, at any point between zero flow and the maximum operating range flow attainable against the characteristic curve.

### 16.4.3 Horizontal centrifugal pumps

#### 16.4.3.1 GENERAL

The requirements specified in this section apply to the following types of horizontal centrifugal pumps:

- Horizontal end suction – back pull-out pumps
- Double suction axially split case pumps
- Horizontal multistage axially split and ring section pumps.

The design/manufacture requirements specified in this section shall be applicable to other types of centrifugal pumps not included in the list above, except as otherwise specified in subsequent sections allocated to other types of centrifugal pumps.

All pumps shall be supplied complete with their driver, coupling, guard and all necessary ancillary equipment, mounted on a common baseplate.

The horizontal end suction back pull-out centrifugal pumps shall be compliant with WSA 130, with nominal duty and dimensions as per ISO 2858. Pumps with suction and discharge flanges larger than DN200 and DN150 respectively, shall meet the duty point specified, with dimensions as per the manufacturer's standards, but the pump design shall comply with the technical requirements of WSA 130 ISO End Suction Centrifugal Pumps, WSA 131 - ISO End Suction Centrifugal Motor Pumps and any other requirements stipulated in this Specification.

End suction back pull-out pumps shall include a spacer coupling to enable the withdrawal of the impeller and shaft assembly without disturbing the driver or casing. The discharge flange shall be oriented at a 90° angle to the suction flange. Mechanical seals shall be fitted with a drain.

Multi-stage ring section pumps shall be of a design that achieves balance of axial thrust and minimises radial thrust. Bearings and mechanical seals at both ends of the shaft shall be accessible and removable without having to dismantle the casings or disturbing the suction and discharge pipework.

Flexible connections shall be provided at all equipment where vibration, expansion or loading may be detrimental to the equipment as determined by the design.

## 16.4.3.2 MATERIALS OF CONSTRUCTION

Where not specified, materials shall be selected with proper reference to the specified operating environment, pumped medium, guaranteed/expected service life and availability. Unless otherwise specified in the datasheet supplied by Unitywater, pumps components shall be constructed from the materials detailed in Table 2.2 of WSA 130, based on the water corrosivity classification shown in Table 2.1 of WSA 130. Copper alloy components shall be dezincification resistant in accordance with AS 2345.

Phenolic insulating sets or dielectric unions shall be used for cathodic protection when dissimilar metals are joined.

## 16.4.3.3 BASEPLATES

A common baseplate shall accommodate pump and drive unit with the necessary adjusting devices to allow accurate alignment of the pump/motor coupling. The pump/drive unit baseplate shall be designed with sufficient rigidity to maintain alignment in accordance with the requirements of the coupling manufacturer without requiring additional rigidity to be supplied from the foundations.

The mounting pads for the pump and drive shall be milled/machined flat and level. Packers and shims shall comply with Section 5.2.5 of this document.

The motor and gearbox shall be positively located so that they can be readily removed and replaced into position without requiring extensive coupling alignment checks. The baseplate and hold-down (anchor) bolts must be designed to withstand the forces and moments transmitted from the pump, motor and connected suction and discharge pipework.

Motor feet shall be provided with jacking bolts to assist with alignment of the coupling.

The baseplate shall be manufactured from carbon steel and hot dip galvanized in accordance with System 24, Section 10.4 of this Specification. The baseplate shall be stress relieved after welding prior to galvanizing.

## 16.4.3.4 COUPLINGS

Couplings shall be compliant with the requirements detailed in Section 12.2 of this Specification. Centrifugal double suction single or multi-stage axially split pumps and multi-stage ring type pumps must be provided with spacer type couplings to enable accessing and removing bearings and mechanical seals without having to remove the top casing or drive unit.

All couplings shall be selected with capacity to transmit 150% of the full starting torque of the driver, as required by WSA 130.

## 16.4.3.5 REVERSE ROTATION

All pump motor and coupling components shall withstand without damage temporary reverse flow through the pump with a reverse speed up to at least 120% of the pump's rated speed, due to inadvertent reverse operation of the pump, such as may occur during commissioning, untimely closure of a non-return valve, etc.

## 16.4.3.6 CASING

Single and double volute casings shall be selected to maximise pumping efficiency for the duty point specified in the datasheet. Ring section multi-stage pumps shall be provided with U-turn channels or similar arrangements to create an efficient inter-stage flow pattern. Wear rings and other components in the pump casing that may be subject to wear shall be easily removable for refurbishment or replacement.

The suction and discharge flanges of double suction and multi-stage axially split case pumps shall be located at opposite ends of the pump at an angle on  $90^{\circ}$  to the drive shaft. The suction and discharge flanges of multi-stage ring section pumps shall typically be located at the top at the two ends of the pump but shall be rotatable at  $90^{\circ}$  to the left or the right as required by the design configuration of the pump station.

Flanges shall be arranged so that bolt holes symmetrically straddle the north/south, east/west and horizontal/vertical centre lines. The casing shall have an allowable operating pressure rating equal or lower than that of the suction and discharge flanges. The pump casing and the suction and discharge flanges shall be designed to withstand the static and dynamic forces and moments transmitted by the suction and discharge pipework.

The casing casting shall be dressed to a good commercial standard to expose any surface imperfections. Casting shall be compliant with the material grades and quality requirements specified in Section 20.1 of this Specification. Internal wetted surfaces shall be treated with a coating system compliant with WSA 130. Following surface preparation as per Section 10.4 of this Specification, the external surface of the casing shall be coated in accordance with Corrosion Protection System 6, Section 10.4 in this Specification, with topcoat AS 2700 Colour Code B14.

All mating surfaces shall be accurately machined and provided with deep registers, dowels and spigots to ensure alignment.

If specified on the data sheet, or where required by the design, tapping points shall be provided on the pump flanges or casing for connection of pressure gauges and venting, drain and seal flushing pipework, in accordance with WSA 130 Section 3.4.2, item (i).

Instrument tappings shall be welded to the pipe and fitted with a screwed reducing nipple and  $\frac{1}{2}$ " BPST ball valve of stainless-steel construction. Venting connections shall be positioned on the highest practicable point on the casing and shall be sized as per the pump's manufacturer standard. All unused, tapped holes shall be fitted with solid, corrosion resistant metal plugs.

## 16.4.3.7 SHAFT

The shaft shall:

- the shaft shall be machined from solid one-piece bar stock of ASTM A 276/A276M:431 in accordance with WSA 130
- have a ground finish over its entire length
- be equipped with replaceable shaft sleeves in areas subjected to wear from gland packing or other contact type sealing arrangements. Shaft sleeves are not required for pumps fitted with mechanical seals
- be sized to withstand the maximum stresses, vibration and whirling to be generated under all operating conditions
- be stepped at each sleeve and each impeller in the case of multi-stage pumps.

The rotating assembly including shaft and impeller shall be designed such that the first lateral critical speed is not less than 150% higher than the maximum operating speed of the pump. The first lateral critical speed shall be calculated for the maximum diameter impeller able to be fitted to the pump, without any support from wearing ring(s) or neck ring(s).

The maximum lateral deflection of the shaft shall be determined to establish permissible internal clearances, taking into account all lateral hydraulic reactions on the impeller and any external loads.

## 16.4.3.8 IMPELLER

The pump impeller shall be a one-piece casting specifically selected for the duty and conditions detailed in the data sheet or as required by the design.

The impeller shall be fixed to the shaft such that axial movement is prevented and shaft rotation in either direction shall not cause it to loosen.

The impeller shall be statically and dynamically balanced prior to assembly to a G 6,3 Balance Quality Grade at the maximum operating speed in accordance with ISO 21940-11. The impeller and shaft assembly shall then be dynamically balanced to Grade G 2,5 at the maximum operating speed. Then the assembled rotating elements shall then have the coupling fitted and the complete assembly shall be dynamically balanced to Grade G 2,5.

Impeller tip speeds for raw water, treated water, recycled water and clear effluent shall not exceed 40 m/s.

## 16.4.3.9 WEAR RINGS

Replaceable wear rings shall be provided:

- on clean water pumps between the impeller and casing at the front and back of the impeller
- on the suction side of fully shrouded impellers and fitted to the matching parts of the bowls
- on the back side of all impellers that have balancing holes and fitted to the matching parts of the bowls.

The construction of wearing rings shall be such as to enable easy replacement when required. Materials must be selected as to avoid galling.

Replaceable wear rings shall be of one piece and shall be securely locked in position to prevent rotation.

#### 16.4.3.10 BEARINGS

Bearings shall be of metric dimensions and be manufactured by a well-established and easily sourced manufacturer. Bearings shall be able to safely withstand all operating thrust and radial loads.

The shaft bearings shall be ball or roller bearings designed for an L<sub>10</sub> Rating Fatigue Life of a minimum of 50,000 hours, as defined in ISO 281 at the maximum operating speed.

Bearing mountings shall be designed to allow for variations in shaft temperature.

The bearing housing shall be totally enclosed to prevent contamination. The bearing housing shall be sealed at the shaft openings by lip seals.

Bearings shall be lubricated by grease lubrication.

Extension tubes shall be fitted to lubrication points to allow convenient positioning of, and access to, automatic lubricators for maintenance and replacement purposes. Extension tubes shall be primed prior to fitting automatic lubricators.

Sealed-for-life bearings may be provided, however, the acceptability will be assessed on a case-by-case basis.

#### 16.4.3.11 SEALS

Seals shall comply with requirements of Section 22 of this specification.

#### 16.4.3.12 FASTENERS

All bolts, anchors and fasteners, internal and external to the pump, shall be manufactured from the materials and grades specified in Section 6 of this Specification.

#### 16.4.3.13 VIBRATION

Acceptable vibration levels shall be as specified in ISO 10816.7 and Section 4.6. Requirements for monitoring equipment shall be as noted in the datasheets.

#### 16.4.3.14 GUARDS

Rotating shafts shall be fitted with guards designed in accordance with Section 8 of this Specification.

#### 16.4.3.15 PAINTING

Painting of components shall be in accordance with relevant systems of Section 10.4.1 of this Specification. Manufacturer's standard painting systems may be considered suitable where they are equal to or better than the provisions of this Specification.

Surfaces to be coated which will become inaccessible after assembly or installation shall be cleaned and coated before becoming inaccessible.

Internal coating of dry-mount pumps:

- Internal wetted surfaces of cast iron pumps shall be coated in accordance with System 12, Section 10.4 of this Specification. Internal components of the pump include: the inside surface of the volute and back plate. Only cast iron or ductile iron internal components require coating. Wear resistant, bronze, brass or high alloy components may remain uncoated.

External coating of dry-mount pumps:

- External surfaces of cast iron pumps shall be coated in accordance with System 6, Section 10.4 of this Specification. Top-coat colour shall be in accordance with Section 10.1.2 colour code of this Specification.

## 16.4.4 Vertical multistage booster pump sets

### 16.4.4.1 GENERAL

A vertical multistage booster pump set shall consist of a number of identical compact vertical multistage pumps connected in parallel and mounted on a common baseplate and controlled via individual VSD-driven pumps.

The system shall be designed with capacity to supply the peak demands of a distribution network, with the ability to accommodate itself to the fluctuations in the demand regime, whilst maintaining the required design pressures at all points in the network.

Pump materials shall conform to the requirements specified for centrifugal pumps in this Specification. Electric motors shall be compliant with the requirements of [Pr9835](#) - Specification for Electrical Installation at Treatment Plants or [Pr9380](#) - Electrical Installations at Network Sites, as applicable.

### 16.4.4.2 BASEPLATE

A common baseplate shall accommodate the pump and drive units, pipework, valves, fittings and proprietary control panel associated with the pump set. The baseplate shall incorporate the necessary adjusting devices to allow accurate alignment of the pump/motor coupling. The mounting pads for the pump and drive shall be milled/machined flat and level. The motors shall be positively located so that they can be readily removed and replaced into position without requiring extensive coupling alignment checks.

The baseplate shall be manufactured from carbon steel and shall be hot dip galvanized in accordance with System 24, Section 10.4 of this Specification. The baseplate shall be stress relieved after welding and prior to galvanizing.

### 16.4.4.3 PUMPING STATION PIPING

Piping shall be designed in accordance with Section 11 of this Specification and AS 4041.

Each pump shall be provided with suction and discharge isolation valves and a non-return valve. The suction and discharge manifolds shall be provided with pressure transmitters.

Piping shall allow easy removal of equipment for servicing or replacement and comply with the requirements of Section 11.8. Sufficient flexibility shall be provided in the pipework to enable each pump to be removed and replaced without disturbing the adjacent pumps or shutting down the system. If necessary, a removable spool shall be provided between the suction isolation valve and the pump so that the pump impeller can be removed.

Suction lines to the pumps shall be as short as possible. The suction line shall be arranged to allow a balanced flow to the eye of the impeller.

Piping shall be stainless steel Grade 316. The piping shall be arranged to eliminate all vapour pockets. Suction pipework shall be arranged to eliminate the need for automatic air release where possible.

Piping shall be supported and flexible enough to prevent damage due to vibration and to minimise the pump load transmitted to the pump.

#### 16.4.4.4 DIAPHRAGM TANK

Booster sets shall include a diaphragm tank, sized to ensure effective operation of the booster set under all operating conditions, including delivery of low flows without excessive pump starts and stops, and smooth transition of flows across the full range.

The tank shell shall be fabricated from carbon steel with internal and external coating systems as per the manufacturer's specification. The diaphragm material shall be Butyl. The diaphragm tank shall be complete with a pressure gauge, relief valve and pressure charging point.

The diaphragm tank shall have a minimum PN16 pressure rating and shall be compliant with applicable requirements of AS 1210 and shall take guidance from, but not necessarily conform to Section 17 of this Specification.

### 16.4.5 Sewage submersible pumps

#### 16.4.5.1 GENERAL

Submersible pumps shall comply with WSA 101 Industry Standard for Submersible Pumps for Sewage Pumping Stations. In addition to that standard and this Specification, the following provisions shall apply to submersible pumps.

The pumps must be designed and manufactured with such geometric, hydraulic and construction characteristics as to enable the efficient handling of unscreened sewage containing fibrous solids, plastic bags, sand/grit, mineral and organic oils and other similar materials, without clogging. Grinder/macerator pumps for wet installations may be considered, subject to approval by Unitywater.

The pumps shall consist of a single stage centrifugal pump driven by an electric motor via a common shaft, forming a compact, strong and watertight unit, capable of being installed under submerged or dry conditions.

The impeller and casing shall be designed to suit the specified amount of fluid contaminants including solid particles. This must include wear, corrosion and mechanical shock resistant materials and open impeller design, with non-clog characteristics and high hydraulic efficiency. Submersible pumps may be controlled via an automated pump unblocking control system that initiates a short reverse rotation / forward rotation cycle. Submersible pumps shall be capable of withstanding this reverse / forward flow operation without damage.

The impeller shall have non-clogging characteristics, and the flow passages shall be able to handle solids of up to 80mm diameter.

The impeller shall be statically and dynamically balanced to a G 6,3 Balance Quality Grade at the maximum operating speed in accordance with ISO 21940-11. The complete assembly of rotating elements including motor shall then be dynamically balanced to a minimum Grade G 6,3 at the maximum operating speed.

Electric motors shall be protected from overheating, as per the requirements of [Pr9835](#) - Specification for Electrical Installation at Treatment Plants, [Pr9380](#) - Electrical Installations at Network Sites and WSA 101.

For requirements of electric motors associated with sewage submersible pumps for wet well and dry well installation, refer to [Pr9835](#) - Specification for Electrical Installation at Treatment Plants or [Pr9380](#) - Electrical Installations at Network Sites, as applicable.

#### 16.4.5.2 SUBMERSIBLE PUMPS FOR WET WELL INSTALLATION

A typical submersible pump in wet well arrangement is shown in SEQ-SPS-1300-2. The installation arrangement for submersible pumps to be installed in water and wastewater treatment plants for sludge transfer purposes shall be as determined by design on a case-by-case basis.

Submersible pumps shall be supplied complete with a discharge pedestal with integral duckfoot bend and guiderails, including mounting brackets to support the guide rails at the top of the wet well or any alternative arrangement as determined by design.

The connection of the pump's discharge flange to the duckfoot bend/pedestal shall be of a design that enables the removal and re-installation of the pump, without disturbing the discharge pipework and with no need for personnel to enter the wet well and/or dewatering the wet well. The connection between the pump's discharge and the fixed duckfoot bend shall provide a leak proof joint under a minimum of 1.25 x the maximum design head.

Where the flange drilling pattern on the pump discharge differs from the flange drilling pattern on the locking plate, a flange adapter ring shall be provided to accommodate the differences, or the locking plate may be drilled to suit the pump, subject to approval by Unitywater. Refer to form [F10209](#) - Pump Flange Drilling Instruction for flange dimensional data.

Where a submersible pump is to be fitted to a Forrers discharge pedestal, the designer is to verify that the pump will have enough clearance between the pump suction and the wet-well floor. The designer shall also ensure that the pump arrangement is able to resist lift from the thrust generated at operating pressure while maintaining an effective seal between the pump discharge and pedestal. Forrers pedestal dimensions are tabulated below.



## Pr9693 - Specification for Mechanical Installations

Table 34: Forrers Pump Pedestal Dimensions

| Discharge Line size | Pedestal height – centreline of pump discharge to base of pedestal – [mm] |
|---------------------|---|
| DN75                | 140   |
| DN100               | 203   |
| DN150               | 270   |
| DN200               | 474 – Single square guide rail  |
| DN200               | 279 – Double round guide rail   |
| DN250               | 302   |
| DN300               | 280   |

All components shall be of materials suitable for submergence in the specified fluid. The pump components shall be constructed with the basic minimum materials specified in Table 2.1 of WSA 101, except for the following components, some of which are also applicable to pumps for dry well installation:

- Impeller: ASTM A 532/A532M CI II Type B
- Guide rails: Stainless steel pipe Schedule 40S ASTM A 312/A312M Grade 316L
- Guide rails support brackets: Stainless steel ASTM A 312/312M Grade 316L or CF8M.

Where pumps are installed in a wet-well configuration, pump installation shall include a heavy-duty stainless steel Grade 316 lifting chain to AS 4797 for each pump unit. A stainless steel Grade 316 'D' shackle shall be provided on the chain end for connection to the pump unit. The chain shall be sized appropriately and shall be supplied with a proof load certificate. Wet-well pump installations shall include a stainless steel Grade 316 hook to fix the lifting chain to an easily reached access point in the wet-well access cover opening.

For submerged conditions, the motor shall be designed to operate at full load with cooling effect due to immersion in the pumped fluid. The temperature of the fluid in which the pump is immersed shall be taken as being up to 30°C.

Thermal switches shall be provided to detect over-temperature in the motor.

Motor/sensor leads shall be sealed to the motor by a compression gland. The cable sheath shall be suitable for continuous submergence, and oil and grease resistant. The cable shall be long enough to allow for one re-termination and in any case shall be a minimum of 15 metres long.

Where separate sensor leads are provided, their compression glands are to be in close proximity to the motor lead compression glands. Sensor lead compression glands positioned at the drive-end of the motor are not acceptable.

Where the size of a pump is sufficient, hand-hole cleanouts shall be provided on the casing to facilitate clearing out of accumulated debris.

### 16.4.5.3 SUBMERSIBLE SEWAGE PUMPS FOR DRY WELL INSTALLATION

Submersible sewage pumps for dry well installation must be designed for vertical or horizontal installation. The pump shall be supplied with a mounting stool, pedestal or footplate fabricated from hot-dip galvanised structural steel plate and sections. The supplier shall provide sufficient information to enable the construction of any support structure required to ensure the structural safety of the installation, while complying with vibration acceptance limits specified in ANSI/HI11.6.

For non-submerged conditions, the motor shall be designed and adequately rated to operate at full load in air with convective cooling, i.e. without additional cooling effect due to immersion in the pumped fluid. Where a closed-loop cooling system is provided, the motor shall be fitted with a jacket containing glycol or similar coolant. The coolant shall be cooled via a heat exchanger on the back-plate of the volute or similar arrangement. Motors which use the pumped medium or an external water supply circulating around a cooling jacket are not acceptable.

For either arrangement, the temperature of the pumped fluid shall be taken as being up to 30°C.

For pumps with a motor rated power of more than 7.5 kW, or as otherwise specified in the Unitywater supplied data sheet, water-in-oil sensors shall be provided to detect water leakage into the oil chamber.

Sump pumps shall be equipped with a suction screen of aperture less than maximum sphere size which can be pumped.

### 16.4.5.4 PAINTING - SUBMERSIBLE SEWAGE PUMPS

Submersible pumps with a motor rated power of 3 kW or less shall be painted to the Manufacturer's standard painting system.

For pumps with a motor rated power of more than 3 kW, the following painting system shall apply:

- Internal coating of submersible sewage or sludge pumps:
  - Internal wetted surfaces of cast iron pumps shall be coated in accordance with System 11, Section 10.4 of this Specification. Internal components of the pump include: Impeller, wear plate, back plate and inside surface of the volute.
  - Only cast iron, ductile iron, bronze or brass internal components require coating, wear resistant, or high alloy components shall remain uncoated.
- External coating of submersible sewage pumps:
  - External surfaces of cast iron pumps shall be coated in accordance with System 9, Section 10.4 of this Specification, or a high build two-pack epoxy system to 300 µm DFT (minimum). Top-coat colour shall be in accordance with Table 5: Colour code for top coat on corrosion protected equipment colour code of this Specification, or to Manufacturer's standard colour.
- Pump pedestal and locking plate coating:
  - Pump pedestals and locking plates shall be coated internally and externally in accordance with System 9, Section 10.4 of this Specification, or a high build two-pack epoxy system to 300 µm DFT (minimum). Top-coat colour shall be in accordance with Table 5: Colour code for top coat on corrosion protected equipment colour code of this Specification, or to Manufacturer's standard colour.

- Pump guide rail bracket coating:
  - Cast iron and ductile iron pump guide rail brackets shall be coated in accordance with System 9, Section 10.4 of this Specification.

## 16.4.6 Grit pumps – dry mount

Grit pumps shall be close-coupled units suitable for pumping grit laden water, furnished with totally recessed impeller of the vortex pattern to prevent the fouling of solids and fibrous materials on the impeller. All internal clearances shall provide for a free passage of 100 mm to preclude the clogging of the pump and suction lines.

The pump casing and impeller shall be constructed from ASTM A 532/A532M Grade NiHard 4 White Cast Iron Class 1, Type D and equipped with mechanical seals.

The shaft shall be solid stainless steel Grade 316 through the mechanical seal. Carbon steel shafts are not acceptable.

The impeller shall produce a turbine-like flow pattern within the casing, generating flow. To prevent grit from entering the seal area, all impellers less than full diameter shall be trimmed with the back shroud remaining at full diameter so that a minimum clearance from shroud to casing is maintained. Both the end of the shaft and the bore of the impeller shall be tapered to permit easy removal of the impeller from the shaft.

The pump shall be arranged so that the complete rotating element can easily be removed from the casing without disconnecting the electrical wiring or disassembling the motor, impeller, back-plate or seal.

The pump shall be sealed against leakage by a single mechanical seal, constructed to be automatically drained. The seal shall be of carbon and ceramic materials with the mating surface lapped to a flatness tolerance of one light band. The rotating ceramic element shall be held in mating position with the stationary carbon seal by stainless steel Grade 316 spring(s).

Bearings shall be ball or roller bearings designed for an L<sub>10</sub> Rating Fatigue Life of a minimum of 50,000 hours, as defined in ISO 281 at the maximum operating speed.

## 16.4.7 Self-priming Sewage Pumps

Self-priming sewage pumps shall be of the wet prime type, requiring only initial filling of the dedicated storage space in the proprietary designed casing. The pump shall be capable of re-priming itself without operator intervention after every priming cycle. The pump shall be capable of operating efficiently under the maximum suction lift specified in the data sheet supplied by Unitywater.

The pump shall be driven by electric motor via flexible coupling. The whole assembly shall be mounted on a common base. The rotating assembly shall be removable to enable inspection of the pumps shaft and bearings without disturbing the pump casing or the pipework. The top cover shall also provide easy access to the interior of the pump. The pump shall be sealed against leakage by a single cartridge mechanical seal. Bearings shall be ball or roller bearings designed for an L<sub>10</sub> Rating Fatigue Life of a minimum of 50,000 hours, as defined in ISO 281 at the maximum operating speed.

The pump components shall be manufactured from the same materials and grades specified for sewage submersible pumps for dry wet installation.

## 16.5 Rotary positive displacement pumps

### 16.5.1 General

For the purposes of this Specification, a rotary positive displacement pump is a pump in which a liquid is trapped in confined volumes and transported from an inlet port to an outlet port by the rotational movement of the pumping element. The requirements specified in this section apply to the following types of rotary positive displacement pumps:

- Rotary lobe pumps
- Progressive cavity pumps
- Peristaltic pumps.

All rotary positive displacement pumps shall be compliant with the requirements of ISO 14847.

Pressure relief valves shall be included in the pump assembly to protect the pump assembly against excessive pressure that may develop as a result of a discharge pipework blockage or inadvertent closure of an in-line isolation valve while the pump is operating.

### 16.5.2 Pump drive

The maximum pump speed shall be selected for reliable and maintenance-free operation.

The maximum motor speed shall not exceed the allowable limit specified in the data sheet provided by Unitywater for operation at 50 Hz for the specified pump type.

The pump shall be driven by a geared motor included in the SEQ Accepted Mechanical Products and Material List. The gearbox shall be capable of transmitting the maximum motor output torque and shall have a minimum American Gear Manufacturers Association (or equivalent) service factor of 1.5 for all pumping duties. A belt drive between the pump and motor is not acceptable.

The gearbox shall incorporate accessible oil filling and drain plugs that allow in-situ oil removal/replenishment without excessive spillage. A means of checking the oil level shall be provided.

The gearbox shall be adequately supported to prevent excessive vibration under all operating conditions.

### 16.5.3 Dry running

If necessary, for the protection of the pump in dry running conditions, the pump assembly shall be provided with protective devices and systems to prevent damage to the pump. These may include methods to detect no flow, low pressure in the suction line or low level in a supply tank and provide a signal to the PLC for pump shut down.

## 16.5.4 Solids handling capability

The pump shall be sized to handle materials which may be contained in the fluid being pumped without blockages. Materials in sludge/wastewater may include:

- debris such as plastic bags
- fibrous solids and stringy materials
- grit and other abrasive solids
- minerals and oils.

The pump shall be non-clogging and non-ragging.

## 16.5.5 Rotary lobe pumps

### 16.5.5.1 GENERAL

The pumpset shall be of the close-coupled design without motor and gearbox flexible couplings and mounted on a structural steel baseplate and frame.

The pumpset shall be of twin rotor design with lobed rotors mounted on separate parallel shafts, counter rotating within the pump casing. Shaft rotation shall be synchronised to ensure that no contact occurs between the rotors, and/or the rotors and the pump casing.

At the duty point, the speed of rotation of the lobes shall be less than 300 rpm and the tip speed of the rotors shall be less than 2.5 m/s to minimise wear from grit. The pump shall be capable of passing solids of up to 80 mm diameter.

The pumpset shall be capable of dry running, without damage, for extended periods of time. The pumpset may be subject to intermittent and alternate dry and wet running on a regular basis and shall be designed to cater for the surging that this type of operation involves. The pump drive motor shall be capable of and be rated for accepting the shock loading. The pump shall have self-priming capability with no damage to the internal components.

The pumpset shall be designed to permit pumping in either direction.

### 16.5.5.2 ROTORS

The rotors shall be replaceable in-situ. The rotors shall be retained in position by torque-locking assemblies and splines. Any special tools required for the removal, adjustment and installation of rotors shall be supplied with each pumpset. The rotors and shaft shall be marked to ensure correct alignment/synchronisation on re-installation.

### 16.5.5.3 GEARS

Timing gears shall be precision manufactured, involute form spur or helical gears. The gearbox shall be designed to accommodate any thrust forces generated by the timing gears.

## 16.5.6 Progressive cavity pumps

The pump shall be direct coupled to a motor/gearbox unit to suit the range of pump duties. The complete drive unit shall have an ingress protection rating of IP55 or higher. The pump and drive unit shall be mounted on a common fabricated steel baseplate, complete with all necessary guards. All components shall be conservatively selected to suit the specified type of duty with continuous operation.

The motor power output rating shall exceed the power required at maximum duty and worst case operating condition by 30%.

The drive assembly shall enable easy dismantling of the pump. The drive shaft and mechanical seal, where fitted, shall be replaceable without the need to dismantle the bearing housing. If a coupling rod and joints are used, they shall be sealed for life.

The pump casing shall be able to be rotated in 90° steps.

The pump shall be provided with the following:

- a suitable check valve on the discharge pipework, and
- protection against running against a closed discharge, i.e. discharge pressure relief valve or discharge pressure switch.

## 16.5.7 Peristaltic pumps

The casing shall be provided with a bolted, removable front cover to enable the rotor, hose and bearing assemblies to be removed without disturbing inlet/outlet pipework. The casing shall incorporate the bearing housing, which shall be accessible via a removable cover plate.

A burst hose/tube monitoring facility shall be provided.

Connections shall be provided on the rear of the casing to prevent accidental damage/facilitate the removal of the front cover.

Adjustment of the flow rate shall be achieved by variation of the speed of rotation of the pump.

## 16.6 Dosing and metering pumps

### 16.6.1 General

Automatic dosing pump operation shall be provided.

Dosing pumps operating in parallel shall be of identical size. Mismatched pumps shall not be allowed.

On AC motor driven dosing pumps the minimum operating speed shall be no less than 10 Hz or 15 strokes per minute.

Dosing pumps shall be selected based on achieving flow requirements up to and including average flow/average dose at no more than 85% of their maximum speed. Speed can be increased above 85% for flow above this, i.e. maximum flow/maximum dose.

Dosing pump systems shall be provided with facilities for manual venting/priming.

Sodium hypochlorite pumps shall be installed adjacent to solenoid bleed valves to permit automatic degassing, unless the pump is fitted with an integral automatic degassing system.

Dosing pump steady state accuracy shall be within  $\pm 2\%$  over the full dosing range. The steady state accuracy is the variation between the measured flow at any one point compared to measurements taken again with all parameters remaining unchanged and constant, e.g. speed, stroke, chemical, temperature, pressure, etc.

Dosing pump repeatability shall be within  $\pm 3\%$  over the full dosing range.

Dosing pump linearity shall be within  $\pm 3\%$  over the full dosing range. The pump characteristics shall be such that the change in pumped flow rate for different pump settings, e.g. speed or stroke, is linear, i.e. the change in pump flow shall be directly proportional to the change in the relevant pump setting.

## 16.6.2 Diaphragm pumps

Variable stroke length diaphragm pumps shall be provided with integral automatic speed adjustment and manual stroke adjustment. Where specified, automatic stroke adjustment shall be provided. The usable stroke adjustment turndown used when sizing variable stroke length diaphragm pumps shall be limited to 5:1 or 20-100% for mechanically actuated pumps and to 10:1 or 10-100% for hydraulically actuated dosing pumps.

Very small diaphragm-type dosing pumps, i.e. solenoid driven type, incorporating automatic speed adjustment only (i.e. no stroke adjustment) shall be acceptable subject to their being able to meet the dosing range specified on the data sheet and the specified pump accuracy. Solenoid type dosing pumps shall be limited to a minimum of 30 strokes per minute.

Digital stepper-motor driven diaphragm type dosing pumps shall be provided with integral automatic speed adjustment. Continuous operation at 100% stroke rate is acceptable and turndown is limited only by the volume flow rate required for effective mixing and system control.

Where the specified duty cannot be achieved via a pump with a single head, pumps with multiple dosing heads, i.e. duplex or triplex pump heads, may be considered on a case-by-case approach subject to the prior approval of Unitywater.

Hydraulic driven diaphragm dosing pumps for very large or high-pressure applications shall be fitted with double diaphragms and diaphragm rupture detection systems.

Diaphragm pumps shall be arranged to facilitate easy and quick access to the pump's non-return valves to allow clearance of blockages.

Diaphragm pumps shall incorporate either a bleed valve or a means of safely depressurising the pump head to allow maintenance activities to be safely completed on the pump head.

## 16.6.3 Progressive cavity pumps for chemical dosing

Progressive cavity pumps for chemical dosing/metering applications shall also comply with the requirements specified in Section 16.5.6.

If the casing material is incompatible with the dosing chemical, the stator shall be designed to prevent the penetration of the dosing chemical between the stator and casing.

The casing design shall ensure that the rotor and drive end cover can be removed without dismantling the casing itself.

Installation shall be with the suction/inlet connection local to the drive shaft seal, i.e. they are suction on gland (SOG) type.

#### **16.6.4 Peristaltic pumps for chemical dosing**

In addition to the characteristics specified in Section 16.5.7, peristaltic pumps for dosing and metering applications shall include the following features:

- a means of relieving the pressure in the casing in the event of a hose/tube burst
- high/low lubricant level probes with low and high levels used to stop the pump
- lubricant fill/drain points
- an accuracy rate of at least 1%
- a tube adequate for the aggressive and abrasive nature of the products to be handled
- self-priming capacity to not less than 8m of suction head.

## **16.7 Pump testing requirements**

### **16.7.1 Hydrostatic testing**

All pumps shall be hydrostatically tested at the factory with water to 1.5 times the rated pressure of the pump before the unit is painted.

The test pressure shall held for sufficient duration to verify that the pump is free from leaks and weeps during the test period.

Casings showing signs of weeping due to porosity shall be rejected.

### **16.7.2 Pump performance testing – centrifugal pumps**

For pumps with a motor size of less than 30 kW, the manufacturer's type-testing certificate is acceptable and individual pump tests are therefore not required. The pumps must be supplied with type-test certificates guaranteeing that the pump curves submitted are truly representative of the performance of the pumps within the tolerances specified in AS ISO 9906 for a 2B Acceptance Grade.

For pumps with a motor size of 30 kW or more, individual non-witnessed pump tests shall be performed in accordance with AS ISO 9906 with a 2B Acceptance Grade and corresponding tolerances.

The performance of each pump shall be tested using the motor to be supplied with the pump.

The duration of the test shall be sufficient to verify that the pump operates with no undue heating of bearings or vibration, other than that which is inherent to the style of pump under test.

Flow, head, power and other required parameter measurements shall be taken at several flow rates to provide a definable smooth curve for head, efficiency, absorbed power and motor electrical power (all versus flow rate) extending from zero flow to the maximum flow the pump will achieve against the system curve. Vibration testing is not required unless noted otherwise.

Where pumps are operated at variable speed, the test shall be repeated at the lowest speed and any other speed required to achieve the various duty points indicated on the pump data sheet.

The test flow rates shall include:

- zero flow (shut-off head)
- the guaranteed duty point
- all secondary duty points
- maximum achievable flow.

## 17. Surge vessels

### 17.1 General

This Specification covers large surge vessels intended for use on water and sewage pipelines. Small pressure tanks for pump station discharge pressure modulation are excluded from this section (refer to Section 16.4.4.4). Surge vessels shall be air-water type vessels, where the air-water interface in the vessel is a free surface achieved by pressurising the headspace via a separate air compressor system. Bladder type and dipping tube type surge vessels are not acceptable for any application.

Surge vessels shall be manufactured in accordance with AS 1210 - Pressure Vessels.

At a minimum, each vessel shall include the following:

- vessel of steel construction
- single nozzle installed to the lower of the vessel, terminated in a flange to facilitate connection to the pressure main
- five DN100 nozzles installed to the top of the vessel, terminated in a flange to facilitate connection of:
  - level sensing equipment consisting of a radar level transmitter
  - level sensing equipment consisting of electrode-type level switches
  - pressure sensing equipment consisting of a pressure (or differential pressure) transmitter and a pressure gauge
  - compressor air intake and air relief connections
  - pressure relief valve
- twin pressure relief valves at the top of the surge vessel to AS 1271 and compliant with Section 13.23, connected to the vessel via a Seetru change-over valve, or approved equivalent
- a minimum DN600 maintenance access hole, with lifting lugs for removal of the blank flange
- an access platform as described in Section 17.2
- an isolation valve to allow the vessel to be taken offline while keeping the pressure main in service
- a method for draining the vessel when the vessel has been isolated from the pressure main
- lifting lugs for the vessel
- a duty / standby compressor arrangement to supply make-up air to the vessel.

The hazard rating of the surge vessel shall be determined in accordance with AS 4343 and be stated in the pressure vessel documentation.

In sewerage applications, foul air from the air relief and pressure safety relief valves is to be routed back to the wet well.

Certificates of compliance for the pressure relief valve to AS 1210 and AS 3788 must be provided to and made available on-site.

The inlet / outlet nozzle at the bottom of the vessel shall be connected to the pipework with a dismantling joint to allow adequate space for draining the vessel during internal cleaning operations.

The corrosion protection for surge vessels shall be in accordance Section 10.4.1 of this Specification:

- external coating shall be in accordance with System 3
- for water vessels, the internal coating shall be in accordance with System 8
- for wastewater vessels, the internal coating shall be in accordance with System 9.

The geometry of all vessel components shall be designed to ensure smooth transitions and radiused edges, minimising sharp corners and crevices that could compromise coating adhesion, continuity, or coating performance in service.

## 17.2 Installation and access requirements

Surge vessels can be installed either vertically or horizontally, with a preference for vertical vessels to minimise space.

An access platform shall be provided to the vessel to allow safe access to all instrumentation and the manway, for internal cleaning or personnel entry. The platform shall provide adequate space for manway opening and maintenance activities.

Stairways shall be used as the means of access to the access platform. Ladders may be considered in areas where there are significant space restrictions. Ladder access require Unitywater approval. Access methodology shall be considered as part of the Safety in Design process.

The access platform and method of entry to the platform shall comply with the requirements of AS1657.

## 17.3 Instrumentation

Surge vessels shall have suitable nozzles to accommodate the instrumentation listed in Table 35.

Table 35: Surge Vessel Instrumentation and Top Nozzle Connection Details

| Instrument                              | Mounting   |
|---|--|
| Pressure transmitter                    | DN100 vertical or horizontal nozzle mounted on top of vessel             |
| Air release actuated valve & air intake | DN100 vertical or horizontal nozzle, flange mounted manifold             |
| Level transmitter                       | DN100 vertical nozzle with radar level sensor                            |
| Level switches                          | 100 vertical nozzle with 3 electrode holders (Omron BS-01 or equivalent) |
| Pressure relief valve                   | 100 vertical nozzle  |

## 17.4 Surge modelling and vessel sizing

The vessel and pipework sizes and air/water interface level setpoints shall be determined based on a modelling study which covers the entire hydraulic system.

Requirements for the entity undertaking the study, shall include, but not be limited to:

- The transient / surge analysis shall be carried out by a competent surge modeller using suitable software.
- Modelling of pre-mitigation operating scenarios, including but not limited to:
  - Standard pump start and stop, considering any controlled start and stop through VSDs and inclusion of pump inertia.
  - Power failure, resulting in a rapid pump stop, inclusion of pump inertia.
  - Power failure condition with all duty/assist pumps in operation.
- Analysis of proposed mitigations to address any surge or negative pressure risks, including but not limited to:
  - Commentary on consequences of negative pressure occurring, including consideration of the following:
    - Negative pressure in water systems is to be avoided to ensure contaminants are not drawn in through hydrants.
    - Negative pressure in wastewater / recycled water systems may be acceptable, pending the pipe's structural ability to take a negative internal pressure, and risks of seal displacement in rubber ring jointed pipe systems.
  - Modelling of various mitigation scenarios, including air valves (wastewater and recycled water), and surge vessel/s at various sizes to ensure the need for a surge vessel is adequately identified and its size is appropriately chosen. Operating scenarios shall be the same as the pre-mitigation operating scenarios.
  - Summary of the operation of the proposed surge vessel, including but not limited to:
    - Required minimum size of the vessel.
    - Expected levels within the surge vessel across the operating scenarios to demonstrate the vessel will not over-pressurise, or empty and pull air into the pressure main.
    - Recommended operating levels, including vessel target/typical pressure and target level and/or pressure volume within the vessel.

Adequate vessel volume shall be provided to allow for the correct level control over the full range of system pressures. The vessel shall be sufficiently sized to avoid air intake to the pressure main across all operating scenarios.

## 18. Blowers

### 18.1 General

Blowers shall be supplied with the following features:

- Blower assembly consisting of blower, drive motor, and fabricated steel baseplate, supplied as a single unit and mounted on appropriately rated flexible anti-vibration mounts
- Intake filter complete with maintenance indicator (differential pressure indicator) and silencer
- Pressure relief valve
- Discharge check valve
- Unloading valve and silencer, if required
- Discharge silencer and compensation bellows in pipeline
- Blower diffuser according to blower type and application
- Surge protection system, if required
- Acoustic enclosure
- Local Control Panel (LCP), if required.

Blowers shall be provided with the following instrumentation for condition monitoring, as minimum:

- Pressure gauge
- Inlet air high temperature sensor / switch
- Oil high temperature sensor / switch
- Oil temperature gauge
- Oil low pressure sensor / switch
- Oil pressure gauge
- Oil filter differential pressure indicator
- Acoustic enclosure high temperature sensor
- Blower outlet air temperature transmitter
- Vibration sensors on motor and gearbox.

Blowers shall be sized to provide maximum operational efficiency at the standard site and service conditions stated in Section 4.2. The blowers shall be capable of operation with allowances for variations in atmospheric pressure, ambient temperature, and relative humidity, referred to as the Standard Operating Range per Table 36. Blowers must be capable of operating within the Standard Operating Range without derating, risks of condensation, or performance degradation from the full range of specified duties.



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Table 36: Blower Standard Operating Range

| Standard Operating Range   | Minimum | Standard Duty | Maximum |
|----------------------------|---------|---------------|---------|
| Air Temperature (°C)       | 5       | 30            | 45      |
| Relative Humidity (RH%)    | 30      | 60            | 95      |
| Atmospheric Pressure (Kpa) | 101.3   | 101.3         | 101.3   |

Blower power shall be supplied for the minimum, standard (duty) and maximum operating conditions. The blower shall be capable of continuously discharging air at across the entire operating flow and pressure without instability, surge, pressure relief or motor overload.

All pressure and power losses associated with silencers, check valves, and the drive system shall be included in the total power requirement. The blower shall be rated to accommodate these losses and deliver the specified duty accordingly.

All blowers shall be oil free and air cooled unless otherwise specified.

All blowers shall be provided in a duty/standby arrangement (minimum requirement) with both units selected for 100% capacity. It may be acceptable to provide less capacity for the standby unit if multiple units are provided, but the total capacity with any one unit out of action shall be equal to 100%.

Start or stopping of any individual blower under multiple blower system shall not alter the airflow of the plant.

## 18.2 Blower assembly

The blower assembly shall be of a compact modular design, which will ensure a small footprint area to minimise civil construction costs. Each blower and motor, coupled together, shall be mounted on a common steel base, properly braced to form a rigid support for the entire unit. Blowers shall be fitted with anti-vibration mountings unless specified otherwise.

The blower silencers, air manifold and the overall air system shall be designed to eliminate the effects of resonant frequencies and vibration over the whole operating range of the blowers. Vibration must not be transmitted into the building structure under any circumstances.

Blower foundations, supports, restraints, etc. shall be designed and installed with due regard to all static and dynamic forces that will be imposed upon them by the installed equipment, including, as a minimum, forces arising due to surge, thermal effects and vibration.

The blower casing shall be made of cast iron and be designed for easy disassembly for inspection or replacement of parts. The maximum allowable working pressure of the casing shall be at least 1.25 times the maximum specified discharge pressure and shall have a minimum design temperature of 250°C.

Blowers shall be provided with flanged suction and discharge expansion joints to alleviate vibration, expansion and contraction stress between compressor and piping. These expansion joints shall be capable of withstanding the suction and discharge pressure and temperature at all operating conditions.

Each blower shall be provided with a discharge check valve.

The blow off valve / PRV shall discharge to a safe location away from the blower inlet and outside the enclosure. The PRV shall be fitted with a silencer.

## 18.3 Acoustic enclosure

All blowers shall be provided with an enclosure fabricated from galvanized or painted steel sheeting, with internal acoustic insulation for noise attenuation. The enclosure shall be provided with a suitable method of ventilation for blower cooling.

Installation indoors is preferred and shall be adopted wherever site conditions permit. Outdoor installation shall only be considered where indoor installation is not feasible and is subject to prior approval by Unitywater.

Where the blower, and ancillary equipment, including associated pipework are to be installed within a building or structure, the building or structure shall be designed and constructed to ensure adequate noise attenuation. The cumulative sound pressure levels at the building exterior and site boundaries shall comply with noise requirements stated in Section 4.7 at a minimum. Where necessary the blower room and/or blower enclosure shall be fitted with appropriate additional acoustic treatments to prevent excessive noise breakout.

The installation layout shall allow for safe and practical access to the blower, pipework, pipe supports, and associated equipment. Adequate clearances for operation, inspection, maintenance, and equipment removal. Suitable lifting facilities for safe handling of major components during installation and maintenance. All spatial and handling requirements shall comply with manufacturer recommendations and WorkSafe requirements.

Where site constraints necessitate outdoor installation and approval is granted by Unitywater, a weatherproof acoustic enclosure shall be provided as a minimum requirement to ensure compliance with noise and environmental standards.

Enclosures shall be designed to withstand environmental conditions, including temperature fluctuations, humidity, UV exposure, and corrosion, without degradation in performance or structural integrity for the full design life of the blower.

Enclosure shall be provided with access doors or removable panels for access to internal parts that require routine inspection, cleaning or maintenance. or attention. Unless otherwise specified, removable panels shall be less than 20 kg and designed for removal and replacement by one person. The structural integrity of the enclosure shall be maintained when one or more panels are removed. The whole enclosure shall be removable for major overhaul of the machine.

All joints shall be sealed, and gaskets shall be made from UV and weather-resistant neoprene or EPDM rubber and shall be suitable for the application environment. Shafts guards must be separate to any acoustic enclosure.

## 18.4 V-belt drive

Where a V-belt drive is required, the V-belt transmission shall incorporate an automatic belt-tensioning device. Belts shall be standard, commercially available products that are readily obtainable from local suppliers and typically held in stock.

V-belt drives shall be designed with a service factor of 1.5 as minimum.

Pulleys and sprockets shall be mounted on shafts using taper-lock type bushes with keying to ensure secure attachment.

Belt drive installation and alignment shall be carried out in strict accordance with the belt manufacturer's recommendations.

## 18.5 Shafts

Blower shafts that have a finished diameter larger than 200 mm shall be forged steel. Shafts that have a finished diameter equal or less than 200 mm shall be forged steel or hot rolled barstock, providing that barstock meets all quality and heat treatment criteria established for shaft forgings.

Shafts shall be machined throughout their entire length. Chrome plating of the shaft at the journal area is not acceptable.

## 18.6 Bearings

Blower bearings shall be selected based on load, operation speed, and expected service life, in accordance with the requirements specified in Section 12.7.

Hydrodynamic radial and thrust bearings for blowers shall be provided with a forced lubrication system and paired with non-contact air shaft seals (labyrinth or carbon ring) to prevent ingress of process air.

Oil shaft seals shall be mechanical or dual-lip type to retain lubrication and prevent leakage.

Rolling-element bearings for blowers shall be grease-lubricated and sealed with lip-type air and oil seals where appropriate.

Shaft seals shall be labyrinth type, carbon-ring type, mechanical face or a combination of these types.

## 18.7 Accessories

Each blower shall include a fully automated control system to monitor critical parameters of the blower and to control performance. Alarms and monitoring signals shall be provided to the site control system.

The control panel will start, stop and operate the blower, provide detections of malfunctions and shut down the blower if needed. The panel shall be fully enclosed, minimum IP54, and comply with the requirements of Unitywater electrical specifications [Pr9835](#) - Specification for Electrical Installation at Treatment Plants and [Pr9380](#) - Specification for Electrical Installations at Network Sites. The control panel shall be completely linked and wired to other components of the package, requiring only connection to the Unitywater's external piping and wiring circuits. Alarms and monitoring signals shall be provided to the site control system.

## 18.8 Air intake and exhaust air

Unless otherwise specified, the intake ducting shall be in galvanised steel and of adequate proportions to minimise pressure drop and vibration.

Where air is drawn by the blowers directly from the room, appropriate provision shall be made to protect equipment and pipework from low ambient temperatures. Where air is drawn from outside the building, then heat from the machines must be dissipated effectively at times of high ambient temperatures.

Unless otherwise specified, all heat produced by the blowers shall be directed to outside of the building.

## 18.9 Filter and silencer

Blowers shall be fitted with an intake filter/silencer and a discharge silencer to achieve the specified noise levels.

The filter shall be a high efficiency air intake filter-silencer suitable for outdoor mounting, including a filter media fouling tell-tale.

Full flow filters with replaceable elements and filtration shall be subject to vendor and site condition requirements.

Filter cases and heads shall be suitable for operations at a pressure not less than the relief valve setting.

The pressure drop for clean filter elements shall not exceed 15% of the total allowable dirty pressure drop.

The air velocity across the inlet face of the filter at the rated blower flow rate shall not exceed 1.5 m/s under clean conditions.

The intake filter and silencer pressure drop shall be designed to consider the maximum air flow rate of the blower. The filter and silencer shall be connected to the intake of the blower via a flexible connection.

## 18.10 Centrifugal blowers

Unless otherwise specified, the centrifugal blowers shall be single stage with an impeller of a semi open, backward, curved vane design. The impeller shall be manufactured from forged aluminium alloy or high-grade alloy steel. Fabricated steel or aluminium impellers shall not be used.

The blower impeller shall be dynamically balanced and constructed to withstand an overspeed of not less than 115% of its maximum continuous operating speed without permanent deformation, fatigue damage, or imbalance.

Unless otherwise specified, the maximum continuous operating speed of the blower shall not exceed 90% of the manufacturer's certified maximum design speed to ensure mechanical integrity, avoid critical resonance, and provide a safe operational margin.

A fully automated blower control system shall be included as part of the blower installation to monitor critical parameters of the blower and to maintain optimum process conditions and achieve efficient power consumption. This system shall also provide the control logic for varying suction and discharge vanes for flow control. The blowers must start up under unloaded conditions and must only be brought up to full speed when the correct operating conditions have been reached.

The surge protection system and surge control shall be provided and designed to detect any incidence of pneumatic surge.

Rotor shafts shall be provided with seals to prevent the ingress of oil into the casing and to avoid the contamination of the timing gearbox oil. The timing gear service factor shall be minimum 1.6.

The rotor housing shall be positively sealed to prevent oil ingress into air chamber.

Timing gears shall be high-quality, hardened and ground and shall be positively located and secured to the rotor shaft.

The timing gears shall be oil lubricated. The gearcase shall incorporate readily accessible oil filling and drain points to allow oil removal / replacement in situ without excessive spillage and disturbing blower stage mounting, an oil level window sight glass shall be provided.

### 18.10.1 High speed turbo blowers

For high-speed turbo blowers, a blow-off valve shall be provided to allow unloaded start up and surge control. The valve shall be a wafer type butterfly valve, actuated with open/closed limit switches.

A silencer shall be mounted on the discharge of the blow off valve pipework. The silencer shall be constructed of sound absorption material enclosed in a carbon steel outer shell.

High-speed turbo blowers shall be equipped with either active magnetic bearings with an associated backup power supply, or air (aerodynamic) foil bearings incorporating compliant spring foils, as recommended by the Supplier.

The blower shall allow continuous flow control by adjusting impeller speed and support both constant and sliding pressure control within its operating speed range.

Each blower shall include a fully automated control system to monitor critical parameters of the blower and to control performance. Alarms and monitoring signals shall be provided to the site control system.

The conical diffuser and the blow off valve shall be integrated into the acoustic hood and shall be supported by a steel structure to protect the blower unit against external loads.

The blower shall automatically shutdown (or starting shall be inhibited) in any case that may cause damage to the blower or other plant. These conditions shall include but not be limited to the following fault/alarm conditions:

- high inlet air temperature (reverse flow)
- blow-off/unloading valve fault
- surge conditions
- high outlet air temperature
- high acoustic enclosure internal temperature, and
- high blower vibration.

## 18.11 Positive displacement blowers

Positive displacement blowers shall be air-cooled, delivering oil-free air.

Where the blower and drive motor use a V-belt arrangement, it shall comply with Section 18.4.

Direct couplings shall be of the flanged, flexible type and shall be capable of transmitting the absorbed power at the drive shaft with a service factor of 2. The couplings shall be a matched pair, parallel bored, and keyed to their shafts.

The rotor and shaft assembly shall be integrally machined from a single forging or casting to ensure maximum structural integrity, precise alignment, and long-term reliability under continuous operating conditions.

Rotating components and seals shall withstand the pressures, temperatures and corrosive properties of the process air.

The rotor shall be a one-piece casting with a precision machined profile and integral shafting or permanently secured steel stub shafts.

Operating pressure should be no greater than 85 % of the blower's maximum continuous pressure rating.

Operating speed shall not exceed 90% of the maximum design speed.

Individual external relief valves shall be provided for each positive displacement type blower. These valves only protect the air-end from over pressure.

The casing shall be fitted with a front cover plate which can be easily removed to give access to the rotating components.

### 18.11.1 Rotary lobe and rotary screw blowers

If oil-lubricated bearings are provided for rotary lobe/screw blowers, bearing housings shall incorporate readily accessible oil filling ports and drain plugs to allow oil removal/replacement in situ without excessive spillage and without disturbing blower stage mountings and/or ancillary equipment. Oil level windows/sight glasses shall be provided for monitoring.

## 18.12 Air pipework

Air pipework shall be sized selected to minimise high pressure losses in the system and to prevent any adverse pressure drop and any carry over of moisture past the drain legs. The air flow velocity shall not be less than 6 m/s but not exceed 15 m/s.

Drainage points shall be provided and at regular intervals and at the lowest point of any falling pipe. Drainage points shall be formed by equal tees with a down pointing leg fitted preferably where changes of direction occur. Branch take offs shall be from the top of the main. Traps and automatic drain valves shall be installed as appropriate.

Thermal expansion and contraction systems shall be included in the pipework system. Sufficient and suitable bellow type expansion joint with supports, guiding pipe and control rod shall be provided to accommodate the pipe movement. The metal bellow and guiding pipe shall be made of stainless steel 316 as minimum, unless otherwise specified.

Where required, thermal insulation and cladding or protection mesh wire guarding shall be arranged in a manner which provides access to valves and other components for maintenance purposes.

Pipework shall be pneumatically pressure tested, with test points provided at the outlet and inlet of the pipework.

Wall penetrations and pipework supports shall be as per Section 11.4, 11.5 and [Pr9903](#) - Specification for Building and Structural Works.

## 18.13 Performance requirements

The blower shall be performance tested in accordance with the relevant standards as follows:

For Centrifugal Blowers:

- ISO 5389 – turbo compressors –performance test code
- ASME PTC10 - Performance Test Code on Compressors and Exhausters
- Acoustic AS 2221.1 – Methods for measurement of airborne sound emitted by compressor units including prime movers and by pneumatic tools and machines
- ISO 20816-1 Mechanical vibration — Measurement and evaluation of machine vibration — Part 1: General guidelines and Section 4.6 and Section 4.7 of this Specification.

For Positive Displacement Blowers:

- BS 1571-2 – Specification for testing Positive displacement compressors and exhausters.
- BS ISO 1217 - Methods for acceptance tests regarding volume rate of flow and power requirements of displacement compressors
- DIN EN 1012-1 – Compressors and vacuum pumps 02-2011
- DIN 1945-1 - Displacement compressor - thermodynamic acceptance and performance test
- Noise AS 2221.1 Acoustics — Noise test code for compressors and vacuum pumps — Engineering method (Grade 2)
- ISO 20816-1 Mechanical vibration — Measurement and evaluation of machine vibration — Part 1: General guidelines and Section 4.6 and Section 4.7 of this specification.

## 19. Compressors

### 19.1 General

Compressors shall incorporate the following equipment:

- compressor assembly consisting of blower, drive motor, and fabricated steel baseplate, supplied as a single unit and mounted on appropriately rated flexible anti-vibration mounts
- inlet filter complete with maintenance indicator and silencer
- non return valve as appropriate
- flexible connection to the inlet and outlet pipework as appropriate (to prevent transfer of vibration)
- pressure relief valve
- automatic unloading valve with silencer if required
- discharge silencer
- acoustic enclosure
- pressure gauge
- Local control Panel (LCP) if required.

Instrumentation for condition monitoring as minimum:

- discharge low pressure switch
- discharge high pressure switch
- discharge high temperature switch
- motor high temperature switch
- high oil temperature and low oil pressure switches as appropriate
- high Compressor Vibration switch.

Unless specified otherwise, compressors shall be oil free and air-cooled, fully integrated with all the necessary auxiliary equipment including the enclosure.

The compressor shall be rated for continuous operation and comply with the relevant standard (e.g. ISO 1217, API 617, ASME PTC 10 or ISO 5389).

Compressor capacity shall match the maximum air demand without exceeding its rated duty or stability limits. A clear safety margin shall be allowed, of at least 0.2 bar or per manufacturer recommendation.

The compressor shall be selected in conjunction with an appropriately sized air receiver to avoid short cycling and ensure stable pressure control under intermittent demand.

Under no circumstances shall a compressor be selected to operate at or above the continuous maximum temperature or discharge pressure specified by the compressor manufacturer.

The compressor shall be capable of operating under an automatic control system (load/unload, start/stop, variable speed, or guide vanes) to maintain receiver pressure within preset limits during variable demand.

## 19.2 Acoustic enclosures

Installation indoors is preferred and shall be adopted wherever site conditions permit. Outdoor installation shall only be considered where indoor installation is not feasible and is subject to prior approval by Unitywater.

Compressors shall be fitted with acoustic enclosures per the requirements of Section 18.3.

## 19.3 Filters

Filter assemblies shall be fitted with a differential pressure indicator to indicate when the air intake filter is fouled, or any other premature high differential pressure event occurs.

Clear access shall be provided for dismantling and installing the filter without the requirement to remove any other major plant component.

The intake silencer shall be located downstream of the filter, and it shall be acoustical absorption type with fibreglass packing.

The efficiency of the filter shall be greater than 99% removal for particles 5 microns and larger.

An air inlet unloader shall be included in the intake air system if specified. The unloader shall control and match the incoming air supply to the system demands while the compressor turns at constant speed. The unloader should be pneumatically operated by matching a regulated air pressure with reduced discharge line or receiver pressure.

Filters with replaceable elements shall be provided before and after the dryer to prevent desiccant contamination or carryover.

## 19.4 Accessories

Each compressor shall include a fully automated control system to monitor critical parameters of the compressor and to control performance. Alarms and monitoring signals shall be provided to the site control system.

The control panel will start, stop and operate the blower, provide detections of malfunctions and shut down the blower if needed. The panel shall be fully enclosed, minimum IP54, and comply with the requirements of Unitywater electrical specifications; [Pr9835](#) - Specification for Electrical Installation at Treatment Plants and [Pr9380](#) - Specification for Electrical Installations at Network Sites.

The control panel shall be completely linked and wired to other components of the package, requiring only connection to the Unitywater's external piping and wiring circuits. Alarms and monitoring signals shall be provided to the site control system.

All monitoring instruments provided for local monitoring of compressor performance (e.g. oil temperature/ pressure gauges, filter pressure drop indicators) shall be visible without the need to remove panels.

## 19.5 Centrifugal compressors

Centrifugal compressors shall be the single stage centrifugal type driven through speed increasing gear unit by an electric motor, and shall be factory mounted on a common base plate with all accessories required for a complete system. Each system shall include a discharge check valve.

Single stage compressors shall be horizontally split, single stage units with overhung shaft design or impellers mounted between bearings, integral suction and tangential discharge. The motor shall be 1500 rpm (fixed speed) totally enclosed fan cooled (TEFC) squirrel cage induction type.

Each compressor shall develop a discharge pressure at least 0.05 bar above the specified discharge pressure when the capacity is reduced to 70% of the capacity at the specified discharge pressure. Compressors shall operate satisfactory without surging at any point between 60 and 100% of the specified capacity.

Each section of the casing shall be equipped with a casing drain. Casing drains shall be piped together and the common drain line piped to the edge of the baseplate. A drain valve shall be provided.

Impellers may be of either fabricated or cast construction. Fabricated impellers shall be made of aluminium alloy (5083-H112 or 6061-T6) or stainless-steel grade 316 (to ASTM A 240/A240M) as minimum, unless otherwise specified.

Each shaft shall be of ample size to transmit the maximum applied power and to carry all applied radial loads without excessive deflection.

Each rotor assembly shall be supported at both ends by oil or grease-lubricated anti-friction bearings. Oil leakage points shall be trapped to prevent air contamination. Suitable seals shall also be provided to prevent bearing contamination and to prevent loss of bearing lubricant.

Bearings and bearing life shall be accordance with Section 12.7, unless otherwise specified. Bearings shall be mounted in housings outboard of the casing heads. Bearing housings shall be arranged to permit inspection and replacement of the bearings without disconnecting the piping or disassembling the blower. Shaft speed shall not exceed the bearing manufacturer's recommendations.

Each compressor shall be equipped with a dry type air filter located upstream of the suction inlet.

## 19.6 Positive displacement compressors – Rotary / Screw

### 19.6.1 Rotary lobe compressors

Rotary lobe machines shall be sized to deliver directly the necessary flow rate of air at the pressure required by the media filter or by the process. Drivers may be variable speed to suit the application requirements. Due allowance shall be made for operating a pressure safety valve set at a higher pressure without overloading the compressor or its driver.

Under no circumstances shall a compressor be selected to operate at or above the continuous maximum temperature or discharge pressure specified by the compressor manufacturer. In process applications where the discharge pressure may approach the maximum permitted, the machine control system shall shut down on high discharge temperature and from a suitable switch and thermistor provided.

Where necessary to facilitate starting of the compressor (e.g. at reduced voltage), an unloading arrangement shall be incorporated in the compressor delivery system and shall include a motorised valve operated via auxiliary contacts on the compressor motor starter.

Each compressor shall have an inlet air filter, inlet and discharge silencers, a pressure safety valve, pressure gauge, check valve and isolating valve.

Where appropriate, the compressor and its accessories may be pre-assembled on a steel frame. A sheet steel guard shall be bolted to the baseplate.

## 19.6.2 Screw compressors

Screw compressors shall be oil-free unless otherwise specified.

Screw compressors for intermittent duty shall be rated for continuous operation at twice the maximum air demand and shall be suitable for intermittent operation to maintain the associated air receiver pressure between pre-set limits irrespective of air demand up to the maximum value.

Screw compressors for continuous duty shall be sized to deliver directly the flow rate of air at the pressure required by the process. Due allowance shall be made for operating a pressure safety valve set at a higher pressure without overloading the compressor or its driver.

Where appropriate, the compressor and its accessories may be pre-assembled on a steel frame. A sheet steel guard shall be bolted to the baseplate.

## 19.7 Performance requirements (testing)

Refer to the Unitywater Infrastructure Standards and Assurance Team for details.

## 19.8 Air receivers

Air receivers, where specified, shall be designed in accordance with the specified system flow rate and pressure requirements.

The receiver shall incorporate the following items as a minimum:

- Pressure Relief Valve (PRV)
- outlet isolation valve
- automatic drain valve with strainer / filter
- pressure gauge
- any sensors/switches necessary for interfacing with the compressor control system
- lifting facilities as determined by the receiver weight.

Air receivers shall be of welded steel construction complying to AS 1210 with a corrosion allowance of 2 mm as minimum. The corrosion protection for air receivers shall be in accordance System 3, Section 8.4 of this Specification.

Air receivers may be either vertically or horizontally mounted according to capacity. The vessels shall have suitable supporting feet or cradles as appropriate.

Certificates of compliance for pressure relief valve to AS 1210 and AS 3788 must be provided to and made available on-site.

The hazard rating of the air receiver shall be determined in accordance with AS 4343 and be stated in the pressure vessel documentation.

Where rated lifting lugs are included, these shall be certified and compliant with AS 4991.

Moisture shall be removed from the system via automatic moisture traps. A manual bypass valve around the automatic trap shall be provided.

The compressor discharge shall be fitted with automatic condensate drains on low points of the discharge piping and the air receiver. Condensate drains shall be solenoid operated with timer control.

## 19.9 Air dryers

Where specified, air dryers shall be selected to efficiently and reliably achieve system requirements given the local environmental conditions. All air-drying systems shall be suitable for outdoor installation. Air dryers shall be designed for 24 hours continuous service with no redundancies.

Where compressors are not fitted with integral air dryers, a separate downstream refrigerant type air dryer shall be provided. The air dryer shall be sized to deliver air below dew point at the compressor's rated flow.

## 19.10 Compressed air pipework

Air pipework shall be constructed of Grade 316 Stainless Steel to ASTM A312/A312M, Schedule 10S sizing as per ASME B36.19. Alternative materials may be considered where the external environmental exposure does not permit the use of stainless steels.

Pipework up to and including 50mm NB shall be joined using a crimped fitting system compliant with Section 11.8.2, or a screwed joint compliant with Section 11.8.7. Pipework over 50mm NB shall be flange jointed, compliant with Section 11.8.3.

Drainage points shall be provided and at regular intervals and at the lowest point of any falling pipe. Drainage points shall be formed by equal tees with a down pointing leg fitted preferably where changes of direction occur. Branch take offs shall be from the top of the main. Traps and automatic drain valves shall be installed as appropriate.

Thermal insulation and cladding where fitted shall be arranged in a manner which provides access to valves and other components for maintenance purposes.

## 20. Materials

### 20.1 Castings

Preferred grades for cast materials are outlined in the table below.

Table 37: Preferred Grades for Casting Material

| Material                 | Preferred Grade                                    |
|--------------------------|--|
| Spheroidal Graphite Iron | AS 1831, grade 450-310-10                          |
| Austenitic Iron          | ISO 2892, grade S-Ni Cr 20 2 (spheroidal graphite) |
| Carbon Steel             | ASTM A27/A27M, Grades N-1, 65-35 and 70-36         |
| Stainless Steel          | ASTM A 351/351M, Grade CF8M                        |

Castings shall be close and uniform in grain, homogeneous and free from blowholes, porosity, shrinkage, cracks and other injurious defects. Filling of holes with any substance shall not be permitted. Castings shall be properly cleaned, fettled and have all lumps and rough areas smoothed.

Defects in steel castings may be repaired by electric welding to the extent allowed by recognised good practice, provided that the approval of the Superintendent is first obtained.

### 20.2 Stainless steel

Stainless steel plate and bar subjected to welding during the manufacture of any component shall be Grade 316L (X2CrNiMo1712 to ISO 9328). Stainless steel plate or bar not subjected to welding shall be grade 316 (X5CrNiMo1712 to ISO 9328).

Stainless steel in shafts, spindles or similar shall be grade 420 (X20Cr13 to ISO 9328).

All stainless steel shall be passivated in accordance with System 21, Section 10.4.22. Stainless steel fabrications in highly corrosive environments, un-vented sewage applications in the presence of hydrogen sulphide such as sewage pump station wet-wells shall be electropolished in accordance with System 22, Section 10.4.23 of this Specification.

Graphite greases, graphite packing and graphite compounds shall not be used in contact with stainless steel.

Stainless steel sheet and components shall be kept separate from carbon steels during fabrication, storage and assembly. Abrasive grinding and cutting wheels previously used on carbon steels shall not subsequently be used on stainless steels. Protective coverings and space separation of storage, fabrication and working areas shall be used to prevent contamination of stainless steels with particles of carbon steel.

## 20.3 Carbon steel

Carbon steel utilised for fabrication shall be to AS/NZS 3679.1, minimum grade 250.

All mechanical equipment of carbon steel construction shall be hot dip galvanized or shall be given protective coatings appropriate for the environmental exposure as required in Section 10.4 Corrosion Protection. Such equipment shall include pipe and machinery supports, platforms, stairs, guardrails, baseplates, covers, and other items as specified.

## 20.4 Fibre Reinforced Plastic

Fibre Reinforced Plastic (FRP) products shall be manufactured from materials and by processes complying with international standards for the water industry.

Refer to the Unitywater Infrastructure Standards and Assurance Team for more details

## 21. Pressure gauges and pressure gauge connection points

All pressure gauges shall comply with AS 1349. Pressure gauges shall be Bourdon tube gauges unless otherwise specified.

For wastewater and sludge applications, pressure gauges shall be independently mounted on a stub branch line not less than DN50 for pipe sizes of DN50 and above. For pipe sizes below DN50 the stub branch shall be the same size as the pipe. All gauges shall be protected by a stainless steel seal diaphragm. An isolating valve shall be installed in each stub branch line on the pump side of the diaphragm. A bleed valve shall be provided on a tee between the isolation valve and the gauge to enable zeroing of the gauge. All gauges shall have concentric dials of at least 100 mm graduated in kilopascals (kPa). Under maximum head conditions the gauge pointer shall not exceed 90% of Full-Scale Deflection (FSD). Ideally the guaranteed duty head shall be approximately 70% FSD.

Pump suction gauges shall be compound gauges to read both pressure and vacuum.

A test certificate for each gauge must be provided in the relevant section(s) of the Operating and Maintenance Manuals.

Pressure gauges shall be mounted in a position that is clearly visible from a walkway or access platform. Where practicable, pressure gauges on an item of plant shall be mounted at the same height.

Where gauge connections are requested without the gauge being fitted, the connection shall be provided with the isolation valve.

## 22. Gaskets and seals

### 22.1 General requirements

All elastomers, gaskets, and sealants must be chemically compatible with the conveyed medium, UV and temperature-resistant, and free from asbestos.

Seals shall be designed for a life of 100,000 hours except for applications where this cannot be achieved by current seal technology. In this exception long life seals shall be used and the seal installation shall be designed to permit quick replacement without major equipment dismantling. The service life shall be extendable for an additional 100,000 hours with retrofitting.

Seals shall be an approved design effective for their purpose and requiring a minimum of maintenance.

Material for seals shall be natural rubber, synthetic polyisoprene or a mixture of natural rubber and nitrile rubber. The rubber hardness shall be as required by the seal design for the pressure specified and, if required, shall be reinforced with Kevlar fabric.

Subject to the approval of Unitywater, other elastomers with durability and mechanical properties at least equivalent to the materials specified may be substituted.

### 22.2 O-rings

O-rings for flanges shall comply with AS/NZS 4087.

O-rings which seal components shall comply with the relevant sections of AS 1646, ISO 3601-1 and ISO 3601-2.

### 22.3 Mechanical seals

Mechanical seals shall have a design life of five (5) years under specified operating and environmental conditions. The seal component materials selected shall be compatible with the process fluid in which they operate as detailed on the respective pump datasheets to minimise corrosion and wear.

All seals shall be individually replaceable. Spring and other metal components shall be manufactured from stainless steel Grade 316 or stainless steel of equivalent PREN-value. Stationary faces of shaft seals shall be manufactured from solid silicon carbide.

Where mechanical seals are fitted the pump shaft deflection, at the location of the seal, shall be 50 µm or less.

For pumping applications, the seals may be single face seals or double face seals, depending on the service conditions and the fluid being pumped. Seal faces shall be lapped flat to within two (2) helium light bands and the depth of interface roughness shall not exceed 0.3 µm.

Mechanical seals shall preferably be designed to operate without the need for external cooling/flush water. If seal cooling/flush water is required, the flow rate and pressure necessary shall be as recommended by the manufacturer/vendor/supplier. No external flushing and cooling of the seal arrangement shall be required for pumps intended to handle clear treated water.

Pump and seal design shall be such that interface temperatures under operating conditions remain safely below the vaporisation temperature.

## 23. Instrumentation

### 23.1 General

Instrumentation requirements are covered in detail in [Pr9835](#) - Specification for Electrical Installation at Treatment Plants and [Pr9380](#) - Specification for Electrical Installations at Network Sites. Preferred instruments are covered in [F10678](#) - Accepted Electrical Equipment List.

If an instrument is required to be installed below ground then a suitably designed and accessible pit shall be provided.

Where an instrument is to be installed in a below ground pit the pit shall have a sump well, preferably with gravity drainage for water systems (not suitable in wastewater). Where gravity drainage is not feasible, a sump pump shall be installed.

Instrument fittings into pipes are described in Section 11.8.13. All other instrument fitting take-offs connected to mechanical equipment must also comply with Section 11.8.13.

### 23.2 Magnetic flowmeters/flow tubes

Flow tubes must be installed with at least the vendor recommended upstream and downstream clearances. ODN flow tubes are not acceptable on greenfield sites, they may be considered on a case by case basis for brownfield installation.

Earthing rings with protecting edge shall be supplied and installed irrespective of the pipe material.

## Appendix A – References

All equipment and workmanship shall conform to the most recent requirements of relevant statutory Local, State and Commonwealth requirements and applicable, current Australian Standards. All work shall also conform to the Rules and Regulations of the Statutory Authorities having jurisdiction over the Site.

If the requirements of this Specification do not comply with the minimum requirements of the statutory regulations and standards, the latter shall apply. If the requirements of this Specification are more exacting than the minimum requirements of the statutory regulations and standards, the former shall apply.

Where no Australian Standard exists, work shall conform to the most applicable, current international Standard. Where conflict exists between different Codes, Standards or Regulations, the higher requirement shall apply.

Reference to specific clauses in other documents or codes is intended to highlight those points and shall not be taken to imply a lesser importance for all other applicable clauses.

Headings are used for context only and shall not limit the applicability of clauses therein.

While this document provides some contextual information relating to mechanical equipment and installation, this context is added to enable users to understand the application and importance the requirements. This document is not a design guideline.

Where deviation from this specification may improve the design, the designer may submit [F10996](#) - Deviation to Unitywater Technical Specification or Standard Form to the Infrastructure Standards and Assurance Team for consideration.

For general specification improvements, the online Unitywater Technical Specifications Improvement Request Form may be submitted to the Infrastructure Standards and Assurance Team for consideration.

### Applicable Legislation and Regulation

The following primary legislation, regulations and codes apply in relation to this Specification:

- *Work Health and Safety Act 2011* (Qld)
- *Work Health and Safety Regulation 2011* (Qld)
- *Electrical Safety Act 2002* (Qld)
- *Electrical Safety Regulation 2013* (Qld)
- *Environmental Protection Act 1994* (Qld)
- *Environmental Protection Regulation 2019* (Qld)
- *Environmental Protection (Noise) Policy 2019* (Qld)
- *Queensland Building and Construction Commission Act 1991* (Qld)
- *Water Supply (Safety and Reliability) Act 2008* (Qld)
- *Plumbing and Drainage Act 2018* (Qld)
- *Plumbing and Drainage Regulation 2019* (Qld).

## Codes of Practice (ratified by Legislation)

The following Workplace Health and Safety Queensland Codes of Practice apply:

- Managing Noise and Preventing Hearing Loss at Work Code of Practice 2021, WorkSafe QLD
- Scaffolding Code of Practice 2021, WorkSafe QLD
- SEQ Water Supply and Sewerage Design and Construction Code (SEQ WS & SD & C Code) including the following parts:
  - SEQ water supply and sewerage design criteria
  - SEQ sewerage code (SEQ-WSA-02)
  - SEQ Water supply code (SEQ-WSA-03)
  - SEQ sewage pumping station code (SEQ-WSA-04)
  - SEQ vacuum sewerage Code (SEQ-WSA-06)
  - SEQ (low) pressure sewerage code (SEQ-WSA-07)
  - SEQ Asset Information Specification
  - Infrastructure products and Materials lists
- National Construction Code (NCC) 2019 Volume One Amendment 1
- Queensland Development Code (QDC)
- NCC 2019 Volume Two Amendment 1
- NCC 2019 Volume Three Amendment 1
- Managing the work environment and facilities Code of Practice 2021.

## Codes of Practice (not ratified by Legislation)

- WSA 01 – Polyethylene Pipeline Code
- WSA 101 – Industry Standard for Submersible Pumps for Sewage Pumping Stations
- WSA 109 – WIS for Flange Gaskets and O-Rings Version
- WSA 130 – Industry Standard for ISO End Suction Centrifugal Pumps
- WSA 131 – ISO End Suction Centrifugal Motor Pumps
- WSA 201 – Manual for Selection and Application of Protective Coatings.

## Standards directly referenced in this document

Table 38: Australian and International Standards

| Standard             | Title   |
|----------------------|---|
| <b>ANSI/HI 11.6</b>  | Rotodynamic Submersible Pumps: for Hydraulic Performance, Hydrostatic Pressure, Mechanical and Electrical Acceptance Tests          |
| <b>API 609</b>       | Butterfly Valves: Double-flanged, Lug- and Wafer-type, and Butt-welding Ends  |
| <b>API 617</b>       | Axial and Centrifugal Compressors and Expander-compressors  |
| <b>AS 1055</b>       | Acoustics - Description and measurement of environmental noise  |
| <b>AS 1111.1</b>     | ISO metric hexagon commercial bolts and screws – product grade C - bolts  |
| <b>AS 1111.2</b>     | ISO metric hexagon commercial bolts and screws – product grade C - screws   |
| <b>AS 1112.1</b>     | ISO metric hexagon nuts Style 1 - Product grades A and B  |
| <b>AS 1112.2</b>     | ISO metric hexagon nuts Style 2 - Product grades A and B  |
| <b>AS 1112.3</b>     | ISO metric hexagon nuts Product grade C   |
| <b>AS 1112.4</b>     | ISO metric hexagon nuts Chamfered thin nuts - Product grades A and B  |
| <b>AS 1170.0</b>     | Structural design actions: General principles   |
| <b>AS 1170.1</b>     | Structural design actions: Permanent, imposed and other actions   |
| <b>AS 1170.2</b>     | Structural design actions: Wind actions   |
| <b>AS 1170.4</b>     | Structural design actions: Earthquake actions in Australia  |
| <b>AS 1192</b>       | Electroplated coatings - Nickel and chromium  |
| <b>AS 1210</b>       | Pressure Vessels  |
| <b>AS 1237.1</b>     | Plain washers for metric bolts, screws and nuts for general purposes  |
| <b>AS 1237.2</b>     | Tolerances for fasteners  |
| <b>AS 1271</b>       | Safety valves, other valves, liquid level gauges and other fittings for boilers and unfired pressure vessels                        |
| <b>AS 1281</b>       | Cement mortar lining of steel pipes and fittings  |
| <b>AS 1319</b>       | Safety signs for the occupational environment   |
| <b>AS 1345</b>       | Identification of the contents of pipes, conduits and ducts   |
| <b>AS 1349</b>       | Bourdon tube pressure and vacuum gauges   |
| <b>AS 1432</b>       | Copper tubes for plumbing, gasfitting and drainage applications   |
| <b>AS 1554</b>       | Structural steel welding  |
| <b>AS 1565</b>       | Copper and copper alloys - Ingots and castings  |
| <b>AS 1572</b>       | Copper and copper alloys - Seamless tubes for engineering purposes  |
| <b>AS 1580.108.1</b> | Paints and related materials - Methods of test Determination of dry film thickness on metallic substrates - Non-destructive methods |
| <b>AS 1627</b>       | Metal finishing - Preparation and pretreatment of surfaces  |
| <b>AS 1628</b>       | Water supply - Metallic gate, globe and non-return valves   |
| <b>AS 1646</b>       | Elastomeric seals for waterworks purposes   |
| <b>AS 1657</b>       | Fixed platforms, walkways, stairways and ladders - Design, construction and installation  |

| Standard     | Title  |
|--------------|--|
| AS 1789      | Metallic and other inorganic coatings - Electroplated coatings of zinc with supplementary treatments on iron or steel            |
| AS 1831      | Ductile cast iron  |
| AS 1897      | Fasteners - Electroplated coatings   |
| AS 2107      | Acoustics - Recommended design sound levels and reverberation times for building interiors                                       |
| AS 2129      | Flanges for pipes, valves and fittings   |
| AS 2221.1    | Methods for measurement of airborne sound emitted by compressor units including prime movers and by pneumatic tools and machines |
| AS 2345      | Dezincification resistance of copper alloys  |
| AS 2528      | Bolts, stud bolts and nuts for flanges and other high and low temperature applications   |
| AS 2549      | Cranes, hoists and winches - Glossary of terms   |
| AS 2700      | Colour standards for general purposes  |
| AS 3566      | Self-drilling screws for the building and construction industries  |
| AS 3600      | Concrete structures  |
| AS 3788      | Pressure equipment - In-service inspection   |
| AS 3879      | Solvent cements and priming fluids for PVC (PVC-U and PVC-M) and ABS and ASA pipes and fittings                                  |
| AS 3894      | Site testing of protective coatings  |
| AS 3972      | General purpose and blended cements  |
| AS 3990      | Mechanical equipment - Steelwork   |
| AS 4024      | Safety of machinery  |
| AS 4024.1501 | Safety of machinery: Design of safety related parts of control systems - General principles for design                           |
| AS 4041      | Pressure piping  |
| AS 4100      | Steel structures   |
| AS 4254.1    | Ductwork for air-handling systems in buildings: Flexible Duct  |
| AS 4254.2    | Ductwork for air-handling systems in buildings: Rigid Duct   |
| AS 4343      | Pressure equipment – Hazard levels   |
| AS 4794      | Non-return valves for waterworks purposes - Swing check and tilting disc   |
| AS 4795.1    | Butterfly valves for waterworks purposes Wafer and lugged  |
| AS 4795.2    | Butterfly valves for waterworks purposes Double flanged  |
| AS 4796      | Water supply - Metal-bodied and plastic-bodied ball valves for property service connection                                       |
| AS 4797      | Stainless steel chain for lifting purposes   |
| AS 4809      | Copper pipe and fittings - Installation and commissioning  |
| AS 4991      | Lifting devices  |
| AS 5216      | Design of post-installed and cast-in fastenings in concrete  |
| AS 5830.1    | In-line ball valves for use in plumbing water supply systems Metal bodied  |
| AS 5830.2    | In-line ball valves for use in plumbing water supply systems Plastics-bodied   |
| AS 60529     | Degrees of protection provided by enclosures (IP Code)   |

| Standard         | Title  |
|------------------|--|
| AS ISO 5801      | Fans - Performance testing using standardized airways (ISO 5801:2017, MOD)   |
| AS ISO 7.1       | Pipe threads where pressure-tight joints are made on the threads Dimensions, tolerances and designation                              |
| AS ISO 7.2       | Pipe threads where pressure-tight joints are made on the threads Verification by means of limit gauges                               |
| AS ISO 9906      | Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1, 2 and 3   |
| AS/NZS 1260      | PVC-U pipes and fittings for drain, waste and vent applications  |
| AS/NZS 1269      | Occupational Noise Management  |
| AS/NZS 1477      | PVC pipes and fittings for pressure applications   |
| AS/NZS 1554.6    | Structural steel welding Welding stainless steels for structural purposes  |
| AS/NZS 1567      | Copper and copper alloys - Wrought rods, bars and sections   |
| AS/NZS 1580.0    | Paints and related materials - Methods of test - Introduction and list of methods  |
| AS/NZS 1734      | Aluminium and aluminium alloys - Flat sheet, coiled sheet and plate  |
| AS/NZS 1866      | Aluminium and aluminium alloys - Extruded rod, bar, solid and hollow shapes  |
| AS/NZS 2032      | Installation of PVC pipe systems   |
| AS/NZS 2280      | Ductile iron pipes and fittings  |
| AS/NZS 2312.1    | Guide to the protection of structural steel against atmospheric corrosion by use of protective coatings Paint coatings               |
| AS/NZS 2312.2    | Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings Hot dip galvanizing      |
| AS/NZS 2566      | Buried flexible pipelines  |
| AS/NZS 2638      | Gate valves for waterworks purposes  |
| AS/NZS 2845.1    | Water supply - Backflow prevention devices Materials, design and performance requirements  |
| AS/NZS 2845.3    | Water supply - Backflow prevention devices Field testing and maintenance of testable devices   |
| AS/NZS 2885.1    | Pipelines - Gas and liquid petroleum Design and construction   |
| AS/NZS 3518      | Acrylonitrile butadine styrene (ABS) compounds, pipes and fittings for pressure applications   |
| AS/NZS 3678      | Structural steel - Hot-rolled plates, floorplates and slabs  |
| AS/NZS 3679.1    | Structural steel   |
| AS/NZS 3690      | Installation of ABS pipe systems   |
| AS/NZS 3750      | Paints for Steel Structures  |
| AS/NZS 4020      | Testing of products for use in contact with drinking water   |
| AS/NZS 4024.1601 | Safety of machinery: Guards - General requirements for the design and construction of fixed and movable guards (ISO 14120:2015, IDT) |
| AS/NZS 4024.1704 | Safety of machinery: Guards - Human body measurements - Anthropometric data  |
| AS/NZS 4087      | Metallic flanges for waterworks purposes   |
| AS/NZS 4129      | Fittings for polyethylene (PE) pipes for pressure applications   |
| AS/NZS 4130      | Polyethylene (PE) pipes for pressure applications  |



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| Standard                  | Title  |
|---------------------------|--|
| <b>AS/NZS 4131</b>        | Polyethylene (PE) compounds for pressure pipes and fittings  |
| <b>AS/NZS 4158</b>        | Thermal-bonded polymeric coatings on valves and fittings for water industry purposes   |
| <b>AS/NZS 4361.1</b>      | Guide to hazardous paint management  |
| <b>AS/NZS 4441</b>        | Oriented PVC (PVC-O) pipes for pressure applications   |
| <b>AS/NZS 4680</b>        | Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods  |
| <b>AS/NZS 4761</b>        | Competencies for working with electrical equipment for hazardous areas (EEHA)  |
| <b>AS/NZS 4765</b>        | Modified PVC (PVC-M) pipes for pressure applications   |
| <b>AS/NZS 4998</b>        | Bolted unrestrained mechanical couplings for waterworks purposes   |
| <b>AS/NZS 60079</b>       | Explosive atmospheres  |
| <b>AS/NZS IEC 60947.8</b> | Low-voltage switchgear and control gear: Control units for built-in thermal protection (PTC) for rotating electrical machines                          |
| <b>AS/NZS ISO 17672</b>   | Brazing - Filler metals  |
| <b>ASME B 16.9</b>        | Factory-Made Wrought Butt welding Fittings   |
| <b>ASME B36.10</b>        | Welded and Seamless Wrought Steel Pipe   |
| <b>ASME B36.19</b>        | Welded and Seamless Wrought Stainless Steel Pipe   |
| <b>ASME PTC10</b>         | Axial and Centrifugal Compressors  |
| <b>ASTM A 1010</b>        | Standard Specification for Higher-Strength Martensitic Stainless Steel Plate, Sheet, and Strip   |
| <b>ASTM A 126</b>         | Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings   |
| <b>ASTM A 240/A240M</b>   | Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications      |
| <b>ASTM A 276/A276M</b>   | Standard Specification for Stainless Steel Bars and Shapes   |
| <b>ASTM A 312/A312M</b>   | Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes  |
| <b>ASTM A 351/A351M</b>   | Standard Specification for Castings, Austenitic, for Pressure-Containing Parts   |
| <b>ASTM A 380/A380M</b>   | Standard Practice for Cleaning, Descaling, Pickling, and Passivation of Stainless Steel Parts, Equipment, and Systems                                  |
| <b>ASTM A 403/A403M</b>   | Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings  |
| <b>ASTM A 48/A48M</b>     | Standard Specification for Gray Iron Castings  |
| <b>ASTM A 53/A53M</b>     | Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless   |
| <b>ASTM A 532/A532M</b>   | Standard Specification for Abrasion-Resistant Cast Irons   |
| <b>ASTM A 536</b>         | Standard Specification for Ductile Iron Castings   |
| <b>ASTM A 554</b>         | Standard Specification for Welded Stainless Steel Mechanical Tubing  |
| <b>ASTM A182/A182M</b>    | Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |



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| Standard                | Title   |
|-------------------------|---|
| <b>ASTM A27/A27M</b>    | Standard Specification for Steel Castings, Carbon, for General Application  |
| <b>ASTM A29/A29M</b>    | Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought   |
| <b>ASTM B 209M</b>      | Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate  |
| <b>ASTM B 928/B928M</b> | Standard Specification for High Magnesium Aluminum-Alloy Products for Marine Service and Similar Environments   |
| <b>ASTM D 4285</b>      | Standard Practice for Indicating Oil or Water in Compressed Air   |
| <b>BS 1571-2</b>        | Specification for testing of positive displacement compressors and exhausters   |
| <b>BS 4235-1</b>        | Specification for metric keys and keyways – Parallel and Taper keys   |
| <b>BS 4235-2</b>        | Specification for metric keys and keyways - Woodruff keys and keyways   |
| <b>BS EN 13397</b>      | Industrial valves. Diaphragm valves made of metallic material   |
| <b>BS EN 1561</b>       | Founding. Grey cast irons   |
| <b>BS EN 1563</b>       | Founding. Spheroidal graphite cast irons  |
| <b>BS EN 1982</b>       | Specification for copper alloys. Ingots and castings  |
| <b>BS ISO 1217</b>      | Displacement compressors. Acceptance tests  |
| <b>DIN 1945-1</b>       | Displacement compressor; thermodynamic acceptance and performance test  |
| <b>DIN 976-1</b>        | Fasteners - stud bolts - Part 1: metric thread  |
| <b>DIN EN 1012-1</b>    | Compressors and vacuum pumps - Safety requirements - Part 1: Air compressors  |
| <b>EN 1092-1</b>        | Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 1: Steel flanges  |
| <b>EN 485-2</b>         | Aluminium and aluminium alloys - Sheet, strip and plate - Part 2: Mechanical properties   |
| <b>IFI-505</b>          | Metric Break Mandrel Blind Rivets   |
| <b>ISO 10816.7</b>      | Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 7: Rotodynamic pumps for industrial applications, including measurements on rotating shafts |
| <b>ISO 1217</b>         | Displacement compressors  |
| <b>ISO 14692</b>        | Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping   |
| <b>ISO 14847</b>        | Rotary positive displacement pumps — Technical requirements   |
| <b>ISO 16422-1</b>      | Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure — Part 1: General   |
| <b>ISO 16422-2</b>      | Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure – Part 2: Pipes   |
| <b>ISO 16422-5</b>      | Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure – Part 5: Fitness for purpose of the system                             |
| <b>ISO 20816-1</b>      | Mechanical vibration — Measurement and evaluation of machine vibration — Part 1: General guidelines   |
| <b>ISO 21940-11</b>     | Mechanical vibration — Rotor balancing — Part 11: Procedures and tolerances for rotors with rigid behaviour   |
| <b>ISO 281</b>          | Rolling bearings — Dynamic load ratings and rating life   |
| <b>ISO 2858</b>         | End-suction centrifugal pumps (rating 16 bar) — Designation, nominal duty point and dimensions  |



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| Standard   | Title  |
|------------|--|
| ISO 2892   | Austenitic cast irons — Classification — Technical Corrigendum 1   |
| ISO 3601-1 | Fluid power systems — O-rings — Part 1: Inside diameters, cross-sections, tolerances and designation codes |
| ISO 3601-2 | Fluid power systems — O-rings — Part 2: Housing dimensions for general applications                        |
| ISO 4014   | Fasteners — Hexagon head bolts — Product grades A and B  |
| ISO 4032   | Fasteners — Hexagon regular nuts (style 1)   |
| ISO 5389   | Turbocompressors   |
| ISO 8000   | Data Quality   |
| ISO 80000  | Quantities and Units   |
| ISO 9001   | Quality management systems — Requirements  |
| ISO 9328   | Steel flat products for pressure purposes  |
| SSPC-SP 1  | SSPC - The society for protective coatings Solvent cleaning  |
| SSPC-SP 10 | SSPC - The society for protective coatings Near-White Metal Blast Cleaning                                 |

[Pr11231](#) - Unitywater Technical Specification Reference Guide lists all technical specifications and technical notes as well as other relevant technical documents.

Unitywater Specifications directly referenced in this document are below:

Table 39: Unitywater Specifications

| Document No. | Title   |
|--------------|---|
| F9785        | Water Hygiene Field Guide (5C's)  |
| F10209       | Pump Flange Drilling Instruction  |
| F10678       | Accepted Electrical Equipment List  |
| F10975       | Preferred Equipment List for Wastewater Treatment Plants                  |
| F10996       | Deviation to Unitywater Technical Specification.                          |
| Pr8184       | Noise Management Procedure  |
| Pr8187       | Safety in Design Procedure  |
| Pr8843       | Specification for Drawing, Document and Equipment Tag Numbering           |
| Pr9032       | Procedure for Managing Water Quality During Mains Commissioning           |
| Pr9380       | Electrical Installations at Network Sites                                 |
| Pr9821       | Specification for Reservoir Design and Construction                       |
| Pr9835       | Electrical Installations at Treatment Plants                              |
| Pr9903       | Specification for Building and Structural Works                           |
| Pr10753      | Environmental Noise Management Procedure                                  |
| Pr10852      | Specification for Design and Construction of MHL Dosing Systems           |
| Pr10883      | Safety in Design Guidelines   |
| Pr10999      | Specification for Odour Control Unit Design and Construction (Network)    |
| Pr11053      | Specification for Chlorine Dosing Systems Design and Construction         |
| Pr11211      | Specification for Commissioning and Handover of Active and Passive Assets |
| SEQ Code     | SEQ Accepted Civil Infrastructure Products and Material List              |
| SEQ Code     | SEQ Accepted Mechanical Products and Material List                        |



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## Appendix B – Definitions and abbreviations

Definitions, acronyms and abbreviations, relating to this Specification are below:

Table 40: Definitions and abbreviations

| Term                            | Meaning   |
|---------------------------------|---|
| <b>Applicator</b>               | A painter skilled in surface preparation and coating application for mechanical equipment.  |
| <b>Construction</b>             | Any work necessary for the installation, testing and commissioning of a pipeline, maintenance hole or house drain. The term includes such operations as taking care of existing assets, clearing, excavation, erosion control, bedding, laying, jointing, backfilling, restoration, forming, concrete placing, vibrating and stripping, pressure testing and quality testing. |
| <b>Contractor / Constructor</b> | The organisation responsible for constructing and/or installing infrastructure for Unitywater, whether it be by third party under a contract to Unitywater or an in-house entity.   |
| <b>Designer</b>                 | The organisation responsible for designing infrastructure for Unitywater, whether it be by third party under a contract to Unitywater or an in-house entity.<br><br>A designer is a person who is undertaking professional engineering services as defined by the <i>Professional Engineers Act</i> (Qld).  |
| <b>Hazardous Area</b>           | As defined in AS60079, an area in which an explosive atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of (electrical) apparatus.  |
| <b>Manufacturer</b>             | The person, group or company that manufactures or produces goods and equipment.   |
| <b>Materials</b>                | Any raw or manufactured materials or goods. This includes all machinery, equipment and components.  |
| <b>Supplier</b>                 | A person, group or company that provides goods for the use in Unitywater infrastructure.  |
| <b>Unitywater</b>               | May be the Contract Superintendent or the Unitywater representative authorised to issue instructions to the Contractor(s).  |
| <b>Vendor</b>                   | The supplier (re-seller) or factory manufacturer of the valves (not always the same entity) – the information required of the vendor under this Technical Standard must be obtained from the supplier (re-seller) or factory manufacturer as “vendors” as required.   |

| Acronym     | Meaning   |
|-------------|---|
| <b>ABS</b>  | Acrylonitrile Butadiene Styrene   |
| <b>AGMA</b> | American Gear Manufacturers Association   |
| <b>AMPP</b> | Association for Materials Protection and Performance (American society which is used as the standard for coating inspection training) |
| <b>ANSI</b> | American National Standards Institute   |
| <b>AOP</b>  | Allowable Operating Pressure  |
| <b>AOR</b>  | Allowable Operating Range   |



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| Acronym       | Meaning  |
|---------------|--|
| APAS          | Australian Paint Approval Scheme                         |
| API           | American Petroleum Institute                             |
| AS            | Australian Standard                                      |
| ASME          | American Society of Mechanical Engineers                 |
| ASTM          | American Society for Testing and Materials               |
| AWWA          | American Water Works Association                         |
| BS            | British Standard   |
| BSPT          | British Standard Pipe Thread                             |
| CIP           | Coatings Inspector Program (accredited by AMPP)          |
| CR            | Continuous Rovings                                       |
| CSM           | Chopped Strand Mat                                       |
| dB(A) LAeq    | Decibels - A-weighted, equivalent continuous sound level |
| DFT           | Dry Film Thickness                                       |
| DICL          | Ductile Iron Cement Lined                                |
| DIN           | Deutsches Institut für Normung                           |
| DN            | Nominal Diameter (Number) (mm)                           |
| DOL           | Direct On Line   |
| EN            | European Norm  |
| EP Act or EPA | Environmental Protection Act                             |
| EPDM          | Ethylene Propylene Diene Monomer                         |
| EPP           | Environmental Protection Policy                          |
| ERW           | Electric Resistance Weld                                 |
| FOG           | Fats, Oils & Grease                                      |
| FRP           | Fibre-Reinforced Polymer                                 |
| FSD           | Full Scale Deflection                                    |
| GEM           | Brand - GEM Fire Service Pty Ltd                         |
| GR            | Grade  |
| GRP           | Glass Reinforced Plastic                                 |
| HDG           | Hot Dipped Galvanising                                   |
| HDPE          | High Density Polyethylene                                |
| HDT           | Heat Distortion Temperature                              |
| HMI           | Human Machine Interface                                  |
| HVAC          | Heating, Ventilation, and Air Conditioning               |
| ID            | Inside Diameter  |
| IP            | Ingress Protection                                       |
| IP            | Isophthalic Polyester                                    |
| IPAM          | Infrastructure Products and Materials List - SEQ Code    |



## Pr9693 - Specification for Mechanical Installations

| Acronym  | Meaning   |
|----------|---|
| ISO      | International Organisation for Standardisation  |
| LCP      | Local Control Panel   |
| MPa      | Megapascals   |
| PVC-M    | Modified Polyvinyl Chloride   |
| N        | Newtons   |
| NDT      | Non-Destructive Testing   |
| NPSHa    | Net Positive Suction Head available   |
| NPSHr    | Net Positive Suction Head required  |
| OD       | Outside Diameter  |
| P&ID     | Process and Instrumentation Diagram   |
| PE       | Polyethylene  |
| PLC      | Programmable Logic Controller   |
| PN       | Nominal Pressure  |
| POR      | Preferred Operating Range   |
| PP       | Polypropylene   |
| PS       | Product Specification (usually denoted as WSA PS & followed by the PS number)   |
| PSV      | Pressure safety valves  |
| PTFE     | Polytetrafluoroethylene   |
| PVC      | Polyvinyl Chloride  |
| QLD      | Queensland  |
| RAS      | Return Activated Sludge   |
| RPZ      | Reduced Pressure Zone   |
| SEQ      | South-East Queensland   |
| SEQ Code | SEQ Water Supply and Sewerage Design and Construction Code (SEQ WS & SD & C Code) including the following parts: <ul style="list-style-type: none"> <li>• SEQ water supply and sewerage design criteria</li> <li>• SEQ sewerage code (SEQ-WSA-02)</li> <li>• SEQ Water supply code (SEQ-WSA-03)</li> <li>• SEQ sewage pumping station code (SEQ-WSA-04)</li> <li>• SEQ vacuum sewerage Code (SEQ-WSA-06)</li> <li>• SEQ (low) pressure sewerage code (SEQ-WSA-07)</li> <li>• SEQ Asset Information Specification</li> <li>• Infrastructure products and Materials lists.</li> </ul> |
| SI       | International System of Units   |
| SMACNA   | Sheet Metal and Air Conditioning Contractors' National Association  |
| SOG      | Suction on Gland  |
| SS       | Stainless Steel   |
| SSPC     | Society for Protective Coatings   |



## Pr9693 - Specification for Mechanical Installations

| Acronym    | Meaning                                  |
|------------|--|
| TP         | Type                                     |
| TWAS       | Thickened Waste Activated Sludge         |
| UHMW       | Ultra-High Molecular Weight              |
| UHMWPE     | Ultra High Molecular Weight Polyethylene |
| PVC-U      | Unplasticised Polyvinyl Chloride         |
| VE         | Vinyl ester                              |
| VSD        | Variable Speed Drive                     |
| WAS        | Waste Activated Sludge                   |
| WHS        | Work, Health & Safety                    |
| WR         | Woven Rovings                            |
| WSA & WSAA | Water Services Association of Australia  |